



ENTECH
ENGINEERING, INC.

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

**GEOLOGIC HAZARD / LAND USE STUDY
AND PRELIMINARY
SUBSURFACE SOIL INVESTIGATION
STERLING RANCH
EL PASO COUNTY, COLORADO**

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Prepared for

Morley-Bentley Investments, LLC
15 N. Nevada Avenue
Colorado Springs, Colorado 80903

Attn: Virgil Sanchez

A roadway specific soils report is not available. 4 borings (10,, 16, 21. 27) from this report are generally aligned with the proposed roadways. Also attached to the end is the soils reports for the BGP bridge and SR Rd bridge crossings. Classic is preparing soils reports to support their upcoming east side preliminary plans which will further define soils as adequate for roadways. October 31, 2006
A soils analysis will be performed for pavement design as well.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

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

Matthew W. Muzzy, P. E.
#24263

KAH/MWM/mf

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Reviewed by:

Joseph C. Goode, Jr., P.E.
President



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1.0 SUMMARY

Project Location:

The project lies in portions of Sections 27, 28, 32, 33 and 34, Township 12 South, Range 65 West and a portion of the NW ¼ of Section 4, Township 13 South, Range 65 West of the 6th Principal Meridian. The site majority of the site is located east of Vollmer Road and north of Woodmen Road in El Paso County, Colorado. A portion of the property lies between Black Forest Road and Vollmer Road.

Project Description:

Total acreage involved in the project is approximately 1400 acres. Grading and development plans were not available at the time of this report.

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. Preliminary foundation recommendations are also included.

Land Use and Engineering Geology:

Specific grading or development plans are not available at this time; however, the site was found to be suitable for development. Geologic conditions will impose some constraints on development. These include areas of artificial fill, hydrocompaction and loose or potentially collapsible soils, unstable slopes, potentially unstable slopes, expansive soils, floodplain, areas of ponded water, seasonally shallow groundwater areas and potentially seasonally shallow groundwater areas. Shallow bedrock will also be encountered on much 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 portions of Sections 27, 28, 32, 33 and 34, Township 12 South, Range 65 West and a portion of the NW¼ of Section 4, Township 13 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The majority of the site is located east of Vollmer Road approximately one mile north of Woodmen Road. Approximately 40 acres is located between Black Forest Road and Vollmer Road. The location of the site is shown on the Vicinity Map, Figure 1.

The topography of the site is generally gently to moderately sloping to the south with some steep slopes along drainages in the extreme southwestern and central portions of the site. Sand Creek flows in a southerly direction through the central portion of the site and Cottonwood Creek flows in a southwesterly direction in the extreme southwestern portion of the site. No water was observed flowing in these creeks at the time of this investigation; however, areas of standing water were observed in portions of the drainages. Other minor drainages exist on the site. No water was observed flowing in any of the minor drainages at the time of this investigation. The area of the site is indicated on the USGS Map, Figure 2. Previous site uses have included sand and gravel quarrying, and grazing and pasture lands. Existing sand and gravel quarries are located in the extreme southwestern corner of the site and in the central portions of the site. The quarry in the central portion of the site was active at the time of this investigation. The site contains primarily low field grasses, weeds and with scattered deciduous trees and shrubs in the drainage areas. Site photographs, taken on September 6, 2006, are included in Appendix A. The approximate locations and directions of the photographs are indicated on the Geology Map, Figure 14.

Total acreage involved in the proposed development is approximately 1400 acres. Development and grading plans were not available at the time of this report.

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.
- Preliminary recommendations pertaining to foundations, floor slabs and concrete, and land use.

4.0 FIELD INVESTIGATION

Our field investigation consisted of the preparation of a geologic map of bedrock features and significant surficial deposits. The Soil Conservation Service (SCS) survey was reviewed to evaluate the site (Reference 1). Additionally A Geologic and Engineering Geologic Study prepared by Charles J. Robinson and Associates in 1977 for El Paso County Planning Department was reviewed to evaluate the site (Reference 2 through 4).

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, 45 test borings were drilled by Entech Engineering, Inc. as a part of the preliminary subsurface soil investigation for the site. The borings were drilled with a power driven continuous flight auger drill rig to 15 and 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 3 and on the Geology Map, Figure 14. 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 both FHA Swell Testing and Swell/Consolidation Testing. 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 performed by Entech Engineering, Inc. for Wolf Ranch which lies west of the site (References 5 and 6). Geologic Hazard Studies were also performed by Entech Engineering, Inc. for Highland Park which lies north and northwest of the site (References 7 and 8). 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 9). 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, alluvial, and eolian soils. The site's stratigraphy will be discussed in more detail in Section 5.4.

5.2 Soil Conservation Service

The Soil Conservation Service (Reference 1) has mapped five soil types on the site (Figure 4). In general, the soils range from sandy and gravelly loam to loamy sand. Soils are described as follows:

<u>Soil Type</u>	<u>Description</u>
8	<u>Blakeland loamy sand, 1-9% slopes:</u> Dark grayish brown loamy sand and grading to pale brown sand. Permeability is rapid. Erosion is moderate with soil blowing hazard severe. Good potential for urban development.
9	<u>Blakeland Complex, 1-9% slopes:</u> Dark grayish brown loamy sand underlain by brown to pale brown loamy sand. This complex includes 60% Blakeland Soils, 30% Fluvaquentic Haplaquolls and 10% other soils. Permeability is rapid. Erosion hazard is moderate. Blakeland Soil has good potential for home sites. Limitation to development on Fluvaquentic Haplaquolls includes the hazard of flooding.
19	<u>Columbine gravelly sandy loam 0-3% slopes:</u> Grayish brown gravelly, sandy loam with a gravelly loamy sand subsoil. Permeability is very rapid. Erosion hazard is slight to moderate. Limitations to development include hazard of flooding in some areas.
71	<u>Pring coarse sandy loam, 3-8% slopes:</u> Dark grayish brown to brown coarse sandy loam. Permeability is rapid. Erosion hazard is moderate. Good potential for home sites.
85	<u>Stapleton – Bernal sandy loams:</u> Grayish brown sandy loam with sandy clay loam subsoil. Permeability is moderate to rapid. Erosion hazard is moderate. Limitations to development include frost action potential, slope, and depth to bedrock

Complete descriptions of the soils are presented in Figures 5 through 9. The soils have generally been described to have moderate to very rapid permeabilities. Limitations to development are varied on the different soil types and include frost action potential, depth to bedrock, slope, and the hazard of flooding. 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 slight to moderate erosion hazards, depending on soil type.

5.3 Robinson Study

A study performed by Charles S. Robinson and Associates, Inc. in 1977 for El Paso County Planning Department was reviewed for soils and engineering factors for land use (References 2 through 4). The Robinson Study Geology Map showing the site is presented in Figure 10. Geologic Units described on this site include al: Alluvium, Qp: Piney Creek Alluvium, Qes: Eolian Sand, and Tkd: Colluvium Dawson Formation. The Piney Creek Alluvium on this site has been redesignated by the Colorado Geological Survey (Reference 10) since the Robinson Mapping. It is currently considered areas of Piney Creek Alluvium with Broadway Alluvium and Louviers Alluvium. A Summary of Geologic Units and Engineering Factors for Land use from the Robinson Study is presented in Table 2. The Broadway Alluvium (Qb) and Louviers Alluvium (Qlo) have been included in the table and the discussion.

The recent Alluvium (al) is mapped within the major drainage on-site such as Cottonwood Creek and Sand Creek. These materials are described as poor for foundation stability and are subject to periodic flooding and erosion. Excavation and compaction are described as easy except where boulders occur.

The Piney Creek Alluvium (Qp) has been mapped on much of the site. These materials are described as good to poor for foundation stability. Expansive clays or high groundwater may be encountered in some areas. Potential geologic hazards also include steep slopes along stream channels that may be unstable. Excavation and compaction is described as easy. The Piney Creek Alluvium is a source of sand and gravel.

The Broadway Alluvium (Qb) is described as good for foundation stability. Steep slopes at the edges of terraces may occur that are unstable. Excavation and compaction are described as easy. The addition of fines may be needed to achieve proper compaction. The Broadway Alluvium is considered a source of sand and gravel.

The Louviers Alluvium (Qlo) is described as generally excellent for foundation stability. Expansive clays may occur locally. Excavation is described as easy and compaction as moderately easy. The Louviers Alluvium is considered a source of sand and gravel.

The Eolian Sand deposits (Qes) have been mapped on portions of the site. These are wind-deposited materials. They are described as fair to good for foundation stability. They are subject to wind erosion and hydrocompaction. Excavation is described as easy. Vibrating equipment may be necessary to achieve proper compaction. The Eolian Sand deposits are a source of commercial sand.

The Colluvium Dawson Formation (Tkd) is mapped in the northern portions of the site. These materials are described as fair to excellent for foundation stability. Expansive clays and claystone may be encountered and steep slopes may occur that may be unstable. Excavation and compaction are described as moderately difficult to difficult.

The Engineering Geology Maps from the Robinson Study were also reviewed. The Robinson Study Engineering Geology Map showing the site is presented in Figure 11. The majority of the site is mapped as 2A: Stable alluvium, colluvium and bedrock on gentle to moderate slopes (5% to 12%). Northeastern portions of the site are mapped as 3B: Expansive and potentially expansive soil and bedrock on flat to moderate slopes (0% to 12%). The western portions of the site are mapped as 1A: Stable alluvium and colluvium on flat to gentle slopes (0% to 5%). Scattered areas of 2D occur: Eolian deposits generally on flat to gentle slopes of upland areas. The northwestern portions of the site are mapped as 2E: Low terraces and valleys of minor tributary streams. Some of the drainages are mapped as 7A: Physiographic floodplain where erosion and deposition presently occur and is subject to recurrent flooding.

5.4 Site Stratigraphy

The Colorado Springs Geologic Map showing the site is presented in Figure 12 (Reference 11). The CGS Falcon NW Quadrangle Geologic Map showing the site is presented in Figure 12 (Referenced 10). The Geology Map prepared for the site is presented in Figure 13. Seven mappable units were identified on this site, which are identified as follows:

- **Qaf Artificial Fill of Quaternary Age:** These are man-made fill deposits. Some of the fill is associated with earthen dam embankments on-site. Other areas are associated with the quarrying and stockpiling that has occurred on-site.
- **Qal Recent Alluvium of Quaternary Age:** These are recent stream deposits that have been deposited along the valley floors and in the drainages that exist on-site, and in the main channels of Cottonwood Creek and Sand Creek. These materials consist of silty to clayey sands and sandy clays. Some of these alluviums may contain highly organic soils.
- **Qp Piney Creek Alluvium of Quaternary Age:** This is a stream deposited material typically occurring as terrace deposits along the main drainage of Cottonwood Creek and Sand Creek. The Piney Creek typically consists of dark brown silty to clayey sands and sandy clays.
- **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. These 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.
- **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.
- **Qlo Louviers Alluvium of Quaternary Age:** These are alluvial terrace deposits which occur as yellowish brown silty to clayey sands with sandy clay lenses. Generally this deposit is well stratified and may contain lenses of clay, silt and gravel.
- **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. This soil layer varied from 1 to 11 feet in the test borings. 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 Reconnaissance Geologic Map of Colorado Springs and Vicinity, Colorado* by Scott and Wobus in 1973 (Figure 12), and the *Geologic Map of the Falcon NW Quadrangle* by Madole, 2003 (Figure 13, Reference 10). The Robinson Study prepared for El Paso County Planning Department in 1977 (Figure 10, Reference 2) and *The Geologic Map of the Colorado Springs-Castle Rock Area Front Range Urban Corridor, Colorado*, by Trimble and Machette, 1979 (Reference 12) were also used in mapping this site. The test borings from the subsurface investigation by Entech Engineering, Inc. were used in evaluating the site and are included in Appendix B of this report. A Summary of the Geologic Units mapped on this site by the Robinson Study is included in Table 2 (Reference 4).

5.5 Soil Conditions

Two soil and two rock types were encountered in the 45 borings drilled for the preliminary subsurface soil investigation: slightly silty to very clayey sand (Type 1); sandy to very sandy clay (Type 2); silty to clayey sandstone bedrock (Type 3); and sandy claystone bedrock (Type 4). 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 was classified as slightly silty to very clayey sand (SM, SW-SM, SC-SM, SM-SP). The Type I sand was encountered at the ground surface in every boring except B-34, where no Type I sand was encountered. The thickness of the Type I sand ranged from not present to more than 20 feet depending on bore hole location. SPT N-values in the Type I sand ranged from 3 to 46 blows per foot (bpf) indicating the Type 1 sand to be very loose to dense in terms of in-place compactness. The median SPT N-value measured in the Type I sand was 19 bpf,

suggesting an overall medium dense condition. Water content and grain size testing of Type I sand samples resulted in water contents ranging from approximately 1 to 14 percent with approximately 6 to 44 percent of the particle sizes being smaller than the No. 200 sieve. One FHA swell test completed on a very clayey sample of the Type I sand resulted in a low expansion potential.

Soil Type 2 was classified as sandy to very sandy clay (CL). The Type 2 sandy clay was encountered in 11 of the 45 borings and was typically observed beneath or interbedded with the Type 1 sand. Thickness of the sandy clay ranged from not present to approximately 8 feet, depending on bore hole location. SPT N-values in the sandy clay ranged from 13 to 29 bpf with a median SPT N-value of 20 bpf indicating the Type 2 sandy clay to be generally stiff in terms of in-place consistency. Water content and grain size testing of the sandy clay showed it to have water contents ranging from approximately 5 to 19 percent with approximately 51 to 64 percent of the particle sizes smaller than No. 200 sieve. Atterberg Limits testing of 3 samples of sandy clay resulted in liquid limits ranging from 27 to 40 percent and plastic indices ranging from 13 to 25 percent. Swell/Consolidation and FHA Swell testing of the Type 2 sandy clay showed swell strains as high as 1.8 percent and swell pressures ranging from 455 to 4179 psf which suggests the sandy clay exhibits low to very high expansion potential.

Sulfate solubility testing was performed on one sample of the sandy clay, with a result of 0.10 percent soluble sulfate by dry weight. The soluble sulfate concentration suggests negligible to moderate sulfate degradation potential to exposed concrete.

Soil Type 3 was classified as silty sandstone bedrock (SM, SM-SW, SC). The sandstone was encountered in 42 of the 45 borings at depths ranging from approximately 1 to more than 19 feet bgs. The sandstone surface typically exhibited SPT N-values greater than 50 bpf indicating very dense in-place compactness. FHA Swell Testing of the sandstone resulted in swelling pressures ranging from 360 to 1014 psf. Swell/Consolidation testing of the silty sandstone resulted in swelling strains as high as 1.0 percent. The swell testing indicates a typically low expansion potential for the sandstone.

Soil Type 4 was classified as sandy claystone bedrock (CL). The claystone was encountered in 16 of the 45 borings. SPT N-values measured in the claystone typically indicated hard consistencies. Swell/Consolidation testing of the claystone resulted in a swelling strains ranging

from 0.3 to 2.7 percent and swelling pressures ranging from 846 to 1845 psf, which are indicative of a low to moderately high expansion potential.

A summary of the laboratory testing results for each of the soil and rock types is presented in Table 1 and a presentation of the overall laboratory results is included in Appendix C. A summary of the depth to bedrock and depth to groundwater encountered in the borings is included in Table 3.

5.6 Groundwater

Groundwater was encountered in 18 of the 45 borings at depths ranging from 3.5 feet to 19 feet below the ground surface. Groundwater was not encountered within 15 to 20 feet of the ground surface in any of the other test borings during or subsequent to drilling. The depth to groundwater measured in the borings is presented in Table 3. 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 and/or potentially seasonal shallow groundwater have been identified on the site. Figure 20 shows the areas where shallow groundwater (i.e. less than approximately 10 feet below ground surface) is expected.

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 14). 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, hydrocompaction, collapsible or loose soils, unstable slopes, potentially unstable slopes, expansive soils, floodplains, seasonally shallow groundwater areas, potentially seasonal shallow groundwater areas and areas of ponded water. The following hazards will need to be addressed during development of the site:

Expansive Soils

Expansive soils were encountered in some of the test borings drilled on-site. 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 13); however, very highly expansive soils have been encountered in some of the test borings drilled on the site. 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 90% 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 20 feet or more and require penetration into the bedrock material a minimum of 4 to 6 feet, depending upon building loads. Another option is post tension slabs. 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 subdivision or building site.

Subsidence Area

Based on a review of a Subsidence Investigation Report for the Colorado Springs area by Dames and Moore, 1985 (Reference 14) and the mining report for the Colorado Springs coal field (Reference 15), 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 to moderately sloping and do not exhibit any past or potential unstable slopes or landslides. The steeply sloping areas along Cottonwood Creek have been identified as unstable slopes. Some of the steeper slopes along Sand

Creek have been identified as unstable and potentially unstable slopes. The mitigation recommendation for these areas is as follows:

Potentially Unstable Slopes

Some of the very steep slopes along the drainages 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: Building should be avoided in these areas. Proper control of drainage at both the surface and in the subsurface is extremely important. Areas of ponded water at the surface should be avoided above these slopes. Utility trenches, basement excavations and other subsurface features should not be permitted to become water traps which may promote saturation of the subsurface materials. A setback of 60 feet from the crest of these slopes is recommended.

Another option for mitigation is to stabilize the slopes. This may involve regrading the slope to no steeper than 3:1. Another option is the use of engineer-designed retaining walls. Where retaining walls are not used, erosion protection may be necessary to prevent undercutting by the creek during periods of high water.

Unstable Slopes: Some of the slopes along Cottonwood Creek and Sand Creek are mapped as unstable. In these areas, soil materials exist at slope angles too steep to support a load above the slope without failure to the slope. Erosion by the creek is also possible in some areas. Structures should be located a minimum of 60 feet away from the crest of the slopes, unless additional site-specific investigation and slope stability analysis is performed or the slopes are stabilized. Stabilization could involve regrading to a more stable slope angle, or the use of retaining walls, buttresses or tie backs. Should regrading be considered, slopes should be no steeper than 3:1. Erosion protection may also be required in some areas, particularly on the outside curves of the creek where active erosion takes place during periods of runoff.

Debris Fans

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

Groundwater and Floodplain Areas

Areas within the drainages on-site have been identified as areas of seasonally high groundwater areas, potentially seasonally high groundwater areas and floodplains. Additionally, areas where ponded water accumulates also exist on-site. The Cottonwood Creek and Sand Creek drainages have been mapped as floodplain zones according to the FEMA Map Nos. 08041CO5298F, and 08041CO5358F, Figure 14 (Reference 16). These areas are discussed as follows:

Floodplain: Construction is not anticipated within the main channel of the Cottonwood Creek and Sand Creek floodways. It is anticipated any proposed construction 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. Building areas within the floodplain will require filling to raise the building area above floodplain and seasonally shallow groundwater levels. Mitigation for Seasonally Shallow Groundwater levels discussed below is recommended for construction in the floodplain zone. Finished floor levels must be one foot above the floodplain level. Exact floodplain locations and drainage studies are beyond the scope of this report.

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. Areas of shallow groundwater may exhibit unstable subgrade conditions in terms of bearing support of construction equipment during overlot grading.

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 2.5 feet 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 16. Structures should not block drainages. Swales should be created to intercept surface runoff and carry it safely around and away from structures. It is anticipated that the site grading may mitigate the drainages in some areas. The water table may be of sufficient depth to minimize the effects on buildings in some areas.

Seasonal High Groundwater Area: In these areas, high subsurface moisture conditions, frost heave potential and highly organic soils may exist, particularly on a seasonal basis. Seasonal high groundwater areas may also present an unstable subgrade condition in terms of providing bearing support of construction equipment during overlot grading.

Mitigation: In areas where development is desired, overlot grading may mitigate some areas. All organic material, soft or wet soils should be removed prior to any filling. The same mitigation recommendations for potentially seasonal shallow groundwater areas as discussed previously should be followed in these areas of seasonal shallow groundwater. In some areas, it may be necessary to dewater the excavation. Underslab drains or interceptor drains may be used in addition to perimeter drains to prevent the intrusion of water into areas below grade. Typical Drain Details are presented in Figures 16 through 18. It may be desirable to build up the building areas to raise the foundation further above the groundwater level. Any grading should be done in a manner that directs surface flow around construction to avoid areas of ponded water. Structures should not block drainages, but swales should be created to intercept surface runoff and carry it safely around and away from structures. Additional investigation will be necessary to determine the water depth and its affect on development. Areas other than those mapped could encounter groundwater that may affect shallow foundations on-site.

Areas of ponded water: These are areas where water ponds behind earthen dams on-site. It is anticipated these areas could be avoided by development unless regraded. Should construction be considered in these areas, regrading will be necessary in order to fill the area above the groundwater level. All soft or organic soils should be removed prior to filling. The same mitigation techniques for seasonal shallow groundwater areas are also recommended for these potential pond areas.

Artificial Fill

Areas of artificial fill were observed in areas of the site. Some areas of artificial fill are associated with earthen dams that exist on-site. Other areas are associated with quarrying and stock piling that has occurred on-site.

Mitigation: Where uncontrolled fill is encountered beneath foundations, mitigation will be necessary. Mitigation typically involves removal and recompaction at a minimum of 90% of its maximum Modified Proctor Dry Density, ASTM D-1557.

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 movements upon saturation of these surficial soils. The low density, uniform grain sized, windblown sand deposits are particularly susceptible to this type of phenomenon. Other material types may also be susceptible.

Mitigation: The potential for settlement movement 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.

Loose or Collapsible Soils

Areas of loose and collapsible soils were encountered in some of the test borings drilled on-site. These areas are sporadic, therefore, none have been indicated on the map. Consolidations ranging from 0.1% to 2.3% were measured on some of the soil samples tested. Areas of loose densities were encountered in the soil profiles of some of the test borings. Areas with low soil density may present unstable conditions in terms of supporting construction equipment during overlot grading.

Mitigation: Should loose or collapsible soils be encountered beneath foundations, removal and recompaction of the upper 2 to 3 feet with thorough moisture conditioning will be necessary. Where fill is required, it will be necessary to remove the loose soils prior to placement of the fill. Specific recommendations should be made after additional investigation of each building site.

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 Residence 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 17) 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 9). The bedrock encountered in the test borings did not exhibit steeply dipping characteristics, therefore mitigation is not necessary.

Radioactivity

Radon levels for the area have been reported by the Colorado Geologic Survey in the Open-File, Report No. 91-4 (Reference 18). 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 19). 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 20). 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 21), 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 22), portions of the site are mapped as A3 – Alluvial fan deposits: sand, A4 – Alluvial fan deposit; probable aggregate resource, U3 – Upland deposits: sand, and V3: valley fill deposits: sand. According to the *Evaluation of Mineral and Mineral Fuel Potential* (Reference 23), 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. Thirteen out of 45 test borings have greater than 10 feet of sand or gravel materials overlying the bedrock materials.

According to the *Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands* (Reference 23), 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 23). 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

Site Conditions

The existing geologic and geotechnical conditions at the site will likely impose some constraints on the proposed development and construction. Avoidance or regrading can mitigate many hazards such as unstable slopes; low lying floodplain areas; areas of seasonal shallow

groundwater and potential seasonal shallow groundwater; and areas where ponded water can occur. Other constraints identified on the site such as hydrocompaction; loose or collapsible soils; expansive soils; artificial fill; and potential shallow groundwater can be mitigated through proper engineering design and construction. Geologic conditions and land use considerations for the site are presented in Table 2.

The majority of the soils at typical foundation depths consist of sands, clays, sandstone and claystone. Areas of shallow bedrock will be encountered on the site particularly in locations mapped as Tkd: Dawson Formation. Additionally, surficial deposits in many areas of the site have been removed in quarried areas where shallow bedrock will be encountered. A map of areas where shallow bedrock was encountered in the test borings is presented in Figure 19. Areas of shallow bedrock may be encountered during development other than those mapped. It is anticipated shallow bedrock will be encountered on most of this site. 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. Blasting may also be necessary where hard, cemented sandstone is encountered.

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 90 percent of the maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Other options include drilled piers or post tension slabs.

Areas of seasonal shallow groundwater may be encountered on the site. Seasonal high and potentially high groundwater areas may present localized unstable subgrade conditions with respect to supporting construction equipment during overlot grading. In shallow groundwater areas, drains may be necessary to control seepage within the foundation zone. Additional subsurface investigation is recommended when site grading and development plans are available to determine the depth to groundwater and its affects on construction. Site surface grading can eliminate some of the minor drainages/wet areas. Any soft or organic soils should

be removed prior to any fill or foundation construction. A map of High Groundwater Areas is presented in Figure 20.

The floodplain areas of the Cottonwood Creek and Sand Creek drainages exist on portions of the site. 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. Finished floor elevations must be a minimum of one foot above the floodplain level and drains may be necessary to help prevent the intrusion of water into areas below grade. Soft, potentially unstable soils were encountered in areas of the floodplain and will need mitigation in advance of building construction. Approval of a Drainage Plan will be necessary prior to construction in the floodplain zone. Specific floodplain location and drainage studies are beyond the scope of this report.

Areas of hydrocompaction were identified on the site where there is potential for soil settlement upon saturation. Good surface and subsurface drainage is critical in these areas to avoid accumulation of standing water and saturated conditions. The ground surface should be positively sloped away from structures at all points. Roof drains and gutter down spouts should be made to discharge well away from structures and planting and watering in the immediate vicinity of structures should be minimized.

Soft and/or collapsible soils were encountered in some of the test borings drilled on-site. These soils are sporadic; therefore, none have been indicated on the maps. All soft, collapsible, or wet soils should be mitigated prior to any construction or fill placement. Areas of soft, collapsible unstable or wet soils may present localized difficulties during overlot grading with respect to subgrade support for construction equipment.

Unstable slopes and potentially unstable slopes exist along Cottonwood Creek and Sand Creek. A minimum building setback of 60 feet is recommended from the crest of these slopes unless site-specific investigation or slope stability analysis is performed. Another option is to stabilize the slopes. Unstable and 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 slope retaining walls. Erosion protection may be necessary along these slopes to prevent further erosion.

Areas of erosion (gullies) were observed along some of the tributary drainages on the site. Regrading and establishing vegetation may mitigate the majority of erosion potential after site grading and construction. Where erosion is more severe or continues, the use of check dams or sediment traps in the drainage ways may be necessary. Erosion control has been discussed in Section 7.0 of this report.

Preliminary Foundation Recommendations

Forty-five borings were spaced and drilled over approximately 1400 acres to conduct preliminary characterization of the site. By in large the borings encountered 1 to 20 feet of silty sand and sandy clay overlying sandstone and claystone bedrock. Of the four soil and rock types encountered in the borings, the silty sand and sandstone were the more predominant. Laboratory and field-testing of the silty sand and sandstone indicated low to moderate expansion potential and typically medium dense in-place soil compactness. The expansive potential and density condition of the silty sand suggest that shallow foundations consisting of spread footings can likely be used to satisfactorily support typical 1 and 2-story residential structures. When utilizing shallow foundations, foundation walls and footings should extend a minimum of 30 inches below the finished exterior site grade for frost protection. Reinforcement for foundation walls should be designed such that the walls can span a minimum of 10 feet unsupported distance under the building design load.

The less predominant sandy clay and claystone encountered in the borings typically exhibited low to very high expansion potentials. Shallow foundations (i.e. spread footings) can be also used in these areas provided overexcavation of the expansive materials from beneath the footings and floor slabs is conducted to mitigate the potentially expansive behavior of the soil and bedrock.

Soil and rock excavated from beneath footings and floor slabs should be replaced with non-expansive, mineral soil compacted to at least 90 percent of its maximum dry density as determined by ASTM –D-1557. Based on the conditions encountered in the borings drilled at the site, it is anticipated that overexcavated materials from the site can be reused as foundation fill provided the material is thoroughly moisture conditioned to within 2 percent of its ASTM D-1557 optimum water content prior to compaction.

Additional subsurface investigation is recommended for each building area as development plans for the site are finalized in order to better understand the in-place geotechnical conditions and in particular understand the soil/rock expansion potential for a specific area. Maximum allowable soil bearing capacities for each building area and need for foundation drainage should be determined as part of the additional subsurface investigation.

In the event areas of expansive soil and/or bedrock are encountered on the site which consistently exhibit moderate to very high expansion potentials, foundations consisting of post-tensioned grade supported floor slabs or drilled piers can be considered to mitigate the expansive conditions. Post-tensioned slabs would be designed to undergo total and differential movements as a result of the underlying expansive materials without causing distress to the supported structure. Drilled piers would extend through the site soils and into the site bedrock to a depth expected to be unaffected by expansion. Pier lengths would be predicated on soil depth and the expansion potential of both the soil and bedrock. Pier construction dewatering could be necessary in areas where groundwater is encountered. Temporary casing of pier holes could also be necessary to stabilize the walls of the pier holes during drilling and concrete placement. Additional subsurface investigation would be necessary to determine pier lengths for specific building areas and subgrade moduli would need to be determined for use in the post-tensioned slab design.

Floor Slabs

Floor slabs founded on expansive clays or on loose sands should be expected to experience movement. Removal and replacement of expansive soils with nonexpansive soils and/or removal and recompaction of loose, non-expansive granular soils is recommended to minimize slab movement. Grade supported floor slabs should be separated from structural portions of buildings and be allowed to move freely should movement of the supporting subgrade occur. Interior building partitions should be constructed in a manner such that they do not transmit floor slab movements to the roof or overlying floors. Fill placed below floor slabs should be non-expansive and compacted to a minimum of 90 percent of its maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). In areas where only minimal slab movement can be tolerated, structurally supported floors should be considered.

Surface and Subsurface Drainage

Positive surface drainage must be maintained around all structures to minimize infiltration of surface water. A minimum ground surface slope of 5 percent in the first 10 feet adjacent to foundation walls for landscaped areas and 2 percent for paved areas is recommended. The use of drainage swales or interceptor drains may be necessary to direct runoff from the upslope side of structures. All roof drains and gutter downspouts should be extended to discharge well beyond the foundation backfill zone.

Subsurface perimeter drains positioned at footing grade are recommended for structures with useable space below the finished ground surface. If expansive soils are encountered in the foundation excavation, perimeter drains are recommended around the foundation. Depending on groundwater conditions, underslab or interceptor drains may also be necessary. Drains should consist of a perforated drainpipe, a gravel collection layer and approved filter fabric. All drains should be provided with a free flowing gravity outlet. If such an outlet is not available, a sump and pump water removal system will be necessary. Typical drain details are presented as Figures 16 through 19.

Backfill

Backfill placed around foundations and in utility trenches should be compacted to a minimum of 90 percent of the soil's maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Backfill material should be placed in horizontal lifts having compacted thicknesses of six inches or less and at water contents conducive to adequate compaction, usually ± 2 percent of the ASTM D-1557 optimum water content. Mechanical methods can be used for placement and compaction of backfill; however, use of heavy equipment near foundation walls should be avoided. No water flooding techniques of any type should be used for compaction of backfill on the site.

Trench backfilling should be performed in accordance with appropriate municipal and county earthwork standards and specifications. All excavating should be performed in accordance with OSHA guidelines.

Structural Fill

Any areas to receive fill should have all topsoil, organic material, or debris removed. Any previously placed uncontrolled fill should be recompacted prior to placing new fill. The fill receiving surface should be scarified and moisture conditioned to within 2 percent of its optimum water content and compacted to a minimum of 90 percent of its ASTM D-1557 maximum dry density prior to placing new fill. New fill should be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 90 percent of the maximum ASTM D-1557 dry density. Fill material should be free of vegetation or other unsuitable material and should not contain rocks or fragments greater than six (6) inches in size. Topsoil, strippings and/or other organic debris should not be mixed with the structural fill. Fill material should be placed at a water content conducive to compaction, usually ± 2 percent of the ASTM D-1557 optimum water content. Fill slopes should be constructed at angles no steeper than 3 horizontal to 1 vertical and be properly benched into existing soils to allow for complete and thorough compaction. The placement and compaction of fill should be observed and tested by a Soils Engineer during construction. Any import materials should be approved by a Soils Engineer prior to delivery to the site.

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. Development and Grading Plans should be reviewed prior to final approval.

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. Reporting such discrepancies to Entech Engineering, Inc. soon after they are discovered would be greatly appreciated and could possibly help avoid construction and development problems. Additional investigation is

recommended as development and grading plans are finalized. 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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TABLES

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556

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	4	2-5			10.0	NV	NP	<0.01			SM-SW	SAND, SLIGHTLY SILTY
1	9	5			22.4						SM	SAND, SILTY
1	12	5			8.6						SM-SW	SAND, SLIGHTLY SILTY
1	17	2-3			11.7						SM-SP	SAND, SLIGHTLY SILTY
1	19	5			15.9						SM	SAND, SILTY
1	20	10			10.7						SM-SW	SAND, SLIGHTLY SILTY
1	25	2-5			8.4						SM-SW	SAND, SLIGHTLY SILTY
1	26	5			17.3						SM	SAND, SILTY
1	41	5			44.1	23	7		574		SC-SM	SAND, VERY CLAYEY-SILTY
1	42	2-3			7.4						SM-SW	SAND, SLIGHTLY SILTY
1	44	5-10			5.7						SM-SW	SAND, SLIGHTLY SILTY
2	7	5	5.6	98.0		29	13			-2.3	CL	CLAY, SANDY
2	13	2-3			54.6				455		CL	CLAY, VERY SANDY
2	21	7						0.10	4179		CL	CLAY, SANDY
2	23	7							1085		CL	CLAY, SANDY
2	27	9							2300		CL	CLAY, SANDY
2	31	5	27.9	95.4	64.2	40	25			1.8	CL	CLAY, SANDY
2	34	2-5			51.5	27	13				CL	CLAY, VERY SANDY
3	5	15	10.4	118.6		24	11			-0.1	SC	SANDSTONE, CLAYEY
3	6	15-20			14.8			0.01			SM	SANDSTONE, SILTY
3	11	10			17.1						SM	SANDSTONE, SILTY
3	13	10			36.0						SM	SANDSTONE, SILTY
3	14	5			20.4						SM	SANDSTONE, SILTY
3	18	15							456		SM	SANDSTONE, SILTY
3	22	5	23.3	100.7	21.1	NV	NP			0.0	SM	SANDSTONE, SILTY
3	28	5-10			17.8						SM	SANDSTONE, SILTY
3	29	7							485		SC	SANDSTONE, CLAYEY
3	30	10			9.1						SM-SW	SANDSTONE, SLIGHTLY SILTY
3	33	5			14.4						SM	SANDSTONE, SILTY
3	35	15			11.1						SM-SW	SANDSTONE, SLIGHTLY SILTY
3	36	2-5			18.7				1014		SC	SANDSTONE, CLAYEY

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
3	38	5			13.3						SM	SANDSTONE, SILTY
3	39	15	11.0	124.3	42.8	33	16			1.0	SC	SANDSTONE, VERY CLAYEY
3	40	2.3							360		SM-SC	SANDSTONE, SILTY, CLAYEY
4	1	5	13.4	117.8	68.1					0.9	CL	CLAYSTONE, SANDY
4	3	7			55.3	32	18		846		CL	CLAYSTONE, VERY SANDY
4	24	2.3							1757		CL	WEATHERED CLAYSTONE, SANDY
4	25	10							1845		CL	CLAYSTONE, SANDY
4	33	15	24.3	100.7	73.0	51	28			2.7	CH	CLAYSTONE, SANDY
4	40	15	14.8	117.6	71.5	38	16	0.00		1.0	CL	CLAYSTONE, SANDY
4	43	20	12.6	121.0						0.3	CL	CLAYSTONE, SANDY

Table 2: Summary of Geologic Units

MAP SYMBOL	MAP UNIT DESCRIPTION & PHYSICAL CHARACTERISTICS	WORKABILITY	SURFACE DRAINAGE, ERODIBILITY & GROUNDWATER	SUITABILITY FOR WASTE DISPOSAL	FOUNDATION STABILITY	POTENTIAL GEOLOGIC HAZARDS	KNOWN, REPORTED & POSSIBLE GEOLOGIC RESOURCES
al	ALLUVIUM: Silt, sand, gravel and boulders in the bed of streams, on valley floors and in the lowest terraces along streams.	Excavation and compaction easy except where bouldery.	Infiltration: Medium to high. Runoff: Moderate. Subject to stream scour and stream bank erosion. Water table may be permanently or seasonally within a few feet of the surface.	Septic Systems: Unsatisfactory, generally within or adjacent to waterway and in area of seasonal high ground water. Dump sites: Unsatisfactory because of high ground water or seasonal flooding.	Poor, loose and erodible materials.	Deposits are subject to annual or periodic flooding. Low terrace banks may be undercut by stream erosion.	Source of sand and gravel.
Qp	PINEY CREEK ALLUVIUM: Organic rich clayey silt and sand with gravel, cobbles and boulders in terraces along most of the present streams. Locally alluvium, derived from expansive bedrock will have a low to high potential for swelling. Top of terraces is about 20 feet above stream level.	Excavation and compaction easy.	Infiltration: Medium to low. Runoff: Moderate to rapid. Locally water may stand in flat areas for several days following heavy precipitation. Moderately resistant to erosion. Water table may be permanently or seasonally within a few feet of the surface. Yield to wells range 1 to 100 gallons per minute. Along Fountain Creek south of Colorado Springs yield in excess of 1000 gallons per minute.	Septic Systems: Excellent to poor. In some areas ground water table may be too high.	Good to poor. May have expansive clay or high ground water in some areas.	Locally expansive soils; low areas may be subject to flooding. Steep slopes along stream channels may be unstable or undercut by stream erosion.	Source of sand and gravel.
Qb	BROADWAY ALLUVIUM: Gravelly sand and silt with cobbles and boulders in terraces west of fountain and Monument Creeks, and coarse sand in terraces along streams joining from the east. Tops of terraces about 40 feet above major streams.	Excavation: Easy. Compaction: Easy where sufficient fines are available.	Infiltration: High. Runoff: Low. High to moderate resistance to erosion. Yield to wells range from 10 to 100 gallons per minute.	Septic System: Generally satisfactory if sufficient fines are available to provide adequate percolation rates. Dump Sites: Generally unsatisfactory because of high infiltration rates.	Good.	Steep slopes at edges of terraces may be unstable.	Source of sand and gravel.

