BUCKHORN GEOTECH

Civil, Structural & Geotechnical Engineers

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August 31, 2006

RECEIVED
JUL 31 2013
Durango Field Office
Division of Reclamation,
Mining and Safety

Lone Eagle Land Brokerage
21330 6785 Ct.
Montrose, CO 81402

Attn: Mr. Joseph Burns

RE: GROUNDWATER MONITORING RESULTS
MONTROSE 552-ACRE RANCH
MONTROSE COUNTY, COLORADO

Dear Mr. Burns:

Please find enclosed the results of the groundwater monitoring for the Montrose 552-Acre Ranch, located between Government Springs Road to the south, T Road to the north, west of the Uncompahgre River, east of U.S. Highway 550 and extending to Sims Mesa, in Montrose County. The Geologic Report for this property was completed and submitted to you on May 5, 2006. These groundwater monitoring results form the final portion of our geologic analysis.

Twenty groundwater monitoring standpipe piezometers were installed on the property during January, February, and March, as part of our site investigation. As indicated on the attached Site Plan, Standpipe #1 (SP#1) through Standpipe #20 (SP#20) were placed in each test pit location prior to backfilling the excavations. The piezometers were monitored during a period from April 10 to July 27, 2006. The results of the monitoring are presented on the attached spreadsheets. The reading on April 10, 2006, was taken to demonstrate the groundwater level prior to the irrigation season. Generally, the piezometers situated in agricultural areas experienced high groundwater levels due to flood-type irrigation practices, while the piezometers positioned within the escarpment and on top of the mesa remained relatively dry during the monitoring period.

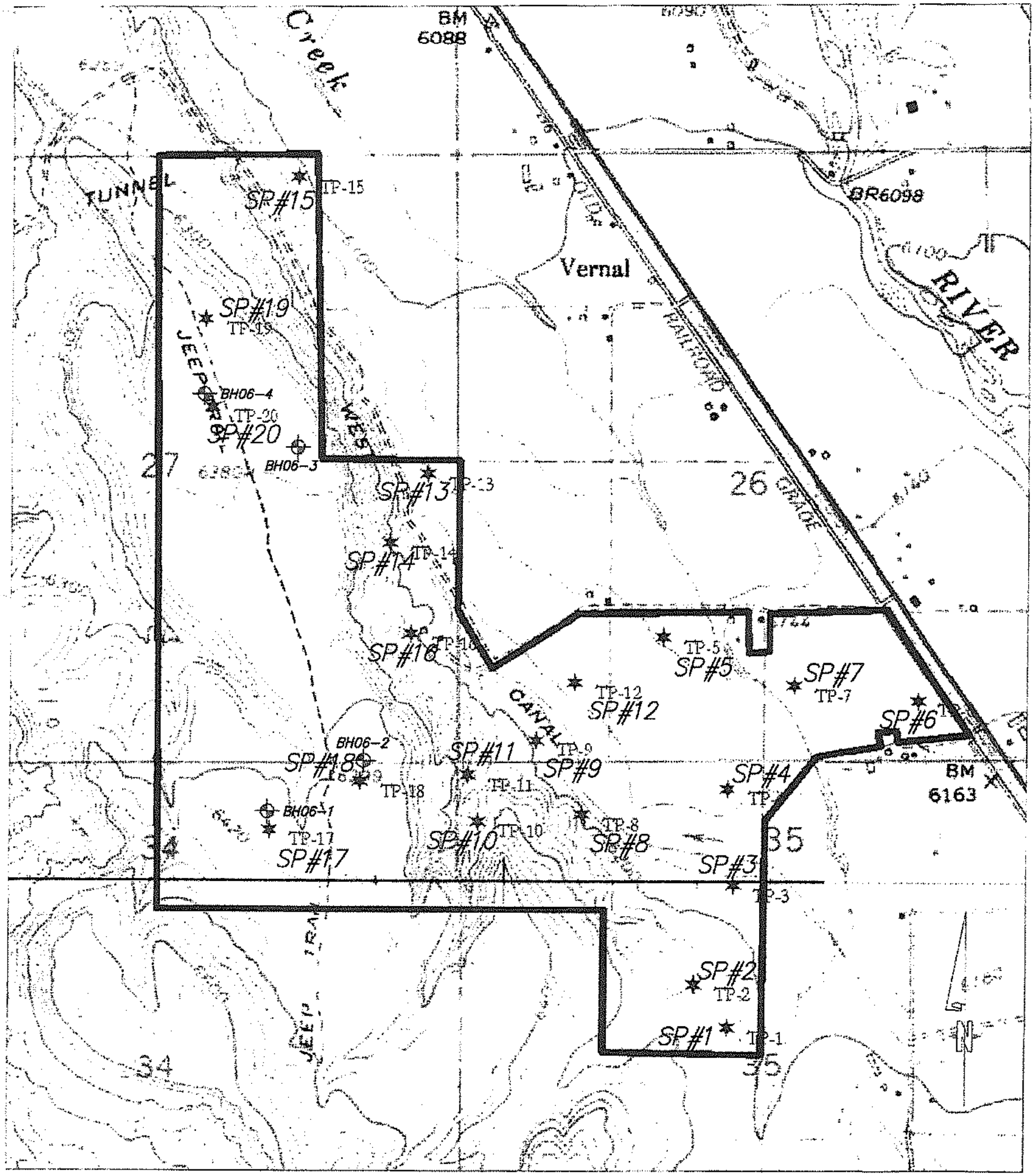
It was a pleasure to work with you on this project. Buckhorn Geotech is a full-service engineering firm providing foundation, site drainage, structural, and retaining structure design services, as well as construction materials testing and inspections. If you require any of these services or have any questions regarding the above, please do not hesitate to contact us.

Respectfully Yours,
BUCKHORN GEOTECH, INC.

Timothy P. Brethauer, Geologist

Encl.: Site Map, Monitor Well Summary

SITE MAP



DRAWING NUMBER
1
OF 1

INVESTIGATION TB
DRAFTER TB
DATE April, 2006
JOB NO. 06-023-GEO

Lone Eagle Land Brokerage
MONTROSE 552-ACRE RANCH
MONTROSE COUNTY, COLORADO

BUCKHORN GEOTECH
Civil, Structural, and Geotechnical Engineers, Inc.
222 South Park Avenue
Montrose, Colorado 81401
Phone (970) 249-6828 Fax (970) 249-0945

BUCKHORN GEOTECH

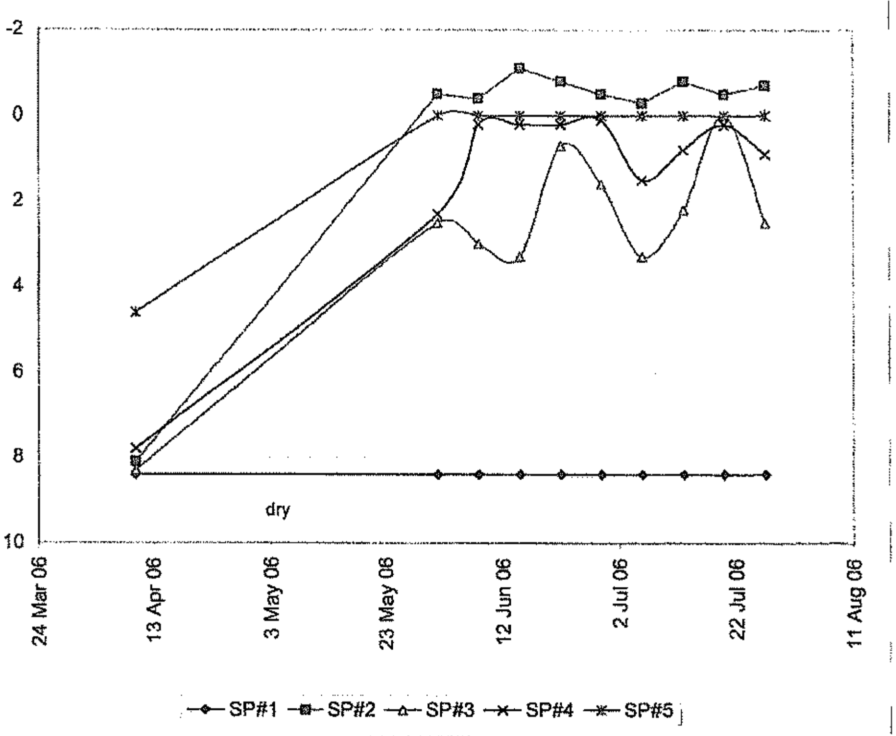
Civil, Structural & Geotechnical Engineers

Year 2006 Groundwater Study Summary

Montrose 552-acre Ranch
06-023-GEO

Standpipe #	1	2	3	4	5
Location	TP#1	TP#2	TP#3	TP#4	TP#5
Depth (ft.)	8.4	8.1	8.3	7.8	4.6
Observation Date					
Apr 10, 2006	dry	dry	dry	dry	dry
Jun 1, 2006	dry	-0.5	2.5	2.3	0
Jun 8, 2006	dry	-0.4	3	0.2	0
Jun 15, 2006	dry	-1.1	3.3	0.2	0
Jun 22, 2006	dry	-0.8	0.7	0.2	0
Jun 29, 2006	dry	-0.5	1.6	0.1	0
Jul 6, 2006	dry	-0.3	3.3	1.5	0
Jul 13, 2006	dry	-0.8	2.2	0.8	0
Jul 20, 2006	dry	-0.5	0	0.2	0
Jul 27, 2006	dry	-0.7	2.5	0.9	0