Table 2: Summary of Geologic Units (Continued)

MAP SYMBOL	MAP UNIT, DESCRIPTION & PHYSICAL CHARACTERISTICS	WORKABILITY	SURFACE DRAINAGE, ERODIBILITY & GROUNDWATER	SUITABILITY FOR WASTE DISPOSAL	FOUNDATION STABILITY	POTENTIAL GEOLOGIC HAZARDS	KNOWN, REPORTED & POSSIBLE GEOLOGIC RESOURCES
Qlo	LOUVIERS ALLUVIUM: Gravelly sand and silt with cobbles and boulders in terraces along Fountain and Monument Creek; coarse sand along tributaries from east. Locally may have clays with a low to high potential for swelling. Occurs as the major terrace at the confluence of Fountain and Monument Creeks. Top of terraces is about 70 feet above major streams.	Excavation: Easy Compaction: Moderately easy.	Infiltration: High except where clayey. Runoff: Low. Moderately to highly resistant to erosion. Yield to wells ranges from 10 to 100 gallons per minutes.	Septic Systems: Fair to poor dependent on adequate percolation rates. Dump Site: Unsatisfactory because of high infiltration rates.	Generally excellent. May have expansive clays locally.	Locally may have expansive clays.	Source of sand and gravel.
Qes	EOLIAN SAND (wind-deposited sand): Coarse to fine-grained sand. Occurs adjacent to streams and on upland ridges east of Monument and Fountain Creeks. Forms rolling upland surface in southeastern Colorado Springs and in Peterson Field area. Extensive deposits occur north and east of Falcon.	Excavation: Easy. Compaction: Vibratory equipment may be necessary for proper compaction.	Infiltration: Medium to high. Runoff: Low. Erodible by wind if vegetation is removed.	Septic Systems: Poor to fair depending on percolation rate. Dump Site: Unsatisfactory because of high infiltration rates.	Fair to good. May be subject to compaction.	Susceptible to wind erosion if vegetation is removed. May be subject to hydrocompaction. Walls of trenches may collapse if unsupported.	Source of commercial sand.

Table 2: Summary of Geologic Units (Continued)

MAP SYMBOL	MAP UNIT, DESCRIPTION & PHYSICAL CHARACTERISTICS	WORKABILITY	SURFACE DRAINAGE, ERODIBILITY & GROUNDWATER	SUITABILITY FOR WASTE DISPOSAL	FOUNDATION STABILITY	POTENTIAL GEOLOGIC HAZARDS	KNOWN, REPORTED & POSSIBLE GEOLOGIC RESOURCES
Tkd	<p>COLLUVIUM DAWSON FORMATION (upper part) (includes areas of bedrock): Coarse-grained and pebbly arkosic sand, clay and silty derived from arkosic sandstone, claystone and shale. Claystone and shale may be expansive. Lowest unit of sandstone forms cliffs at Austin Bluffs, Pulpit Rock and Palmer Park.</p>	Excavation and compaction moderately difficult to difficult in cliff forming units.	<p>Infiltration: Medium to high.</p> <p>Runoff: Low to high in clays and shales.</p> <p>Highly erodible by gullying and slope wash. Yield to wells ranges from 4 to 500 gallons per minute.</p>	<p>Septic Systems: Excellent to poor, depending on percolation.</p> <p>Dump Sites: Unsuitable because of potential of polluting major ground water aquifers.</p>	Fair to excellent. Clay and claystone may be expansive.	Expansive clay. Talus deposits form at base of cliffs and steep slopes may be unstable.	Locally may contain seams of lignite.

Table 3: Summary of Depth to Groundwater and Bedrock

Test Boring No.	Depth of Bedrock (ft.)	Depth to Groundwater (ft.)	Upper Soil Type	Geologic Unit
1	2	6	SM/CL	Qes/Tkd
2	4	11	SM/CL	Qb
3	7	>15	SM	Qb
4	6	>15	SM-SW	Qes
5	11	8.5	SM	Qlo
6	14	>20	SM	Qlo
7	14	>20	SM/CL	Qlo
8	14	>20	SM-SW	Qlo
9	19	>20	SM	Qlo
10	9	9	SW-SW	Qlo
11	9	14	SM-SW	Qlo/Qes
12	14	13.5	SM-SW	Qb
13	8	>15	CL/SC	Qb
14	4	>15	SM-SW	Qb
15	4	>15	SM	Qb
16	15	>20	SM	Qlo
17	>20	>20	SM-SP	Qes
18	8	7.5	SM	Qlo
19	7	>15	SM	Tkd
20	16	>20	SM	Qlo
21	8	10	SM	Qlo
22	4	3.5	SC	Qb
23	8	>15	SC	Qb
24	2	>15	SM/CL	Tkd
25	9	>15	SM-SW	Tkd
26	14	19	SM	Qlo
27	10	>15	SM	Qlo
28	2	>15	SM	Tkd
29	2	>15	SM	Tkd
30	6	11	SM/CL	Tkd
31	7	8	SM/CL	Tkd
32	11	11	SM/CL	Tkd
33	4	>15	SM	Qlo
34	8	6	CL	Qal/Tkd
35	3	>15	SM	Tkd
36	1	>15	SC	Tkd
37	2	>15	SM	Tkd
38	2	>15	SM	Tkd
39	3	>15	SM	Tkd
40	2	8	SM-SC	Tkd
41	6	9	SM/SC/CL	Qb
42	6	12	SM-SW	Qlo
43	16	>20	SM-SW	Qlo
44	18	11	SM-SW	Qlo
45	14	12.5	SM	Qes

FIGURES

REVISION		BY



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 V1e.



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Drawn

Date

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Date

Job No.

82556

Fig. No.

5

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.



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Drawn	Date	Checked	Date
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JOB NO.

82556

FIG. NO.

6

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, side-oats 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 low, 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.



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Drawn	Date	Checked	Date

Job No.

82556

Fig. No.

7

71—*Pring coarse sandy loam, 2 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, 2 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.



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SCS SOIL DESCRIPTION

Drawn	Date	Checked	Date
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Job No.

82556

Fig. No.

8

35—Stapleton-Bernal sandy loams. 3 to 20 percent slopes. These gently sloping to moderately steep soils are on upland ridges and hills. Elevation ranges from about 6,500 to 6,800 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.

The Stapleton soil makes up about 40 percent of the complex, the Bernal soil about 30 percent, and included soils about 30 percent.

Included with these soils in mapping are areas of Blakeland loamy sand, 1 to 9 percent slopes; Louviers silty clay loam, 3 to 18 percent slopes; Travessilla-Rock outcrop complex, 8 to 90 percent slopes; Truckton sandy loam, 3 to 9 percent slopes; and small outcrops of arkose sandstone and shale.

The Stapleton soil is commonly on the lower part of slopes. It is deep and well drained. It formed in sandy alluvium derived from arkosic bedrock. Typically, the surface layer is grayish brown sandy loam about 11 inches thick. The subsoil is grayish brown gravelly sandy loam about 6 inches thick. The substratum extends to a depth of 60 inches or more. It is pale brown gravelly sandy loam in the upper part and grades to gravelly loamy sand in the lower part.

Permeability of the Stapleton 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.

The Bernal soil is commonly on ridges and hills. It is shallow and well drained. It formed in material weathered from sandstone and modified by eolian sediment. Typically, the surface layer is dark grayish brown sandy loam about 4 inches thick. The subsoil is brown sandy clay loam about 7 inches thick. The substratum is brown sandy loam about 2 inches thick. Hard, light colored sandstone is at a depth of about 13 inches.

Permeability of the Bernal soil is moderate. Effective rooting depth is 8 to 20 inches. Available water capacity is low. Surface runoff is medium, and the hazard of erosion is moderate.

The soils in this complex are used for grazing livestock, for wildlife habitat, and as homesites.

The native vegetation on the Stapleton soil is mainly western wheatgrass, side-oats grama, needleandthread, and little bluestem. The dominant shrub on this soil is true mountainmahogany. Yucca is present in some places.

The native vegetation on the Bernal soil is mainly blue grama, side-oats grama, western wheatgrass, Scribner needlegrass, and needleandthread. The dominant shrubs and trees are mountainmahogany, skunkbush sumac, and one-seeded juniper. There are lesser amounts of pinyon pine.

Deferred grazing late in summer and early in fall improves the condition of the range on the Stapleton soil. Careful management of plant cover is essential because of the difficulty of vegetating the Bernal soil. Properly locating livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings generally are suited to the Stapleton soil. Soil blowing is the main limitation for 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.

Windbreaks and environmental plantings generally are not suited to the Bernal soil. Onsite investigation is needed to determine if plantings are feasible.

Rangeland wildlife, such as antelope, cottontail, coyote, and scaled quail, is best adapted for life on the soils in this complex. Proper livestock grazing management is necessary if wildlife and livestock share the range. Livestock watering developments are also important, and they are used by various wildlife species.

The main limitations of the Stapleton soil for urban use are frost-action potential and slope. The main limitations of the Bernal soil are depth to bedrock, frost-action potential, and slope. Special designs for sites, buildings, and roads and streets are needed to control soil blowing and water erosion on construction sites where vegetation has been removed. Capability subclass VIe.



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Date

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Date

Job No.

82556

Fig. No.

9

REVISION	BY

DATE	8/15/06
SCALE	AS SHOWN
JOB NO.	82556
POLICE No.	10

F O R E S T

22

21

20

19

TKd

TKd

SITE

Qp

Qs

Qp

Qes

USGS COLORADO SPRINGS GEOLOGY MAP
STERLING RANCH
EL PASO COUNTY, CO.
FOR: MORLEY-BENTLEY INVESTMENTS, LLC

JOB NO.:
82556

FIG NO.:

12



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

DRAWN:
M. WELLS

DATE:
8/15/06

CHECKED:

DATE:

147/49

P GEO

1) dwg.

SA RPT

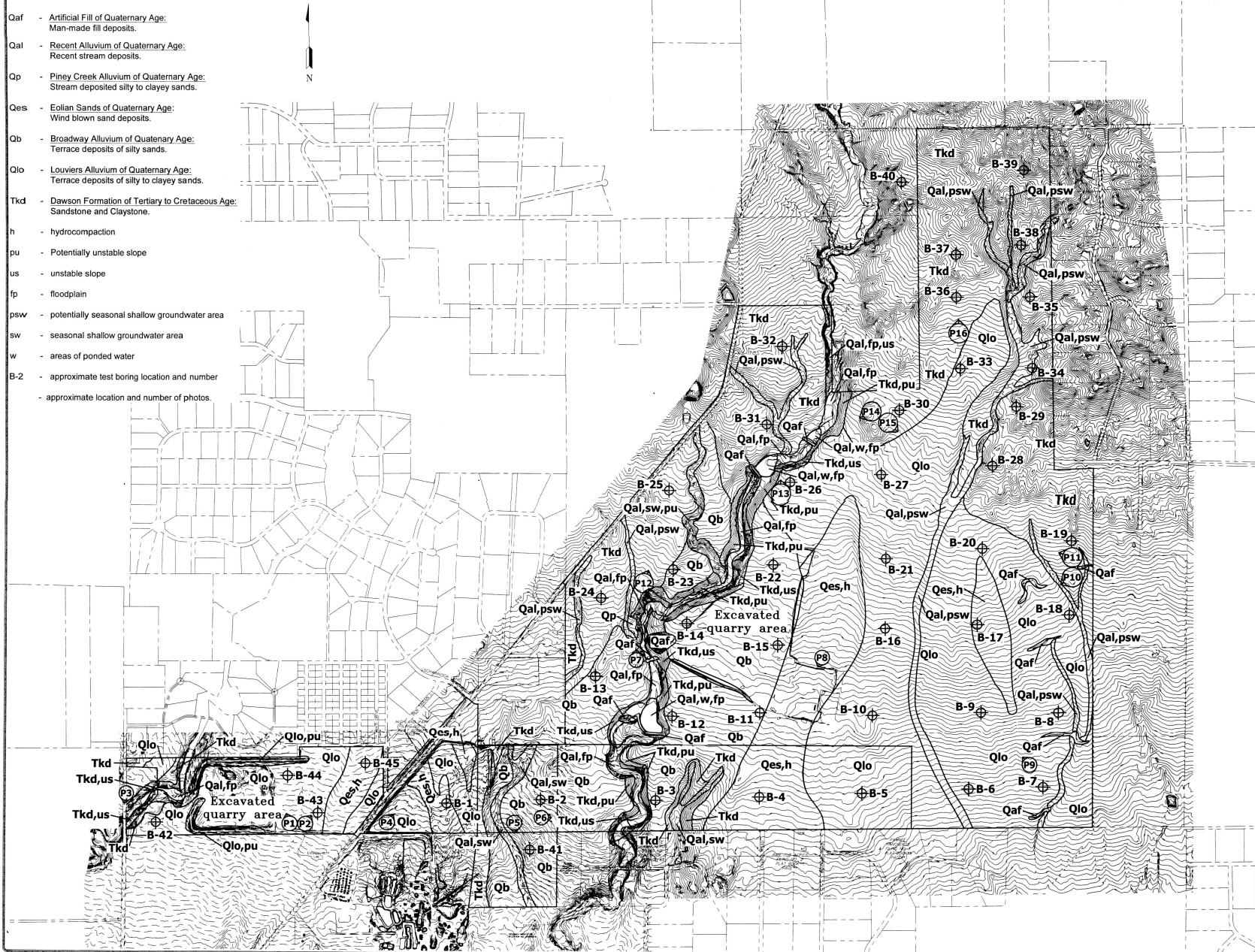
ERLWK

EPRT

M

LEGEND

- Qaf - Artificial Fill of Quaternary Age:
Man-made fill deposits.
- Qal - Recent Alluvium of Quaternary Age:
Recent stream deposits.
- Qp - Piney Creek Alluvium of Quaternary Age:
Stream deposited silty to clayey sands.
- Qes - Eolian Sands of Quaternary Age:
Wind blown sand deposits.
- Qb - Broadway Alluvium of Quaternary Age:
Terrace deposits of silty sands.
- Qlo - Louviers Alluvium of Quaternary Age:
Terrace deposits of silty to clayey sands.
- Tkd - Dawson Formation of Tertiary to Cretaceous Age:
Sandstone and Claystone.
- h - hydrocompaction
- pu - Potentially unstable slope
- us - unstable slope
- fp - floodplain
- psw - potentially seasonal shallow groundwater area
- sw - seasonal shallow groundwater area
- w - areas of ponded water
- B-2 - approximate test boring location and number
- approximate location and number of photos.



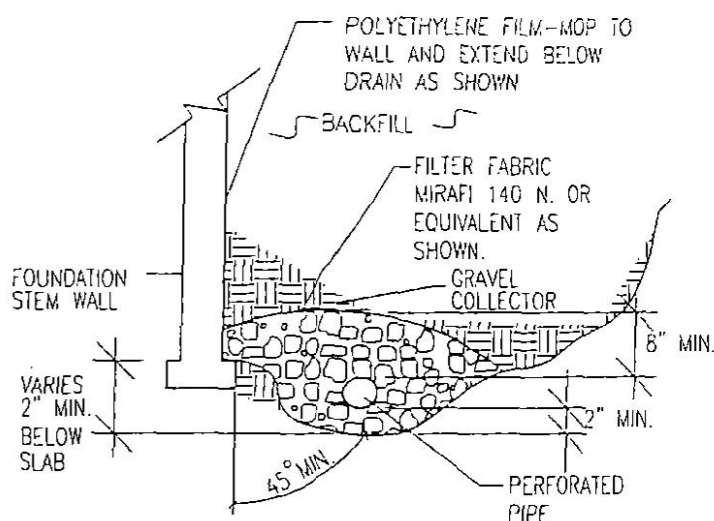
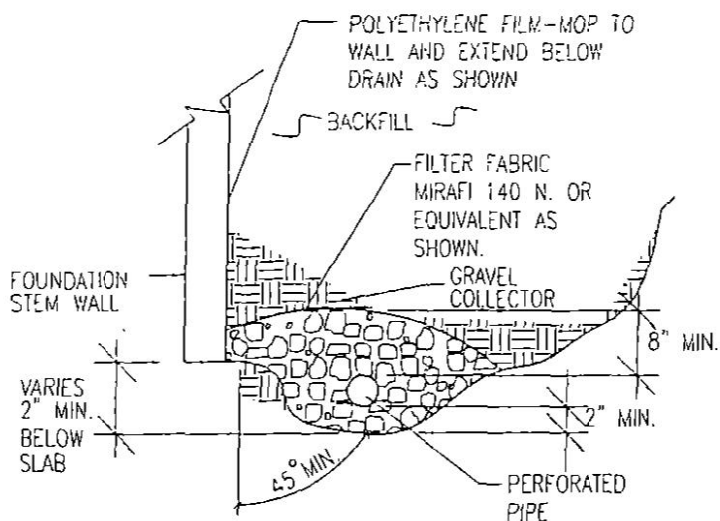
REVISION	BY:

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



GEOLOGY / ENGINEERING GEOLOGY MAP
STERLING RANCH
EL PASO COUNTY, CO.
FOR: MORLEY-BENTLEY INVESTMENTS

DRAWN BY: J. WICKHAM
DESIGNED BY: KAN
CHECKED BY:
DATE: 2/25/2008
SCALE: 1"=500'
JOB NO.: B2556
FIGURE NO.: 14



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

PERIMETER DRAIN DETAIL

DRAWN:
R.J. OLSON

DATE:

DESIGNED:

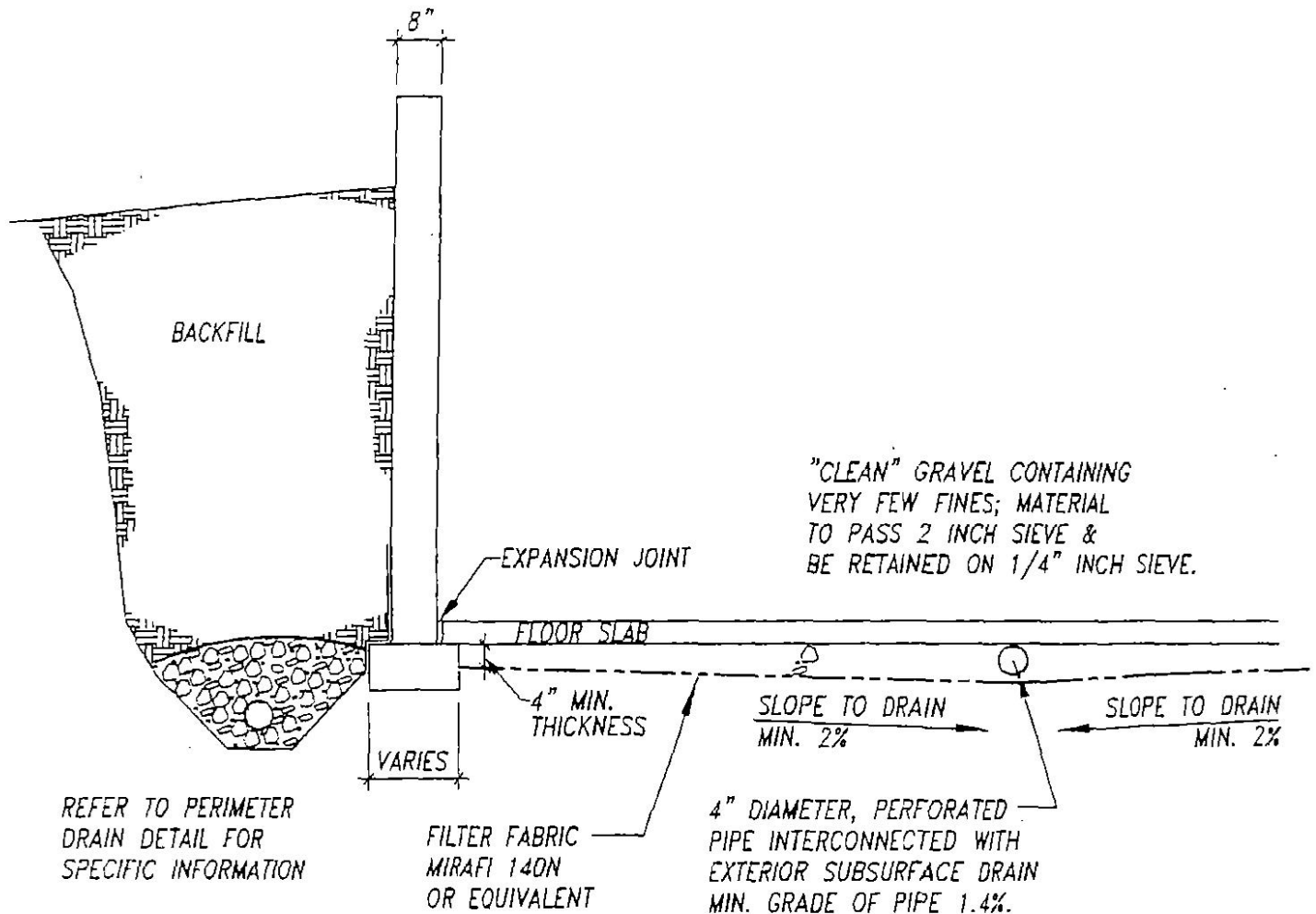
CHECKED:

JOB NO.:

82556

FIG NO.:

16



TYP. UNDERSLAB DRAINAGE
LAYER (CAPILLARY BREAK)

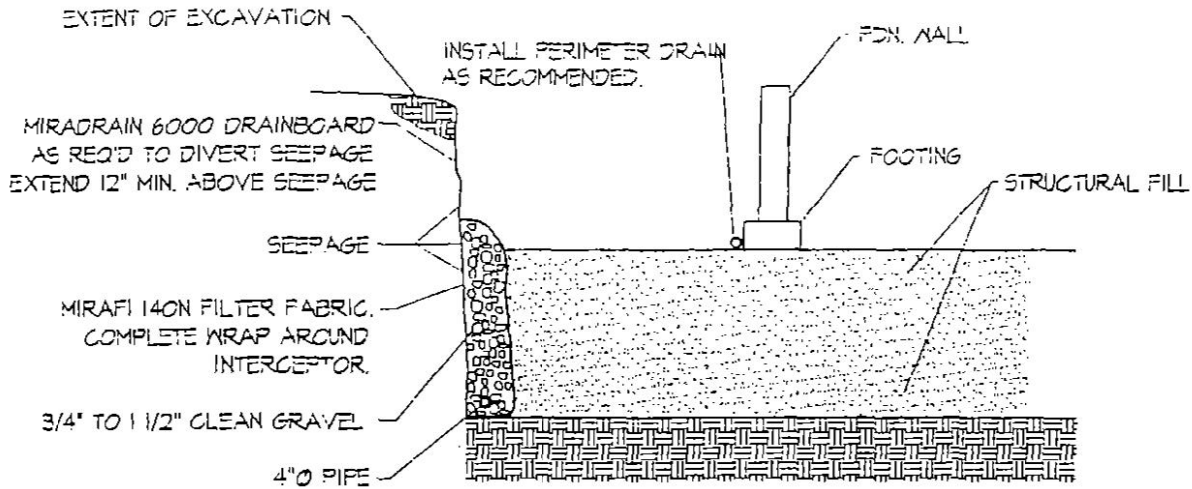


ENTECH
ENGINEERING, INC.

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

REVISION	BY

DESIGN	C. WALTON
CHECKED	
DATE	
SCALE	MTS
REV NO.	E22556
SHEET	17



NOTE:
EXTEND INTERCEPTOR DRAIN TO DAYLIGHT

INTERCEPTOR DRAIN DETAIL

N.T.S.

INTERCEPTOR DRAIN DETAIL



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

REVISION	BY

DATE	8/25/00
BY	NTS
OF	16
SHEET	16

APPENDIX A: Site Photographs

APPENDIX B: Test Boring Logs

TEST BORING NO. 1
 DATE DRILLED 8/23/2006
 Job # 82556

TEST BORING NO. 2
 DATE DRILLED 8/23/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 6', 8/25/06						
SAND, SILTY, TAN						1
						4
CLAYSTONE, SANDY, GRAY	5			50	12.1	4
BROWN, HARD, MOIST				50	11.2	4
				6"		
	10			50	13.1	4
				7"		
	15			50	9.8	4
				5"		
	20					

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 11', 8/25/06						
SAND, SILTY, FINE TO COARSE						
GRAINED, DARK BROWN TO						
BROWN, MEDIUM DENSE,				12	2.0	1
MOIST						
WEATHERED CLAYSTONE,	5			30	13.3	4
SANDY, GRAY, VERY STIFF,						
MOIST						
	10			50	11.1	3
				6"		
	15			50	18.9	3
				5"		
	20					



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

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

KAM

9/5/06

JOB NO.:
 82556

FIG NO.:

B-1

TEST BORING NO. 3
 DATE DRILLED 8/4/2006
 Job # 82556

TEST BORING NO. 4
 DATE DRILLED 8/4/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/7/06						
SAND, SILTY, GRAVELLY, FINE TO COARSE GRAINED, DARK BROWN TO RED BROWN, MEDIUM DENSE, MOIST	5			17	5.6	1
				29	8.3	1
CLAYSTONE, VERY SANDY, BROWN, MOIST			*		12.7	4
SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, LIGHT BROWN, VERY DENSE, MOIST	10			50 6"	10.5	3
	15			50 4"	9.4	3
	20					

* - BULK SAMPLE TAKEN

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/4/06 CAVED TO 14.5', 8/7/06, DRY						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, DARK BROWN TO TAN, MEDIUM DENSE TO DENSE, MOIST	5			11	1.9	1
				37	6.2	1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, LIGHT GRAY, VERY DENSE, MOIST	10			50 5"	8.0	3
	15			50 4"	6.2	3
	20					



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

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

Kass

9/15/06

JOB NO.:

82556

FIG NO.:

B-2

TEST BORING NO. 5
 DATE DRILLED 8/4/2006
 Job # 82556

TEST BORING NO. 6
 DATE DRILLED 8/4/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS

WATER @ 8.5', 8/7/06

SAND, GRAVELLY, SILTY, FINE
 TO COARSE GRAINED, DARK
 BROWN TO TAN, LOOSE TO
 MEDIUM DENSE, MOIST TO DRY

CLAY, SILTY, LIGHT GRAY,
 STIFF, MOIST

SANDSTONE, CLAYEY, FINE
 TO COARSE GRAINED, LIGHT
 GRAY, VERY DENSE, MOIST



Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			8	3.9	1
			17	1.8	1
10			15	12.2	2
15			50 5"	9.4	3
20			50 3"	9.0	3

REMARKS

DRY TO 20', 8/4/06
 CAVED TO 19.5',
 8/7/06, DRY

SAND, SILTY, GRAVELLY, FINE
 TO COARSE GRAINED, DARK
 BROWN TO TAN, LOOSE TO
 DENSE, DRY TO MOIST

SANDSTONE, SILTY, FINE TO
 COARSE GRAINED, LIGHT
 GRAY, VERY DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			9	1.4	1
			9	4.2	1
10			30	6.7	1
15			50 10"	7.9	3
20			50 4"	9.3	3



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JOB NO.:

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FIG NO.:

B-3

TEST BORING NO. 7
 DATE DRILLED 8/4/2006
 Job # 82556

TEST BORING NO. 8
 DATE DRILLED 8/9/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 20', 8/7/06							DRY TO 20', 8/9/06 CAVED TO 19.5', 8/10/06, DRY						
SAND, SILTY, FINE TO COARSE GRAINED, DARK BROWN TO BROWN, MEDIUM DENSE, DRY CLAY, SANDY, BROWN, STIFF, MOIST	5			18	1.5	1	SAND, GRAVELLY, SLIGHTLY SILTY, FINE TO COARSE GRAINED, DARK BROWN TO TAN, LOOSE TO DENSE, MOIST	5			7	2.3	1
				22	15.8	2					10	8.9	1'
SAND, SILTY, GRAVELLY, FINE TO COARSE GRAINED, LIGHT BROWN, MEDIUM DENSE, MOIST	10			26	6.0	1		10			30	8.5	1
				50	8.9	3	SANDSTONE, SILTY, FINE TO COARSE GRAINED, LIGHT BROWN TO BROWN, VERY DENSE, MOIST	15			50 10"	9.9	3
SANDSTONE, SILTY, FINE GRAINED, LIGHT GRAY, VERY DENSE, MOIST	15												
CLAYSTONE, SANDY, GRAY BROWN, VERY STIFF, MOIST	20			46	9.8	4		20			50 4"		3



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FIG NO.:
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TEST BORING NO. 9
 DATE DRILLED 8/9/2006
 Job # 82556

TEST BORING NO. 10
 DATE DRILLED 8/9/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS

DRY TO 20', 8/10/06

SAND, SILTY, FINE TO COARSE
 GRAINED, DARK BROWN TO
 BROWN, LOOSE TO DENSE,
 MOIST

SANDSTONE, SILTY, FINE TO
 COARSE GRAINED, LIGHT GRAY,
 VERY DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			15	4.0	1
5			5	2.9	1
10			17	3.8	1
15			30	10.4	1
20			50	8.5	3
			11"		

REMARKS

WATER @ 9',
 8/10/06

SAND, SLIGHTLY SILTY, FINE
 TO COARSE GRAINED, LIGHT
 BROWN, MEDIUM DENSE, MOIST

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

CLAYSTONE, SANDY, GRAY,
 HARD, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			13	2.9	1
5			27	8.9	1
10			50	11.7	3
			8"		
15			50	13.2	4
			3"		
20					



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FIG NO.:
 B-5

TEST BORING NO. 11
 DATE DRILLED 8/9/2006
 Job # 82556

TEST BORING NO. 12
 DATE DRILLED 8/4/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER AT 14, 8/10/06							WATER @ 13.5', 8/7/06						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				16	2.8	1	SAND, GRAVELLY, SLIGHTLY SILTY, FINE TO COARSE GRAINED, DARK BROWN TO TAN, MEDIUM DENSE, MOIST TO WET				15	3.0	1
	5			17	2.9	1		5			20	2.5	1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY TO BROWN, VERY DENSE, MOIST TO WET	10			50 6"	7.2	3		10			24	13.2	1
	15			50 4"	10.6	3	CLAYSTONE, SANDY, LIGHT GRAY, HARD, MOIST	15			50	12.2	2
											*	16.0	2
							SANDSTONE, SILTY, FINE GRAINED, LIGHT GRAY, VERY DENSE, MOIST	20			50 5"	14.2	3

* - BULK SAMPLE TAKEN



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FIG NO.:

B-6

TEST BORING NO. 13
 DATE DRILLED 8/23/2006
 Job # 82556

TEST BORING NO. 14
 DATE DRILLED 8/14/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/23/06 CAVED TO 13.5', 8/25/06, DRY							DRY TO 15', 8/14/06 CAVED TO 14.5', 8/16/06, DRY						
SAND, SILTY, BROWN CLAY, VERY SANDY, BROWN, STIFF, MOIST	5			20	5.6	1	SAND, GRAVELLY, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST	5			14	4.4	1
				19	8.0	2	WEATHERED SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, DENSE, MOIST SANDSTONE, GRAVELLY, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST				45	8.8	3
SANDSTONE, SILTY, FINE GRAINED, LIGHT GRAY, VERY DENSE, MOIST	10			50 6"	12.8	3		10			50 5"	8.8	3
SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST	15			50 5"	8.5	3		15			50 5"	10.6	3
	20							20					



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JOB NO.:

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FIG NO.:

B-7

TEST BORING NO. 15
 DATE DRILLED 8/14/2006
 Job # 82556

TEST BORING NO. 16
 DATE DRILLED 8/9/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS

DRY TO 15',
 8/16/06

SAND, SILTY, FINE TO COARSE
 GRAINED, TAN, MEDIUM DENSE,
 MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			12	11.6	1
5			50 9"	10.4	3
10			50 5"	9.0	3
15			50 4"	9.6	3
20					

REMARKS

DRY TO 20', 8/9/06
 CAVED TO 19',
 8/10/06, DRY

SAND, SILTY, FINE TO COARSE
 GRAINED, BROWN TO TAN,
 MEDIUM DENSE TO DENSE,
 MOIST TO VERY MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			14	5.9	1
5			15	9.3	1
10			25	5.9	1
15			31	13.5	1
20			50 3"	6.7	3



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TEST BORING LOG

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JOB NO.:
 82556
 FIG NO.:
 B-3

TEST BORING NO. 17
 DATE DRILLED 8/9/2006
 Job # 82556

TEST BORING NO. 18
 DATE DRILLED 8/9/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS

DRY TO 20', 8/10/06

SAND, SLIGHTLY SILTY, FINE
 TO COARSE GRAINED, DARK
 BROWN TO TAN, LOOSE TO
 DENSE, MOIST TO VERY
 MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			18	1.9	1
5			18	2.6	1
10			8	12.8	1
15			26	7.8	1
20			32	12.9	1

REMARKS

WATER AT 7.5', 8/10/06

SAND, GRAVELLY, SILTY,
 FINE TO COARSE GRAINED,
 DARK BROWN TO TAN, MEDIUM
 DENSE TO DENSE, MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			27	7.3	1
5			46	4.6	1
10			50 7"	28.0	3
15			50 5"	19.4	3
20					



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FIG NO.:

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TEST BORING NO. 19
 DATE DRILLED 8/10/2006
 Job # 82556

TEST BORING NO. 20
 DATE DRILLED 8/9/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS

DRY TO 15',
 8/10/06
 CAVED TO 14.5',
 8/11/06, DRY

SAND, SILTY, GRAVELLY, FINE
 TO COARSE GRAINED, LIGHT
 BROWN, LOOSE TO DENSE,
 DRY TO MOIST

SANDSTONE, GRAVELLY,
 SILTY, FINE TO COARSE GRAINED,
 GRAY, VERY DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			5	1.7	1
5			30	5.6	1
10			50 5"	9.5	3
15			50 4"	9.0	3
20					

REMARKS

DRY TO 20', 8/10/06

SAND, GRAVELLY, SLIGHTLY
 SILTY, FINE TO COARSE
 GRAINED, BROWN TO TAN,
 MEDIUM DENSE, MOIST TO
 VERY MOIST

SANDSTONE, GRAVELLY,
 SILTY, FINE TO COARSE
 GRAINED, TAN, VERY DENSE,
 MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			22	3.3	1
5			24	3.1	1
10			22	7.7	1
15			22	14.1	1
20			50 6"	11.5	3



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FIG NO.:

B-10

TEST BORING NO. 21
 DATE DRILLED 8/9/2006
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TEST BORING NO. 22
 DATE DRILLED 8/9/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS

WATER @ 10', 8/10/06

SAND, GRAVELLY, SILTY,
 FINE TO COARSE GRAINED,
 BROWN TO TAN, MEDIUM
 DENSE TO DENSE, MOIST

CLAY, SANDY, GREEN BROWN,
 MOIST

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

CLAYSTONE, SANDY, GRAYISH
 BROWN, HARD, MOIST

* - BULK SAMPLE TAKEN

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			24	1.6	1
5			31	2.7	1
5			*	16.9	2
10			50 9"	10.0	3
15			*	10.8	3
15			*	11.5	4
15			50 6"	10.3	4
20					

REMARKS

WATER @ 3.5', 8/10/06

SAND, GRAVELLY, CLAYEY,
 FINE TO COARSE GRAINED,
 TAN, MEDIUM DENSE, MOIST

WEATHERED SANDSTONE, SILTY,
 FINE GRAINED, GRAY, DENSE,
 WET

SANDSTONE, SILTY, FINE TO
 COARSE GRAINED, DARK GRAY,
 VERY DENSE, WET

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			25	9.7	1
5			40	29.8	3
10			50 3"		3
15			50 5"		3
20					



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FIG NO.:

B-11

TEST BORING NO. 23
 DATE DRILLED 8/16/2006
 Job # 82556

TEST BORING NO. 24
 DATE DRILLED 8/16/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/17/06							DRY TO 15', 8/16/06 CAVED TO 14.5', 8/17/06, DRY						
SAND, GRAVELLY, SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST				19	4.1	1	SAND, SILTY, BROWN						1
							WEATHERED CLAYSTONE, SANDY, TAN, VERY STIFF, MOIST				39	16.2	4
SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST	5			27	11.1	1	SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, GRAY, VERY DENSE, MOIST	5			50 5"	10.3	3
CLAY, SANDY, BROWN, MOIST				*	17.2	2							
CLAYSTONE, SANDY, GREEN BROWN, HARD, MOIST	10			50 10"	18.6	4	CLAYSTONE, SANDY, GRAY BROWN	10			50 5"	9.7	3
													4
SANDSTONE, CLAYEY, FINE GRAINED, LIGHT BROWN, VERY DENSE, MOIST	15			50 6"	11.9	3	SANDSTONE, SILTY, FINE TO MEDIUM GRAINED, TAN, VERY DENSE, MOIST	15			50 5"	13.9	3
* - BULK SAMPLE TAKEN	20							20					



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FIG NO.:

B-12

TEST BORING NO. 25
 DATE DRILLED 8/16/2006
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TEST BORING NO. 26
 DATE DRILLED 8/9/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/16/06 CAVED TO 13.5', 8/17/06, DRY							WATER @ 19', 8/10/06						
SAND, GRAVELLY, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST	5			15	2.2	1	SAND, GRAVELLY, SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE TO DENSE, DRY TO MOIST	5			11	0.9	1
				16	2.6	1					17	2.8	1
WEATHERED TO FORMATIONAL CLAYSTONE, SANDY, GREEN BROWN, VERY STIFF TO HARD, MOIST	10			48	15.9	4		10			32	7.9	1
				50	15.6	4							
SANDSTONE, SILTY, FINE TO COARSE GRAINED, BLUE GRAY, VERY DENSE, MOIST	15			50	10.1	3	SANDSTONE, SILTY, GRAVELLY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST	15			50	8.4	3
				3"							4"		
	20							20			50	9.8	3
											4"		



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FIG NO.:

B-13

TEST BORING NO. 27
 DATE DRILLED 8/9/2006
 Job # 82556

TEST BORING NO. 28
 DATE DRILLED 8/10/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/9/06 CAVED TO 14.5', 8/10/06, DRY							DRY TO 15', 8/10/06 CAVED TO 14.5', 8/11/06, DRY						
SAND, GRAVELLY, SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE TO DENSE, MOIST	5			19	2.8	1	SAND, SILTY, DARK BROWN						1
	5			30	6.6	1	WEATHERED SANDSTONE, SILTY, TAN, MEDIUM DENSE, MOIST	5			25	7.1	3
	10			29	19.5	2	SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST	5			50 5"	6.8	3
CLAY, SANDY, GRAY, STIFF, MOIST	10			50 9"	10.2	3		10			50 5"	5.9	3
SANDSTONE, GRAVELLY, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST	15			50 5"	10.4	3		15			50 4"	8.1	3
	20							20					



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FIG NO.:

B-14

TEST BORING NO. 29
 DATE DRILLED 8/10/2006
 Job # 82556

TEST BORING NO. 30
 DATE DRILLED 8/14/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/10/06							WATER AT 11', 8/16/06						
SAND, SILTY, BROWN						1	SAND, SILTY, BROWN						1
						3	CLAY, SANDY, TAN, MOIST				13.0		2
SANDSTONE, SILTY, GRAVELLY, FINE TO COARSE GRAINED, LIGHT BROWN, VERY DENSE, MOIST	5			50 6"	2.3	3	SAND, GRAVELLY, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE TO DENSE, MOIST	5			24	3.4	1
SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, GREEN BROWN, VERY DENSE, MOIST				50 5"	6.4	3	SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST				34	6.6	1
	10			50 6"	9.0	3		10			50 5"	9.3	3
	15			50 4"		3	CLAYSTONE, SILTY, GREEN BROWN, HARD, MOIST	15			50 5"	17.2	4
* - BULK SAMPLE TAKEN	20						* - BULK SAMPLE TAKEN	20					



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JOB NO.:
 E2556
 FIG NO.:
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TEST BORING NO. 31
 DATE DRILLED 8/14/2006
 Job # 82556

TEST BORING NO. 32
 DATE DRILLED 8/14/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER AT 8', 8/16/06							WATER @ 11', 8/16/06						
SAND, SILTY, GRAVELLY, FINE TO COARSE GRAINED, DARK BROWN, MEDIUM DENSE, MOIST				19	6.1	1	SAND, SILTY, BROWN CLAY, SANDY, BROWN						1
CLAY, SANDY, TAN, STIFF, MOIST	5			24	18.8	2	SAND, GRAVELLY, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST TO VERY MOIST	5			37	5.0	1
											23	8.7	1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, LIGHT GRAY, VERY DENSE, MOIST TO WET	10			50 7"	12.6	3		10			14	13.6	1
							SANDSTONE, SILTY, FINE TO COARSE GRAINED, LIGHT BROWN, VERY DENSE, VERY MOIST						
	15			50 4"	10.4	3		15			50 5"	17.5	3
							CLAYSTONE, SILTY, LIGHT BROWN, HARD, MOIST	20			*	11.2	4
	20										50 5"	10.8	4

* - BULK SAMPLE TAKEN



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82556

FIG NO.:

FB-16

TEST BORING NO. 33
 DATE DRILLED 8/14/2006
 Job # 82556

TEST BORING NO. 34
 DATE DRILLED 8/10/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/16/06							WATER @ 6', 8/11/06						
SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST				22	3.9	1	CLAY, VERY SANDY, DARK BROWN TO BROWN, STIFF TO FIRM, MOIST				26	4.9	2
SANDSTONE, SILTY, GRAVELLY, FINE TO COARSE GRAINED, LIGHT BROWN, VERY DENSE, MOIST	5			50 10"	6.6	3		5			13	7.0	2
	10			50 7"	11.8	3	SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, TAN, VERY DENSE, WET	10			50 6"	14.2	3
CLAYSTONE, SANDY, BROWN, HARD, MOIST	15			50 9"	24.8	4		15			50 5"	7.9	3
	20							20					



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TEST BORING LOG

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DATE:

[Signature]

8/15/06

JOB NO.:

82556

FIG NO.:

B-17

TEST BORING NO. 35
 DATE DRILLED 8/10/2006
 Job # 82556

TEST BORING NO. 36
 DATE DRILLED 8/14/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/10/06 CAVED TO 14.5', 8/11/06, DRY SAND, SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, LIGHT BROWN, VERY DENSE, MOIST							DRY TO 15', 8/14/06 CAVED TO 14', 8/16/06, DRY SAND, SILTY, BROWN SANDSTONE, GRAVELLY, CLAYEY, FINE TO COARSE GRAINED, LIGHT BROWN, VERY DENSE, MOIST						
	5			29	2.4	1		5			50	6.7	3
				50	7.6	3					7"	10.4	3
	10			50	8.6	3		10			50	8.8	3
				6"							5"		
	15			50	6.2	3		15			50	11.8	3
				4"							4"		
	20							20					



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TEST BORING LOG

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1/5/06

9/5/06

JOB NO.:

82556

FIG NO.:

E-13

TEST BORING NO. 37
 DATE DRILLED 8/10/2006
 Job # 82556

TEST BORING NO. 38
 DATE DRILLED 8/10/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/10/06 CAVED TO 14.5', 8/11/06, DRY							DRY TO 15', 8/10/06 CAVED TO 14.5', 8/11/06, DRY						
SAND, SILTY, BROWN						1	SAND, SILTY, BROWN						1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, LIGHT BROWN, VERY DENSE, MOIST	5			50 7"	4.1	3	SANDSTONE, SILTY, GRAVELLY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST	5			50 8"	4.3	3
				50 5"	5.2	3					50 6"	5.5	3
CLAYEY LENSES	10			50 7"	10.2	3		10			50 4"	6.1	3
	15			50 4"	7.4	3		15			50 4"	9.3	3
	20							20					



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TEST BORING LOG

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DATE:

[Signature]

9/15/06

JOB NO.:

82556

FIG NO.:

B-19

TEST BORING NO. 39
 DATE DRILLED 8/10/2006
 Job # 82556

TEST BORING NO. 40
 DATE DRILLED 8/10/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/10/06 CAVED TO 14.5', 8/11/06, DRY							DRY TO 15', 8/10/06 CAVED TO 14.5', 8/11/06, DRY						
SAND, SILTY, GRAVELLY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				18	2.2	1	SAND, SILTY, BROWN						1
SANDSTONE, GRAVELLY, SILTY, FINE TO COARSE GRAINED, RED BROWN, VERY DENSE, MOIST	5			50 10"	9.6	3	SANDSTONE, SILTY, CLAYEY, GRAVELLY, FINE TO COARSE GRAINED, LIGHT BROWN, VERY DENSE, MOIST	5			50 10"	6.7	3
				*	11.0	3					50 5"	4.4	3
	10			50 7"	10.2	3		10			50 5"	8.8	3
SANDSTONE, VERY CLAYEY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST	15			50 5"	11.1	3	CLAYSTONE, SANDY, BROWN, HARD, MOIST	15			50 5"	14.4	4
	20							20					

* - BULK SAMPLE TAKEN



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TEST BORING LOG

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9/5/06

JOB NO.:
82556

FIG NO.:
B-25

TEST BORING NO. 41
 DATE DRILLED 8/23/2006
 Job # 82556

TEST BORING NO. 42
 DATE DRILLED 8/23/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 9', 8/25/06						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST				25	10.4	1
SAND, VERY CLAYEY, VERY SILTY, FINE TO COARSE GRAINED, GRAY, MEDIUM DENSE, MOIST	5			29	10.9	1
CLAYSTONE, SANDY, LIGHT GRAY				*	12.4	4
SANDSTONE, SILTY, FINE TO COARSE GRAINED, LIGHT GRAY, VERY DENSE, VERY MOIST	10			<u>50</u> 7"	11.3	3
	15			<u>50</u> 7"	11.7	3
	20					

* - BULK SAMPLE TAKEN

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 12', 8/28/06						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST				18	4.6	1
	5			25	2.9	1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, LIGHT GRAY, VERY DENSE, MOIST						
	10			<u>50</u> 5"	11.4	4
	15			<u>50</u> 5"	5.0	4
	20					



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TEST BORING LOG

DRAWN:

DATE:

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DATE:

1/2/07

9/5/06

JOB NO.:
82556

FIG NO.:
B-21

TEST BORING NO. 43
 DATE DRILLED 8/23/2006
 Job # 82556

TEST BORING NO. 44
 DATE DRILLED 8/23/2006
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 20', 8/23/06 CAVED TO 17.5', 8/28/06, DRY							WATER @ 11', 8/28/06						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST							SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST TO WET						
	5			13	3.1	1		5			11	3.4	1
				19	6.0	1					17	5.0	1
	10			19	6.1	1		10			18	4.4	1
	15			18	15.6	2		15			22	10.5	1
CLAY, SANDY, GRAY, STIFF, MOIST CLAYSTONE, SANDY, GRAY, HARD, MOIST	20			50 7"	9.5	4	SANDSTONE, SILTY, FINE TO COARSE GRAINED, LIGHT GRAY, VERY DENSE, VERY MOIST	20			50 7"	13.4	3



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DATE:

DK

9/5/06

JOB NO.:

82556

FIG NO.:

3-22

TEST BORING NO. 45
 DATE DRILLED 8/23/2006
 Job # 82556

TEST BORING NO.
 DATE DRILLED
 CLIENT MORLEY BENTLEY
 LOCATION STERLING RANCH

REMARKS

WATER @ 12.5', 8/25/06
 SAND, SILTY, FINE TO COARSE
 GRAINED, BROWN TO TAN,
 MEDIUM DENSE, MOIST

WEATHERED TO FORMATIONAL
 SANDSTONE, SILTY, FINE TO
 COARSE GRAINED, DENSE TO
 VERY DENSE, LIGHT GRAY,
 WET

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			18	6.0	1
			20	4.5	1
10			24	5.8	1
15			33	13.8	3
20			50	10.5	3
			7"		

REMARKS

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



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TEST BORING LOG

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DATE:

K. H.

9/15/06

JOB NO.:
 82556
 FIG NO.:
 13-23

APPENDIX C: Laboratory Test Results

UNIFIED CLASSIFICATION SM-SW

SOIL TYPE # 1

TEST BORING # 4

DEPTH (FT) 2-5

CLIENT

MORLEY BENTLEY

PROJECT

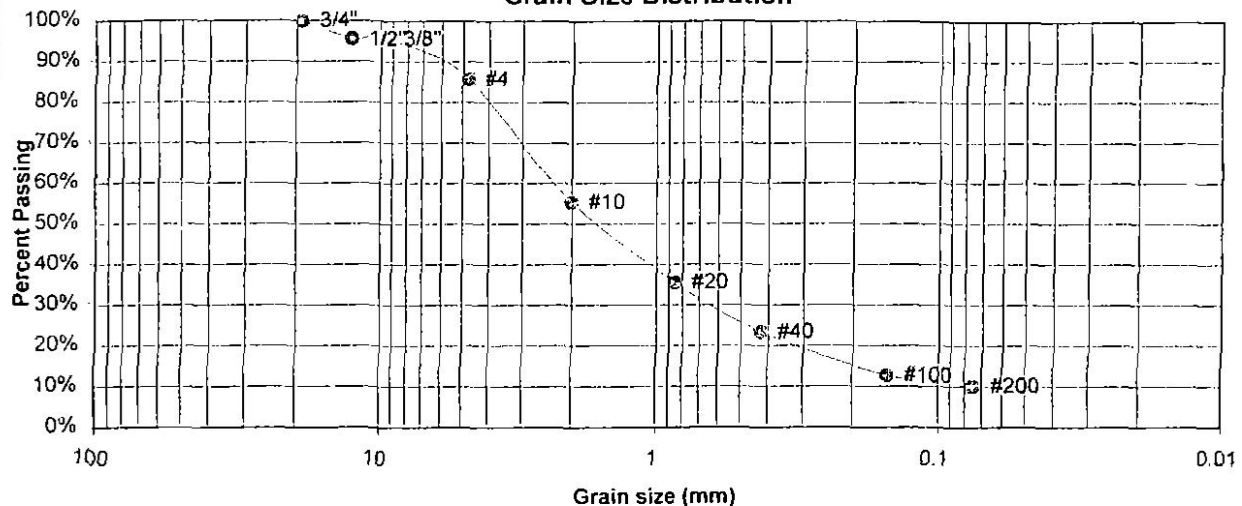
STERLING RANCH

JOB NO.

82556

TEST BY

DG

Sieve Analysis
Grain Size DistributionU.S.
Sieve #Percent
Finer

3"

1 1/2"

3/4"

1/2"

3/8"

4

10

20

40

100

200

100.0%

95.5%

95.5%

85.7%

55.3%

35.6%

23.4%

12.7%

10.0%

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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LABORATORY TEST
RESULTS

DRAWN:

DATE:

CHECKED:

DATE:

11/15/06

9/15/06

JOB NO.:

82556

FIG NO.:

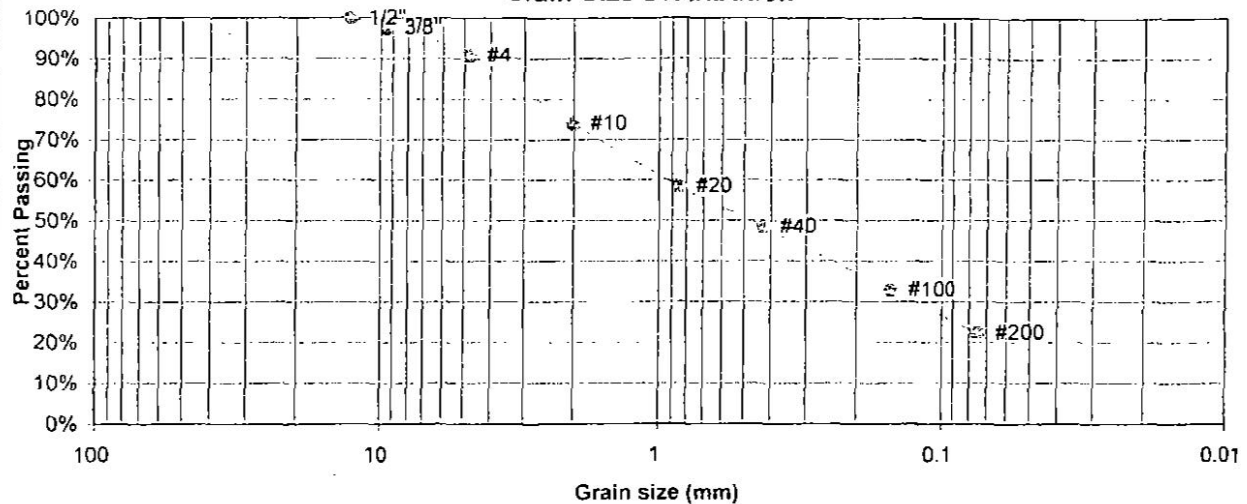
C-1

UNIFIED CLASSIFICATION SM

SOIL TYPE # 1
TEST BORING # 9
DEPTH (FT) 5

CLIENT MORLEY BENTLEY
PROJECT STERLING RANCH
JOB NO. 82556
TEST BY DG

**Sieve Analysis
Grain Size Distribution**



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.5%
4	90.7%
10	74.0%
20	58.4%
40	48.5%
100	32.9%
200	22.4%

**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:

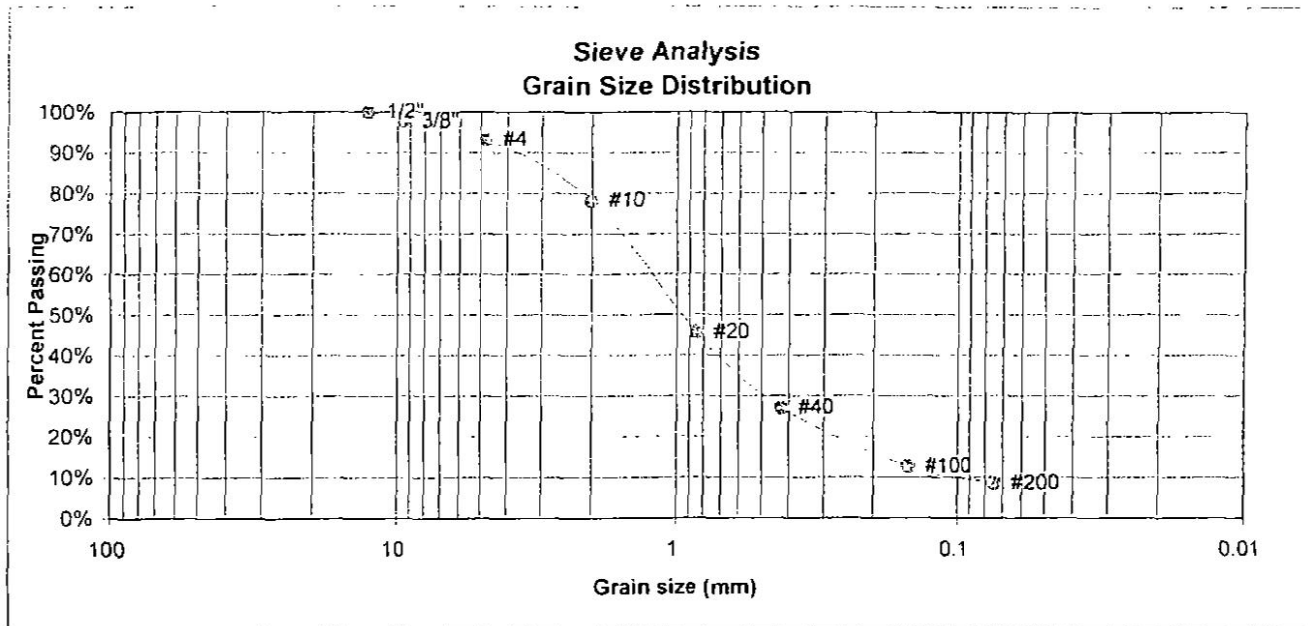
DATE:

JOB NO.:
82556

FIG NO.:
C-2

UNIFIED CLASSIFICATION SM-SW
 SOIL TYPE # 1
 TEST BORING # 12
 DEPTH (FT) 5

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.7%
4	93.2%
10	78.3%
20	45.7%
40	27.1%
100	12.7%
200	8.6%

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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9/5/06

JOB NO.:

82556

FIG NO.:

C-3

UNIFIED CLASSIFICATION SM-SP

SOIL TYPE # 1

TEST BORING # 17

DEPTH (FT) 2-3

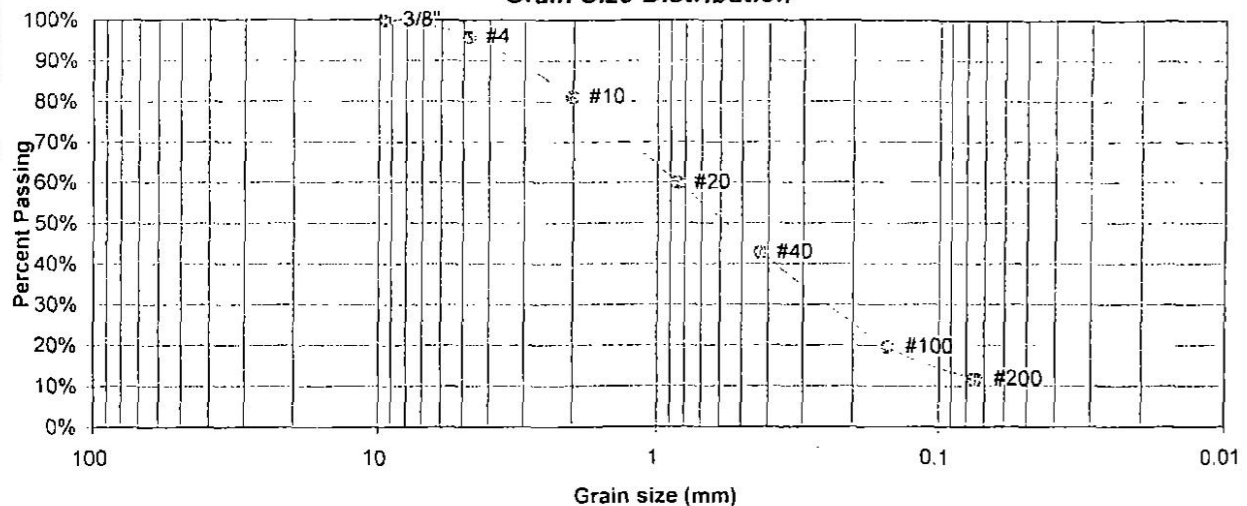
CLIENT MORLEY BENTLEY

PROJECT STERLING RANCH

JOB NO. 82556

TEST BY DG

Sieve Analysis Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.8%
10	81.1%
20	60.0%
40	42.9%
100	19.6%
200	11.7%

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:

JOB NO.:

82556

FIG NO.:

C-4

UNIFIED CLASSIFICATION SM

SOIL TYPE # 1
TEST BORING # 19
DEPTH (FT) 5

CLIENT

MORLEY BENTLEY

PROJECT

STERLING RANCH

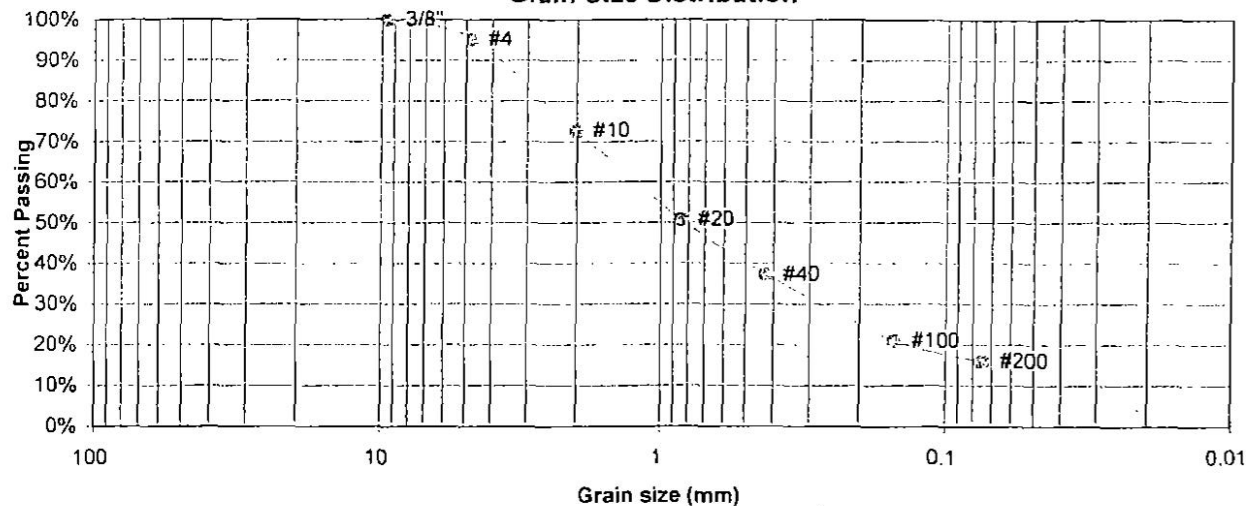
JOB NO.

82556

TEST BY

DG

**Sieve Analysis
Grain Size Distribution**



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.2%
10	72.7%
20	50.8%
40	37.3%
100	21.0%
200	15.9%

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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**LABORATORY TEST
RESULTS**

DRAWN:

DATE:

CHECKED:

DATE:

12/12

9/5/05

JOB NO.:

82556

FIG NO.:

C-5

UNIFIED CLASSIFICATION SM-SW

SOIL TYPE # 1

TEST BORING # 20

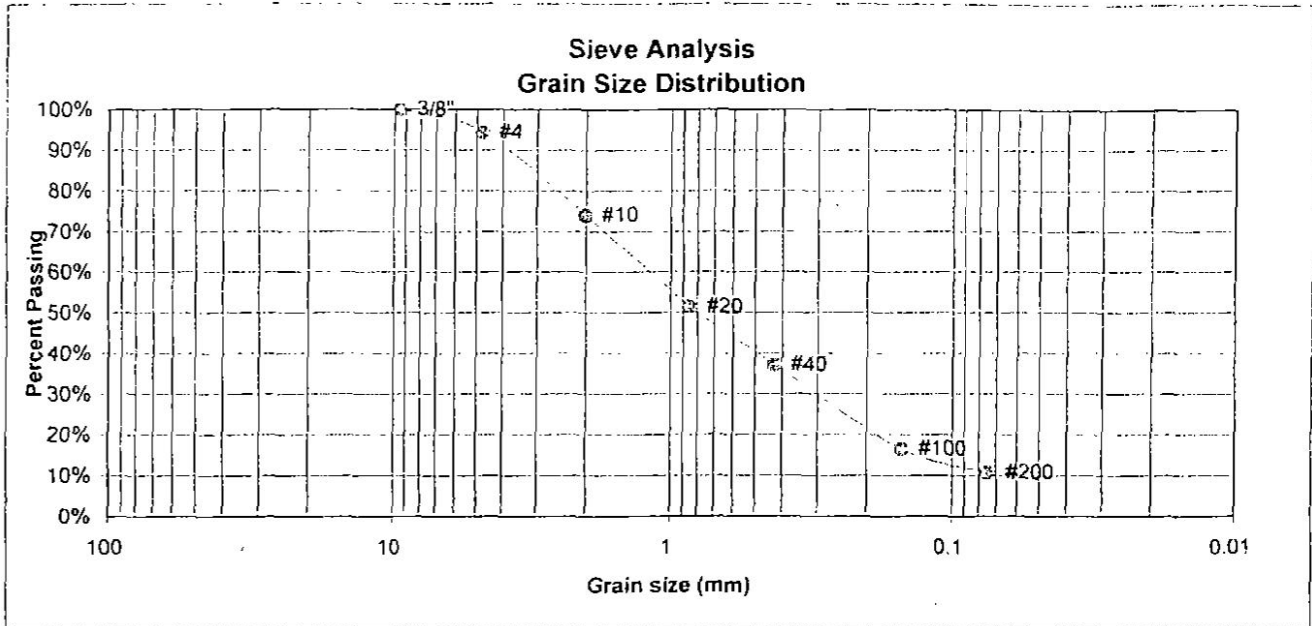
DEPTH (FT) 10

CLIENT MORLEY BENTLEY

PROJECT STERLING RANCH

JOB NO. 82556

TEST BY DG



U.S.
Sieve #

3"

1 1/2"

3/4"

1/2"

3/8"

4

10

20

40

100

200

Percent
Finer

100.0%

94.4%

74.0%

51.4%

37.1%

16.5%

10.7%

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:

1/24/06

9/15/06

JOB NO.:

82556

FIG NO.:

C-6

UNIFIED CLASSIFICATION SM-SW

SOIL TYPE # 1
TEST BORING # 25
DEPTH (FT) 2-5

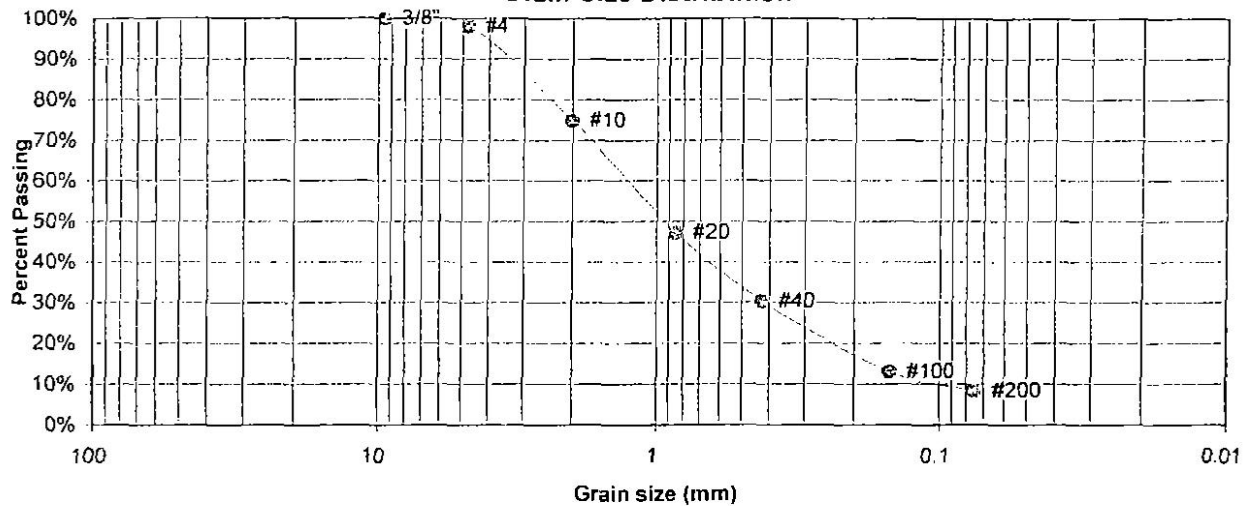
CLIENT MORLEY BENTLEY

PROJECT STERLING RANCH

JOB NO. 82556

TEST BY DG

**Sieve Analysis
Grain Size Distribution**



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.0%
10	74.9%
20	47.2%
40	30.3%
100	13.0%
200	8.4%

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:

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DATE:

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9/5/06

JOB NO.:
82556

FIG NO.:
C-7

UNIFIED CLASSIFICATION SM

SOIL TYPE # 1
TEST BORING # 26
DEPTH (FT) 5

CLIENT

MORLEY BENTLEY

PROJECT

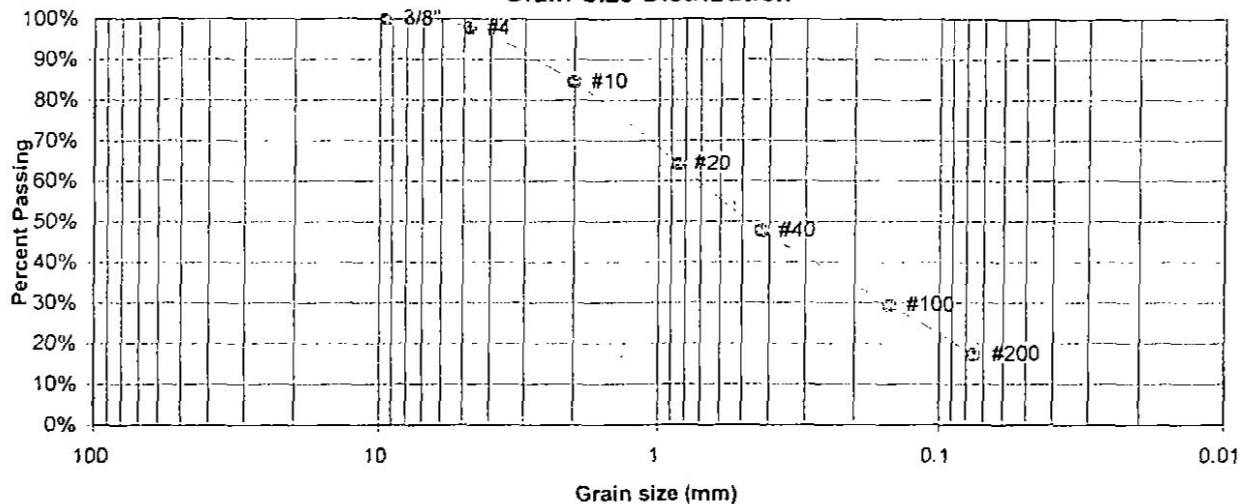
STERLING RANCH

JOB NO.

82556

TEST BY

DG

**Sieve Analysis
Grain Size Distribution**

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.7%
10	84.6%
20	64.2%
40	47.7%
100	29.4%
200	17.3%

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:

11/15

9/5/06

JOB NO.:

82556

FIG NO.:

C-8

UNIFIED CLASSIFICATION SC-SM

CLIENT

MORLEY BENTLEY

SOIL TYPE #

1

PROJECT

STERLING RANCH

TEST BORING #

41

JOB NO.