Groundwater Levels from the Ground Surface

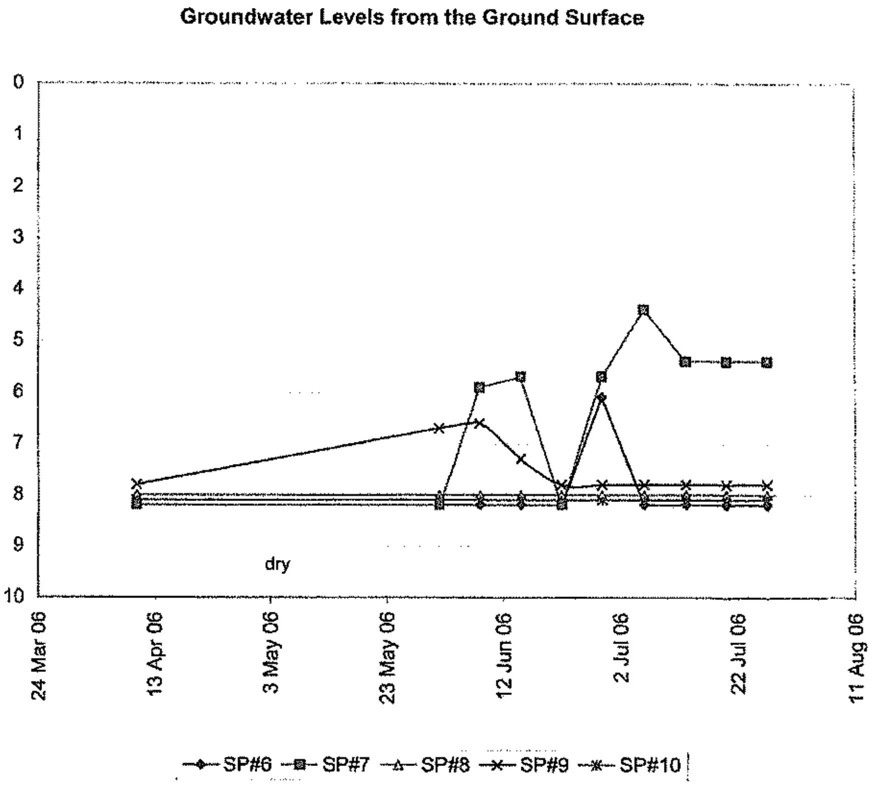


BUCKHORN GEOTECH
Civil, Structural & Geotechnical Engineers

Year 2006 Groundwater Study Summary

Montrose 552-acre Ranch
06-023-GEO

Standpipe #	6	7	8	9	10
Location	TP#6	TP#7	TP#8	TP#9	TP#10
Depth (ft.)	8.2	8.2	8	7.8	8.1
Observation Date					
Apr 10, 2006	dry	dry	dry	dry	dry
Jun 1, 2006	dry	dry	dry	6.7	dry
Jun 8, 2006	dry	5.9	dry	6.6	dry
Jun 15, 2006	dry	5.7	dry	7.3	dry
Jun 22, 2006	dry	dry	dry	dry	dry
Jun 29, 2006	6.1	5.7	dry	dry	dry
Jul 6, 2006	dry	4.4	dry	dry	dry
Jul 13, 2006	dry	5.4	dry	dry	dry
Jul 20, 2006	dry	5.4	dry	dry	dry
Jul 27, 2006	dry	5.4	dry	dry	dry



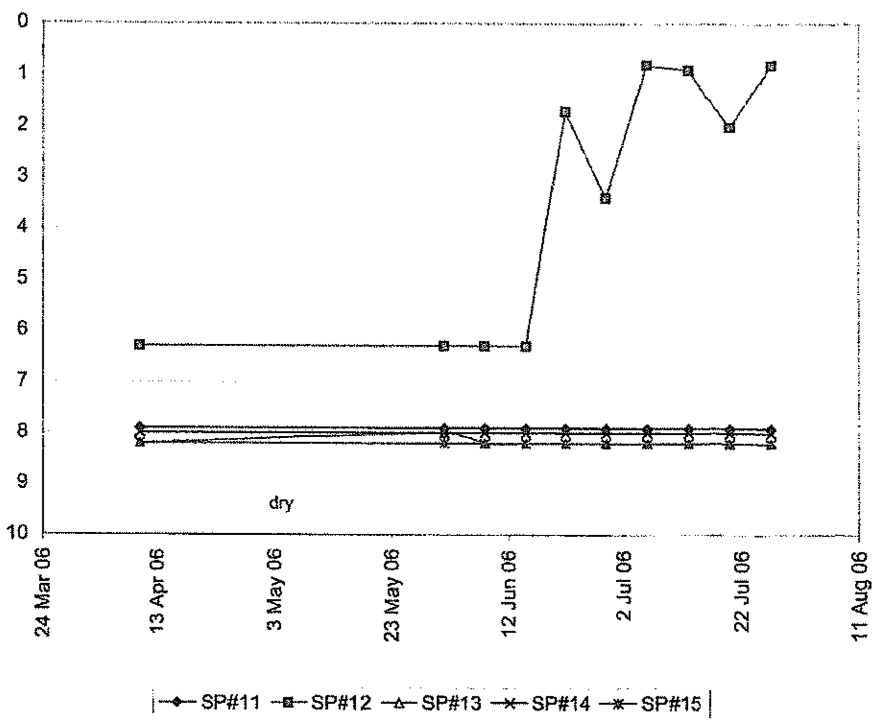
Year 2006 Groundwater Study Summary

Montrose 552-acre Ranch

06-023-GEO

Standpipe #	11	12	13	14	15
Location	TP#11	TP#12	TP#13	TP#14	TP#15
Depth (ft.)	7.9	6.3	8.2	8	8.2
Observation Date					
Apr 10, 2006	dry	dry	dry	dry	dry
Jun 1, 2006	dry	dry	8	dry	dry
Jun 8, 2006	dry	dry	dry	dry	dry
Jun 15, 2006	dry	dry	dry	dry	dry
Jun 22, 2006	dry	1.7	dry	dry	dry
Jun 29, 2006	dry	3.4	dry	dry	dry
Jul 6, 2006	dry	0.8	dry	dry	dry
Jul 13, 2006	dry	0.9	dry	dry	dry
Jul 20, 2006	dry	2	dry	dry	dry
Jul 27, 2006	dry	0.8	dry	dry	dry

Groundwater Levels from the Ground Surface



BUCKHORN GEOTECH

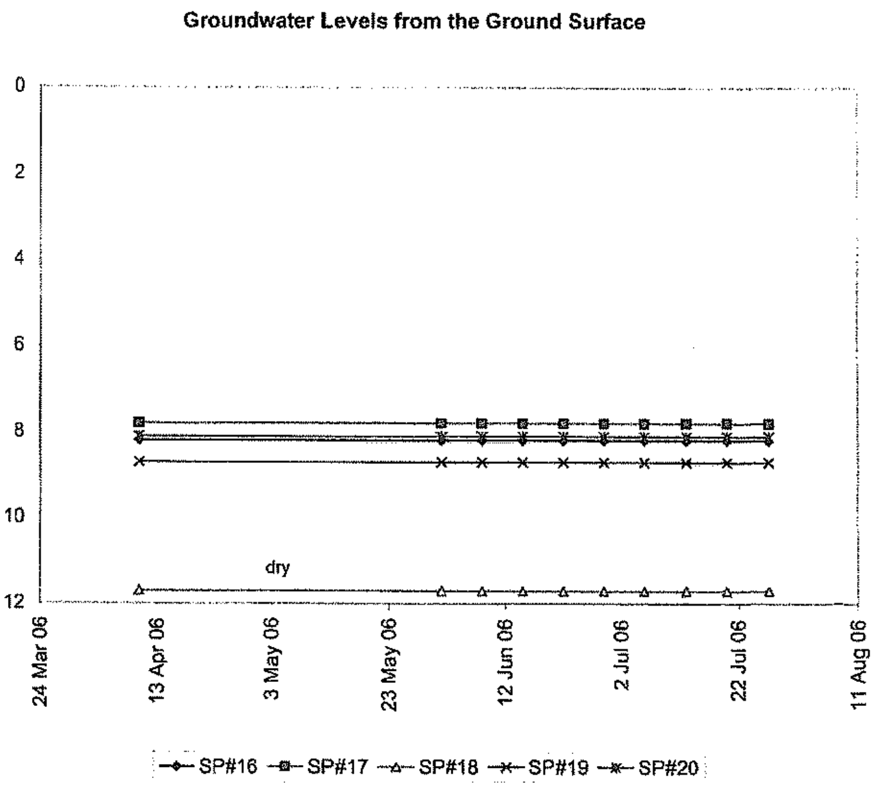
Civil, Structural & Geotechnical Engineers

Year 2006 Groundwater Study Summary

Montrose 552-acre Ranch

06-023-GEO

Standpipe #	16	17	18	19	20
Location	TP#16	TP#17	TP#18	TP#19	TP#20
Depth (ft.)	8.2	7.8	11.7	8.7	8.1
Observation Date					
10-Apr-06	dry	dry	dry	dry	dry
1-Jun-06	dry	dry	dry	dry	dry
8-Jun-06	dry	dry	dry	dry	dry
15-Jun-06	dry	dry	dry	dry	dry
22-Jun-06	dry	dry	dry	dry	dry
29-Jun-06	dry	dry	dry	dry	dry
6-Jul-06	dry	dry	dry	dry	dry
13-Jul-06	dry	dry	dry	dry	dry
20-Jul-06	dry	dry	dry	dry	dry
27-Jul-06	dry	dry	dry	dry	dry