82556

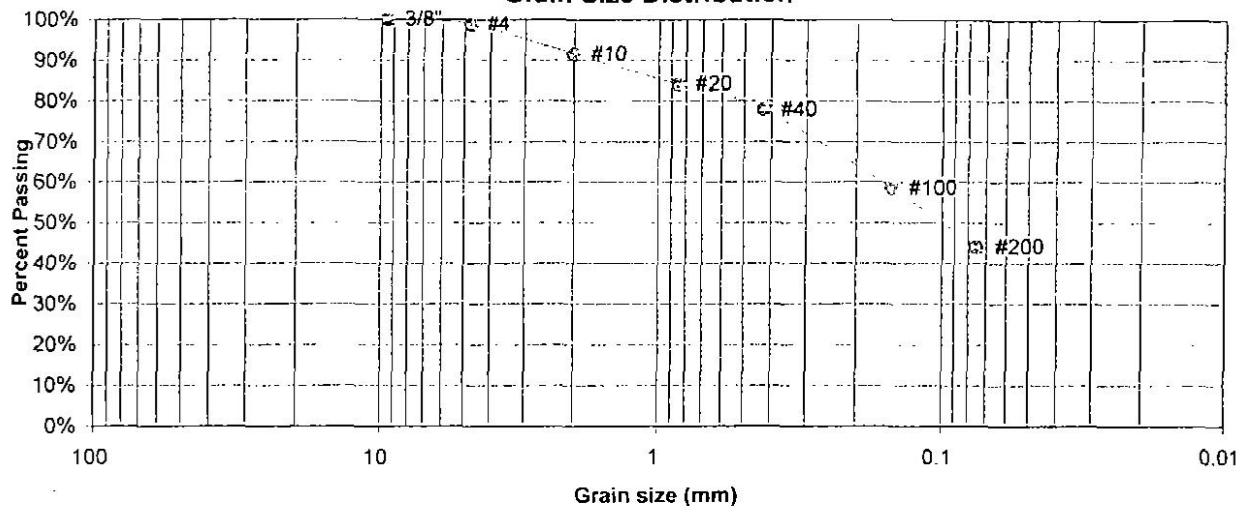
DEPTH (FT)

5

TEST BY

DG

Sieve Analysis Grain Size Distribution

U.S.
Sieve #Percent
Finer

3"
1 1/2"
3/4"
1/2"
3/8"
4
10
20
40
100
200

100.0%
98.8%
91.5%
84.1%
77.9%
58.5%
44.1%

Atterberg
Limits

Plastic Limit 16
Liquid Limit 23
Plastic Index 7

Swell

Moisture at start 7.6%
Moisture at finish 18.1%
Moisture increase 10.5%
Initial dry density (pcf) 106
Swell (psf) 574



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LABORATORY TEST RESULTS

DRAWN:

DATE:

CHECKED:

DATE:

KAM

9/17/06

JOB NO.:

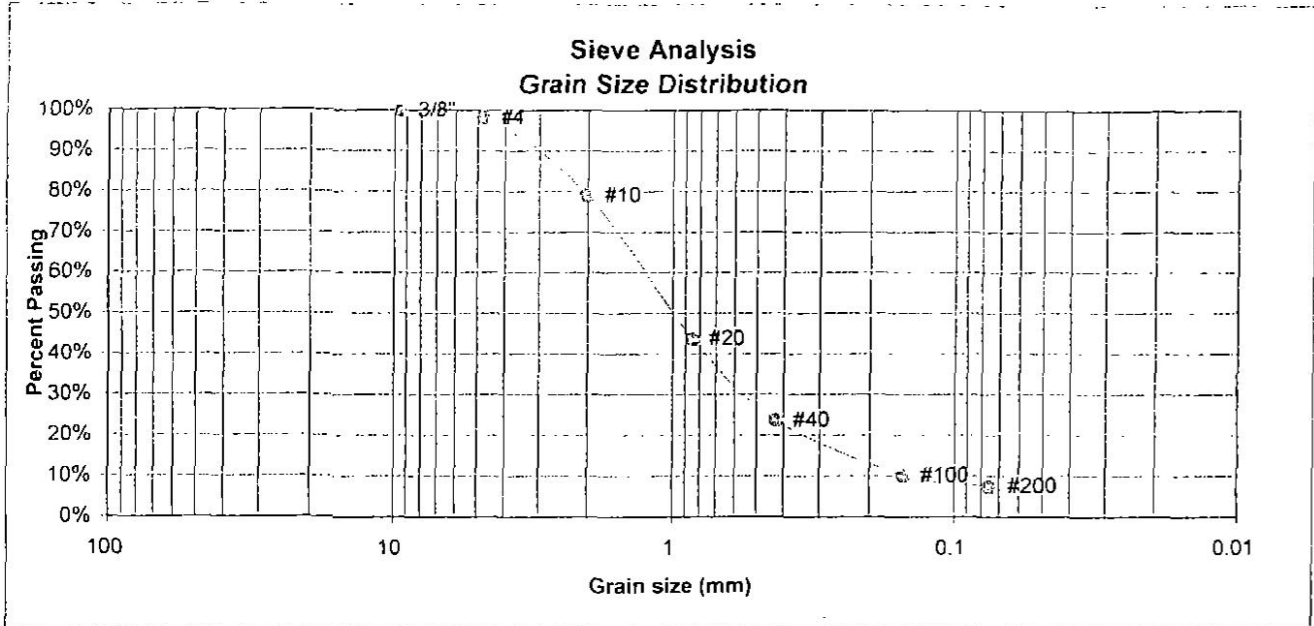
82556

FIG NO.:

C-9

UNIFIED CLASSIFICATION SM-SW
 SOIL TYPE # 1
 TEST BORING # 42
 DEPTH (FT) 2-3

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.2%
10	79.1%
20	43.6%
40	23.6%
100	10.1%
200	7.4%

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:

1/24/06

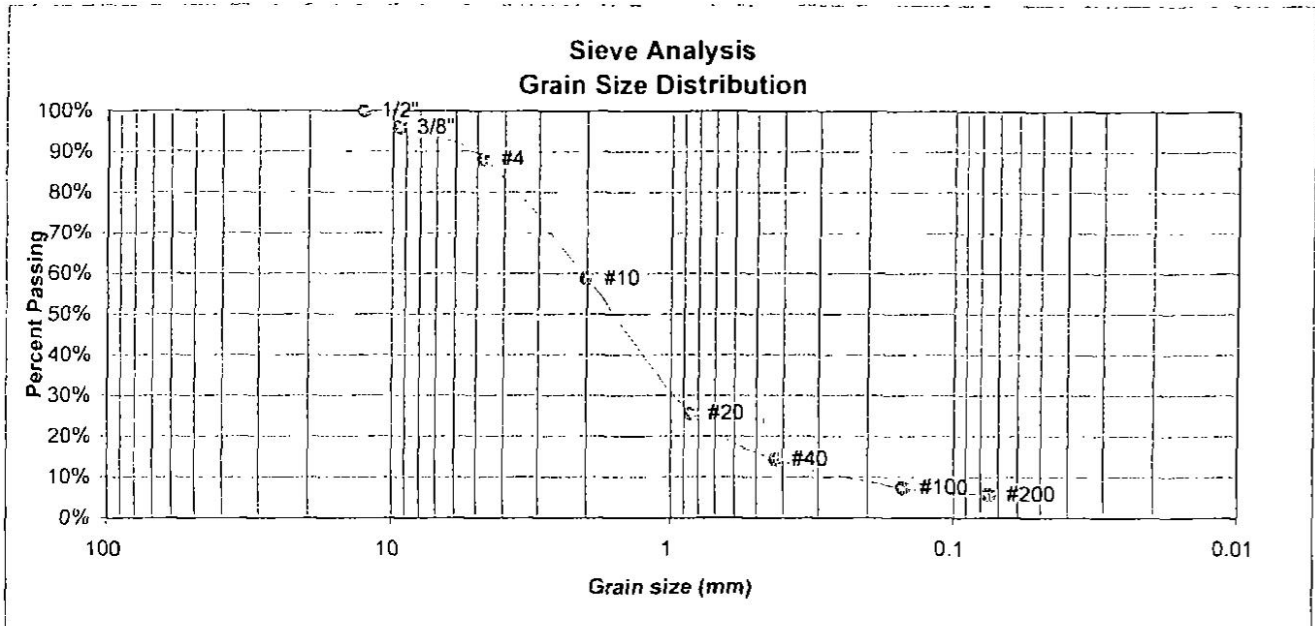
9/15/06

JOB NO.:
82556

FIG NO.:
C-10

UNIFIED CLASSIFICATION SM-SW
 SOIL TYPE # 1
 TEST BORING # 44
 DEPTH (FT) 5-10

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	95.9%
4	88.2%
10	58.8%
20	25.5%
40	14.4%
100	7.4%
200	5.7%

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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JOB NO.:
82556

FIG NO.:

C-11

UNIFIED CLASSIFICATION CL

SOIL TYPE # 2

TEST BORING # 7

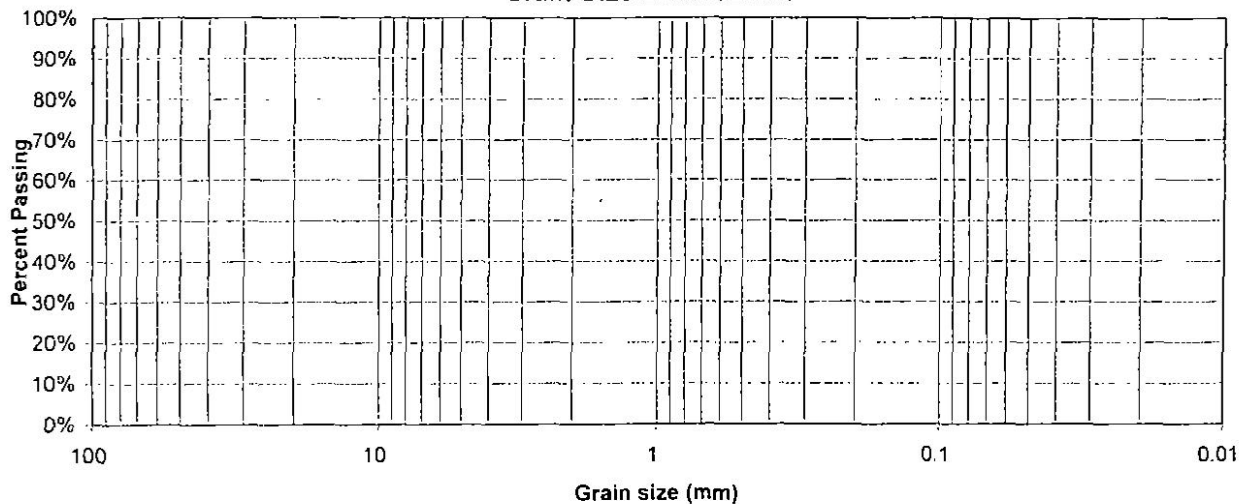
DEPTH (FT) 5

CLIENT MORLEY BENTLEY

PROJECT STERLING RANCH

JOB NO. 82556

TEST BY DG

Sieve Analysis
Grain Size DistributionU.S.
Sieve #Percent
Finer

3"
1 1/2"
3/4"
1/2"
3/8"
4
10
20
40
100
200

Atterberg
Limits

Plastic Limit 16
Liquid Limit 29
Plastic Index 13

Swell

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



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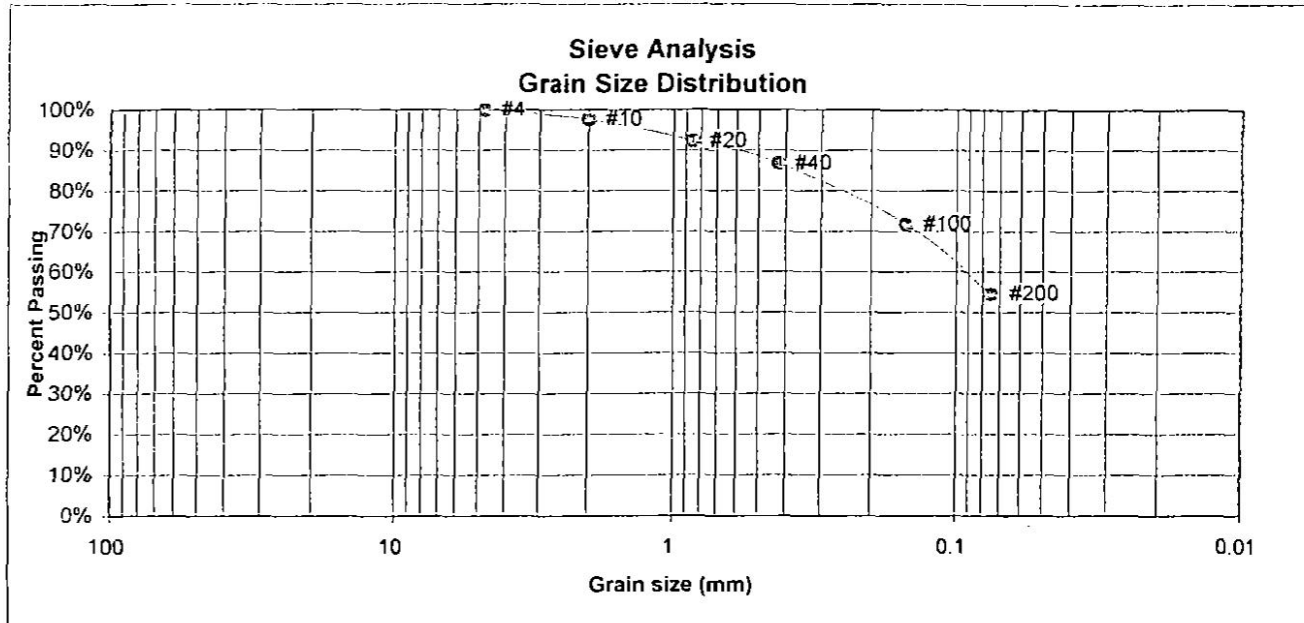
82556

FIG NO.:

C-12

UNIFIED CLASSIFICATION CL
 SOIL TYPE # 2
 TEST BORING # 13
 DEPTH (FT) 2-3

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	97.6%
20	92.3%
40	86.8%
100	71.8%
200	54.6%

Atterberg
Limits
 Plastic Limit
 Liquid Limit
 Plastic Index

Swell
 Moisture at start 11.2%
 Moisture at finish 19.4%
 Moisture increase 8.2%
 Initial dry density (pcf) 100
 Swell (psf) 455



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JOB NO.:

82556

FIG NO.:

C-13

UNIFIED CLASSIFICATION CL

SOIL TYPE # 2

TEST BORING # 21

DEPTH (FT) 7

CLIENT

MORLEY BENTLEY

PROJECT

STERLING RANCH

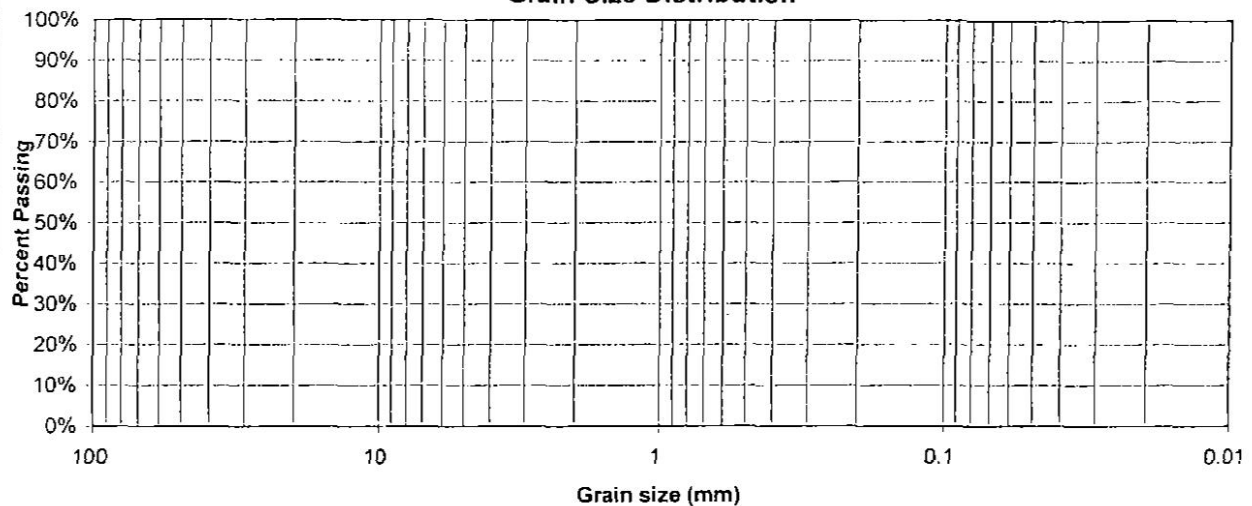
JOB NO.

82556

TEST BY

DG

Sieve Analysis Grain Size Distribution

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 14.8%

Moisture at finish 21.0%

Moisture increase 6.2%

Initial dry density (pcf) 107

Swell (psf) 4179


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9/5/06

JOB NO.:

82556

FIG NO.:

C-14

UNIFIED CLASSIFICATION CL

SOIL TYPE # 2

TEST BORING # 23

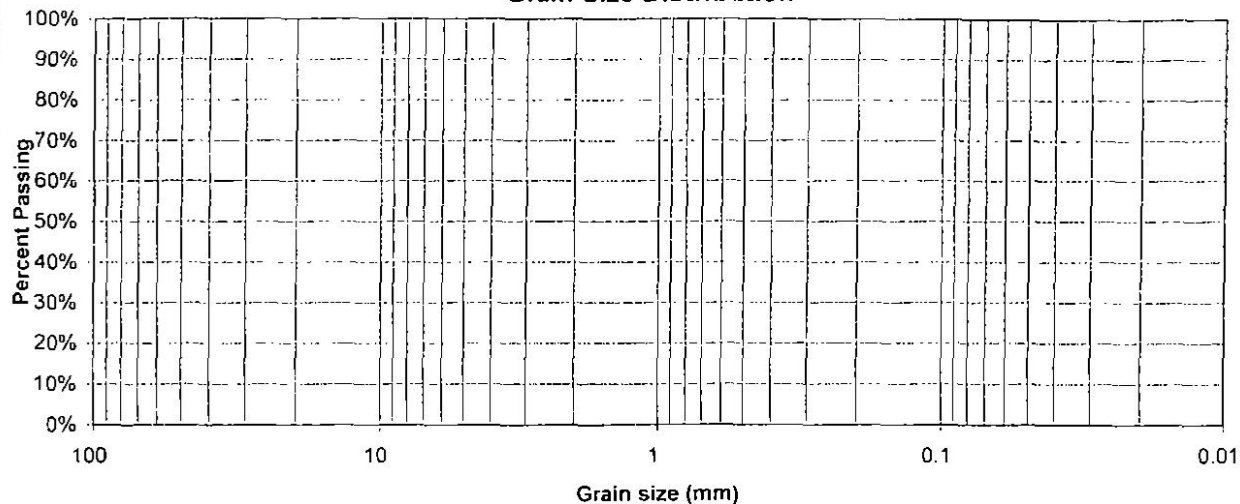
DEPTH (FT) 7

CLIENT MORLEY BENTLEY

PROJECT STERLING RANCH

JOB NO. 82556

TEST BY DG

Sieve Analysis
Grain Size DistributionU.S.
Sieve #Percent
FinerAtterberg
Limits

Plastic Limit

Liquid Limit

Plastic Index

3"
1 1/2"
3/4"
1/2"
3/8"
4
10
20
40
100
200

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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LABORATORY TEST
RESULTS

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DATE:

JOB NO.:

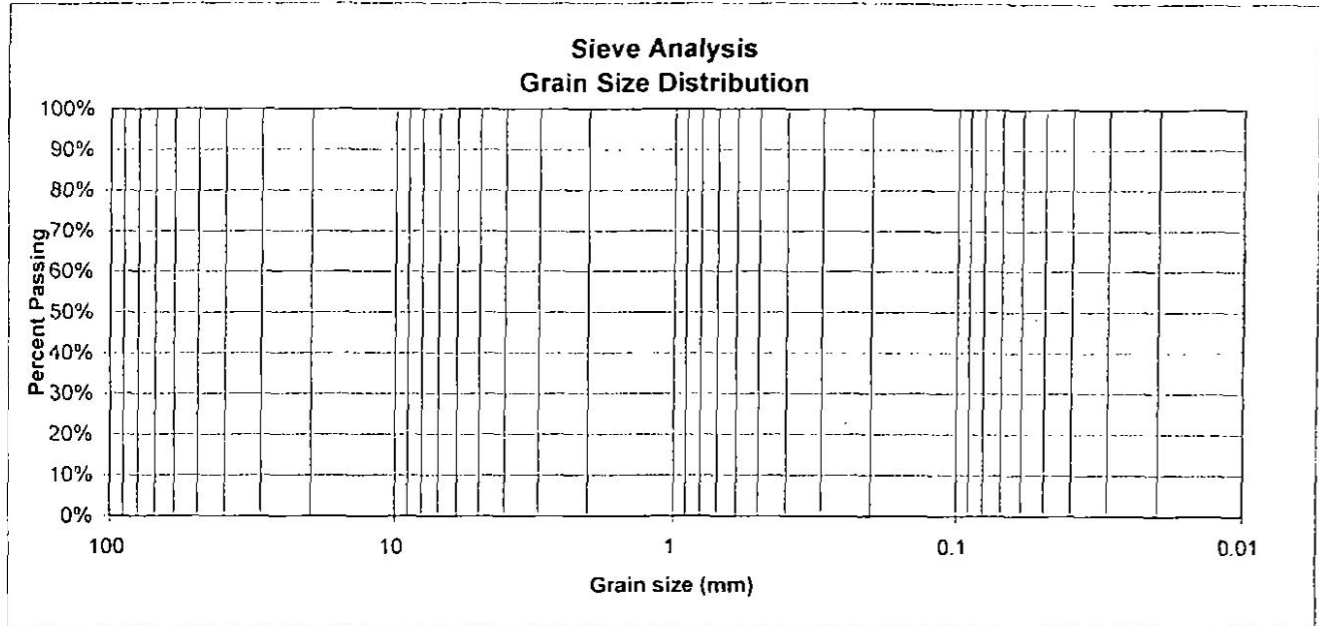
82556

FIG NO.:

C-15

UNIFIED CLASSIFICATION CL
 SOIL TYPE # 2
 TEST BORING # 27
 DEPTH (FT) 9

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



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

Percent
Finer

Atterberg
Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start 13.7%
Moisture at finish 23.2%
Moisture increase 9.6%
Initial dry density (pcf) 103
Swell (psf) 2300



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[Signature]

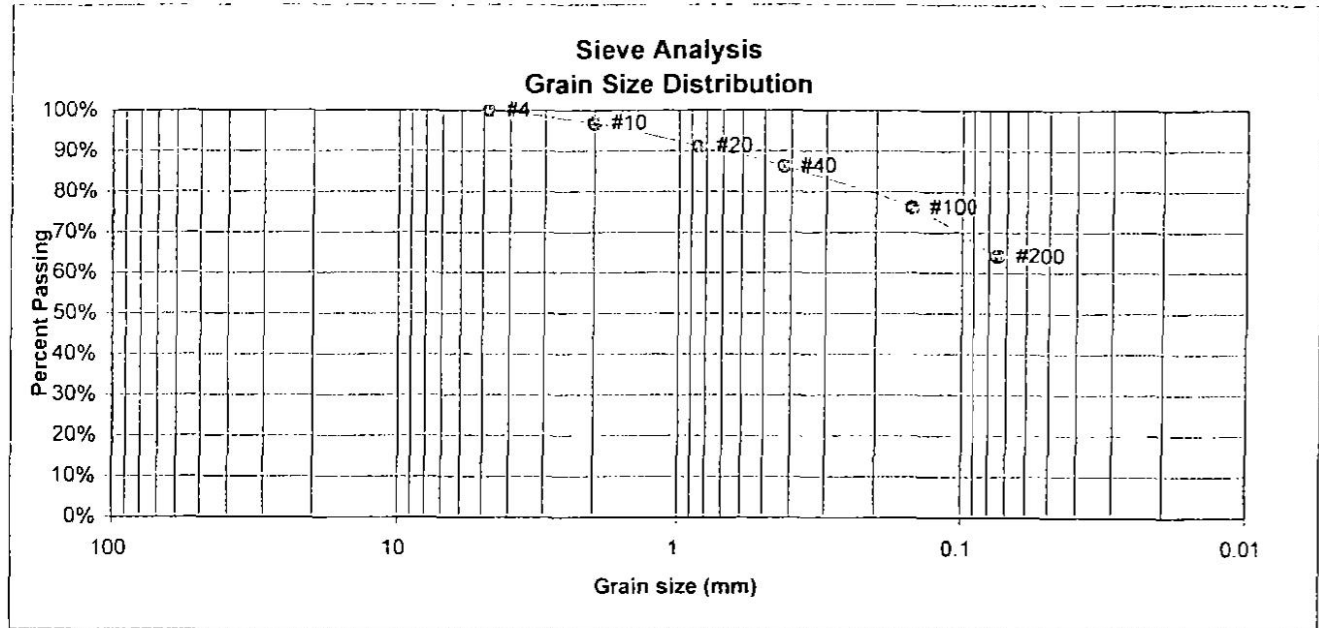
DATE:
9/5/02

JOB NO.:
82556

FIG NO.:
C-16

UNIFIED CLASSIFICATION CL
 SOIL TYPE # 2
 TEST BORING # 31
 DEPTH (FT) 5

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	96.8%
20	91.2%
40	86.3%
100	76.2%
200	64.2%

**Atterberg
Limits**

Plastic Limit	15
Liquid Limit	40
Plastic Index	25

Swell

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



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JOB NO.:

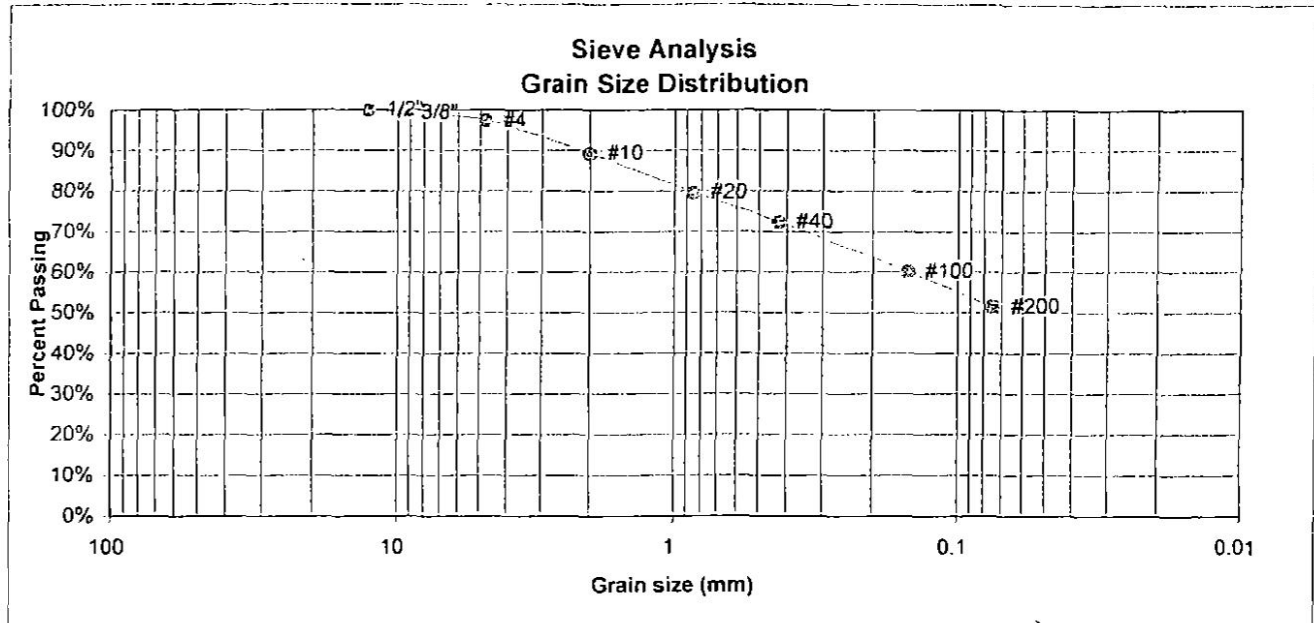
82556

FIG NO.:

C-17

UNIFIED CLASSIFICATION CL
 SOIL TYPE # 2
 TEST BORING # 34
 DEPTH (FT) 2-5

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	99.4%
4	97.4%
10	89.3%
20	79.6%
40	72.4%
100	60.1%
200	51.6%

**Atterberg
Limits**

Plastic Limit	14
Liquid Limit	27
Plastic Index	13

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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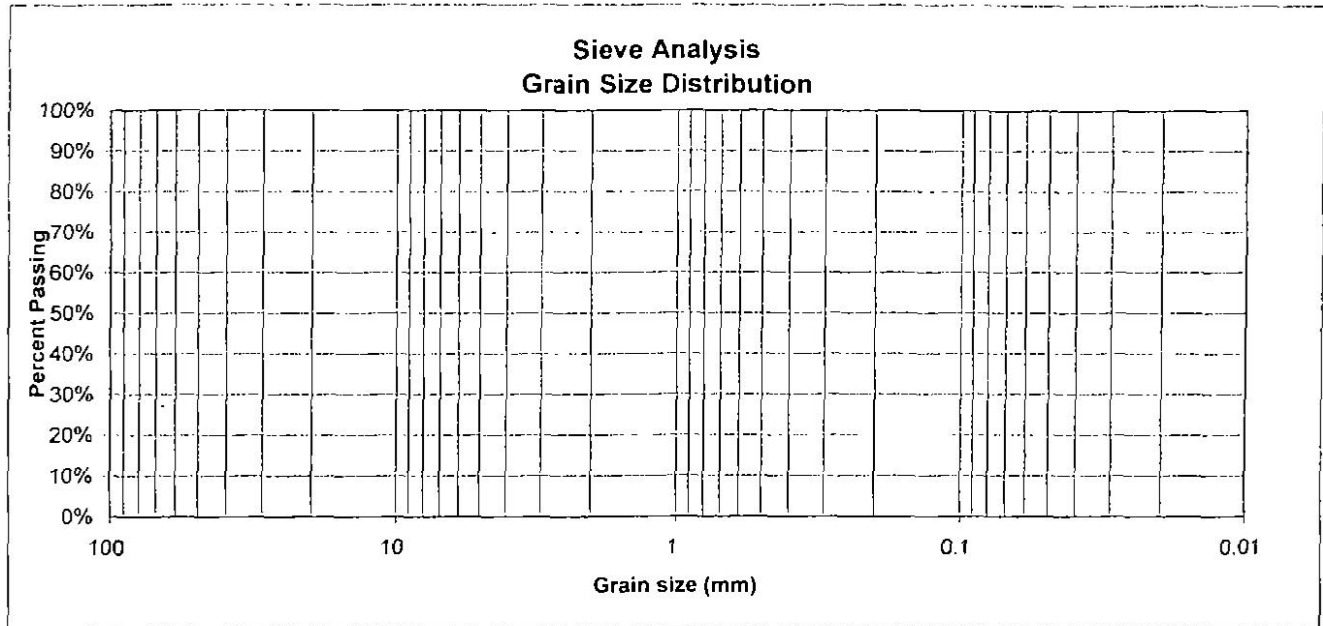
9/5/06

JOB NO.:
82556

FIG NO.:
C-18

UNIFIED CLASSIFICATION SC
 SOIL TYPE # 3
 TEST BORING # 5
 DEPTH (FT) 15

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 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 13
 Liquid Limit 24
 Plastic Index 11

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



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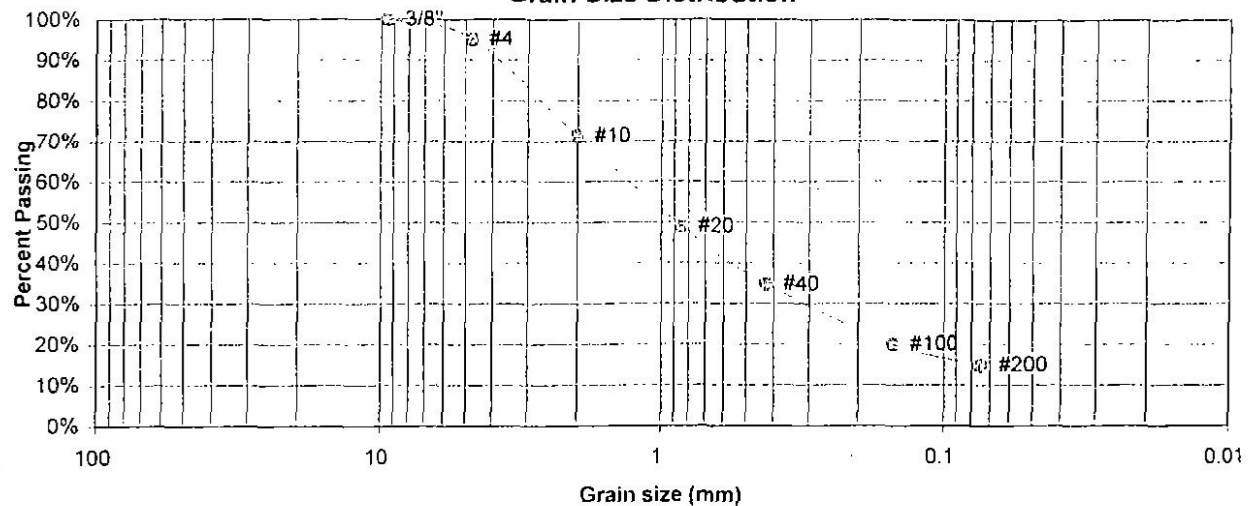
FIG NO.:
C-19

UNIFIED CLASSIFICATION SM

SOIL TYPE # 3
 TEST BORING # 6
 DEPTH (FT) 15-20

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG

Sieve Analysis Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.2%
10	71.4%
20	49.1%
40	34.8%
100	20.0%
200	14.8%

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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JOB NO.:

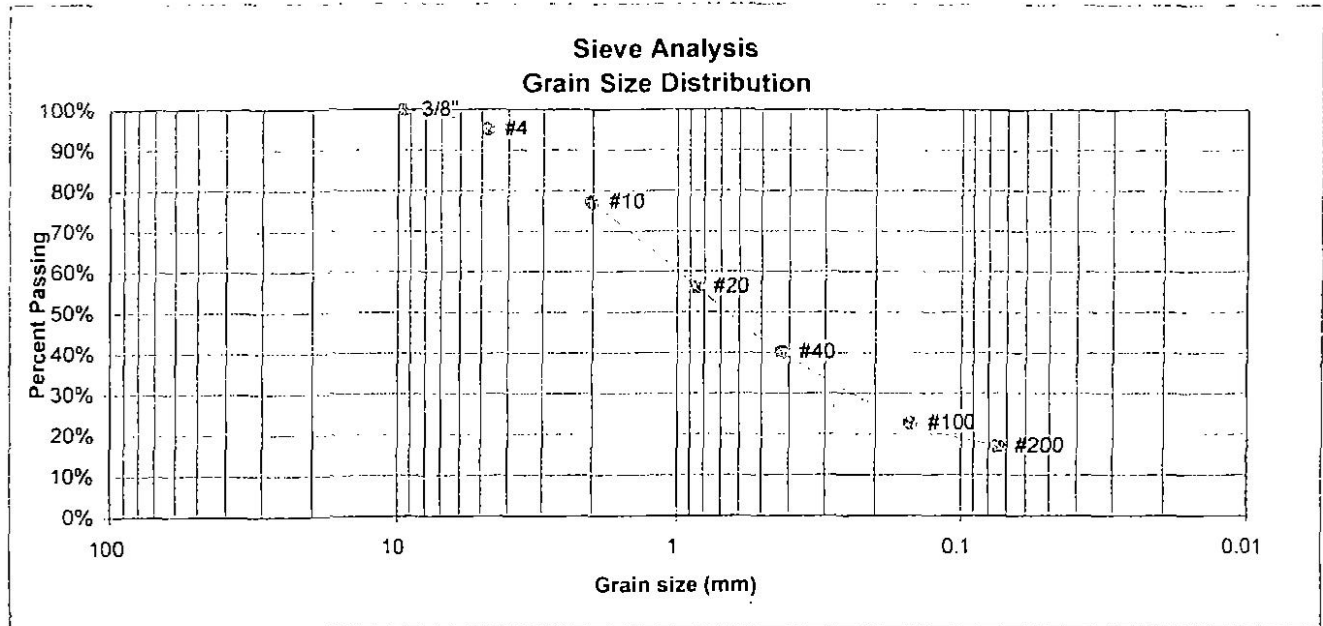
82556

FIG NO.:

C-20

UNIFIED CLASSIFICATION SM
 SOIL TYPE # 3
 TEST BORING # 11
 DEPTH (FT) 10

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.2%
10	77.2%
20	56.2%
40	40.1%
100	22.7%
200	17.1%

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
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JOB NO.:
82556

FIG NO.:
C-21

UNIFIED CLASSIFICATION SM

SOIL TYPE # 3
 TEST BORING # 13
 DEPTH (FT) 10

CLIENT

MORLEY BENTLEY

PROJECT

STERLING RANCH

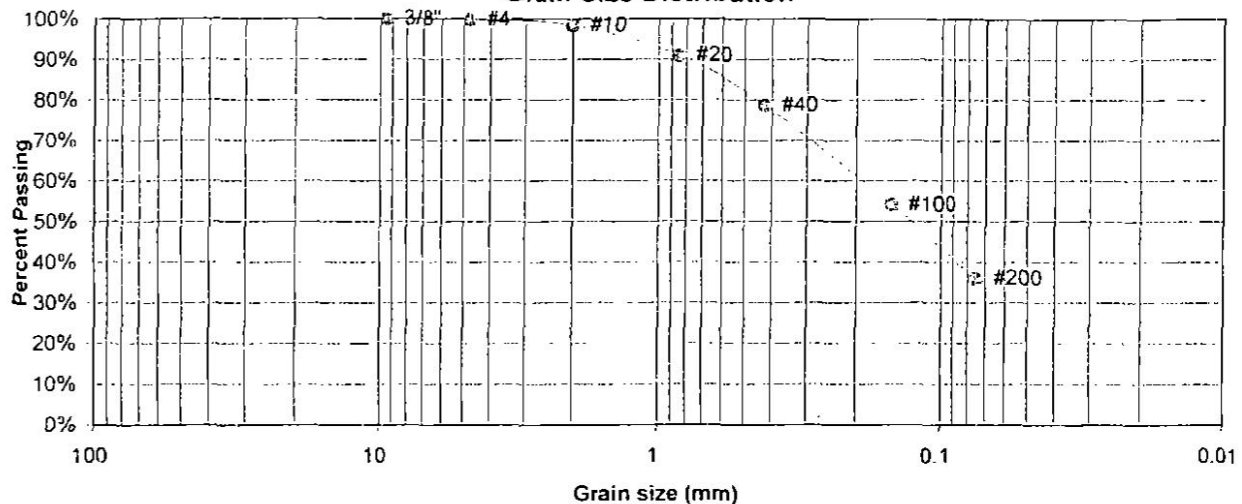
JOB NO.

82556

TEST BY

DG

Sieve Analysis Grain Size Distribution



U.S.
Sieve #

Percent
Finer

3"
 1 1/2"
 3/4"
 1/2"
 3/8" 100.0%
 4 99.8%
 10 98.4%
 20 90.9%
 40 78.7%
 100 54.1%
 200 36.0%

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.:

82556

FIG NO.:

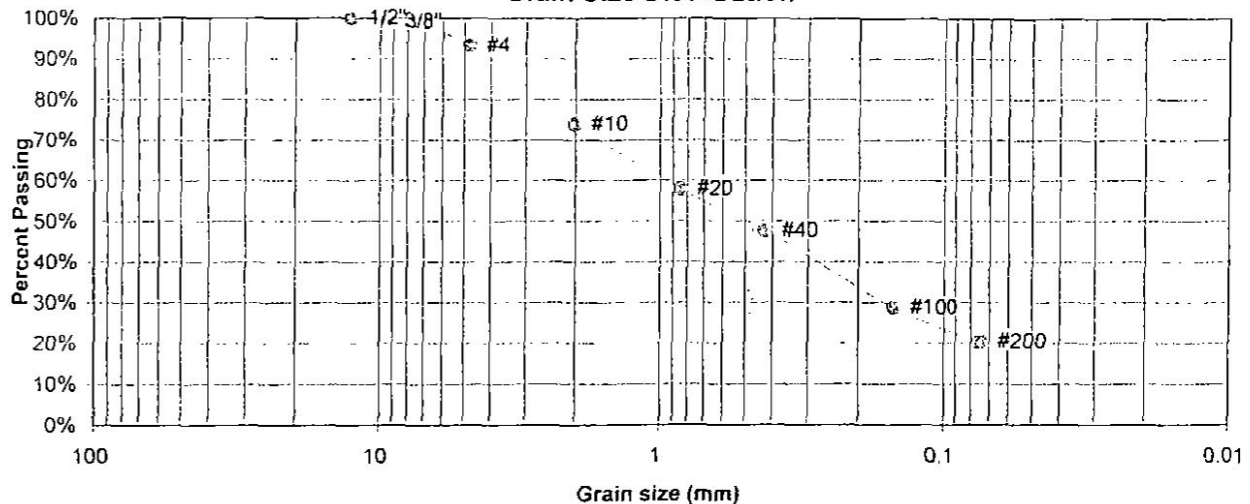
C-2.2

UNIFIED CLASSIFICATION SM

SOIL TYPE # 3
 TEST BORING # 14
 DEPTH (FT) 5

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG

Sieve Analysis Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	99.2%
4	93.4%
10	74.0%
20	57.9%
40	47.7%
100	28.7%
200	20.4%

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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DATE:

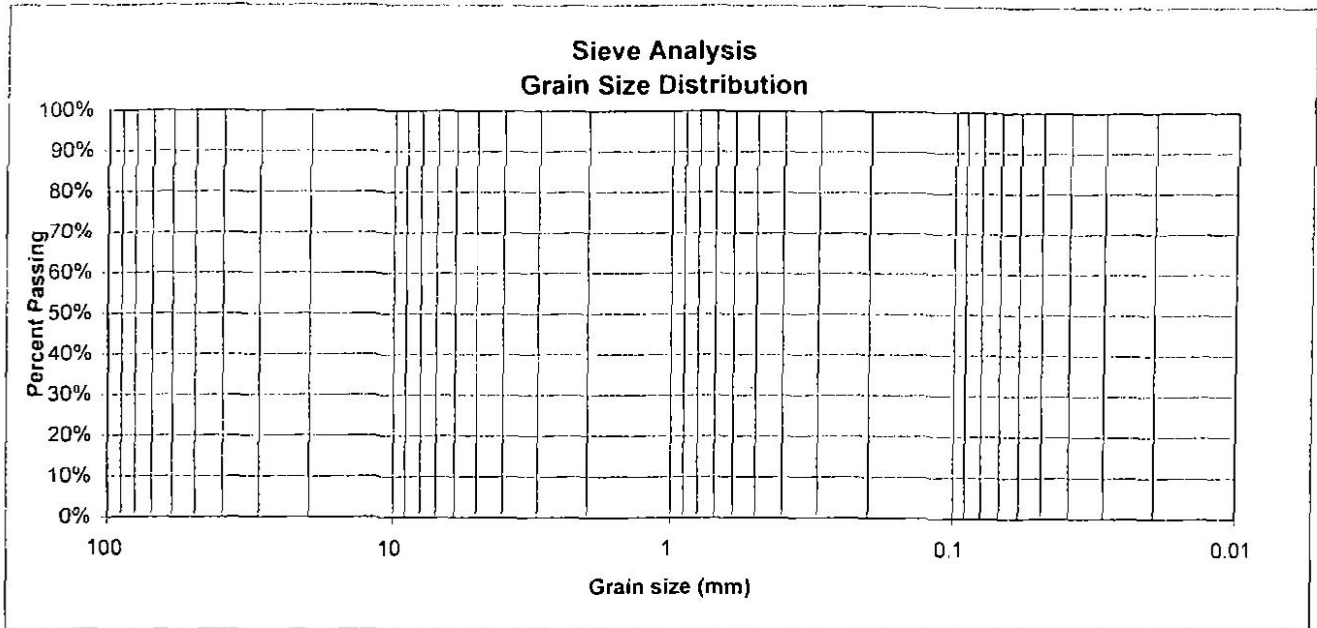
JOB NO.:

82556

FIG NO.:

C-23

<u>UNIFIED CLASSIFICATION</u> SM		<u>CLIENT</u>	MORLEY BENTLEY
<u>SOIL TYPE #</u>	3	<u>PROJECT</u>	STERLING RANCH
<u>TEST BORING #</u>	18	<u>JOB NO.</u>	82556
<u>DEPTH (FT)</u>	15	<u>TEST BY</u>	DG



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
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 12.6%
Moisture at finish 23.0%
Moisture increase 10.3%
Initial dry density (pcf) 96
Swell (psf) 456



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LABORATORY TEST RESULTS

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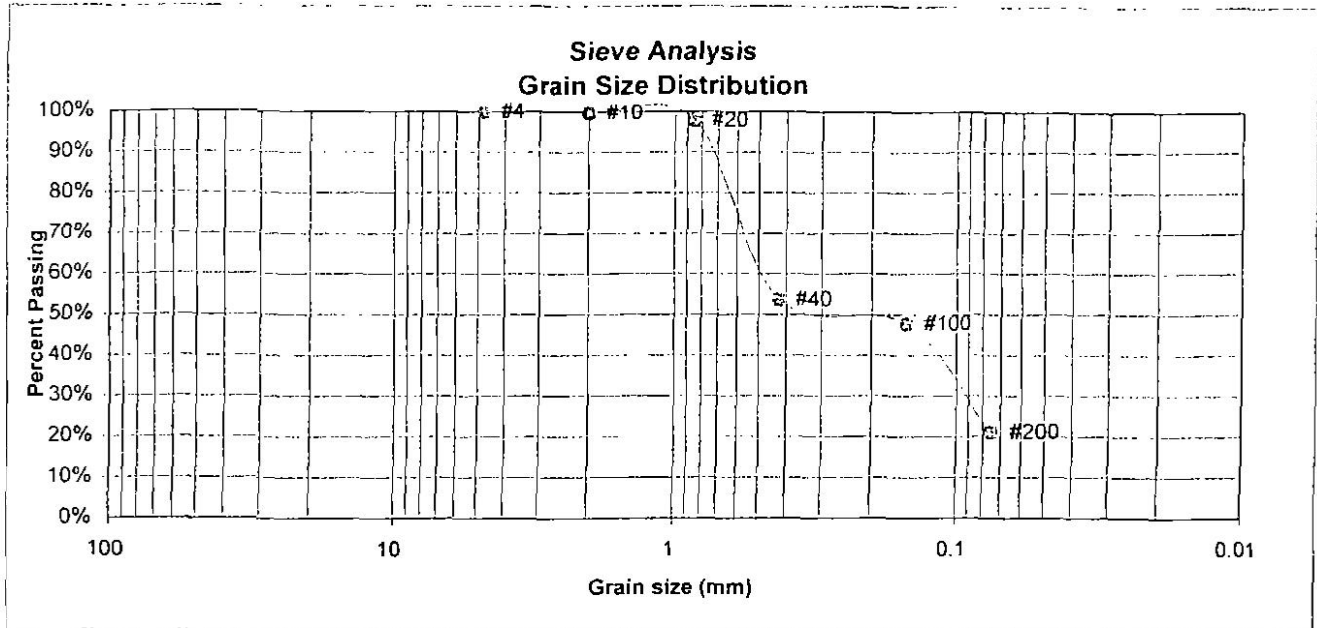
9/15/05

JOB NO.:
82556

FIG NO.:
C-24

UNIFIED CLASSIFICATION SM
 SOIL TYPE # 3
 TEST BORING # 22
 DEPTH (FT) 5

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.7%
20	97.8%
40	53.7%
100	47.7%
200	21.1%

**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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JOB NO.:
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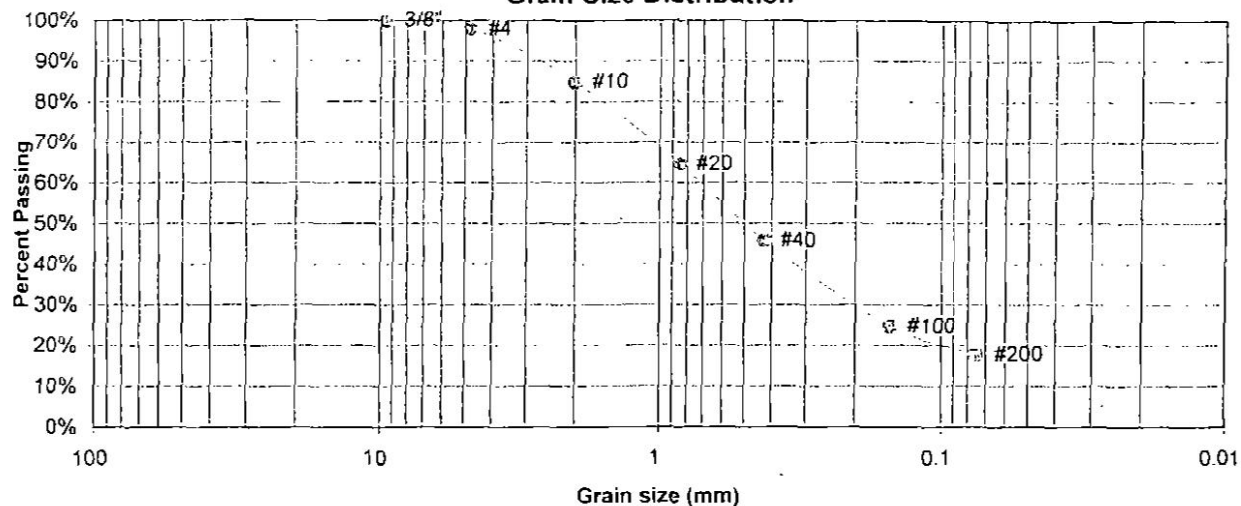
FIG NO.:
C-25

UNIFIED CLASSIFICATION SM

SOIL TYPE # 3
 TEST BORING # 28
 DEPTH (FT) 5-10

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG

Sieve Analysis Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.9%
10	84.9%
20	64.6%
40	45.8%
100	24.6%
200	17.8%

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.:

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FIG NO.:

C-26

UNIFIED CLASSIFICATION SC

SOIL TYPE # 3

TEST BORING # 29

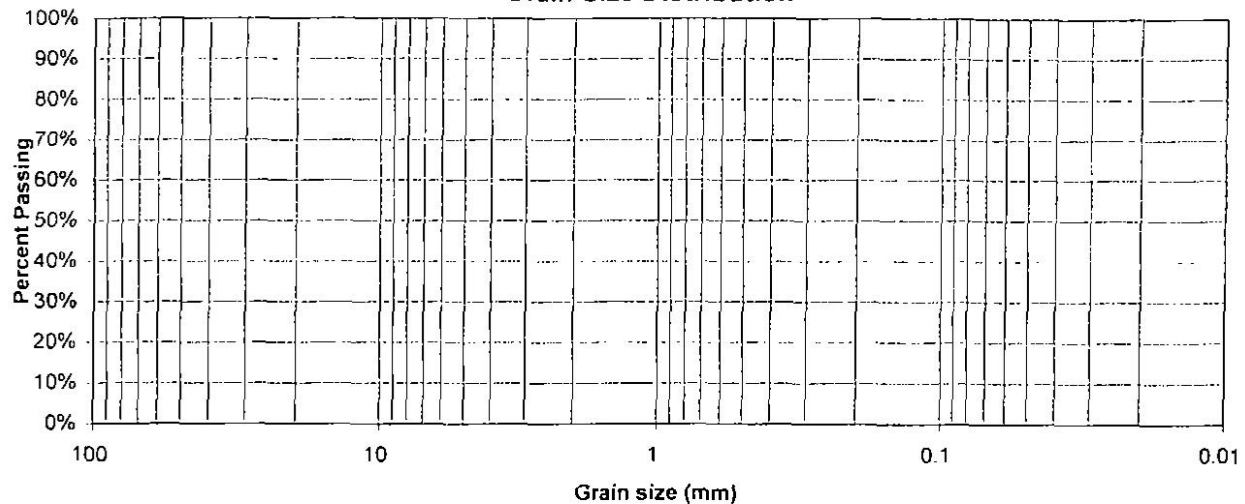
DEPTH (FT) 7

CLIENT MORLEY BENTLEY

PROJECT STERLING RANCH

JOB NO. 82556

TEST BY DG

Sieve Analysis
Grain Size DistributionU.S.
Sieve #Percent
FinerAtterberg
Limits

Plastic Limit

Liquid Limit

Plastic Index

3"
1 1/2"
3/4"
1/2"
3/8"
4
10
20
40
100
200

Swell

Moisture at start 8.5%

Moisture at finish 16.1%

Moisture increase 7.6%

Initial dry density (pcf) 111

Swell (psf) 485


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JOB NO.:

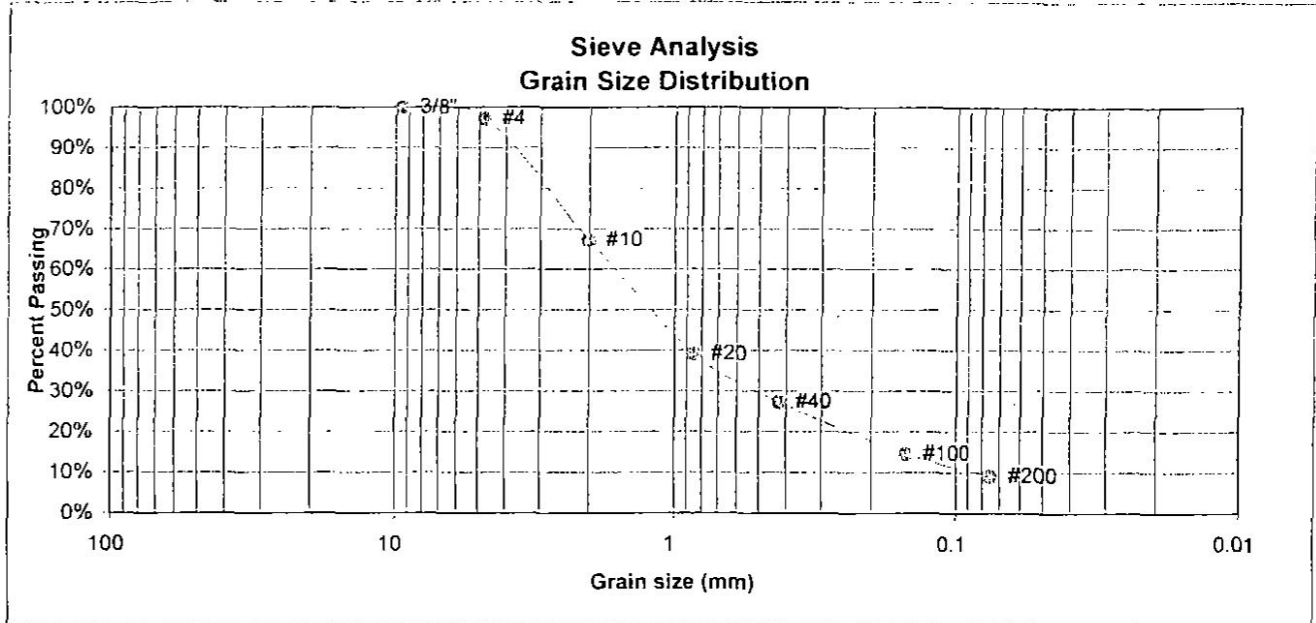
82556

FIG NO.:

C-27

UNIFIED CLASSIFICATION SM-SW
 SOIL TYPE # 3
 TEST BORING # 30
 DEPTH (FT) 10

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer	Atterberg Limits
3"		Plastic Limit
1 1/2"		Liquid Limit
3/4"		Plastic Index
1/2"		
3/8"	100.0%	
4	97.2%	<u>Swell</u>
10	67.3%	Moisture at start
20	39.1%	Moisture at finish
40	27.3%	Moisture increase
100	14.6%	Initial dry density (pcf)
200	9.1%	Swell (psf)



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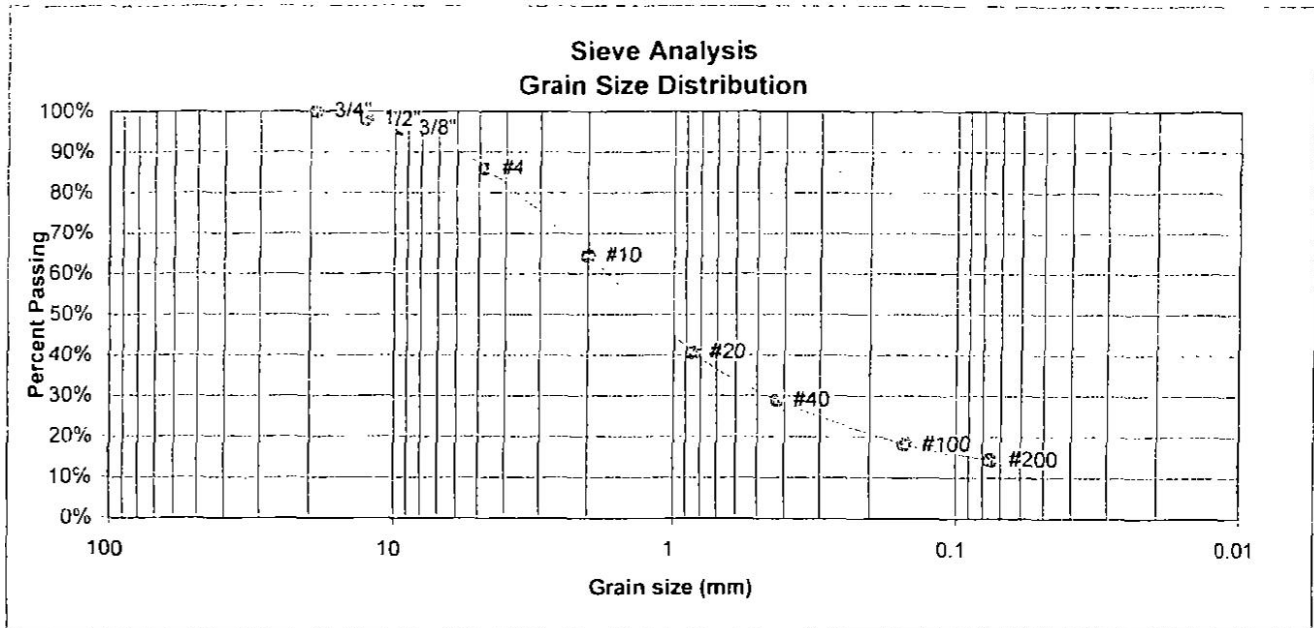
**LABORATORY TEST
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>[Signature]</i>	9/15/06

JOB NO.:
 82556
 FIG NO.:
 C-28

UNIFIED CLASSIFICATION SM
 SOIL TYPE # 3
 TEST BORING # 33
 DEPTH (FT) 5

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	100.0%
1/2"	98.0%
3/8"	95.8%
4	86.0%
10	64.5%
20	40.6%
40	29.0%
100	18.1%
200	14.4%

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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82556

FIG NO.:

C-29

UNIFIED CLASSIFICATION SM-SW

SOIL TYPE # 3

TEST BORING # 35

DEPTH (FT) 15

CLIENT

MORLEY BENTLEY

PROJECT

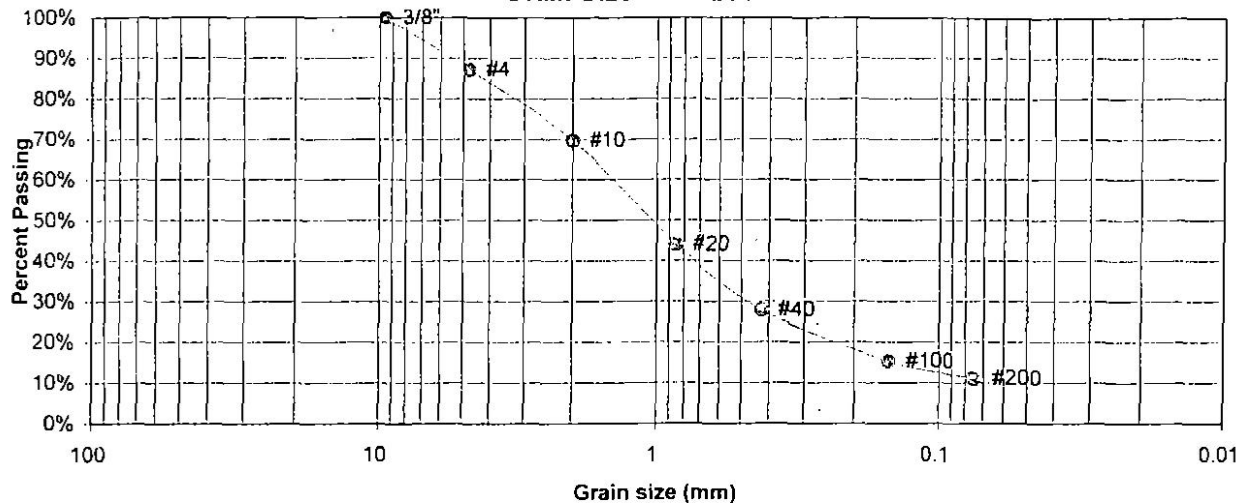
STERLING RANCH

JOB NO.

82556

TEST BY

DG

Sieve Analysis
Grain Size DistributionU.S.
Sieve #Percent
Finer

3"

1 1/2"

3/4"

1/2"

3/8"

4

10

20

40

100

200

100.0%

87.2%

69.7%

44.1%

27.9%

15.2%

11.1%

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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RESULTS

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JOB NO.:

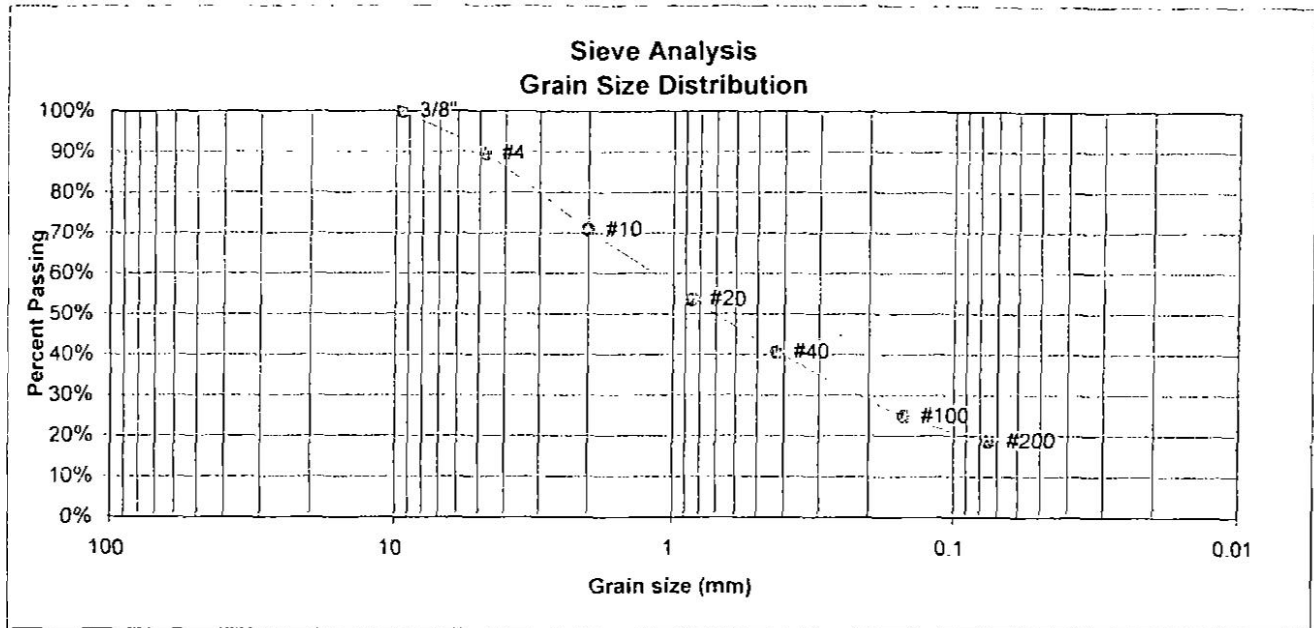
82556

FIG NO.:

C-30

UNIFIED CLASSIFICATION SC
 SOIL TYPE # 3
 TEST BORING # 36
 DEPTH (FT) 2-5

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	89.5%
10	70.9%
20	53.6%
40	40.6%
100	24.9%
200	18.7%

Atterberg
Limits
 Plastic Limit
 Liquid Limit
 Plastic Index

Swell
 Moisture at start 10.3%
 Moisture at finish 17.7%
 Moisture increase 7.4%
 Initial dry density (pcf) 108
 Swell (psf) 1014



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**LABORATORY TEST
RESULTS**

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DATE:

CHECKED:

DATE:

12/10/06

9/15/06

JOB NO.:

82556

FIG NO.:

C-31

UNIFIED CLASSIFICATION SM

SOIL TYPE # 3
 TEST BORING # 38
 DEPTH (FT) 5

CLIENT

MORLEY BENTLEY

PROJECT

STERLING RANCH

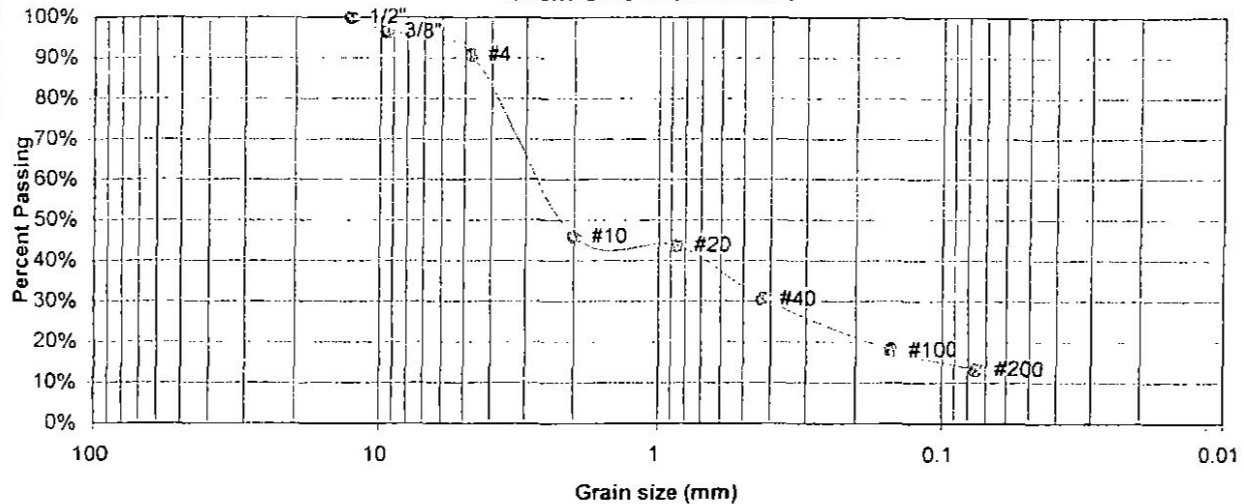
JOB NO.

82556

TEST BY

DG

Sieve Analysis Grain Size Distribution



U.S.
Sieve #

Percent
Finer

3"

1 1/2"

3/4"

1/2"

3/8"

4

10

20

40

100

200

100.0%

96.5%

90.8%

45.9%

43.7%

30.5%

18.0%

13.3%

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

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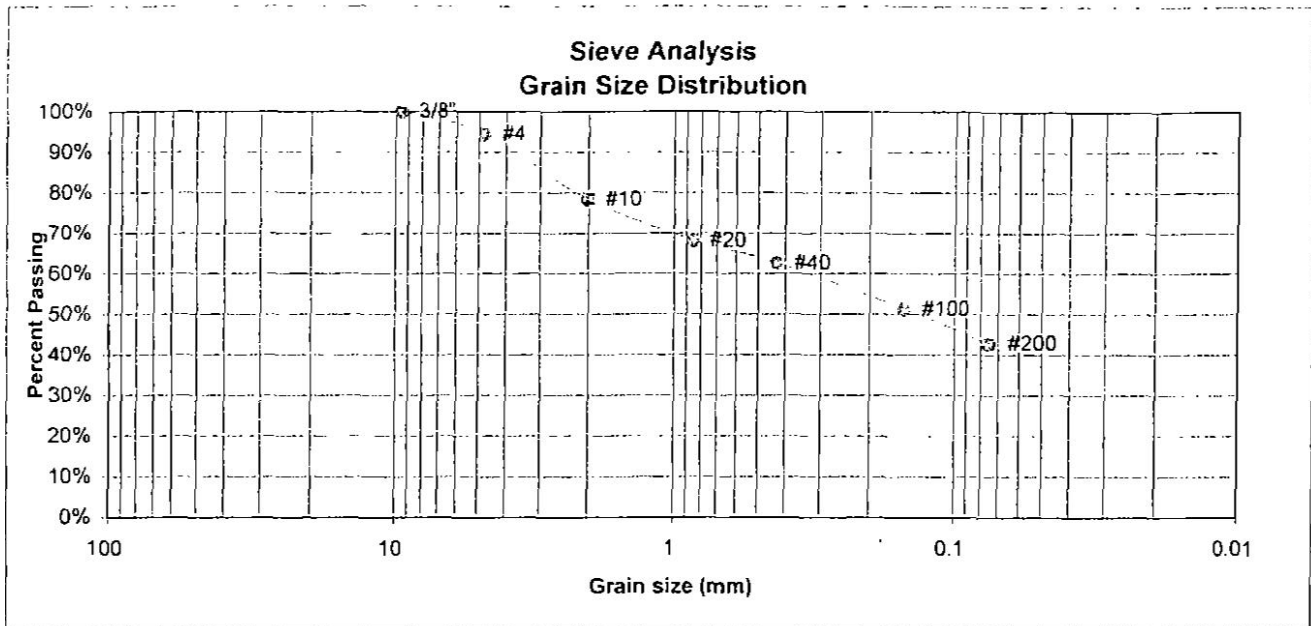
8-2556

FIG NO.:

C-32

UNIFIED CLASSIFICATION SC
 SOIL TYPE # 3
 TEST BORING # 39
 DEPTH (FT) 15

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.4%
10	78.3%
20	68.2%
40	62.5%
100	51.2%
200	42.8%

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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**LABORATORY TEST
RESULTS**

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JOB NO.:
 82556
 FIG NO.:
 C-33

UNIFIED CLASSIFICATION SM-SC

SOIL TYPE # 3

TEST BORING # 40

DEPTH (FT) 2-3

CLIENT

MORLEY BENTLEY

PROJECT

STERLING RANCH

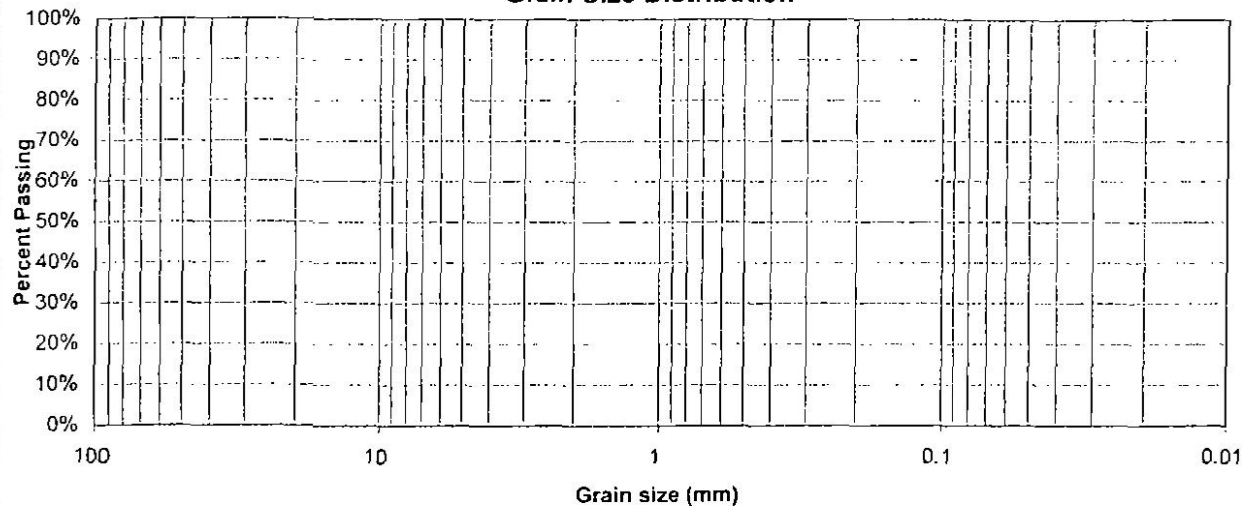
JOB NO.