Groundwater Levels from the Ground Surface

BUCKHORN GEOTECH

Civil, Structural & Geotechnical Engineers

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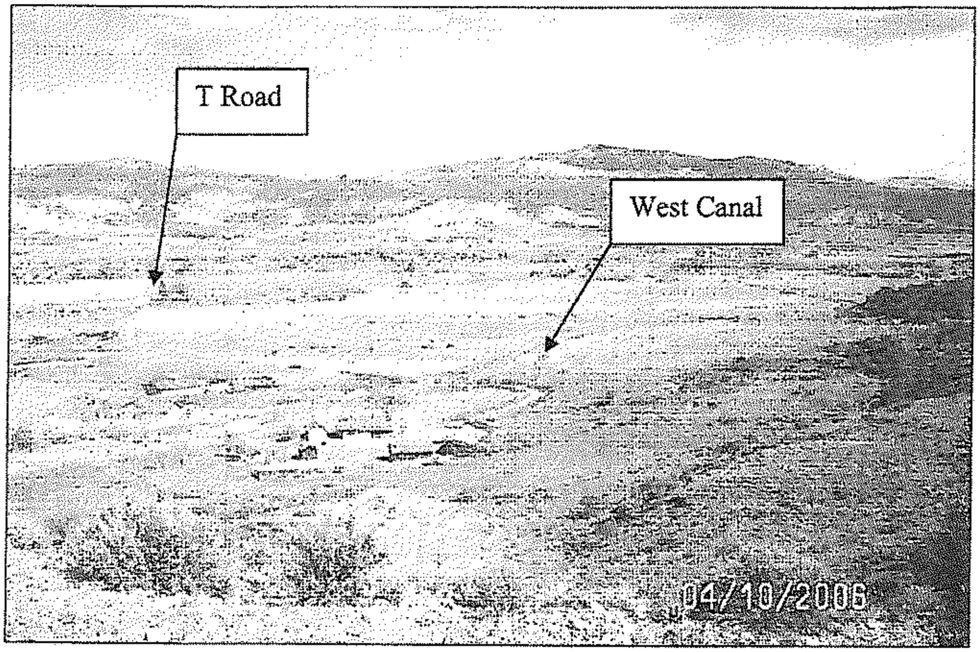
GEOLOGIC REPORT
LOAN EAGLE LAND BROKERAGE
MONTROSE 552-ACRE RANCH
T ROAD
MONTROSE COUNTY, COLORADO

Buckhorn Geotech, Inc. conducted a series of investigations of site and subsurface conditions in January, February, and March of 2006 at the Montrose 552-Acre Ranch in Montrose County, Colorado. This work was performed at the request of the property co-owner, Mr. Joseph Burns, on behalf of Lone Eagle Land Brokerage, Inc. The purpose for the analysis was to assess the general suitability of the property for development of a major subdivision. The investigation consisted of a site inspection, excavation and logging of twenty test pits, drilling and logging of four borings, percolation and radon testing, installation and monitoring of twenty groundwater standpipes, testing of soil materials encountered, and analysis of available data. Our geologic report includes an analysis of the geologic hazards and constraints relating to groundwater, soil and/or geologic conditions within the 552-acre ranch. The following report presents the findings of our investigation and our conclusions and general engineering considerations for planning, development, and construction within the ranch.

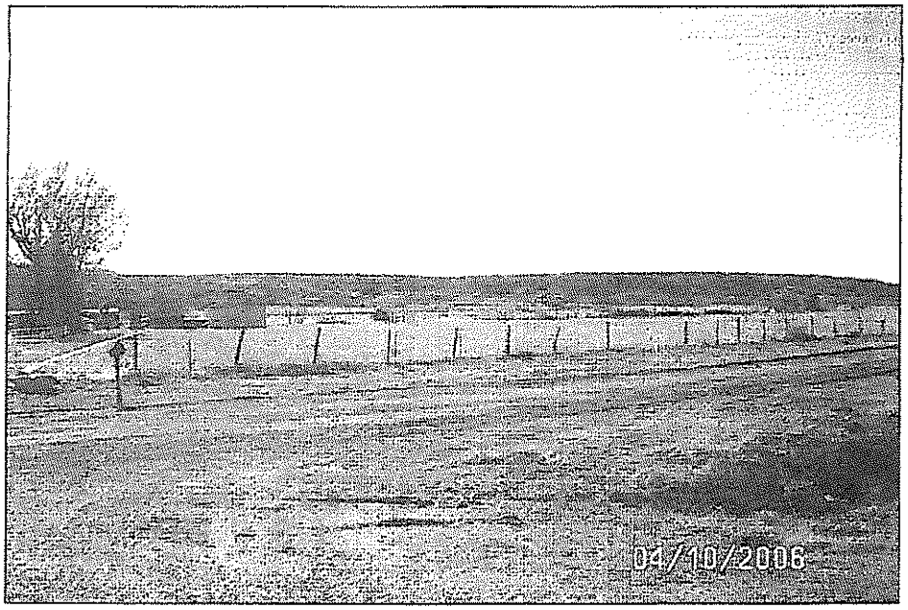
Site Conditions and Proposed Development

The Montrose 552-Acre Ranch is located between Government Springs Road to the south, T Road to the north, west of the Uncompahgre River, east of U. S. Highway 550 and extending west to Sims Mesa, approximately 7 miles south of downtown Montrose (see Vicinity Map). The property is situated in Sections 26, 27, 34, and 35, Township 47 North, Range 9 West, N.M.P.M. The ranch contains a segment of Horsefly Creek to the east, the West Canal, and a portion of the eastern flank of Sims Mesa, locally known as "Moonlight Mesa." Agricultural fields occupy the lower eastern portion of the property between U. S. Highway 550 to the West Canal. The West Canal flows from the southeast corner of the property to the northwest, aligning with the toe of the eastern escarpment of Moonlight Mesa. The top of Moonlight Mesa is relatively level with a subtle general dip to the north and east. A network of small irrigation ditches intersect through the lower fields, while seasonal drainages crease the escarpment and mesa top. The approximate elevation of the property ranges from 6,140 near the highway to 6,500 feet on top of the mesa (*USGS 7.5 Montrose East Topographic Quadrangle*). Topography across the ranch consists of gentle slopes (2 to 5%) on top of the mesa, an escarpment comprised of undulating slopes (30 to 60%) to the east approximately 200 to 250 feet down, and lower nearly level agricultural fields. Vegetation on the non-irrigated mesa top and escarpment consists of sage, yucca, cacti, some juniper and pinon trees, native grasses, and riparian growth such as Russian olives, willows, cottonwoods, and cattails within the drainages leading off the top of the mesa. The lower fields generally consist of hay meadows and some riparian growth along the banks of Horsefly Creek, the West Canal and other surrounding irrigation ditches. An existing homestead, located on the escarpment toe, is surrounded by some landscaped trees and lawn.

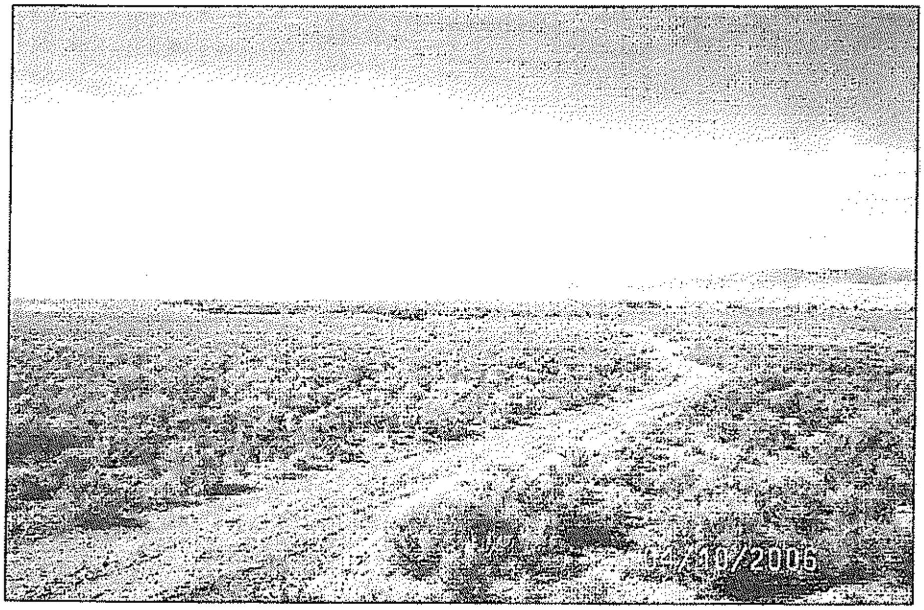
The attached Site Map shows the basic features of the property, including property boundaries, and the approximate locations of our test pits. The following photographs taken from various locations across the property, shows the vegetative cover, local topography, and general characteristics of the ranch.



Looking south from on top of the escarpment, majority of the lower agricultural fields is pictured. T Road is to the left of the photograph, while the West canal is running through the center of the photo.


04/10/2006

Looking west, the escarpment and the eastern most agricultural field can be seen. The frontage road for Highway 550 is pictured in the immediate foreground.


04/10/2006

Looking north, the mesa top is pictured. BLM land boarders the south and west. The escarpment is to the right of the photographer.

Geology

The Montrose 552-Acre Ranch is located within and along the western margin of the Uncompahgre River Valley, which is a northwesterly trending depression lying between the Uncompahgre Plateau uplift to the west and the Gunnison uplift, consisting of pre-Cambrian Black Canyon schist and gneiss, to the east (*Geologic Map of the Montrose 30' x 60' Quadrangle*, USGS Map I-1939: Steven and Hail, 1989). A prominent formation exposed along the west and east margins of the valley is the Dakota Sandstone Formation (*Kd*), a resistant sandstone unit that forms a cap layer on the Uncompahgre Plateau and the western flank of the Black Canyon. The Dakota Sandstone consists of massive, light brown sandstone layers interbedded with weaker, thin strata of gray to black shale, mudstone and some coal. The Mancos Shale Formation (*Km*) overlies the Dakota formation and is the main rock unit immediately underlying the Uncompahgre Valley. The Mancos Shale, a dark-gray to dark-brown, marine clay shale that is locally calcareous or sandy, forms a bedrock wedge that is thickest on the eastern portion of the valley, where it outcrops as "adobe badlands", and thins to the west at the edge of the Uncompahgre Plateau. Under the ranch property, the Mancos Shale is approximately 200 to 300 feet thick and is composed of variably silty, calcareous clay shale with minor inclusions of sandstone, siltstone and limestone.

The valley floor is a broad outwash plain with low mesas formed by melting glaciers. As the glaciers in the surrounding mountains melted, the mud, sand, and gravel contained within the mass of ice was swept downstream, eventually filling in the incised river valley to a depth of 30 to 80 feet. Sims Mesa is an outwash glacial plain that has been isolated by post-glacial down-cutting of the Uncompahgre River. In some places, the escarpment profile shows the cap of glacial outwash as well as the underlying shale bedrock. Erosion of the adjacent adobe hills and terraces has brought fine-grained silts and clays into the valley floor that has spread over the glacial and fluvial alluvium. Subsequent erosion by the river and its tributaries has re-excavated the valley to the shape seen today. This re-excavation has not been a uniform process but has been punctuated by climatic cycles that accelerated the rate of erosion during extended periods which were often followed by periods of quiescence.