82556

TEST BY

DG

Sieve Analysis Grain Size Distribution



U.S.
Sieve #

Percent
Finer

Atterberg
Limits

Plastic Limit

Liquid Limit

Plastic Index

3"

1 1/2"

3/4"

1/2"

3/8"

4

10

20

40

100

200

Swell

Moisture at start 7.1%

Moisture at finish 19.7%

Moisture increase 12.6%

Initial dry density (pcf) 104

Swell (psf) 360



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LABORATORY TEST RESULTS

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DATE:

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JOB NO.:

82556

FIG NO.:

C-34

UNIFIED CLASSIFICATION CL

SOIL TYPE # 4

TEST BORING # 1

DEPTH (FT) 5

CLIENT

MORLEY BENTLEY

PROJECT

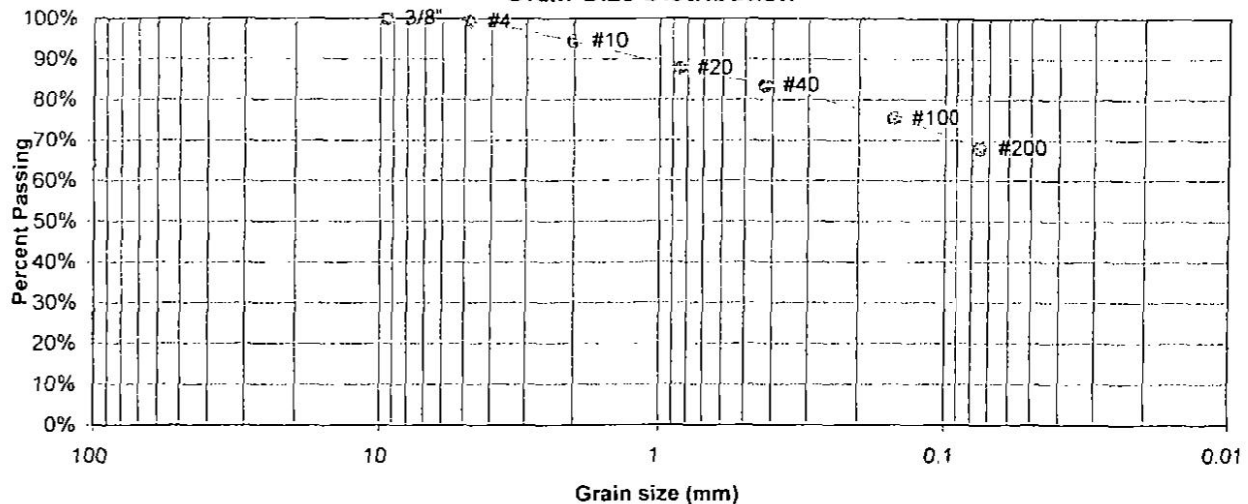
STERLING RANCH

JOB NO.

82556

TEST BY

DG

Sieve Analysis
Grain Size DistributionU.S.
Sieve #Percent
Finer

3"

1 1/2"

3/4"

1/2"

3/8"

4

10

20

40

100

200

100.0%

99.2%

94.4%

87.7%

83.5%

75.5%

68.1%

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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DATE:

LGA

9/15/06

JOB NO.:

82556

FIG NO.:

C-35

UNIFIED CLASSIFICATION CL

SOIL TYPE # 4

TEST BORING # 3

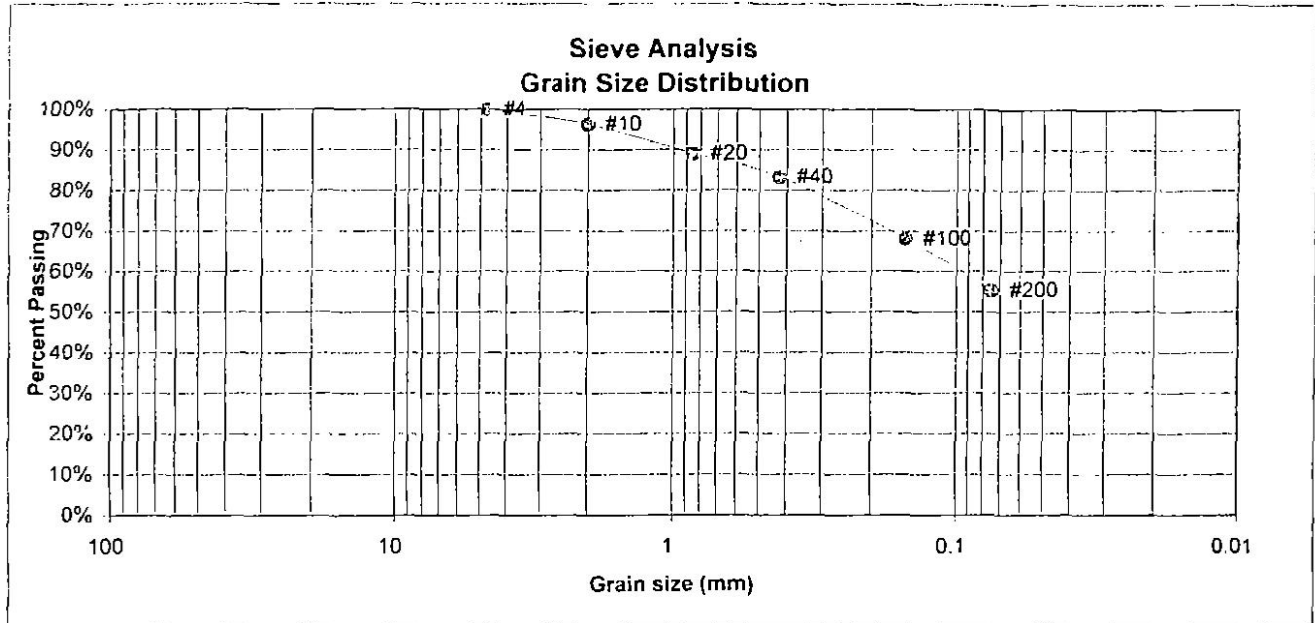
DEPTH (FT) 7

CLIENT MORLEY BENTLEY

PROJECT STERLING RANCH

JOB NO. 82556

TEST BY DG

U.S.
Sieve #

3"

1 1/2"

3/4"

1/2"

3/8"

4

10

20

40

100

200

Percent
Finer

100.0%

96.2%

89.0%

83.3%

68.1%

55.3%

Atterberg
Limits

Plastic Limit 14

Liquid Limit 32

Plastic Index 18

Swell

Moisture at start 10.4%

Moisture at finish 18.3%

Moisture increase 8.0%

Initial dry density (pcf) 107

Swell (psf) 846


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**LABORATORY TEST
RESULTS**

DRAWN:

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CHECKED:

DATE:

Whe

9/5/06

JOB NO.:

82556

FIG NO.:

C-36

UNIFIED CLASSIFICATION CL

SOIL TYPE # 4
 TEST BORING # 24
 DEPTH (FT) 2-3

CLIENT

MORLEY BENTLEY

PROJECT

STERLING RANCH

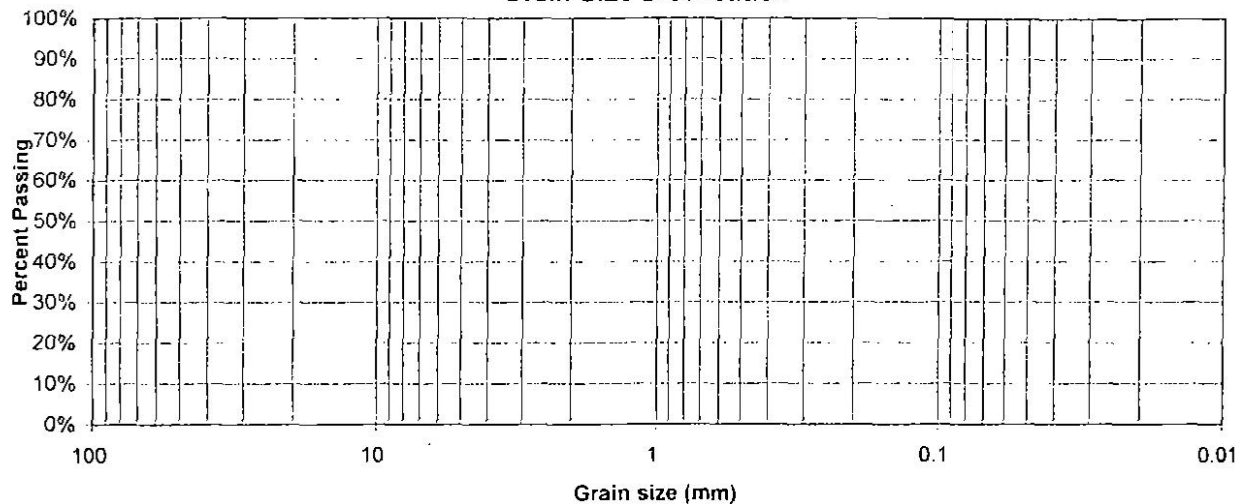
JOB NO.

82556

TEST BY

DG

Sieve Analysis Grain Size Distribution



U.S.
Sieve #

Percent
Finer

Atterberg
Limits

Plastic Limit

Liquid Limit

Plastic Index

3"
 1 1/2"
 3/4"
 1/2"
 3/8"
 4
 10
 20
 40
 100
 200

Swell

Moisture at start	13.0%
Moisture at finish	25.1%
Moisture increase	12.1%
Initial dry density (pcf)	97
Swell (psf)	1757



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LABORATORY TEST RESULTS

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DATE:

JOB NO.:

82556

FIG NO.:

C-37

UNIFIED CLASSIFICATION CL

SOIL TYPE # 4

TEST BORING # 25

DEPTH (FT) 10

CLIENT

MORLEY BENTLEY

PROJECT

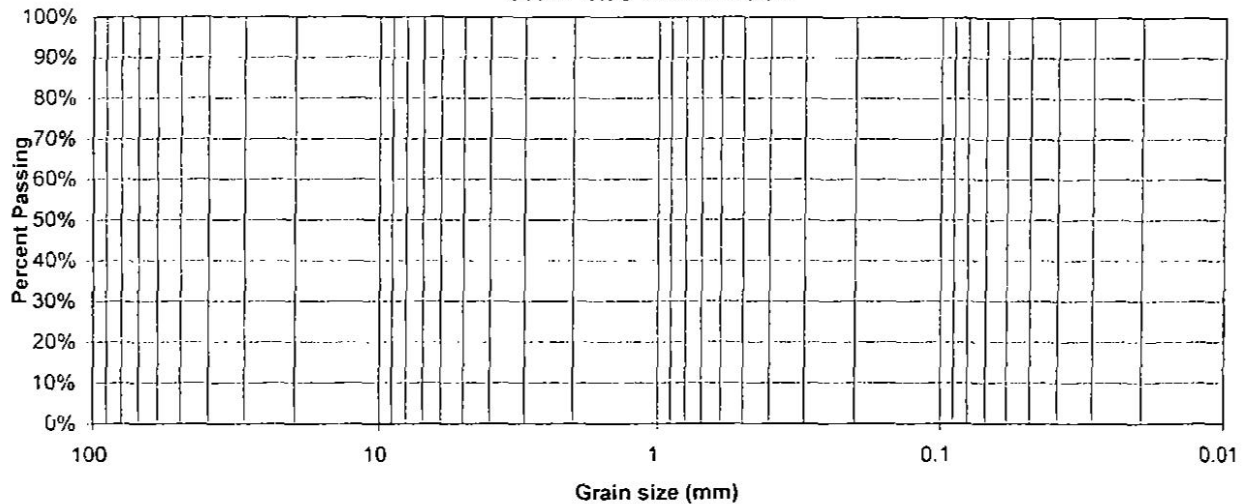
STERLING RANCH

JOB NO.

82556

TEST BY

DG

**Sieve Analysis
Grain Size Distribution****U.S.
Sieve #****Percent
Finer****Atterberg
Limits**3"
1 1/2"
3/4"
1/2"
3/8"
4
10
20
40
100
200Plastic Limit
Liquid Limit
Plastic Index**Swell**Moisture at start 11.2%
Moisture at finish 23.2%
Moisture increase 12.0%
Initial dry density (pcf) 99
Swell (psf) 1845**ENTECH
ENGINEERING, INC.**505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907 (719) 531-5599**LABORATORY TEST
RESULTS**

DRAWN:

DATE:

CHECKED:

DATE:

1/24

9/5/06

JOB NO.:

82556

FIG NO.:

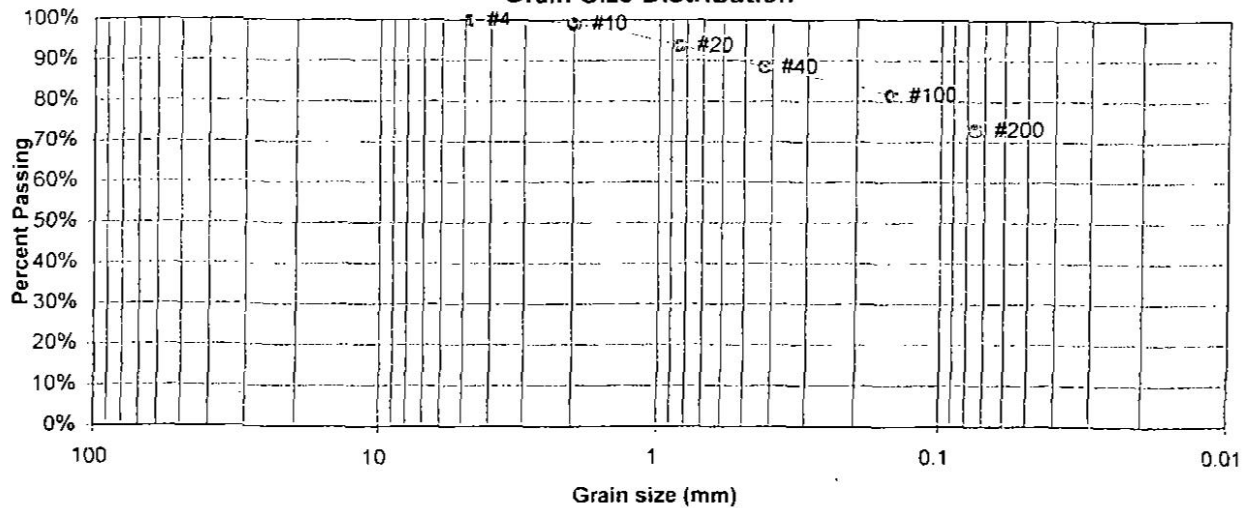
C-38

UNIFIED CLASSIFICATION CH

SOIL TYPE # 4
 TEST BORING # 33
 DEPTH (FT) 15

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG

Sieve Analysis
 Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.1%
20	93.7%
40	88.4%
100	81.5%
200	73.0%

Atterberg

Limits

Plastic Limit 23
 Liquid Limit 51
 Plastic Index 28

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:

JOB NO.:

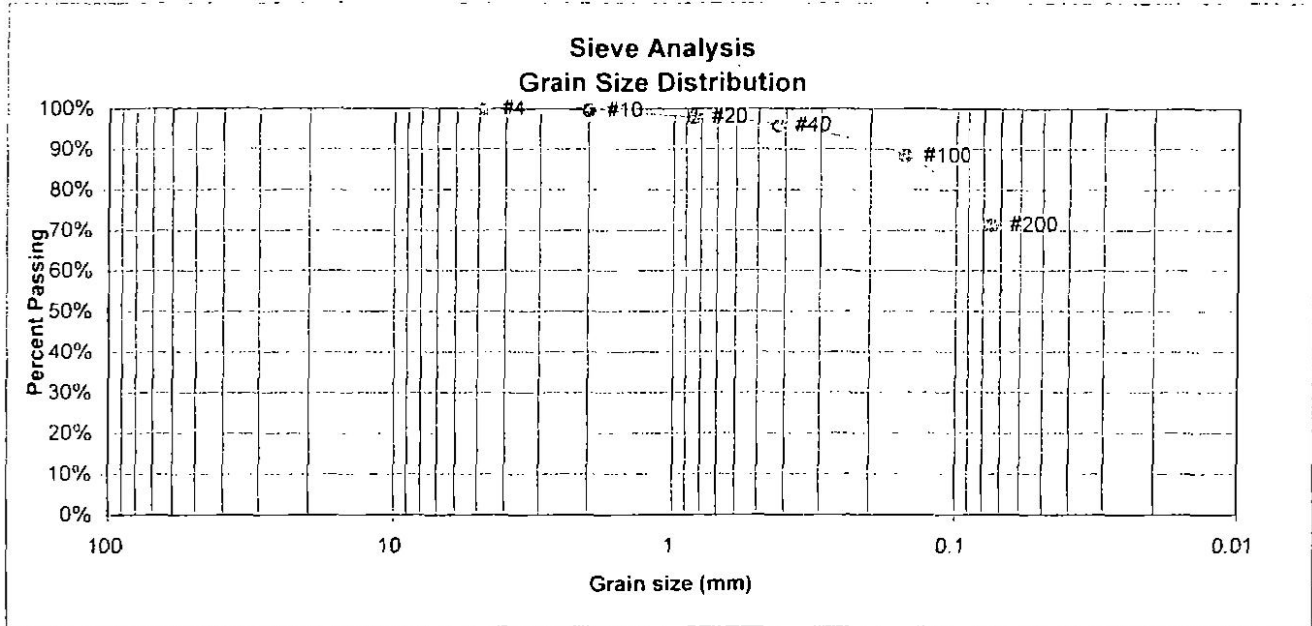
82556

FIG NO.:

C-39

UNIFIED CLASSIFICATION CL
 SOIL TYPE # 4
 TEST BORING # 40
 DEPTH (FT) 15

CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH
 JOB NO. 82556
 TEST BY DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.6%
20	97.9%
40	95.8%
100	88.4%
200	71.5%

**Atterberg
Limits**

Plastic Limit	22
Liquid Limit	38
Plastic Index	16

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:

1/24/06

9/5/06

JOB NO.:

82556

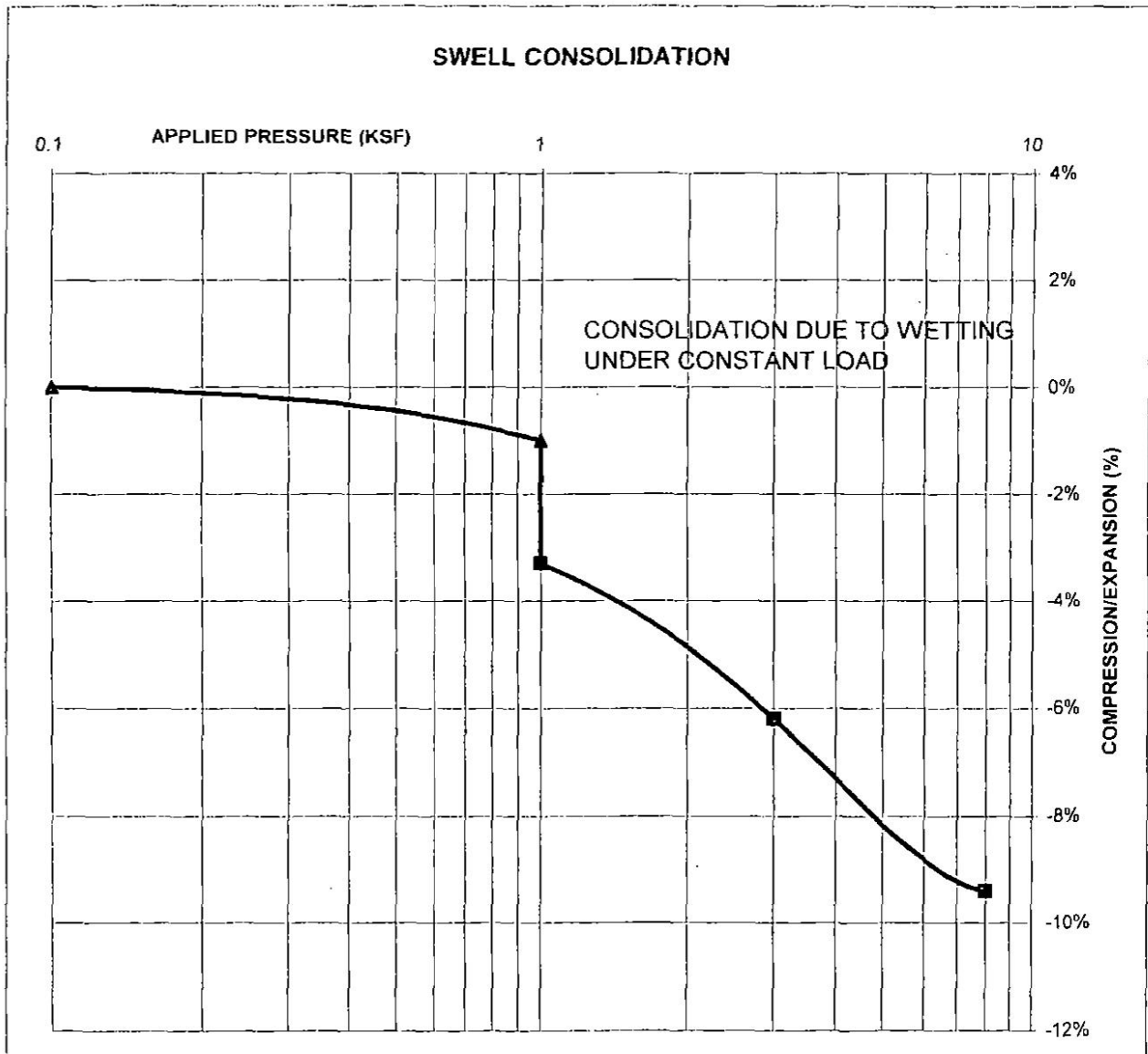
FIG NO.:

C-40

CONSOLIDATION TEST RESULTS

TEST BORING #	7	DEPTH(FT)	5
DESCRIPTION	CL	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)	98		
NATURAL MOISTURE CONTENT	5.6%		
SWELL/CONSOLIDATION (%)	-2.3%		

JOB NO. 82556
CLIENT MORLEY BENTLEY
PROJECT STERLING RANCH



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SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

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DATE:

[Signature] 9/5/06

JOB NO.:

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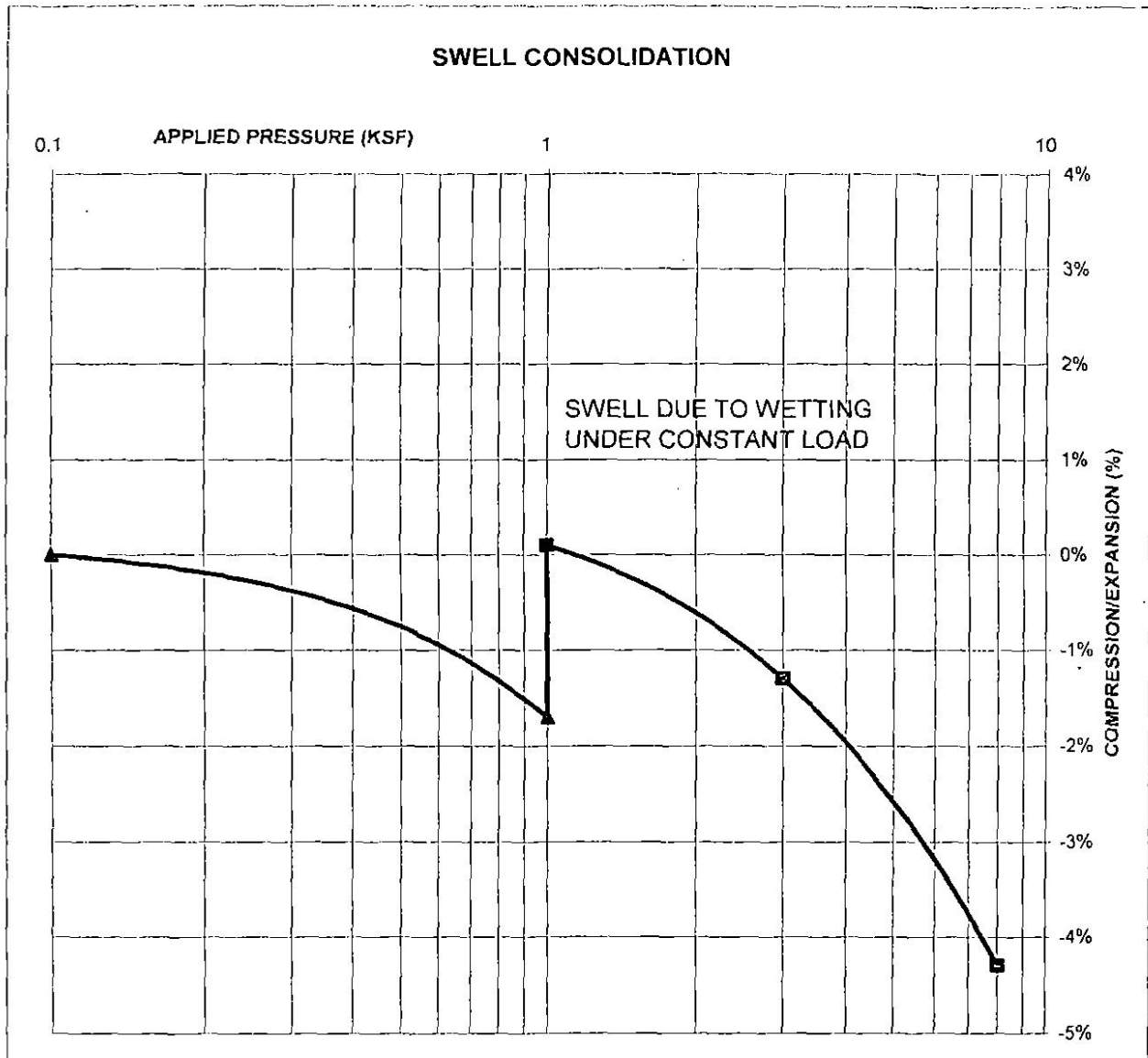
FIG NO.:

C-41

CONSOLIDATION TEST RESULTS

TEST BORING #	31	DEPTH(FT)	5
DESCRIPTION	CL	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)	95		
NATURAL MOISTURE CONTENT	27.9%		
SWELL/CONSOLIDATION (%)	1.8%		

JOB NO. 82556
 CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH



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SWELL CONSOLIDATION TEST RESULTS

DRAWN:

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DATE:

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JOB NO.:

82556

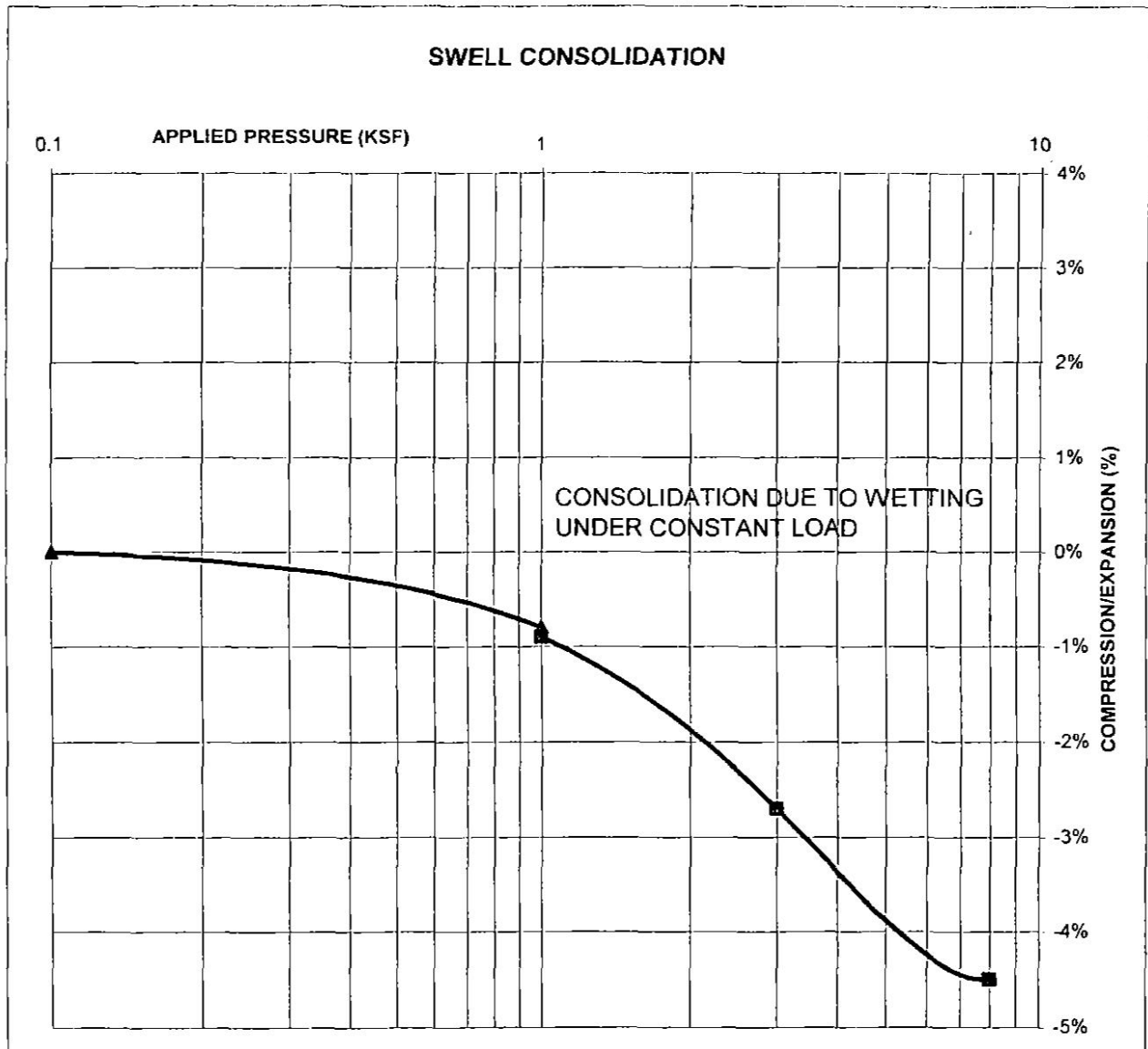
FIG NO.:

C-42

CONSOLIDATION TEST RESULTS

TEST BORING #	5	DEPTH(FT)	15
DESCRIPTION	SC	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)	119		
NATURAL MOISTURE CONTENT	10.4%		
SWELL/CONSOLIDATION (%)	-0.1%		

JOB NO. 82556
CLIENT MORLEY BENTLEY
PROJECT STERLING RANCH



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SWELL CONSOLIDATION TEST RESULTS

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9/5/06

JOB NO.:

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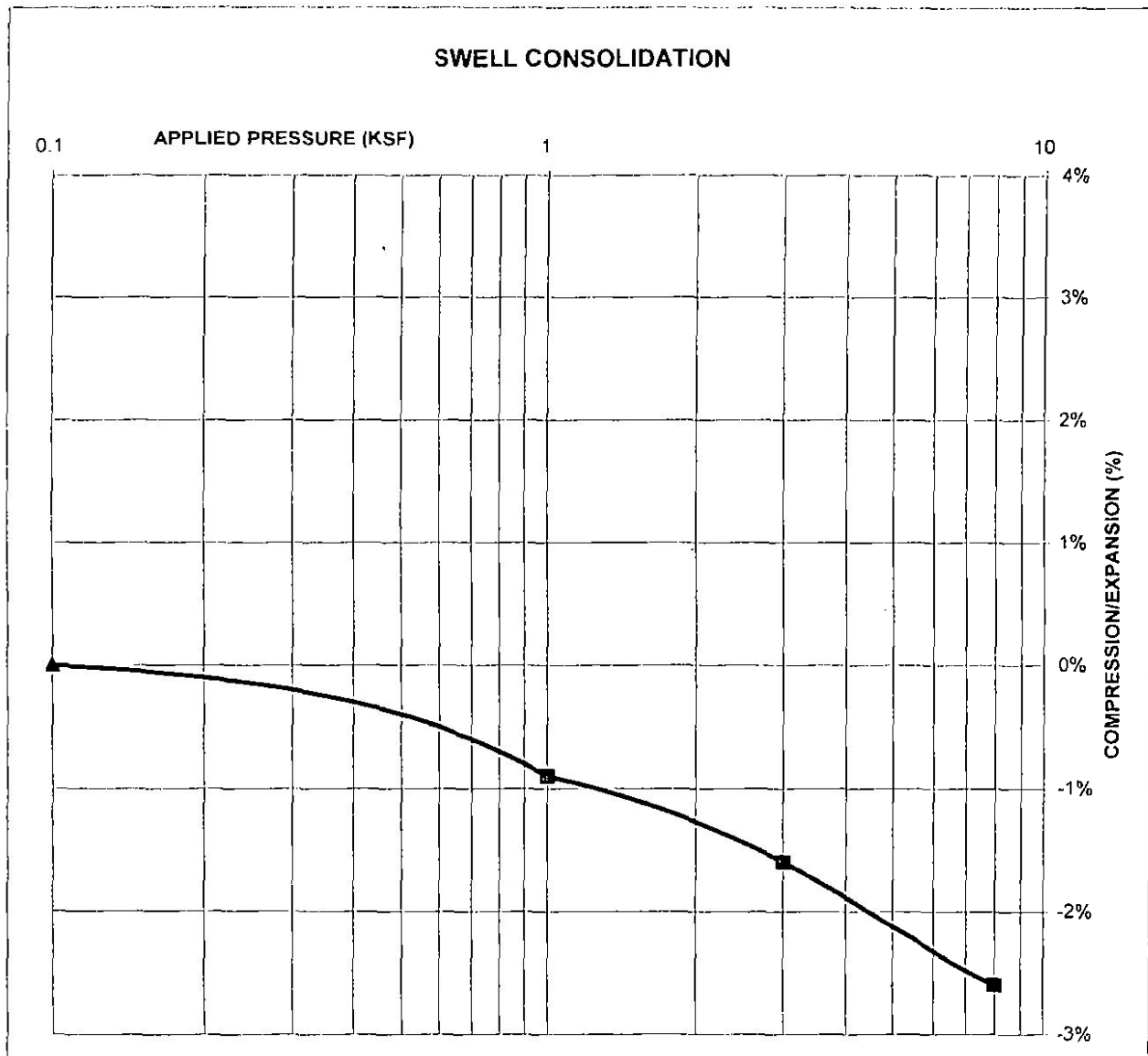
FIG NO.:

C-43

CONSOLIDATION TEST RESULTS

TEST BORING #	22	DEPTH(FT)	5
DESCRIPTION	SM	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)	101		
NATURAL MOISTURE CONTENT	23.3%		
SWELL/CONSOLIDATION (%)	0.0%		

JOB NO. 82556
CLIENT MORLEY BENTLEY
PROJECT STERLING RANCH



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COLORADO SPRINGS, CO 80907 (719) 531-5599

SWELL CONSOLIDATION TEST RESULTS

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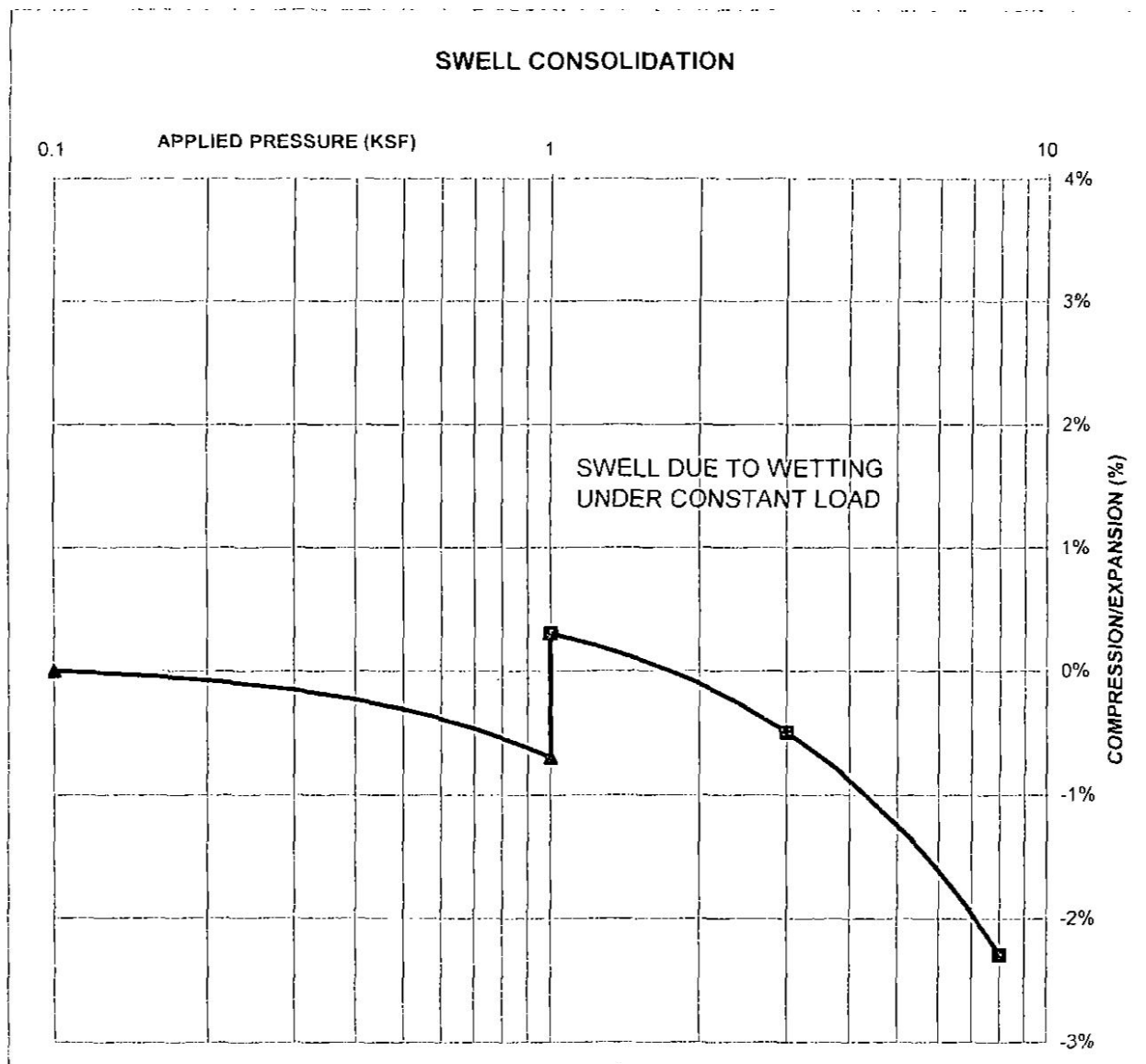
JOB NO.:

FIG NO.:

CONSOLIDATION TEST RESULTS

TEST BORING #	39	DEPTH(FT)	15
DESCRIPTION	SC	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)	124		
NATURAL MOISTURE CONTENT	11.0%		
SWELL/CONSOLIDATION (%)	1.0%		

JOB NO. 82556
 CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH



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 ENGINEERING, INC.
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 COLORADO SPRINGS, CO 80907 (719) 531-5599

SWELL CONSOLIDATION TEST RESULTS

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JOB NO.:

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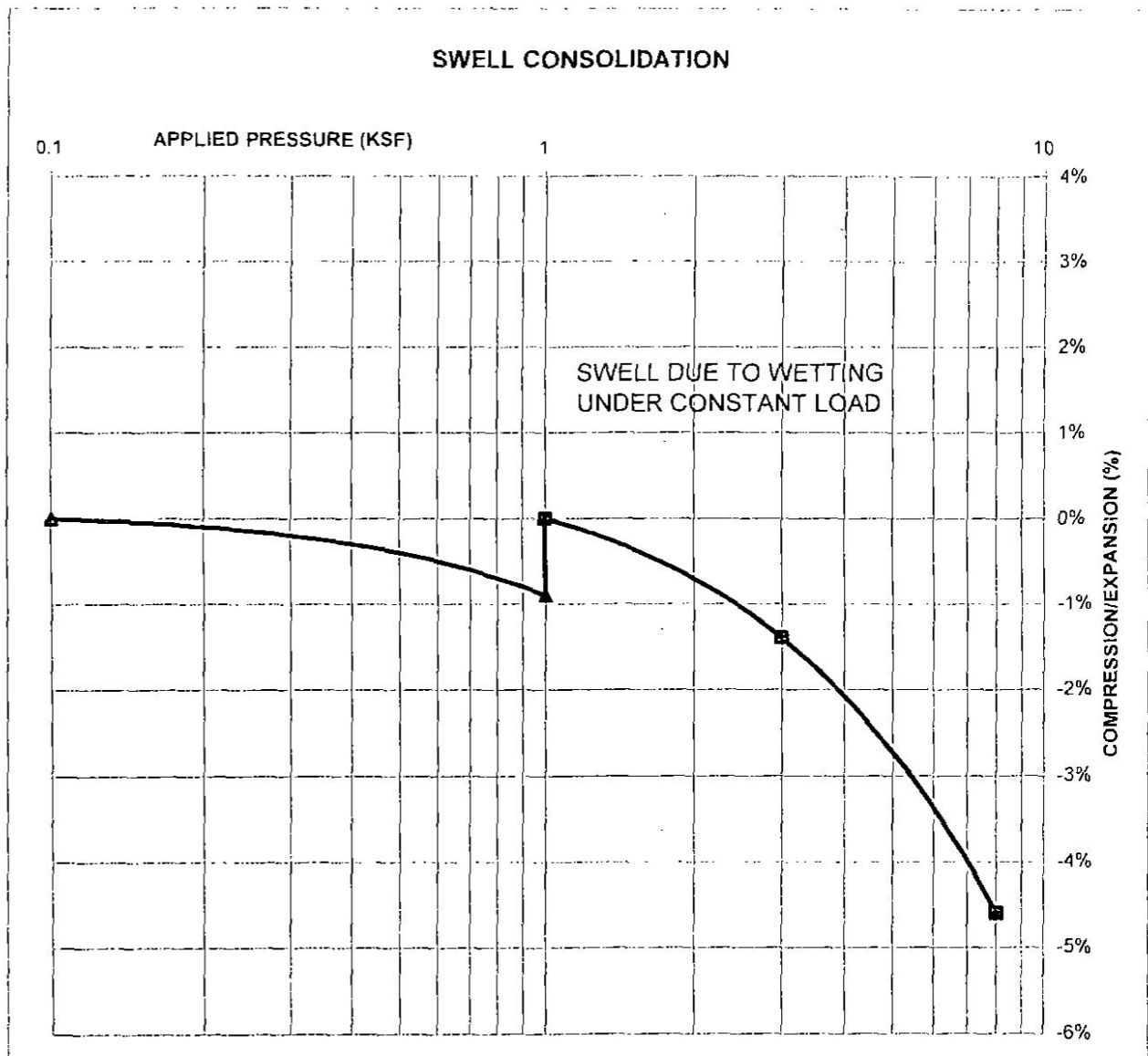
FIG NO.:

0.44

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(FT)	5
DESCRIPTION	CL	SOIL TYPE	4
NATURAL UNIT DRY WEIGHT (PCF)	118		
NATURAL MOISTURE CONTENT	13.4%		
SWELL/CONSOLIDATION (%)	0.9%		

JOB NO. 82556
 CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH



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SWELL CONSOLIDATION TEST RESULTS

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9/15/06

JOB NO.:

82556

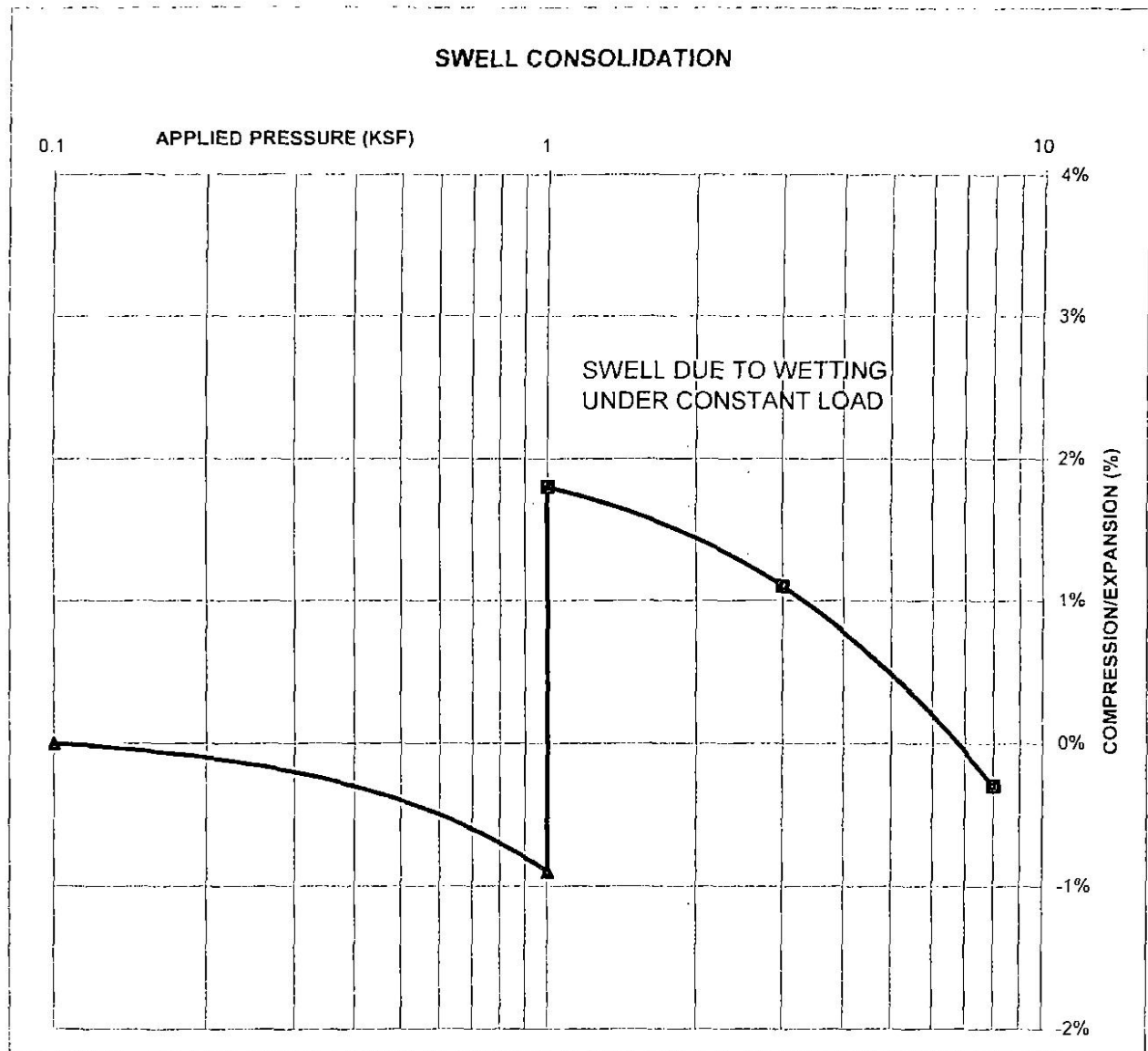
FIG NO.:

C-45

CONSOLIDATION TEST RESULTS

TEST BORING #	33	DEPTH(FT)	15
DESCRIPTION	CH	SOIL TYPE	4
NATURAL UNIT DRY WEIGHT (PCF)	101		
NATURAL MOISTURE CONTENT	24.3%		
SWELL/CONSOLIDATION (%)	2.7%		

JOB NO. 82556
 CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH



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SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED:

DATE:

[Signature] 9/15/06

JOB NO.:

82556

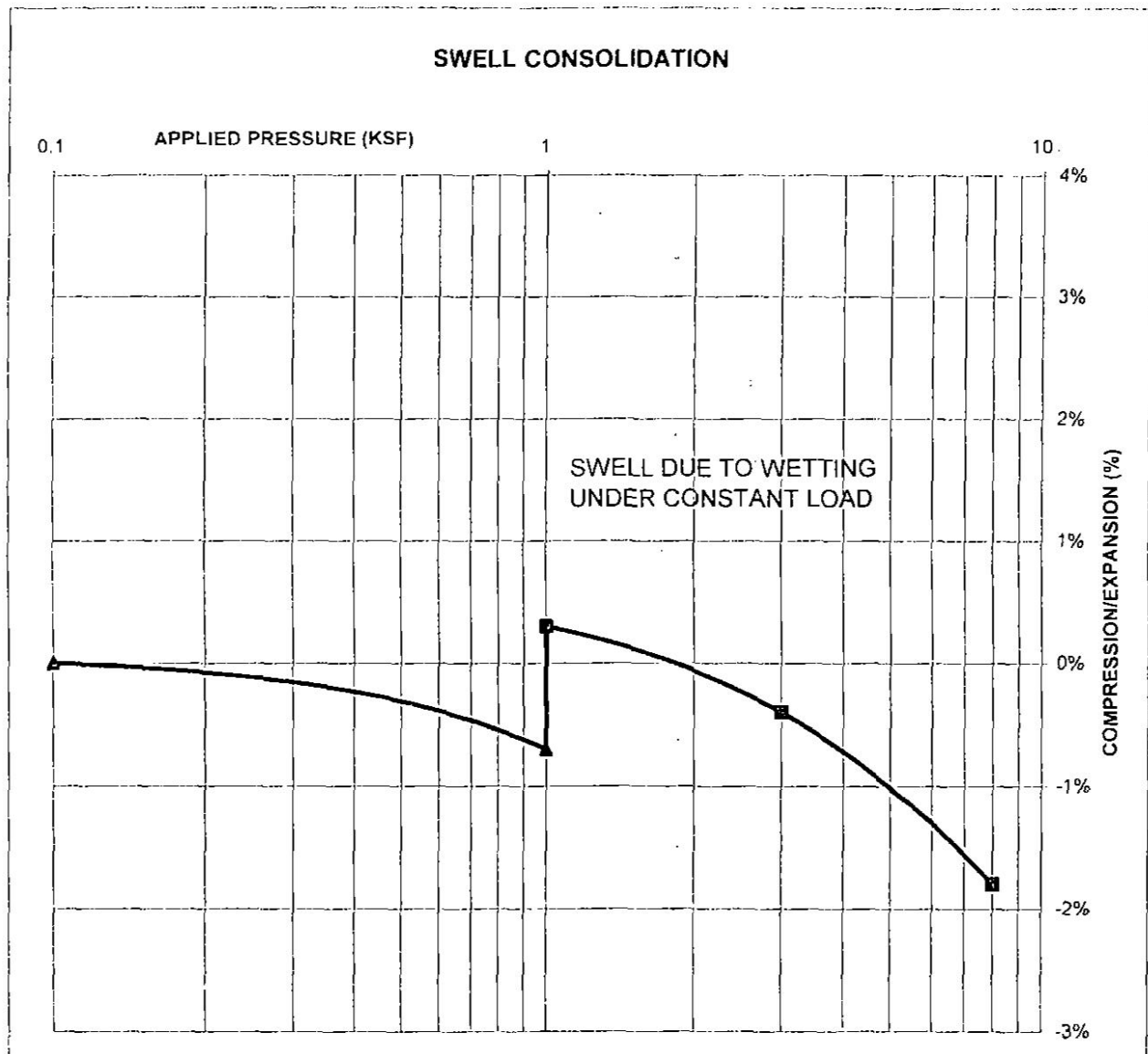
FIG NO.:

C-46

CONSOLIDATION TEST RESULTS

TEST BORING #	40	DEPTH(FT)	15
DESCRIPTION	CL	SOIL TYPE	4
NATURAL UNIT DRY WEIGHT (PCF)	118		
NATURAL MOISTURE CONTENT	14.8%		
SWELL/CONSOLIDATION (%)	1.0%		

JOB NO. 82556
CLIENT MORLEY BENTLEY
PROJECT STERLING RANCH



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SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED:

DATE:

DATE 7/5/06

JOB NO.:

82556

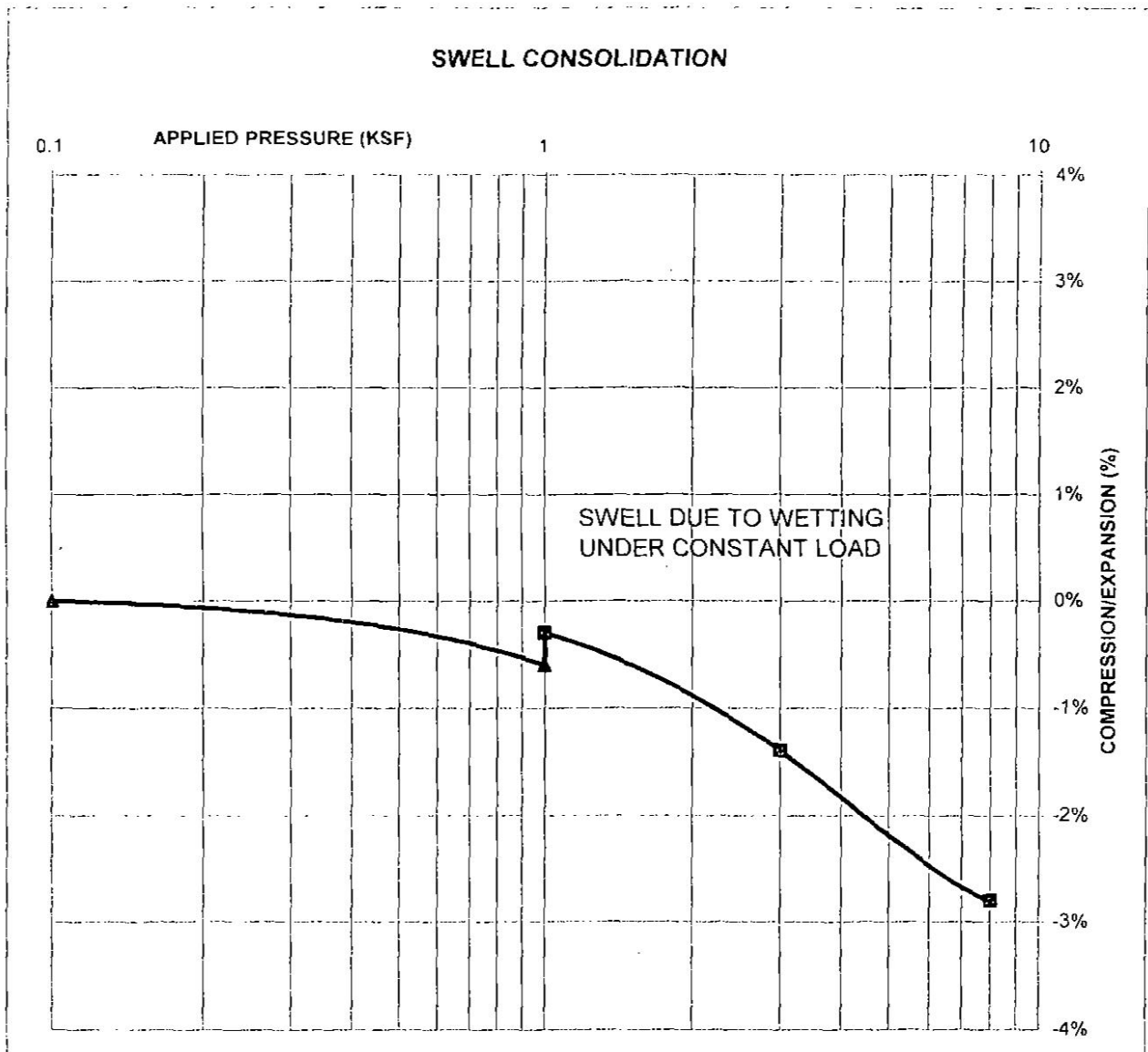
FIG NO.:

C-47

CONSOLIDATION TEST RESULTS

TEST BORING #	43	DEPTH(FT)	20
DESCRIPTION	CL	SOIL TYPE	4
NATURAL UNIT DRY WEIGHT (PCF)	121		
NATURAL MOISTURE CONTENT	12.6%		
SWELL/CONSOLIDATION (%)	0.3%		

JOB NO. 82556
 CLIENT MORLEY BENTLEY
 PROJECT STERLING RANCH



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SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED:

DATE:

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9/15/06

JOB NO.:

82556

FIG NO.:

C-43

CLIENT	MORLEY BENTLEY	JOB NO.	82556
PROJECT	STERLING RANCH	DATE	9/1/2006
LOCATION	STERLING RANCH	TEST BY	DG

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-4	2-5	1	SM-SW	<0.01
TB-6	15-20	3	SM-SW	0.01
TB-40	15	4	CL	0.00
TB-21	7	2	CL	0.10

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505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907 (719) 531-5399

LABORATORY TEST
SULFATE RESULTS

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DATE:

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JOB NO.:

82556

FIG NO.:

C-49



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ENGINEERING, INC.

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

**SUBSURFACE SOIL INVESTIGATION
STERLING RANCH BRIDGES
STERLING RANCH ROAD OVER SAND CREEK
BRIARGATE BOULEVARD OVER SAND CREEK
COLORADO SPRINGS, COLORADO**

Prepared for:

**C&C Land
20 Boulder Crescent, 2nd Floor
Colorado Springs, Colorado 80903**

Attn: Chaz Collins

March 4, 2020

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Austin M. Nossokoff, P.E.



Reviewed by:

Joseph C. Goode, Jr., P.E.
President

AMN/amn

Encl.

Entech Job No. 200045

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Tables

Table 1 Summary of Laboratory Test Results

Table 2 Sterling Ranch Bridges – LPile Design Parameters

Figures

Figure 1: Vicinity Map

Figure 2: Site Plan/Test Boring Location Map

List of Appendices

Appendix A Laboratory Testing Results

Appendix B Laboratory Testing Results

**SUBSURFACE SOIL INVESTIGATION
STERLING RANCH BRIDGES
STERLING RANCH ROAD OVER SAND CREEK &
BRIARGATE BOULEVARD OVER SAND CREEK
EL PASO COUNTY, COLORADO**

1.0 INTRODUCTION

C&C Land is planning the construction of two vehicular bridges over sand creek for the proposed Sterling Ranch Road and Briargate Boulevard in El Paso County northeast of Colorado Springs, Colorado. The approximate location of the site is shown on the Vicinity Map, Figure 1. The planned layouts of the proposed bridges are shown on Figure 2, Site Plan/Test Boring Location Map.

This report describes the subsurface investigation conducted for the planned bridges and provides recommendations for foundation design and construction. The subsurface soil investigation included drilling test borings at four (4) locations within the footprints of the planned bridge foundations, collecting samples of soil, and conducting a geotechnical evaluation of the investigation findings. All drilling and subsurface investigation activities were performed by Entech Engineering, Inc. (Entech). The contents of this report, including the geotechnical evaluation and recommendations, are subject to the limitations and assumptions presented in Section 6.0.

2.0 PROJECT AND SITE DESCRIPTION

It is Entech's understanding that the project will consist of the construction of two (2) vehicular bridges spanning Sand Creek with driven H-pile foundations and associated site improvements. At the time of drilling, the sites for the proposed bridges were vacant. The crossing for the proposed Briargate Boulevard had been graded at the time of drilling. Sand Creek flows to the south. Current vegetation on the site consisted of grasses and small shrubs.

3.0 SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

The subsurface conditions were investigated by drilling four (4) exploratory test borings, one at each bridge abutment. The borings were drilled to depths 20 feet below the existing ground surface using a truck-mounted continuous flight auger-drilling rig supplied and operated by Entech Engineering, Inc. Boring Logs descriptive of the subsurface conditions encountered during drilling and subsequent to drilling are presented in Appendix A. At the conclusion of drilling, observations of groundwater levels were made in each of the open borings. The approximate locations of the test borings are indicated on Figure 2.

Soil samples were obtained from the borings utilizing the Standard Penetration Test (ASTM D-1586) using a 2-inch O.D. split-barrel sampler and a California Sampler. Results of the Standard Penetration Test (SPT) are included on the Test Boring Logs in terms of N-values expressed in blows per foot (bpf). Soil samples recovered from the borings were visually classified and recorded on the Test Boring Logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type numbers are included on the Test Boring Logs. It should be understood that the soil descriptions shown on the Test Boring Logs may vary between boring location and sample depth.

It should also be noted that the lines of stratigraphic separation shown on the Test Boring Logs represent approximate boundaries between soil types and the actual stratigraphic transitions may be more gradual and vary with location. The Test Boring Logs are presented in Appendix A.

Moisture Content, ASTM D-2216, was obtained in the laboratory for all recovered samples. Grain-Size, ASTM D-422, and Atterberg Limits, ASTM D-4318, were determined for various samples for the purpose of classification and to obtain pertinent engineering characteristics. Volume change testing was performed on selected samples using the Swell/Consolidation Test (ASTM D-4546) in order to evaluate potential expansion/consolidation characteristics of the soil and bedrock. Sulfate testing was performed on select samples to determine the corrosive characteristics of the soils. The Laboratory Test Results are included in Appendix B and summarized in Table 1.

4.0 SUBSURFACE CONDITIONS

Four (4) soil types were encountered in the borings drilled for the subsurface investigation: Type 1: silty sand fill (SM), Type 2: very silty sand (SM), Type 3: silty to very silty sandstone (SM), and Type 4: sandy to very sandy claystone (CL). The soils were classified in accordance with the Unified Soil Classification System (USCS) using the laboratory testing results and the observations made during drilling.

4.1 Soil and Rock

Soil Type 1 is a silty sand fill (SM). The sand fill was encountered in Test Boring 1 at the existing ground surface extending to a depth of 6 feet. Standard Penetration Testing conducted on the sand resulted in SPT N-values of 4 to 6 blows per foot (bpf), which indicates loose states. Moisture content and grain size testing resulted in a moisture contents of 7 to 8 percent with approximately 29 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing was performed on a sample of sand fill and resulted in a liquid limit of no value with a plastic index of non-plastic. Sulfate testing on the sand resulted in 0.00 percent soluble sulfate

by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 2 is a very silty sand (SM). The sand was encountered in three (3) of the test borings at the existing ground surface extending to depths of 1 to 10 feet. Standard Penetration Testing conducted on the soil resulted in SPT N-values of 7 to 26 blows per foot (bpf), indicating the sand is loose to medium dense in terms of density. Moisture content and grain size testing resulted in moisture contents of 5 to 20 percent with approximately 40 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing was performed on a sample of sand fill and resulted in a liquid limit of 15 with a plastic index of 3. Sulfate testing on the sand resulted in less than 0.01 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 3 is a silty to very silty sandstone (SM). The sandstone was encountered in all of the test borings at depths ranging from 1 to 10 feet bgs and extending to depths of 12 feet and the termination of the borings (20 feet). Standard Penetration Testing conducted on the soil resulted in SPT N-values of greater than 50 blows per foot (bpf), indicating the sandstone is very dense in terms of density. Moisture content and grain size testing resulted in moisture contents of 10 to 17 percent with approximately 14 to 42 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing resulted in liquid limits of no value to 32 and plastic indexes of non plastic to 6. Sulfate testing on the sandstone resulted in 0.00 to less than 0.01 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 4 is sandy to very sandy claystone (CL). The claystone was encountered in Test Boring 1 at a depth of 12 feet bgs and extending to the termination of the boring (20 feet). Standard Penetration Testing conducted on the soil resulted in SPT N-values of greater than 50 blows per foot (bpf), indicating the soil is hard in terms of consistency. Moisture content and grain size testing resulted in moisture contents of 15 to 16 percent with approximately 59 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing resulted in a liquid limit of 35 and a plastic index of 14.

Additional descriptions and engineering properties of the soil encountered during drilling are included on the boring logs. Laboratory Testing Results are summarized on Table 1 and presented in Appendix B. It should be understood that the soil descriptions reported on the boring logs may vary between boring locations and sampling depths. Similarly, the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil types and the actual transitions between types may be more gradual or variable.

4.2 Groundwater

Groundwater was encountered at depths ranging from 13 to 16.5 feet in Test Boring Nos. 3 and 4. Test Boring Nos. 1 and 2 were dry to 18 feet after drilling. Groundwater may affect development of significant foundation excavations or during installation of deep utilities depending on the final grading plans. Creek flow will vary due to rainfall, drainage, and other factors not readily apparent at this time. It should be noted that groundwater levels, observed at the time of the subsurface investigation, could change due to seasonal variations, changes in land runoff characteristics and future development including of nearby areas.

5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the borings drilled in the planned bridge footprints. If subsurface conditions different from those described herein are encountered during construction or if the project elements change from those described, Entech Engineering, Inc. should be notified so that the evaluation and recommendations presented can be reviewed and revised if necessary.

The site will be developed by constructing two (2) bridges over Sand Creek and associated site improvements at Sterling Ranch Road and Briargate Boulevard Crossings. The proposed bridges are expected to utilize driven H-pile foundations

Subsurface soil conditions encountered in the test borings drilled for the planned interchanges consisted of sand fill and silty to very silty sand overlying silty to very silty sandstone and sandy to very sandy claystone. Bedrock was encountered at depths of 1 to 10 feet in the test borings.

The surficial sands and sand fill were encountered in loose to medium dense states. The underlying sandstone was encountered in dense states, and the underlying claystone was encountered at hard consistencies.

5.1 Foundation Recommendations

The main purpose of the subsurface investigation was to gather soil and bedrock information for the proposed bridge abutments for use in providing foundation recommendations and design values. Recommendations for bridge supports using driven H-piles, shallow spread footings, and parameters for retaining walls are provided.

5.1.1 Deep Foundation Systems (Driven H-piles)

Based on evaluation of the site subsurface conditions, it is believed that the planned H-piles will achieve most of their compressive strength through end bearing and skin friction in the underlying sandstone and claystone bedrock (Soil Types 3 and 4). Some frictional resistance will also be developed in the overburden sand (Soil Type 1). Design parameters for use in the H-pile design, which include allowable end bearing, side resistance, and resisting factors are presented in Table 2. L Pile parameters for the sand, sandstone, and claystone are also included in Table 2. The recommendations and parameters apply to piles spaced by horizontal distances of at least 3 times the pile width. If the piles are spaced closer, reductions in the allowable pile capacity may be warranted. The following unit weights are recommended for the site soil and bedrock.

Unit weight of native overburden sand	120 pcf
Unit weight of sandstone bedrock	125 pcf
Unit weight of siltstone and claystone bedrock	125 pcf

It is recommended that full-time observation of the H-pile installation be performed to compile driving logs for each pile. At a minimum, the log should include: the driving resistance per foot of pile and per inch of pile over the last 3 inches; the pile driver make and model; rated energy; pile cushion/condition; observed damage; and final pile top location. The guidance set forth in the

State of Colorado Standard Specifications for Road and Bridge Construction, Section 502, Piling, is recommended. Piles should be driven 10 feet into bedrock or refusal.

5.1.2 Shallow Foundation Parameters

Structures associated with the bridges can be supported with shallow foundations resting on the native sands, recompacted loose sands, or sandstone. It should be noted that due to potential shallow groundwater on this site (due to the proximity to Sand Creek), extensive subgrade improvements are anticipated to support shallow foundations. The foundation members should bear on the native site sands, sandstone, or be recompacted according to the "Structural Fill" paragraph. Any topsoil must be removed and the existing subgrade cleared of any debris prior to excavation. Loose soils or uncontrolled fill material beneath foundation components will require removal and recompaction. Any expansive soils encountered beneath the foundation will require removal and replacement with non-expansive structural fill compacted according to the "Structural Fill" paragraph. Any new fill should be placed to the requirements of the "Structural Fill" paragraph. On-site granular sands may be used as structural fill as approved by Entech. Any import material should be approved by Entech prior to hauling to the site.

Provided the above recommendations are followed, an allowable bearing pressure of 2400 psf is recommended for the native sands. For recompacted sands or imported granular structural fill, an allowable bearing capacity of 3000 psf is recommended. An allowable bearing capacity of 4000 psf is recommended for undisturbed sandstone. Footings should extend a minimum of 30 inches below the adjacent exterior surface grade for frost protection. Following the above foundation subgrade preparation recommendations, and adhering to the recommended maximum allowable bearing pressure, it is expected to result in foundation designs which should limit total and differential vertical movements.

Foundation excavations are recommended to extend at least 3 feet horizontally beyond the foundation limits in order to provide adequate space for installation of drain materials (if necessary) and placement of controlled fill. All foundation excavation side slopes should be inclined at angles of 1½ horizontal to 1 vertical or flatter, as necessary, to provide for excavation sidewall stability during construction or as required by OSHA regulations.

Entech should observe overexcavated subgrades as well as the overall foundation excavation subgrade and evaluate if the exposed conditions are consistent with those described in this report. Entech should also provide recommendations for overexcavation depth and other subgrade improvements, if necessary, and the need for drain systems based on the excavation conditions observed at that time.

5.1.3 Retaining Wall Parameters

The following values are recommended for use in designing retaining walls with unbalanced lateral loading that may be associated with this project. Roadway/Vehicle surcharge loading is required for wall design.

Recommended Design Values – Lateral Loading

Equivalent fluid density for lateral earth pressure (active), pcf (site granular soils)	45
Equivalent fluid density for lateral earth pressure (passive), pcf	300
Equivalent fluid density for lateral earth pressure (at rest), pcf	60
Soil density (compacted sand), pcf	125
Angle of Internal Friction (loose silty sand and sandy clay-silt)	26°
Angle of Internal Friction (compacted silty sand)	34°
Coefficient of sliding between concrete and silty gravelly sand	0.35
Bearing capacity of sand, psf	2400 psf
Bearing capacity of sandstone, psf	3500 psi

*Note: The above lateral loading design values are for level back slope angles and no surcharge loads. If wall backfill is submerged, water pressures must be taken into account as additional wall loading. If backfill slope angles are greater than zero degrees, or if the backfill is surcharged, the design values must be adjusted to account for additional lateral loading.

5.2 Site Seismic Classification

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

5.3 Surface and Subsurface Drainage

Positive surface drainage must be maintained around structures to minimize infiltration of surface water. A minimum gradient of 5 percent in the first 10 feet adjacent to foundation components is recommended. A minimum gradient of 2 percent is recommended for paved areas. All grades should be directed away from structures.

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

5.4 Concrete

Soluble sulfate testing was conducted on three samples of the site soils to evaluate the potential for sulfate attack on concrete placed below the surface grade. The test results indicated less than 0.01 percent soluble sulfate by weight for the site soils. The test results indicate the sulfate component of the in-place site soils present a negligible exposure threat to concrete placed below grade that comes into contact with the site soils.

Type II cement is recommended for concrete at this site. To further avoid concrete degradation during construction it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in foundation excavations prior to the placement of concrete. If standing water is present in the foundation excavations, it should be removed by ditching to sumps and pumping the water away from the foundation area

prior to concrete placement. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

5.5 Foundation Excavation Observations

Subgrade preparation for bridge foundations and associated improvements should be observed by Entech Engineering prior to construction of the foundation elements in order to verify that (1) no anomalies are present, (2) materials of the proper bearing capacity have been encountered or placed, and (3) no soft, loose, uncontrolled fill material, expansive soil or debris are present in the foundation area prior to concrete placement or backfilling. Pile driving should be observed to verify proper embedment or refusal. Piles should be driven 10 feet into bedrock or refusal. Entech should make final recommendations for over-excavation or stabilization, if required, at the time of excavation observation, if necessary.

5.6 Structural Fill

Areas to receive fill should have all topsoil, organic material or debris removed. Fill must be properly benched. The surface should be scarified and moisture conditioned to within ± 2 percent of its optimum moisture content and compacted to 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557) beneath footings or floor slabs prior to placing new fill. New fill beneath footings should be non-expansive and be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557). These materials should be placed at a moisture content conducive to compaction, usually ± 2 percent of Proctor optimum moisture content. The placement and compaction of fill should be observed and tested by Entech Engineering, Inc. Imported soils should be approved by Entech Engineering, Inc. prior to being hauled to the site and on-site granular soils prior to placement.

Compacted, non-expansive granular soil, free of organics, debris and cobbles greater than 3-inches in diameter, is recommended for filling foundation components. All fill placed within the foundation areas should be non-expansive and be compacted to a minimum of 95 percent of the

soils maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Fill material placed beneath floor slabs should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of six inches or less. Fill should be placed at water contents conducive to achieving adequate compaction; usually within ± 2 percent of the optimum water content as determined by ASTM D-1557. Mechanical methods can be used for placement and compaction of fill; however, heavy equipment should be kept at distance from foundation walls and below slab infrastructure to avoid overstressing. No water flooding techniques of any type should be used for compaction or placement of foundation or floor slab fill material.

5.7 Utility Trench Backfill

Fill placed in utility trenches should be compacted to a minimum of 95 percent of its maximum dry density as determined by the Standard Proctor Test (ASTM D-698) for cohesive soils and 95 percent as determined by the Modified Proctor Test (ASTM D-1557) for cohesionless soils. Fill should be placed in horizontal lifts having a compacted thickness of six inches or less and at a water content conducive to adequate compaction, within ± 2 percent of the optimum water content. Mechanical methods should be used for fill placement; however, heavy equipment should be kept at a distance from foundation walls. No water flooding techniques of any type should be used for compaction or placement of utility trench fill.