According to the *Geologic Map of the Montrose 30' x 60' Quadrangle* (USGS Map I-1939), the lower agricultural fields and portions of the mesa are mapped as undivided stream alluvium, alluvial-fan deposits, and terrace gravel (*Qa*), consisting of "alluvial deposits in floodplains flanking modern streams, alluvial fans at the mouths of tributaries, and older gravels covering stream terraces graded to former stream levels," while the escarpment is mapped as Mancos Shale *(Km)*. Much of the Mancos Shale along the margins of the Uncompahgre River valley is covered by surficial outwash deposits, as observed during our investigation. The conditions encountered during our field investigation are consistent with this mapping.

Soil Classification

According to the *Delta-Montrose Area Soil Survey* (Soil Conservation Service: Cline et al., 1967), the soils in the lower agricultural fields are classified as Vernal clay loam (*VeA*, 0 to 2% slopes), Colona clay, gravel substratum (*CsA*, 0 to 2% and *CoC*, 2 to 8% slopes), Genola clay loam (*GeA*, 0 to 2% slopes), Billings silty clay (*BdB*, 2 to 5% and *BdC*, 5 to 10% slopes), Billings silty clay loam (*BgC*, 5 to 10% slopes), and Chipeta-Persayo-Mesa association (*CkC*, 2 to 10% slopes) surrounding the existing homestead. The majority of the escarpment is classified as Rough Broken Land, Shale and Till Materials (*Rv*), while the soils on top of the mesa are classified as Mesa clay loam to Mesa gravelly clay loam (*MlA*, 0 to 2%, *MlB*, 2 to 5%, *MoB*, 2 to 5%, and *MoA*, 5 to 10% slopes).

Vernal soils are deep, well-drained, and moderately fine-textured soils formed on stream terraces, which are not highly susceptible to erosion, have a moderate organic content, and have a stable structure. Colona soils are deep, moderately well drained, and mainly fine textured. They form on floodplains and at the low end of alluvial fans in uniform, fine-textured, calcareous alluvium derived mainly from sedimentary rocks, and are very similar to Genola soils. Billings soils are deep, well-drained, moderately to fine-textured, and calcareous soils that are formed on the lower portion of gently sloping alluvial fans in sediments washed from adjacent exposures of shale and siltstone. Billings soils are noted for their weak and unstable structure. Rough Broken Land, Shale and Till Materials occur on the steeply sloping sides of erosional valleys and isolated mesas. Mesa soils are deep, well drained, and moderately fine textured grassland soils formed on mesas and high terraces in gravelly, calcareous alluvium of mixed mineralogy. These soil types are consistent with the findings of our field investigation.

Geologic Hazards

A variety of geological hazards can exist in western Colorado as a result of elevation, extreme, topography, soil/geologic conditions, surface and groundwater, and climatic effects. The hazards that potentially affect the Montrose 552-Acre Ranch are discussed below. Some buildings, roadways, and septic systems throughout the region have experienced negative impacts due to slope movement, expansive and compressible soils, and groundwater problems. Appropriate engineering techniques for design and construction relating to troublesome climate and soil conditions should be used to reduce the potential for such problems. However, because of the overall dynamic characteristics of the area, almost every site is subject to at least some degree of potential risk. These risks are explained below.

Unstable Slopes

Slopes on the property range from approximately 2 to 5% on top of the mesa, 30 to 60% as uneven slopes on the escarpment, and nearly level agricultural fields on the valley floor. The slopes of the escarpment appear to be well-vegetated and stable. Although some steep slopes in the region that are composed of these materials are susceptible to potential slope movement, we did not observe any features that may indicate recent movement such as leaning or splayed trees, *scarps, soil tension cracks, seeps, disrupted vegetation, or hummocky topography.* Although the slopes of the escarpment appear currently stable, they can be destabilized through design and construction practices that ignore the potential for earth movement. If development through the escarpment is proposed, we recommend a slope stability analysis.

Slope stability can be impaired by cutting into steep slopes (especially near the toe of the slope), applying loads at the crest of a slope, careless removal of vegetation, and introducing soil moisture or disrupting the existing pattern of surface or subsurface water flow. Providing logical landscape topography, developing an integrated grading and drainage plan, and retaining cut slopes over 3 feet high will be important in preserving site stability. Due to the multiple possible home sites, slope stability will be a site specific issue. Slope stability should be examined for each building site (as needed) as development is planned. Other recommendations for enhancing slope stability are presented in the *Conclusions and Recommendations* Section of this report.

Erosion

Erosion can be a hazard due to sparse vegetation, low organic content of the soil, sloping terrain, weak soil structure, and/or a thin layer of soil over bedrock. During medium- to high-intensity precipitation events, large volumes of runoff can drain from the surrounding areas, causing a concentration of high flows in the seasonal drainages. High velocity runoff can erode surface sediments and scour channel walls, causing widening and/or down-cutting of drainages. Careful soil and water management is recommended along drainages and for construction on or near the escarpment to maintain and enhance the existing stability. Careful and conscientious construction practices should be used when developing to minimize the potential for erosion.

Shallow Groundwater

Shallow groundwater can be problematic as it weakens foundation soils, creates hydraulic pressure, can seep into the interior of buildings if foundation components are not properly waterproofed, and can interfere with the operation of an improperly designed septic system. On moderate to steep slopes, saturated soil conditions can also contribute to unstable slope conditions. Management of surface and subsurface water at this site is important for the long-term performance of foundation components and slope stability. A comprehensive site drainage plan, designed in tandem with the grading and landscape plans, should be designed to intercept surface and subsurface water and remove it from development areas. Care should also be taken so that outfall from drains is not concentrating the runoff, which could cause erosion or slope stability problems. General recommendations for grading and foundation preparation are given below in the *Conclusions and Recommendations* Section of this report.

Although we did not find groundwater during our subsurface investigations and did not observe any indications of seeps or springs, we did observe iron-oxide staining, mottling, and in some of the lower test pits, an abrupt cessation of roots, suggesting that groundwater may seasonally rise. Since we performed our investigation during a time of the year when irrigation is not occurring and groundwater levels are cyclically low (winter), it is expected that groundwater levels will be higher during the irrigation season. Groundwater monitoring standpipes (piezometers) were installed in the excavations prior to backfilling. These piezometers were positioned to demonstrate the limits of high groundwater that may occur on the property. Groundwater levels will be monitored as per the County requirements. When our measurements are complete, and we are comfortable determining the level of shallowest groundwater, we will tabulate the results to be summarized in a letter that will be an addendum to this report.

Wetlands

Field observations of various areas within the ranch, particularly the southern portion, indicate that potential jurisdictional wetland(s) may exist along principal drainages. Jurisdictional wetlands are defined by the U.S. Army Corps of Engineers as areas that are inundated by surface and/or groundwater in durations sufficient to support a prevalence of vegetation suited to saturated ground conditions. Section 404 of the 1977 Clean Water Act requires a permit to be obtained before a wetland or water of the U.S. can be impacted. Wetlands adjacent to waters of the U.S. such as lakes, rivers, and streams are considered waters of the U.S. In addition, specific County regulations, permits, and setbacks may apply. It is recommended that a wetlands delineation survey be conducted to identify wetland areas that may be impacted by proposed development.

Flooding

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map Panel 402B, the majority of the 552-acre ranch is located in *Zone C*, areas of minimal flooding, where no special precautions are required to mitigate potential flood hazards. Areas within the Horsefly Creek channel are mapped as *Zone A*, areas affected by the 100-year flood. No observable signs of recent flooding were seen on the property. However, due to the mapping designation along Horsefly Creek, the close proximity of the West Canal and surrounding ditches, we recommend that the property owners avoid all potential floodplains and consider elevating the first floor level of any home built downgrade of these water features, a minimum of 1-foot above surrounding grade to minimize the hazard resulting from an unlikely breach.

Expansive and Compressive Soil and Rock

Soil materials containing some types of clay, especially bentonite (montmorillonite), can expand in volume as they absorb water and then shrink as they become dry. In some areas of Colorado, these expansive soils are very hazardous and can cause serious damage to foundations, roadways, pavements, and embankments. The geology of swelling soils, the effects of moisture on these soils, and dealing with construction and landscaping on swelling soils are discussed in the Colorado Geological Survey publication, *A Guide to Swelling Soils for Colorado Homebuyers and Homeowners* (Special Publication #43: Noe et al., 1997). In the Montrose area, these clays are principally derived from Mancos Shale.

Compressive soils are those that have generally been laid down rapidly, have a weak matrix containing voids, and/or are not naturally in a dense or compacted state. Compressive soils typically have a large proportion of fine-grained materials, especially silt, but this is not always the case. For example, alluvial and debris fan deposits contain soil, rock and organic debris that is laid down during flood events in an unsorted and uncontrolled manner. Consequently, the debris contains voids and, although it contains rocks up to boulder-size, the interstitial material is often not dense or in a well-consolidated state. Clayey soils can also be compressive if saturated when loads are applied.

Mancos Shale and its residual soil can be very sensitive to variations in moisture, being quite strong when dry but either expansive or losing strength rapidly when wetted. Additionally, wetting and drying cycles can weaken the shale so that it becomes highly erodible. When in a dry and dense state, the shale and its residual soil can exert expansive pressures when moisture is absorbed. Conversely, when in a loose, highly fractured state, the material can consolidate when wetted under moderate loads. The expansive and compressive characteristics of the shale and soil are discussed in detail in the *Subsurface Conditions* Section of this report.

The potential hazard from expansive and compressive soil is the differential movement of foundation soils under loads applied through the foundation. This hazard can be partly mitigated by control of on-site drainage so that no water is allowed to accumulate, stand, or penetrate into the soil in the vicinity of foundations and slab/pavement areas. Further mitigation can be attained through design of foundation systems that extend to firmer material or which have sufficient strength to resist differential movements. Another option is the removal of the problematic soil and replacement with structural fill. These methods are discussed in further detail below in the *Conclusions and Recommendations* Section. Special Publication #43 gives general explanations and illustrations of design and drainage options on swelling soils.

Seismicity

There are no geologically recent (Quaternary-aged) or potentially active faults identified in the immediate vicinity of the Montrose 552-Acre Ranch in either of the Colorado Geological Survey (CGS) reports relating to earthquake potential [*Earthquake Potential in Colorado—A Preliminary Evaluation* (Bulletin #43: Kirkham and Rogers, 1981) and *Preliminary Quaternary Fault and Fold Map and Database of Colorado* (Open-file Report 98-8: Widmann et al., 1998)]. The closest mapped potentially active faults to the ranch are the Cimarron Fault group, a segmented fault zone located 8 miles northeast of Montrose and continuing for roughly 35 miles to the southeast, and the Roubideau Creek Fault, located roughly 12 miles southwest of Montrose. Both are northwest-trending faults that are interpreted to be Quaternary-aged, but the Cimarron Fault group consists of five distinct sections with apparently different ages and amounts of movement associated with the Laramide Gunnison Uplift that was later reactivated, while the Roubideau Creek Fault appears to be associated with movement on the eastern flank of the Uncompahgre Plateau. The maximum credible earthquake inferred for the Cimarron Fault group is M6.75. A maximum credible earthquake has not been assigned to the Roubideau Creek Fault, but it is believed to be one of the youngest faults in the region, having displaced late Pleistocene to Holocene age landslide deposits, making it less than 15,000 years old.

Montrose County is located in the Colorado Plateau Seismotectonic Province in Colorado, where maximum credible earthquakes are estimated to be on the order of magnitude 5.5 to 6.5, which is equivalent to Modified Mercalli (MM) V to VIII (CGS Bulletin #43). The largest recorded earthquake in the region was the 1960 M5.5 (MM VI) Montrose/Cimarron event [according to the CGS Bulletin #52 entitled *Colorado Earthquake Information, 1867-1996* (Kirkham and

Rogers, 2000) and the CGS website database of earthquake events: *http://geosurvey.state.co.us*]. There were several other similar magnitude earthquakes in the Montrose region: Ridgway in 1897 (MM V), Lake City in 1913 (MM VI) and 1955 (MM VI), Somerset in 1944 (MM VI), and Cimarron Ridge/Montrose in 1962 (MM V). Many other earthquake events less than MM V have been identified for the region.

The Colorado Geological Survey indicates that, based on limited historical records, Colorado is considered to be a region of minor earthquake activity, where moderate to large events are relatively infrequent. However, there is a growing body of evidence that suggests that Colorado is at greater risk than previously thought. According to the Uniform Building Code, western Colorado is in Seismic Risk Zone 1 where distant earthquakes would be expected to cause only minor damage to structures with fundamental periods of vibration greater than one second. Excepting transmission towers, we are unaware of such tall, slender structures in western Colorado. However, the CGS recommends in their Bulletin #43 that a Seismic Risk Zone 2 designation may be more appropriate for all of Colorado except the extreme northeast corner. It also suggests that for areas that are far from known active faults, a minimum of 0.1g horizontal acceleration should be used in design and safety analyses.

Radon Gas

Radon gas is produced by decay of radioactive minerals contained in subsurface rock and soil. The U.S. Environmental Protection Agency (EPA) has determined that radon is the 2nd leading cause of lung cancer and that radon can accumulate in homes if the gas is not properly removed through passive or active methods. The EPA map of Radon Zones indicates that virtually all of western Colorado, including Montrose County, is in Zone 1 (*www.epa.gov/iaq/radon/zonemap/colorado.htm*). Although there is no known safe level of radon, Zone 1 is the zone of highest risk for exposure to radon gas [i.e., greater than 4 picoCuries per Liter (pCi/L)]. The Colorado Geological Survey (CGS) participated in an EPA study in 1987 and 1988 to record indoor radon levels throughout Colorado homes and compiled its results in a report that relates geologic setting and house construction with radon levels (CGS 1991 Open-File Report 91-4). Generally, homes with basements had higher levels of radon than homes with slabs on the same geologic material. In our region of Colorado, Precambrian igneous rocks had the highest readings, followed by older Mesozoic sedimentary rocks, and Tertiary volcanic and volcaniclastic rocks. Radon values in alluvial and glacial valley fill was highly variable. The CGS is careful to state that radon potential can vary considerably within the same geologic unit. This has to do with the non-uniform distribution of uranium, secondary leaching, and the accumulation of uranium and other radioactive elements into other strata.

The EPA recommends testing radon levels in existing homes, but it has not developed a sampling test that will determine levels of radon gas in the native soils <u>prior to construction</u>. This is due to the fact that there are too many factors that affect the movement of radon through soils, such as soil moisture, soil types, weather patterns, and wind, and these factors cannot be completely accounted for or controlled during testing. However, based on levels of radon recorded in existing homes in the region and the presence of rock types that are known to produce radon, it is reasonable to assume that radon is present in the Montrose area. The EPA, the Colorado Department of Public Health and Environment (CDPHE) Radiation Management

Division, and the National Association of Home Builders (NAHB) recommend that all new homes constructed in Zone 1 should include radon-resistant features. They also recommend that after the house is constructed, radon should be measured in the home and if the results are greater than 4 pCi/L, the system should be upgraded from passive to active (usually by installing a fan). In the EPA publication entitled, *Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes* (USEPA Office of Air and Radiation EPA/402-K-01-002, April 2001), they present three practical and inexpensive alternatives for a passive, sub-slab depressurization system: gravel with vents, perforated pipes, or soil gas collection mats. As stated in that EPA publication, radon-reduction techniques not only reduce radon in the home but also are "consistent with state-of-the-art energy-efficient construction…which will result in energy savings and lower utility bills for the homeowner" and they have the added benefits of "decreasing moisture and other soil gases in the home, reducing molds, mildews, methane, pesticide gases, volatile organic compounds, and other indoor air quality problems." It is estimated that retrofitting a house after construction with radon resistant features is 2 to 10 times more expensive than if it had been included in the original construction.

As required by Montrose County Land Use Regulations, radon tests were performed in the soil at each test pit location and sent to a laboratory for evaluation. The test results showed radon levels ranging from lower than the method detection limit (0.5 picoCuries per Liter (pCi/L)) to 38.1 pCi/L (see Radon test results, respectively). A positive reading is common throughout the Uncompahgre Valley.

The *Building Radon Out* EPA publication can be obtained from the CDPHE in Denver by calling (303) 692-3420. Other recommendations for passive and active design and construction techniques for reducing radon gas can be found on the EPA radon website *www.epa.gov/radon/* or the CDPHE radon website *www.cdphe.state.co.us/hm/rad/radon*.

No other geologic hazards are known to be present in the vicinity of the Montrose 552-Acre Ranch.

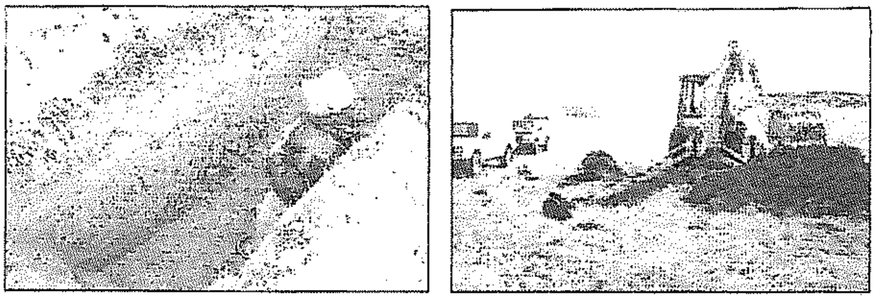
Subsurface Conditions

Twenty test pits (TP#1 through TP#20) and four boreholes (BH06-1 through BH06-4) were excavated/drilled at selected locations shown on the attached Site Map. The locations of the test pits were chosen based upon the anticipated variation in subsurface conditions, access, consideration of existing development, and are thought to be representative of the surficial geologic conditions across the property based on available information. The soil and groundwater conditions were visually examined and logged, and representative samples of soils encountered were brought back to our laboratory for detailed examination and testing. The stratigraphy encountered in the test pits and boreholes and laboratory results are shown on the attached Soil Logs and Logs of Exploratory Drilling. Laboratory test results are shown on the attached laboratory test sheets, and summarized on the attached *Summary of Laboratory Test Results.*

The test pits were excavated using a backhoe/front-end loader. The borings were advanced using a truck-mounted Simco 2800 HS auger rig. The holes were drilled using a 4.25-inch outside diameter (O.D.) continuous-flight solid-stem auger. Soil samples were obtained at discrete intervals while performing in-situ Standard Penetration Tests (SPT) in general accordance with ASTM Standard D-1586, using a 2-inch I.D. "California" split-spoon sampler with liners. The number of blows required to drive the sampler one foot were recorded (SPT "N" penetration resistance values) and, when properly evaluated, indicate the relative density or consistency of the soils. Samples collected from the split spoon sampler were used to classify the soil material and determine its engineering characteristics.

Generally, the 552-acre ranch consists of three different geologic settings; old lower floodplain (agricultural fields), escarpment, and mesa top. The lower agricultural fields are generally comprised of clayey soil with varying amounts of sand and gravel underlain by deep gravel and cobbles. The escarpment is composed of shale, shale outcrops, and overlying sand and gravel deposits eroded from the above mesa top. The mesa top generally consists of an undulating layer of sand, gravel, and cobbles above shale. Test pits #1 through #16 were excavated within the escarpment and throughout the lower agricultural fields, while test pits #17 through #20 and the four drilled boreholes were advanced on top of the mesa. The laboratory test results are summarized in the following paragraphs in accordance with their geologic setting.