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

5.8 General Backfill

Any areas to receive fill outside the foundation limits should have all topsoil, organic material, and debris removed. Fill must be properly benched into existing slopes in order to be adequately compacted. The fill receiving surface should be scarified to a depth of 12-inches and moisture conditioned to ± 2 percent of the optimum water content, and compacted to a minimum of 95 percent of the ASTM D-1557 maximum dry density before the addition of new fill. Fill should be placed in thin lifts not to exceed 6 inches in thickness after compaction while maintaining at least 95 percent of the ASTM D-1557 maximum dry density. Fill material should be free of vegetation and other unsuitable material and shall not contain rocks or fragments greater than 3-inches. Topsoil and strippings should be segregated from all other fill sources on the site. Fill placement and compaction beneath and around foundations, in utility trenches, beneath roadways or other structural features of the project should be observed and tested by Entech during construction.

5.9 Excavation Stability

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

5.10 Winter Construction

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

5.11 Construction Observations

It is recommended that Entech observe and document the following activities during construction of the building foundations.

- Excavated subgrades and subgrade preparation.
- Drilled Pier Installation
- Placement of drains (if installed).
- Placement/compaction of fill material for the foundation components and retaining walls.
- Placement/compaction of utility bedding and trench backfill.

6.0 CLOSURE

The subsurface investigation, geotechnical evaluation and recommendations presented in this report are intended for use of C&C Land with application to the proposed bridges over Sand Creek at Sterling Ranch Road and Briargate Boulevard and their associated site improvements, in El Paso County northeast of Colorado Springs, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in same locality and under similar conditions. No other warranty, expressed or implied is made. During final design and/or construction, if conditions are encountered which appear different from those described in this report, Entech Engineering, Inc. requests that it be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

TABLES

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

CLIENT C&C LAND
PROJECT STERLING RANCH BRIDGES
JOB NO. 200045

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	2-3			29.1	NV	NP	0.00			SM	FILL, SAND, SILTY
2	3	5			39.8	15	3	<0.01			SM	SAND, VERY SILTY
3	2	10			13.9	NV	NP	<0.01			SM	SANDSTONE, SILTY
3	4	2-3			14.7						SM	SANDSTONE, SILTY
3	4	15	17.1	110.2	42.2	32	6	0.00		1.9	SM	SANDSTONE, VERY SILTY
4	1	15	14.3	116.1						1.6	CL	CLAYSTONE, SANDY
4	1	20			58.7	35	14				CL	CLAYSTONE, VERY SANDY

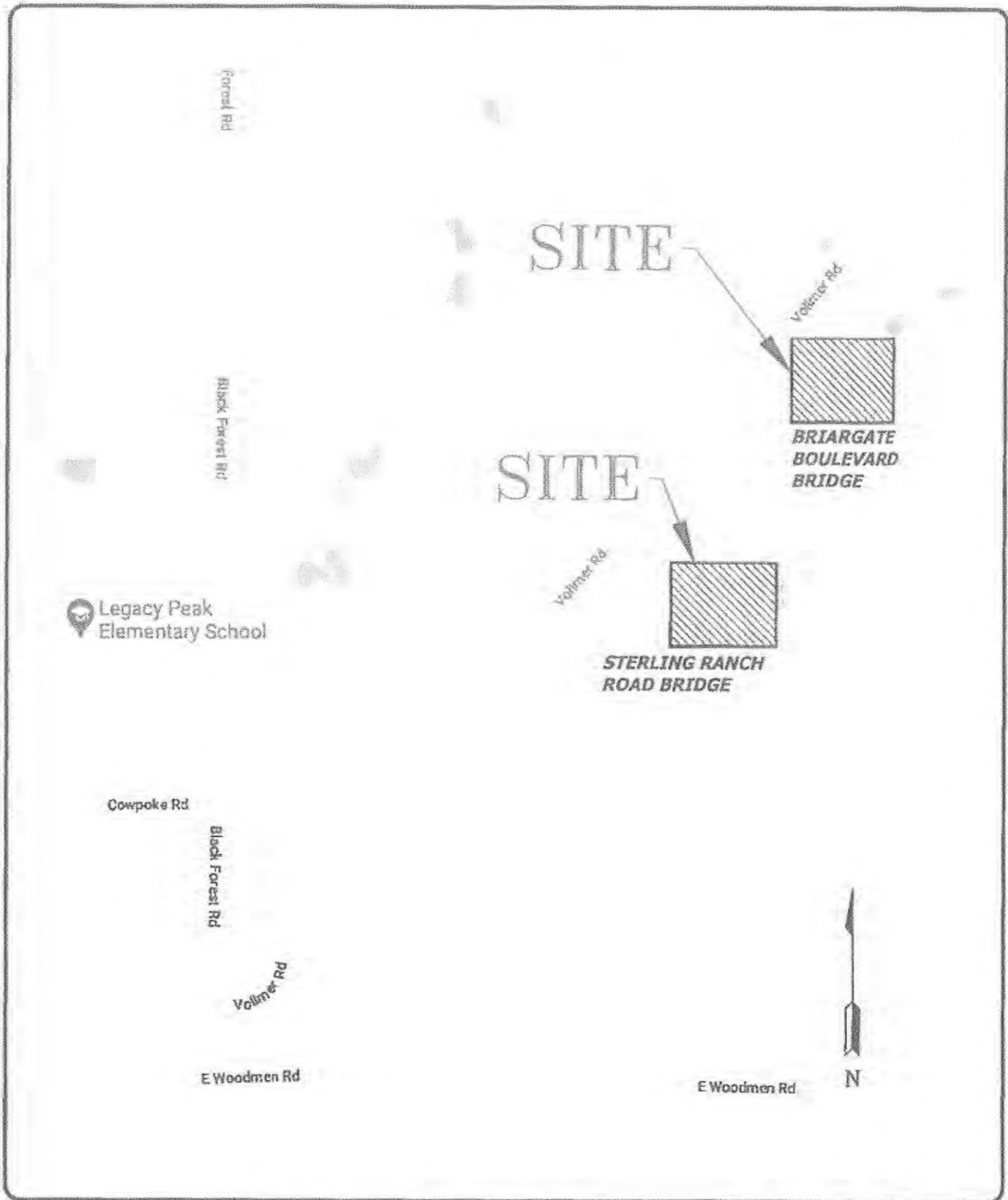
TABLE 2

Sterling Ranch Bridges - LPile Design Parameters

Depth Below Existing Ground Surface		Groundwater Elevation (ft) Below Existing Ground	Soil/Rock Description	Axial Pile Capacity Parameters		PRELIMINARY LPile Parameters					
Top	Bottom			Allowable Side Resistance (ksf)	Allowable End Bearing (ksf)	p-y Curve	Unit Weight γ' (pcf)	Peak Friction Angle ϕ (deg)	Initial Static Modulus of Subgrade Reaction, k (pcf)	Undrained Cohesion s_u (psf)	Strain Factor ϵ_u (in/in)
0	0	12 to 16	Suitable Granular Structural Fill (Dense)	—	—	Sand	120 60*	32	288 360*	N/A	N/A
0	1 to 10		Native Silty Sand	—	—	Sand	120 60*	32	35 360*	N/A	N/A
1 to 10	12 to BCE		Silty Sandstone	3	30	Sand	125 60*	34	228 195	N/A	N/A
12	BCE		Sandy to Very Sandy Claystone	3	30	Clay	115 57*	N/A	500	1500	0.005

* = Submerged

FIGURES



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363 ELATCH DRIVE
COLORADO SPRINGS, CO 80907 (719) 531-2399

Vicinity Map
Sterling Ranch Bridges
Sterling Ranch Rd & Briargate Blvd Over
Sand Creek
El Paso County, CO
For: C & C Land

DRAWN:
AMN

DATE:
2/14/20

CHECKED:

DATE:

JOB NO.:
200045

FIG NO.:
1

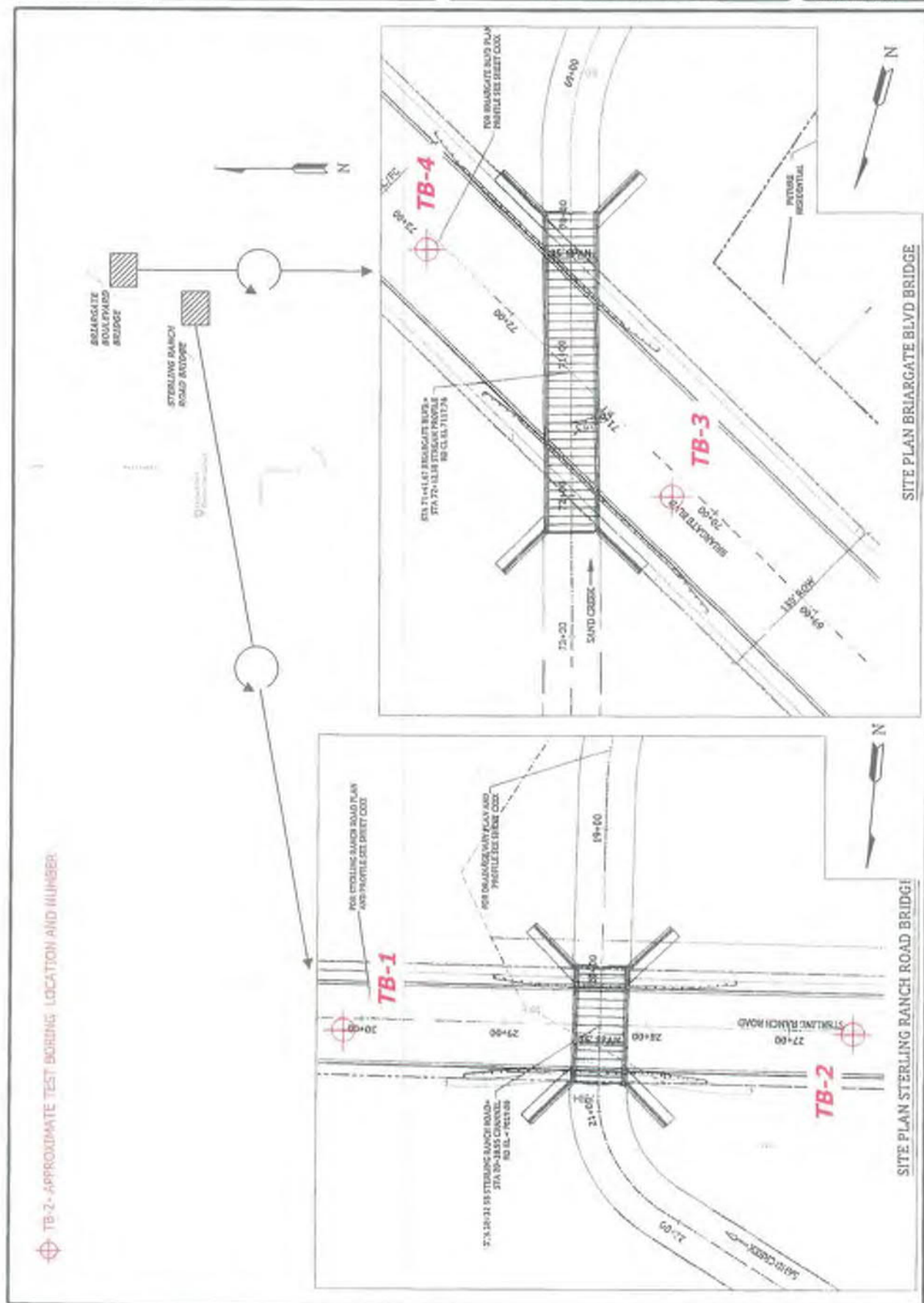
REV	DATE	BY
1	05/05/2015	ST

ENTECH
ENGINEERING, INC.
360 OLIVER STREET, SUITE 200
DENVER, CO 80202 (303) 733-5599



Site Plan/Test Boring Map
Sterling Ranch Bridges
Sterling Ranch Rd & Briargate Blvd
Over Sand Creek
El Paso County, CO
For: C & C Land

PROJECT NO.	150041
DATE	05/05/2015
DESIGNED BY	ST
CHECKED BY	ST
IN CHARGE	ST
SCALE	AS SHOWN
PROJECT NAME	STERLING RANCH BRIDGES



APPENDIX A: Test Boring Logs

TEST BORING NO. 1
 DATE DRILLED 1/23/2020
 Job # 200045

TEST BORING NO. 2
 DATE DRILLED 1/23/2020
 CLIENT C&C LAND
 LOCATION STERLING RANCH BRIDGES

REMARKS

DRY TO 18', 1/28/20

FILL 0-6, SAND, SILTY, FINE
 TO COARSE GRAINED, BROWN,
 LOOSE, MOIST

SANDSTONE, SILTY, FINE
 GRAINED, TAN, VERY DENSE,
 MOIST

CLAYSTONE, SANDY TO VERY
 SANDY, GRAY BROWN, HARD,
 MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0					
5			6	7.7	1
5			4	6.9	1
10			50 7"	14.6	3
15			50 8"	15.3	4
20			50 7"	15.9	4

REMARKS

DRY TO 18', 1/28/20

SAND, SILTY, FINE TO COARSE
 GRAINED, TAN, MEDIUM DENSE,
 MOIST

SANDSTONE, SILTY, FINE
 GRAINED, TAN, VERY DENSE,
 MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0					
5			26	5.2	2
5			50 11"	13.5	3
10			50 6"	10.0	3
15			50 10"	11.2	3
20			50 5"	12.2	3



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505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN

DATE

CHECKED: *h*

DATE 2/10/20

JOB NO
 200045

FIG NO
 A- 1

TEST BORING NO. 3
 DATE DRILLED 1/23/2020
 Job # 200045

TEST BORING NO. 4
 DATE DRILLED 1/23/2020
 CLIENT C&C LAND
 LOCATION STERLING RANCH BRIDGES

REMARKS

WATER @ 16.5', 1/28/20

SAND, SILTY TO VERY SILTY,
 FINE TO COARSE GRAINED, TAN
 TO BROWN, MEDIUM DENSE TO
 LOOSE, MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			16	5.0	2
7			7	19.7	2
10			24	15.1	2
15			50 10"	12.7	3
20			50 10"	17.3	3

REMARKS

WATER @ 13', 1/28/20

SAND, SILTY, TAN
 SANDSTONE, SILTY, FINE TO
 COARSE GRAINED, TAN, VERY
 DENSE, MOIST

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

COARSE GRAINED LENSES

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
2					2
3			50 10"	7.1	3
5			50 11"	9.2	3
10			50 9"	10.3	3
15			10 10"	16.4	3
20			50 4"	14.9	3



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505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN

DATE

CHECKED: *L*

DATE 2/10/20

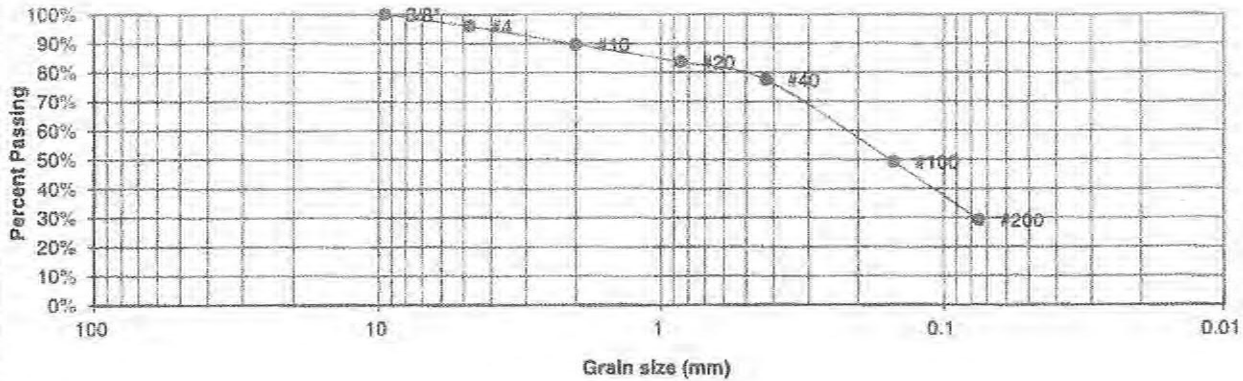
JOB NO.
 200045

FIG NO.
 A- 2

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	C&C LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	1	JOB NO.	200045
DEPTH (FT)	2.3	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.9%
10	89.7%
20	83.6%
40	77.3%
100	49.2%
200	29.1%

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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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

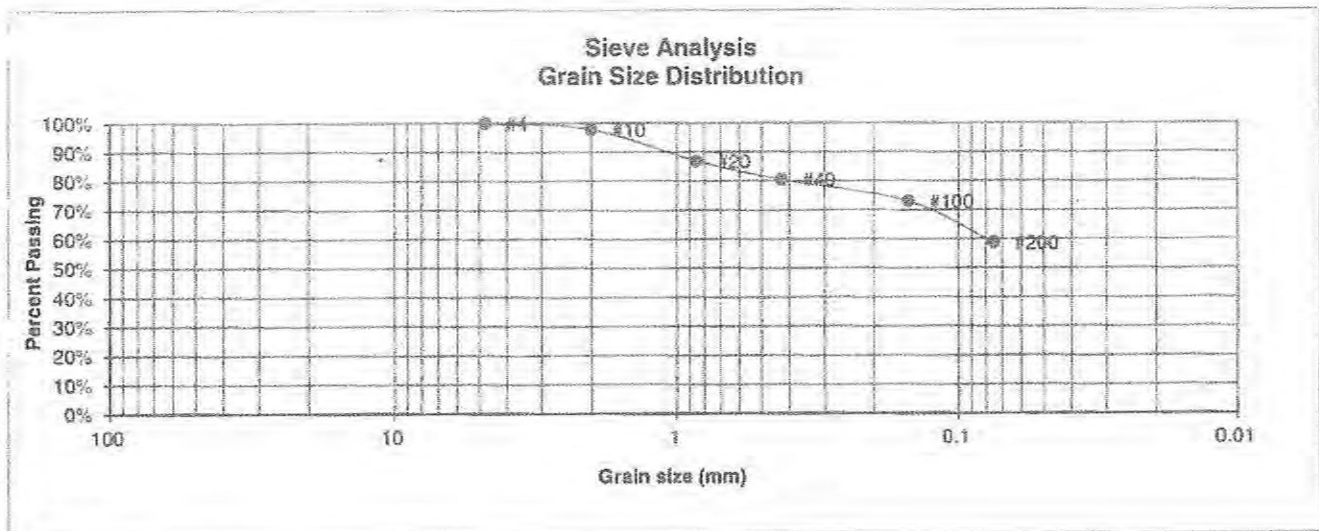
LABORATORY TEST RESULTS

DRAWN:	DATE	CHECKED:	DATE: 2/10/20
--------	------	----------	---------------

JOB NO
200045

FIG NO
B-1

UNIFIED CLASSIFICATION	CL	CLIENT	C&C LAND
SOIL TYPE #	4	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	I	JOB NO.	200045
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	97.8%
20	86.9%
40	80.5%
100	72.9%
200	58.7%

Atterberg Limits	
Plastic Limit	21
Liquid Limit	35
Plastic Index	14

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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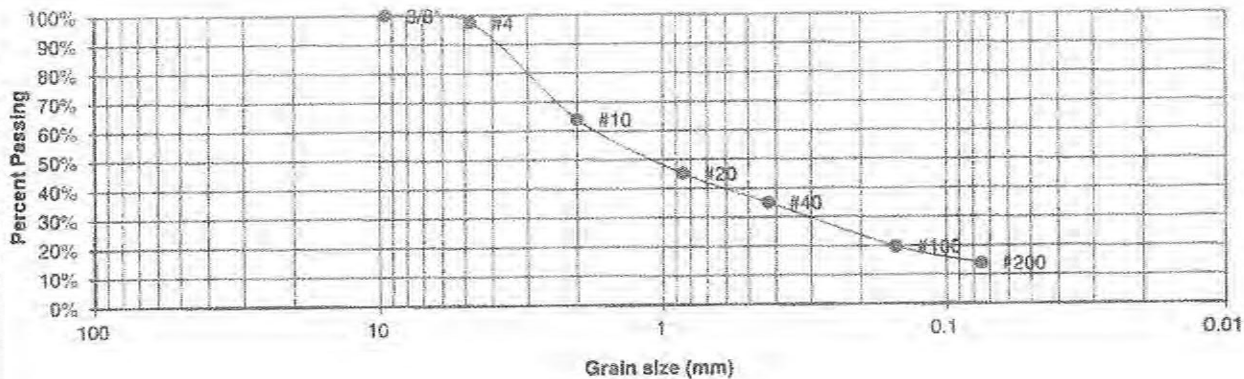
W 2/16/20

JOB NO.
200045

FIG NO.
B-2

UNIFIED CLASSIFICATION	SM	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	2	JOB NO.	200045
DEPTH (FT)	10	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.4%
10	63.9%
20	45.2%
40	35.0%
100	19.7%
200	13.9%

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

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200045

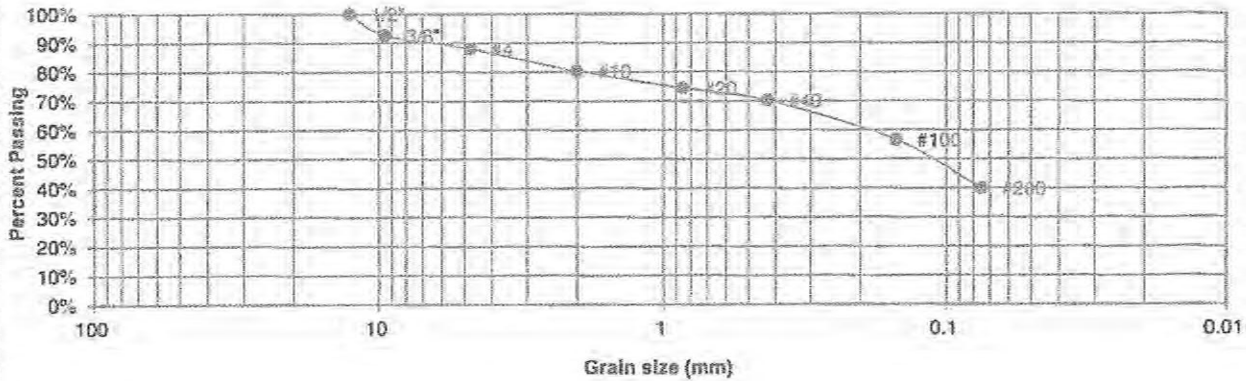
FIG NO

B-3

UNIFIED CLASSIFICATION SM
 SOIL TYPE # 2
 TEST BORING # 3
 DEPTH (FT) 5

CLIENT C&C LAND
 PROJECT STERLING RANCH BRIDGES
 JOB NO. 200045
 TEST BY BL

Sieve Analysis
 Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	92.6%
#4	88.0%
#10	80.3%
#20	74.4%
#40	70.1%
#100	56.5%
#200	39.8%

Atterberg
Limits
 Plastic Limit 12
 Liquid Limit 15
 Plastic Index 3

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



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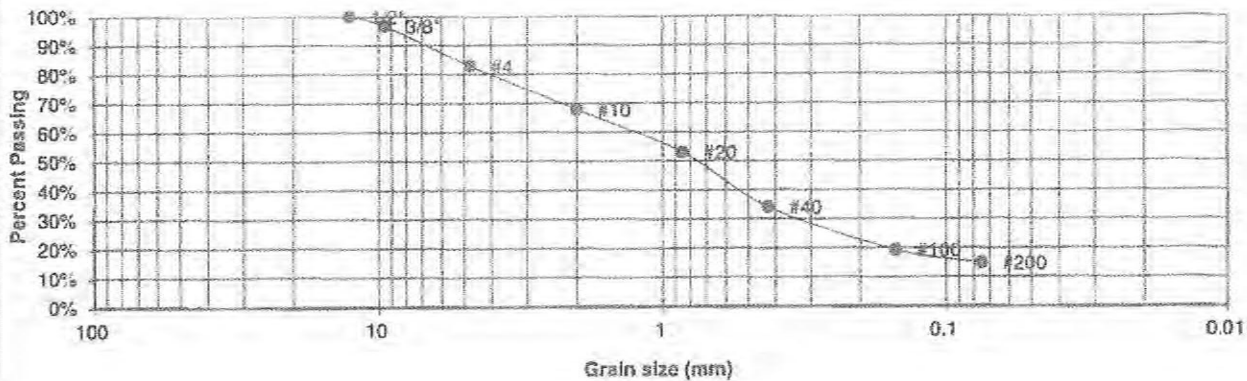
LABORATORY TEST
 RESULTS

DRAWN:	DATE	CHECKED <i>M</i>	DATE 5-2-20
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JOB NO.
 200045
 FIG NO.
 B-1

UNIFIED CLASSIFICATION	SM	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	4	JOB NO.	200045
DEPTH (FT)	2-3	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.7%
#4	82.8%
#10	67.8%
#20	53.0%
#40	34.0%
#100	19.2%
#200	14.7%

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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RESULTS

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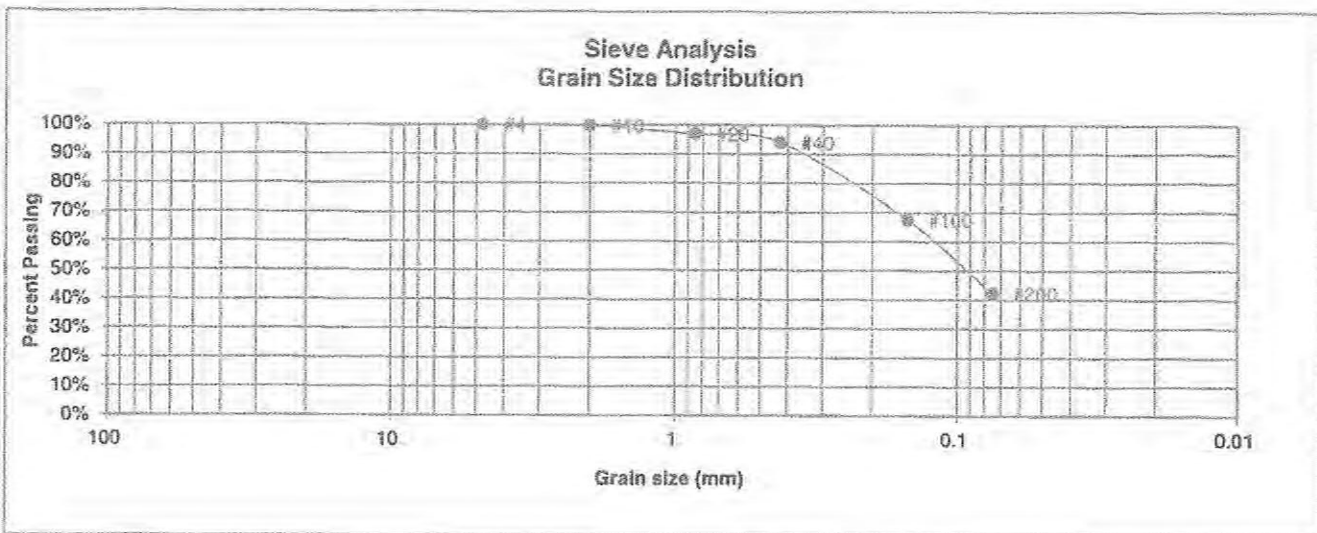
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JOB NO.
200045

FIG NO.
B-5

UNIFIED CLASSIFICATION	SM	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	4	JOB NO.	200045
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	99.7%
20	96.9%
40	94.0%
100	67.4%
200	42.2%

Atterberg	
Limits	
Plastic Limit	26
Liquid Limit	32
Plastic Index	6

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



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JOB NO
200045

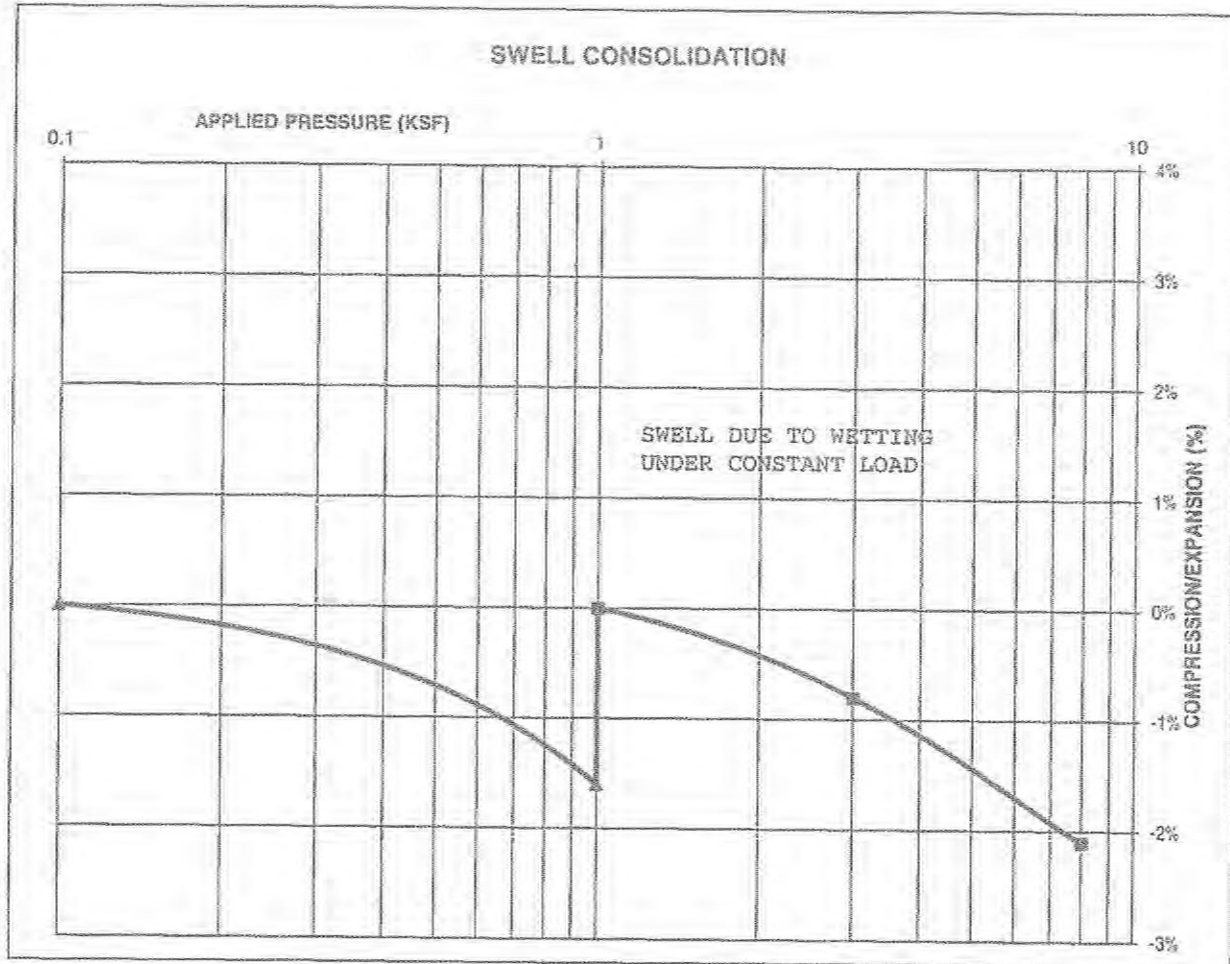
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B-6

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	15
DESCRIPTION	CL	SOIL TYPE	4
NATURAL UNIT DRY WEIGHT (PCF)			116
NATURAL MOISTURE CONTENT			14.3%
SWELL/CONSOLIDATION (%)			1.6%

JOB NO. 200045
 CLIENT C&C LAND
 PROJECT STERLING RANCH BRIDGES



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SWELL CONSOLIDATION TEST RESULTS

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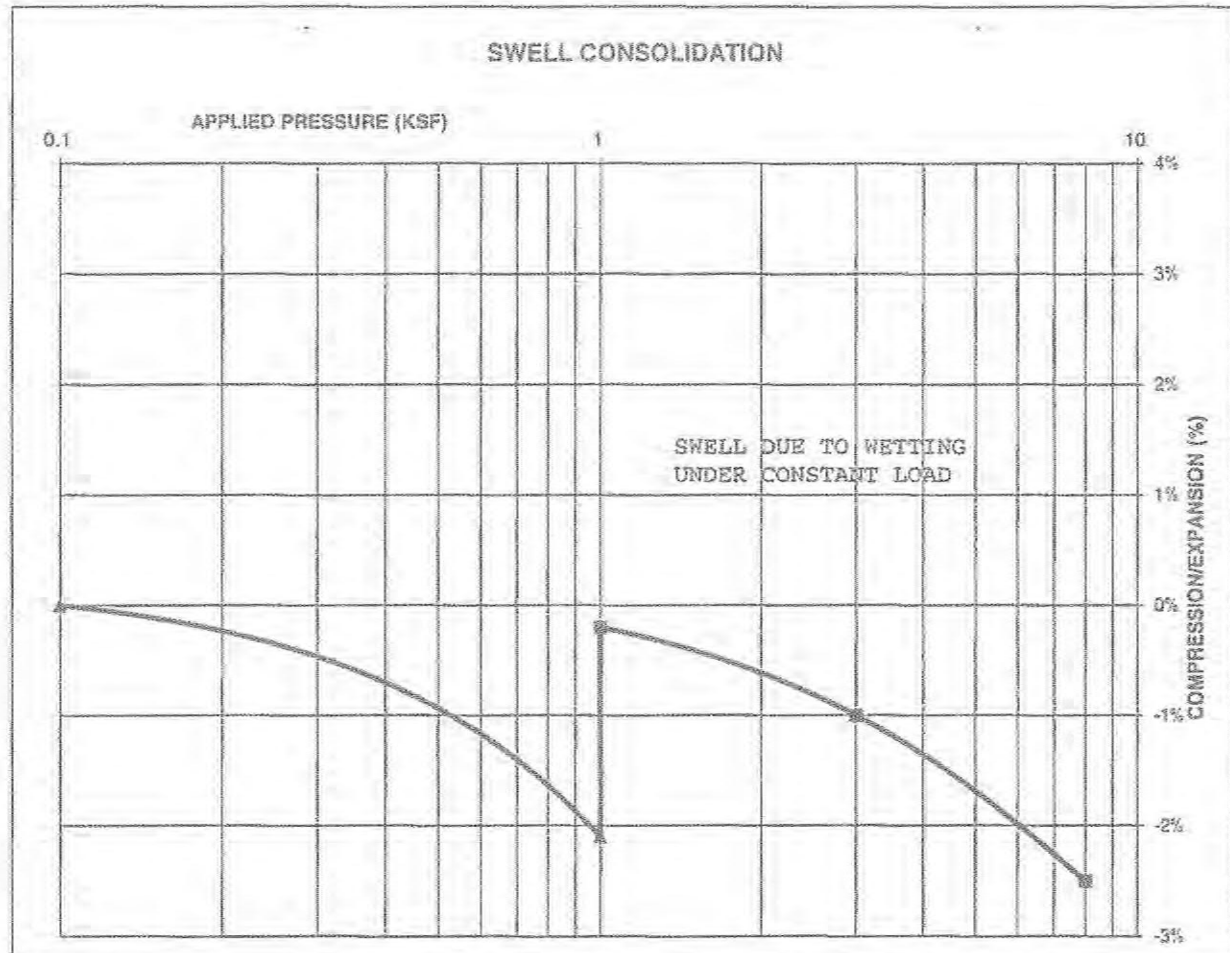
JOB NO.
 200045

FIG NO.
 B-7

CONSOLIDATION TEST RESULTS

TEST BORING #	4	DEPTH(ft)	15
DESCRIPTION	SM	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)	110		
NATURAL MOISTURE CONTENT	17.1%		
SWELL/CONSOLIDATION (%)	1.9%		

JOB NO. 200045
 CLIENT C&C LAND
 PROJECT STERLING RANCH BRIDGES



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SWELL CONSOLIDATION TEST RESULTS

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JOB NO.
 200045

FIG NO.
 B-8

CLIENT	C&C LAND	JOB NO.	200045
PROJECT	STERLING RANCH BRIDGES	DATE	2/4/2020
LOCATION	STERLING RANCH BRIDGES	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	2-3	1	SM	0.00
TB-2	10	3	SM	<0.01
TB-4	15	3	SM	0.00
TB-3	5	2	SM	<0.01

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LABORATORY TEST
SULFATE RESULTS

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JOB NO.
200045

FIG NO

B-9