TP#2, TP#3, TP#4, TP#5, TP#6, TP#7, TP#9, TP#12, and TP#13 were excavated in the agricultural fields. These pits generally consisted of approximately 1-foot of damp, organic, silt and clay topsoil underlain by stiff silt and clay with varying amounts of sand and gravel. TP#6 and TP#7, which were located furthest east, revealed deep gravel and cobbles underlying the silt and clay at depths of 2 and 7.5 feet. Atterberg Limits tests performed on the clayey soils revealed Plasticity Indices (PI) ranging from 19 to 32, indicating that the soil typically has a moderate to high shrink/swell potential with moisture changes. Gradation Analyses performed on the clayey samples indicate that these subsoils are typically composed of 61.6 to 95.3% fines (silt and clay), 2 to 37.7% sand, and 0.0 to 20.1% gravel. A sample of the underlying gravel and cobbles in TP#6 revealed to be Non-Plastic (NP) and composed of 3.2% fines, 27.7% sand, and 69.1% gravel. Drive samples were taken in these soils and subjected to swell/consolidation tests. Under a confining pressure of 2000 pounds per square foot (psf) and left at their in-situ moisture contents ranging from 14.7 to 24.3%, the samples generated estimated swelling pressures ranging from 190 to 950 psf, considered low to moderate (see Summary of Laboratory Test Results, respectively). These excavations were terminated at an approximate depth of 8 feet, with no groundwater being encountered. Samples tested revealed moderately high levels of sulfates.



Soils at TP#3 and TP#4. The photograph on the left shows the typical soil profile revealed in out test pits throughout the lower agricultural fields, while the photo on the right shows a test hole during excavation.

TP#1, TP#8, TP#10, TP#11, TP#14, TP#15, and TP#16 were located within the escarpment. The soil and rock ranged from shale to sand and gravel. Atterberg Limits tests performed on the variety of material found revealed PI's ranging from 22 to 26, indicating that the soils typically have a moderate shrink/swell potential. Gradation analysis were performed on the various samples indicate that these subsoils (not including shale) are typically composed of 50 to 83.7% fines, 16.3 to 31.2% sand and 0 to 29.3% gravel. Drive samples were taken in these soils and subjected to swell/consolidation tests. Under confining pressures ranging from 2000 to 8000 psf and left in their in-situ moisture contents ranging from 11.6 to 12.5% the samples generated swelling pressures ranging from 650 to 2570 psf, considered low to high (see Summary of Laboratory Test Results). These excavations were terminated at an approximate depth of 8 feet, with no groundwater being encountered. A sample of soil from the escarpment area was found to contain a high level of sulfate.

Soils at TP#16. The photograph shows the typical soil profile revealed in out test pits within the escarpment. Note the upper granular material overlying the fractured shale.

TP#17 through TP#20, as well as BH04-1 through BH04-4, were excavated/drilled on top of the mesa. These test pits and borings generally revealed clayey sand and gravel overlying sandy gravel and cobbles, which is underlain by shale at depths ranging from 15 to 35 feet. Atterberg Limits tests performed on the gravelly soils revealed Plasticity Indices (PI) ranging from Non-Plastic (NP) to 19, indicating that the soil typically has a low to moderate shrink/swell potential with moisture changes. Gradation Analyses performed on the sand and gravelly samples indicate that these subsoils are typically composed of 1.2 to 40.7% fines (silt and clay), 6.2 to 54.6% sand, and 16.1 to 92.8% gravel. Drive samples were taken in these soils and subjected to swell/consolidation tests. Under confining pressures ranging from 2000 to 4000 psf and left in their in-situ moisture contents ranging from 6.7 to 9.8% the samples generated swelling pressures ranging from 360 to 1610 psf, considered low to moderate (see Summary of Laboratory Test Results).

Soils at TP#18. The picture shows the typical test pit on top of the mesa.

In summary, the property consists of three separate geologic settings, the lower agricultural fields, escarpment, and upper mesa top, each having distinct soil profiles. Generally the lower fields consist of a mantle of stiff, moderate to highly plastic clay with moderate to high swell potential, which thins out to the east where underlying gravels and cobbles are found at shallow depths. The escarpment is composed of shale outcrops, shale residuum, and small-scale colluvial fans. The top of the mesa generally consists of calcareous sand and gravel with silt and low to moderately plastic clay underlain by sandy gravel and cobbles extending to various depths before reaching shale. Due to the fine-grained nature of the soils and the existing arid conditions in various areas of the property, management of surface and subsurface water will be essential to the long-term performance of the foundation soils.

Percolation Testing

Percolation tests were performed at each of the test pit locations to evaluate the potential for On-site Wastewater Systems (OWS). The soil profiles of these test pits can be seen on the attached *Soil Logs*. The soils found in each percolation hole and the resulting percolation rates are presented in the attached *Summary Table of Percolation Results*. The rates are measured in minutes per inch (mpi), per county requirements.

Generally, the percolation rates at the sites tested on the mesa top were mostly acceptable but, as expected, the escarpment sites tested were variable but mostly on the slow side. The valley floor sites were also variable but some tests provided very slow percolation rates.

The Colorado Health Department requires percolation rates to be between 5 and 60 mpi for the use of a "standard" absorption system, as well as no bedrock, groundwater, or confining layer within four feet of the bottom of treatment zone. Based on our test results, it appears that specially designed systems will be needed in some locations on the escarpment and valley floor. Additional site-specific percolation tests will be necessary for OWS design for each lot, unless the leachfield is located exactly where the tests for this report were conducted.

CONCLUSIONS AND RECOMMENDATIONS

Our evaluation indicates that the Montrose 552-Acre Ranch appears suitable for development that pays careful attention to foundation design, drainage control, site preparation, septic system design, and groundwater management. The following recommendations are offered as measures to enhance the stability of the site and the long-term performance of the foundation soils. These measures cannot and will not arrest or prevent large-scale geologic processes that may be on-going elsewhere on the property and within the Montrose area. Also, as mentioned earlier in this report, some degree of risk is inherent in all construction in mountainous areas of Colorado. The recommended measures are intended to be reasonable and prudent but cannot be considered as absolute protection against the vagaries of nature.

Based on our site investigation and laboratory soil testing, the following **general recommendations** are offered for foundation evaluation and for mitigation of potential site hazards. Aside from pavement design sections, these recommendations are conceptual and are offered as general guidelines, not job specifications. ***Site-specific investigation and testing should be done to verify applicability prior to design and construction.***

Foundation Systems

- Shallow foundations should perform adequately, but may require some subgrade treatment to reduce the potential for post-construction differential movement due to either heave or settlement. This typically involves some overexcavation below foundation level, followed by replacement with structural fill, but can also involve other forms of treatment of the subgrade. Additional alternatives that may provide less risk of foundation movement include post-tensioned raft slabs or deep foundations (drilled caissons, micropiles, or helical piers). Details of these alternatives can be determined through site-specific testing.

- Site-specific soil investigation and testing should be conducted at each proposed building site to determine the specific design parameters required to match the subsurface conditions to the proposed patterns and intensities of loading incurred by each structure. These investigations should address potential for soil expansion, hydrocompaction, and settlement, all of which are known to occur within the highly variable terrain conditions found in the area.

- Shallow foundation systems should be extended into the subsurface a minimum depth below finished grade as prescribed by the local building official for frost heave protection.

- Basements may be considered but the potential for shallow groundwater should be carefully evaluated at each proposed building site prior to development of construction plans.

Floor Systems

- Floor system selection will depend of the results of site-specific soil investigation and testing. Generally, it can be expected that framed floors over crawl spaces will be acceptable when properly ventilated and supported on appropriately designed footings and stem walls. Basements slabs may require special design and/or waterproofing pending the results of groundwater monitoring and further site investigations.

- Where the foundation conditions allow, floating slabs on-grade may be used at the site for garage and interior floor slabs, so long as such slabs will not be subjected to groundwater seepage and/or hydraulic forces. Long-term differential movement between the foundations and slabs on-grade may occur. For this reason, any floating slabs on-grade should be structurally isolated from the foundation, bearing walls, and interior partitions so that the slabs can float freely in response to soil volume changes without distressing the structure. Construction methods exist to provide slip joints with interior finishes so that slab movement does not compromise the finished product.

- We recommend under-slab plumbing be avoided where possible to minimize the potential for leakage under the slabs. Where necessary, under-slab plumbing should be provided with flexible couplings and should be leak-tested prior to being placed in service.

- Suspended floor systems have historically performed well, but are subject to moisture accumulation in the crawlspaces that can not only cause environmental concerns but also compromise the structural integrity of the flooring system over the long-term. To ensure the long-term performance of these systems, site grading, drainage and ventilation of the crawlspace are important considerations.

Exterior Concrete Flatwork

- Exterior concrete flatwork should be designed and constructed so that it drains freely away from structures. Concrete flatwork adjacent to foundations should slope away at a rate of at least ¼-inch per foot.

- Flatwork may be placed on native soil with the topsoil and organic material removed. If fill is needed under exterior flatwork, it should consist of washed rock or structural fill, placed and compacted in accordance with project specifications.

- Flatwork adjacent to exterior doorways should be dowelled into the foundation to prevent long-term differential movement between the flatwork and structure.

- All concrete used at this site in contact with native soil should comply with the recommendations in the *Concrete* Section of these Recommendations.

Retaining Structures

- Lateral loads developed against retaining walls are a function of the height of the retained soil, the backslope angle, soil placed against the walls, the drainage conditions, and the compactive effort applied to the backfill. Walls designed to retain lateral loads should be designed based upon site-specific investigation and testing, and should account for any expansive pressures that may develop within the soil and backfill.

- The retaining walls should have provisions for drainage so that hydrostatic pressures are not allowed to build up. This is usually accomplished by providing free-draining granular backfill between the walls and retained soil, with a collection drain provided at the bottom of this granular zone, and/or the use of weep holes through the face of the walls. The drain systems should be continuous and have positive outfalls which release the collected water well away from the walls in a manner that minimizes the erosive energy of concentrated flow. The design engineer should ensure that drainage design is compatible with design assumptions.

- Fill material placed behind the walls should be specified and compacted as per the design engineer's specifications. Compaction of 85 to 90% of Standard Proctor maximum dry density is typically used to minimize post-construction settlement of the backfill. Over-compaction of the backfill should be avoided so that excessive pressures are not placed against the retaining wall. Unless expressly approved by the design engineer, only hand-operated light-duty compaction equipment should be used within three feet of the wall. The upper one foot of backfill should consist of clayey soil to create a barrier against infiltration of surface runoff.

Concrete

Long-term performance of concrete in contact with soils and rock can be impaired by sulfates present within the soil and bedrock by a phenomenon called "sulfate attack". When sufficient amounts of sulfate are present, the sulfates can react with chemicals in the cement paste, destroying the paste, causing cracks in the concrete, and ultimately reducing or eliminating the concrete strength. Where high quantities of sulfates are known to be present, non-standard cements that can resist the sulfate attacks are used. These cements resist sulfate attacks due to lesser amounts of the sulfate-reactive chemicals used in the manufacturing process. The American Concrete Institute (ACI), as well as other organizations, has provided guidance levels for the types of cements to be used. Water-soluble sulfates tests conducted on samples of the soils encountered in our excavations showed sulfate concentrations ranging from 0.189 to 0.539%, considered by the American Concrete Institute (ACI) to be "moderate to severe" sulfate exposure. Based on this information, Type V sulfate-resistant cement should be used in areas with elevated sulfate concentrations. If securing Type V cement proves difficult at this project location, alternatives may be considered provided the contractor can demonstrate equivalent performance. Typically a Type I/II cement with a specified type and amount of fly ash has been found acceptable. In any case, air entrainment, a maximum water/cement ratio of 0.45, and a minimum unconfined compressive concrete strength of 4,500 psi is recommended by the ACI.

Foundation Drainage and Ventilation

- It is important to prevent moisture from penetrating into the soil beneath or adjacent to foundations. Moisture can accumulate as a result of poor surface drainage, over-irrigation of landscaped areas, subsurface seepage, or condensation from vapor transport.
- Provisions should be made to evacuate subsurface moisture accumulation from around foundations and under floors. This may be accomplished using conventional footing drains in tandem with a positively-vented moisture and radon control system. Alternatively, consideration may be given to using concrete forms that facilitate both dewatering and the removal of radon gases and vapors.
- Floor systems and confined areas above concrete floor slabs should be properly ventilated to allow for the release of moisture and/or radon gas. (See the *Radon Gas* Section of this report for EPA references for design and construction techniques.)
- Aggressive dewatering or other forms of groundwater management may be required if basements are constructed in areas having seasonally high groundwater.
- Roof drainage should be captured by eave gutters. Downspouts should be fitted with extensions to discharge a minimum of 10 feet away from structures or piped into a closed underground drain system and evacuated off-site. In no case should the downspouts be directed into foundation drain systems. These points of discharge should be identified in the site drainage plan so that water is readily removed from the site.

Site Preparation and Grading

- The site drainage plan, in tandem with the landscape and grading plans, should ensure that each lot is adequately drained and that captured runoff is discharged from the development in a manner that is compatible with the natural drainage patterns and pertinent local regulations.
- Surface water should be removed and not allowed to accumulate or stand anywhere near building sites either during or after completion of construction. This includes water from landscaped areas, patios, decks, and roofs. Drainage plans should ensure that precipitation, snowmelt, and runoff are conveyed around and away from buildings as well as driveways. This is typically accomplished by raising the final grade of each building site above the roadways to direct the surface drainage onto the streets.

- An integrated drainage plan should be developed for the property that provides a network of easements and structures to completely control surface runoff. This should include provisions for retention and detention as temporary and/or permanent features of a stormwater management plan.

- Final grading around the perimeter of foundations should slope downward with at least one foot of drop within the first 10 feet of horizontal distance. Concrete flatwork adjacent to the foundations should slope away at a rate of at least ¼-inch per foot.

- As a precaution against an unlikely breach or flooding of Horsefly Creek, the West Canal, or other nearby irrigation canals and ditches, we recommend elevating the first floor level of homes built down grade of these water features, a minimum of 1-foot above surrounding grade to minimize the hazard resulting from an unlikely breach.

- Development should utilize "best practices" for design and construction so that on-site erosion is minimized. This may include selective thinning of vegetation, construction of temporary diversion ditches, silt fencing, and/or dust suppression. If the cumulative area of disturbance equals or exceeds one acre, on-site erosion control should be planned and executed in conformance with Colorado Department of Public Health and Environment (Water Quality Control Division) stormwater discharge regulations. The local building official will be able to provide specific details regarding these requirements

- Grading of all permanent cut and fill slopes should not exceed 2H:1V. All slopes greater than 2H:1V and over 3 feet in vertical height should be restrained by an engineered retaining structure/system.

- Irrigation of lawn and landscaped areas should be kept at a distance of at least 5 feet from the perimeter of the building and sprinkler heads should be set to spray away from and not towards the foundation.

- Backfill placed in utility trenches should be compacted in accordance with project specifications. This will inhibit surface water infiltration and migration towards foundations, as well as to minimize post-construction settlement of the trench backfill.

- Disturbed areas should be revegetated as soon as practical to reduce soil erosion.

- If fill is used during construction, it should meet the gradational and compaction requirements specified by the design engineer and it should be placed and compacted in **maximum 6-inch lifts**, unless otherwise directed by that engineer. Structural fill should not be placed on topsoil, organic debris, or frozen or wet native soil.

Excavation and Shoring

- Temporary excavations should be made consistent with Occupational Safety and Health Administration (OSHA) regulations and with worker safety in mind.

- If the excavations for foundations, floor slabs, or other settlement-sensitive structures will be made or remain open during wet weather or if they will be left open for extended periods, it is recommended that polyethylene sheeting be secured over the excavation faces to minimize sediment runoff and deterioration of the foundation soils. Trafficking should be kept to a minimum, but where these areas will be subject to traffic, it is recommended that these areas be protected by 6 inches of sand and gravel or a 2-inch layer of lean concrete as a working mat. Large rocks exposed in the excavation face should be scaled for worker safety.

- Excavation dewatering may be required if excavations are made during peak groundwater season (spring through summer). The excavations should be designed to accommodate clarification and discharge of this intercepted water. The Montrose County Building Department should be contacted for specific regulations regarding the clarification and discharge of groundwater off-site. Surface runoff above the cuts should be directed away from excavations using berms or diversion ditches.

- We anticipate that excavation of the site soils can be accomplished by conventional excavating equipment.

Pavement Section Design

Pavement section designs for the proposed development are presented below. The section designs are based upon an estimate of 180 residences (assuming density of 1 home per 3-acres), estimated traffic loadings, and results of field and laboratory testing. Two soils types were checked for bearing strength, with areas of native clay resulting in a low bearing strength (CBR-value of 2) and the areas with native gravels and sand resulting in a higher bearing value (CBR-value of 5). Two pavement section designs were developed for the different subgrade conditions.

- Daily traffic volumes were estimated based on the estimated density of development of approximately 180 residential units for the development. The traffic estimations were based upon the Institute of Transportation Engineer's trip generations for residential development with added trips for school buses, trucks, and construction traffic. Vehicle loadings are correlated to an 18-kip Equivalent Single Axle Load (ESAL) for design purposes. The traffic estimation was projected for a 20-year pavement life resulting in 205,000 18-kip ESALs which is lower than the minimum design traffic of 300,000 18-kip ESALs required by Montrose County for residential streets. The required 300,000 18-kip ESALs value was used for the 20-year pavement design.

- The following parameters were used in the analyses, and stem from the *Colorado* Department of Transportation*'s Pavement Design Manual* and the Colorado Asphalt Pavement Association's *Guidelines for the Design and Use of Asphalt Pavements for Colorado Roadways.*

Parameter	clay subgrade	gravel subgrade
Resilient Modulus (ksi)	3.0	7.5
Drainage coefficient	1.0*	1.0*
Reliability (%)	75	75
Serviceability Loss (psi)	2.5	2.5
Strength coefficients:		
HMA	0.44	0.44
ABC	0.12	0.12
SUBBASE	0.10	0.10

*based upon unknown drainage details per CDOT

- Based upon the parameters provided above, the Montrose County minimum pavement section is not adequate for the clay subgrade and the following pavement sections are provided for the given 18-kip design $ESAL_{20}$. For the gravel subgrade the minimum County section of 3-inches of asphalt over 4-inches of Class 6 aggregate and 12-inches of Class 2 subbase is adequate for the design section. Options for alternative sections are given below to allow some flexibility in the section design.

Pavement section for 300,000 18-kip $ESAL_{20}$ (residential streets) CLAY SUBGRADE

Asphalt Thickness (in.)	Base Course Thickness (in.)	Subbase Course Thickness (in.)
3.0	8	14
3.0	6	16
3.0	4	18

Pavement section for 300,000 18-kip $ESAL_{20}$ (residential streets) GRAVEL SUBGRADE

Asphalt Thickness (in.)	Base Course Thickness (in.)	Subbase Course Thickness (in.)	Notes
3.0	4	12	Minimum County section
3.0	4	8	Need County approval (less than minimum section)
3.0	12	0	Need County approval (less than minimum section)

- To provide a stable base for construction of the pavement sections, we recommend that the subgrade be scarified to a minimum depth of 12 inches below the subbase level, moisture conditioned to -2% to +4% of optimum moisture content, and recompacted to a minimum of 95% of Standard Proctor maximum dry density (ASTM D-698). If soft areas are encountered that can not achieve compaction requirements the engineer should determine if a woven geotextile (Mirafi 500X or equivalent) or a biaxial geogrid (such as Tensar BX1200) is required to provide longevity of the roadway.

- Roadbase and subbase sections should have sufficient width to fully extend beneath road shoulders. Construction of the roadway prism should promote drainage away from the prism and subgrade. Adequate borrow ditches and culverts should be provided and, where needed, lateral and/or crossdrains should be installed to keep water away from the roadways.

- Subgrade preparation, backfill gradation and placement, and asphalt and cement concrete mix designs should follow the specifications given in the Montrose County Standards and *Specifications for Roads and Bridges*. Topsoil should be removed and organic material grubbed prior to commencing construction of the road sections.

On-Site Wastewater System Design and Construction

- We measured percolation rates of 3 to greater than 320 minutes per inch (mpi) in the soil at the sites tested. "Special" systems are recommended that accommodate areas demonstrating rates that do not meet or exceed the Colorado Health Department requirements (5 to 60 mpi). It is expected that additional site-specific percolation tests will be necessary for the planned development.

- Water conservation devices should be used in the home to reduce the volume of water that will be passing through the septic system. This will help to extend its working life.

- Care must be taken in locating the disposal areas to ensure proper system operation, compliance with state and local setback criteria, and not to disrupt existing slope stability.

- The percolation tests were conducted in accordance with Colorado State regulations and for engineering of on-site wastewater systems. However, Buckhorn Geotech takes no responsibility for OWS designs carried out by others using this information.

Closing Considerations

This report has been prepared in a manner consistent with local standards of professional geotechnical engineering practice. Investigation of the site for environmental contaminants was not part of our scope of services performed at this site. The classification of soils and interpretation of subsurface stratigraphy is based on our training and years of experience, but is necessarily based on limited subsurface observation and testing. As such, inferred ground conditions cannot be guaranteed to be exact. No other warranty, Express or Implied, is made.

If the proposed arrangement of lots changes from what we have described in this report, we should be notified to reevaluate our recommendations. Also, if during excavation, soil and groundwater conditions are discovered that vary from these discussed herein, construction should be stopped until the situation has been assessed by a representative of Buckhorn Geotech. Construction should be resumed only when remedies or design adjustments, as necessary, have been prescribed.

Additional Services

Thank you for the opportunity to perform this geologic investigation for you. Buckhorn Geotech is a full-service engineering firm providing foundation, roadway, on-site wastewater system, site drainage and grading, structural, and retaining structure design services, as well as surveying, construction materials testing, and inspections. For a full description of our services please talk with us or visit our website at **www.buckhorngeo.com**. If you require any of these services, please do not hesitate to contact us.

To provide continuity and consistency from project start to finish, we should be retained to make observations and carry out materials testing as a service to the owner. As noted above, we recommend the owner contact us to discuss required services and scheduling in advance of the construction phase.

Thank you again for the opportunity to perform this work for you. If you have any questions regarding this report or our services, please do not hesitate to contact us.

Respectfully Submitted,
May5, 2006

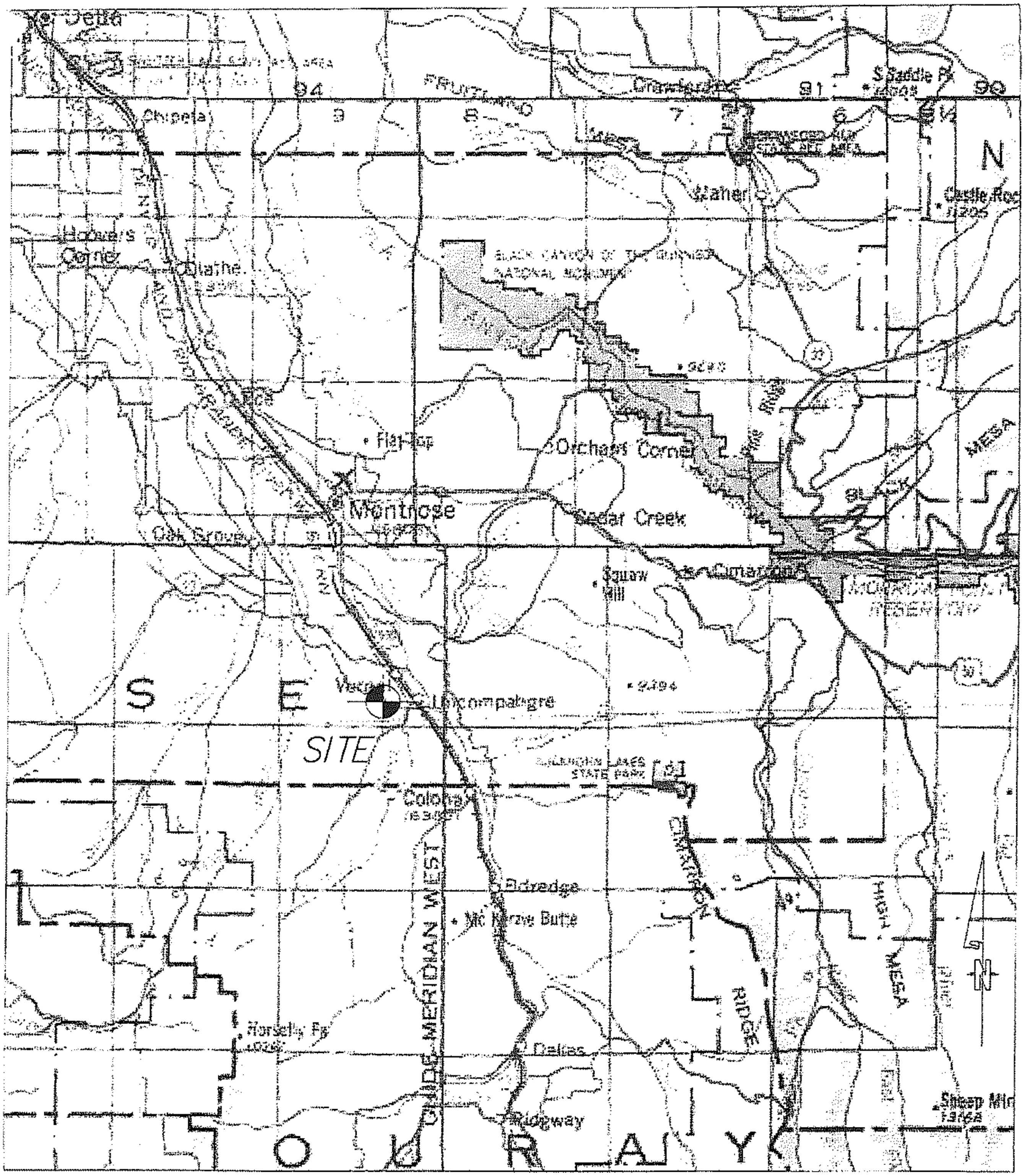
Reviewed by:

Timothy P. Brethauer
Geologist

Thomas E. Griepentrog, P.E.,CPG.

Enclosures: Vicinity Map, Site Map, Radon test results, Soil Logs, Summary Table of Laboratory Results, Atterberg Limits and Sieve Analysis results, Summary Table of Percolation Results, Swell/Consolidation graphs

VICINITY MAP



DRAWING NUMBER 1 OF 1	INVESTIGATION	TB	Loan Eagle Land Brokerage MONTROSE 552-ACRE RANCH MONTROSE COUNTY, COLORADO
	DRAFTER	TB	
	DATE	April 2006	
	JOB NO.	06-023-GEO	

BUCKHORN GEOTECH

Civil, Structural, and Geotechnical Engineers, Inc.
222 South Park Avenue
Montrose, Colorado 81401
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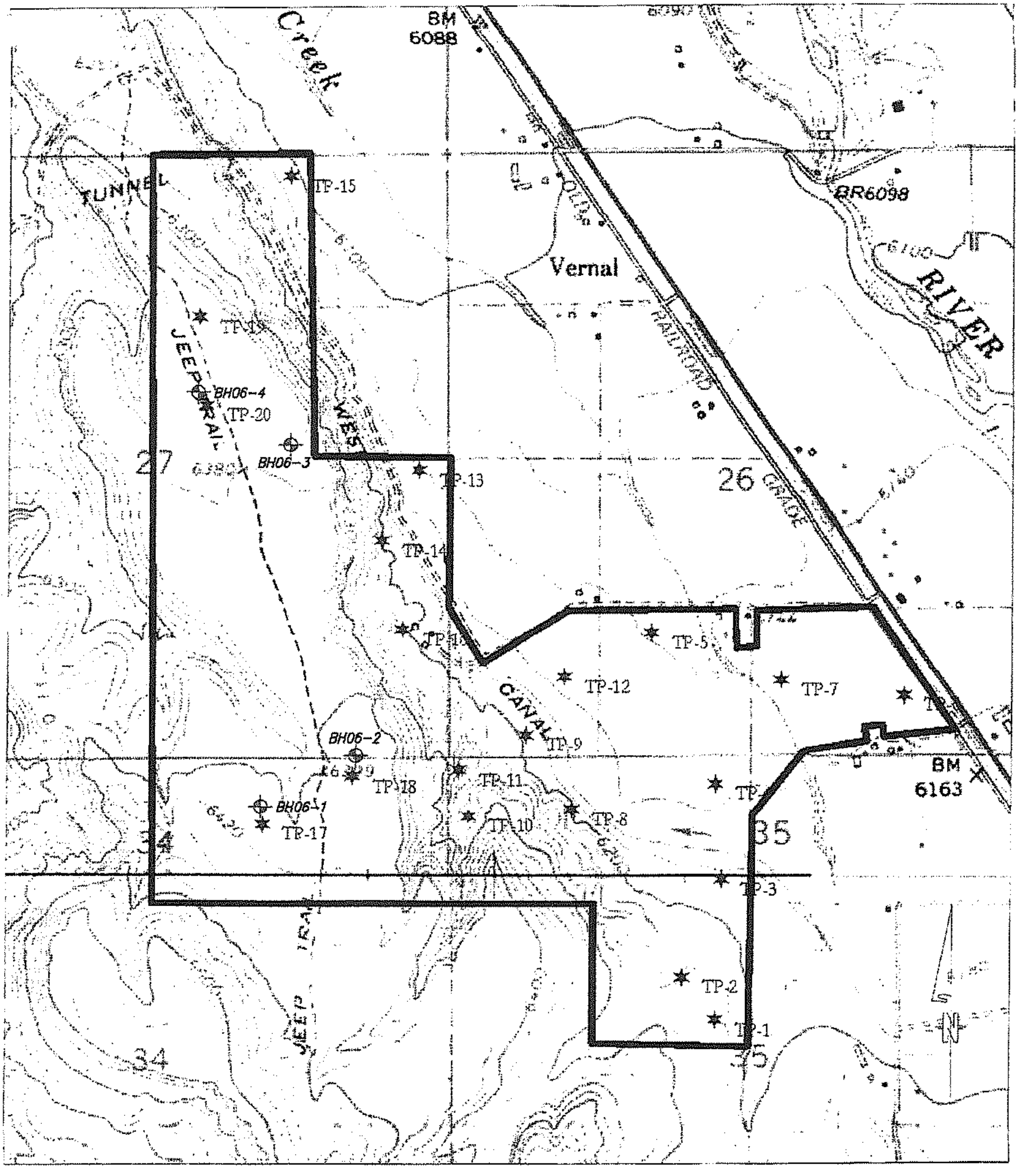
SITE MAP



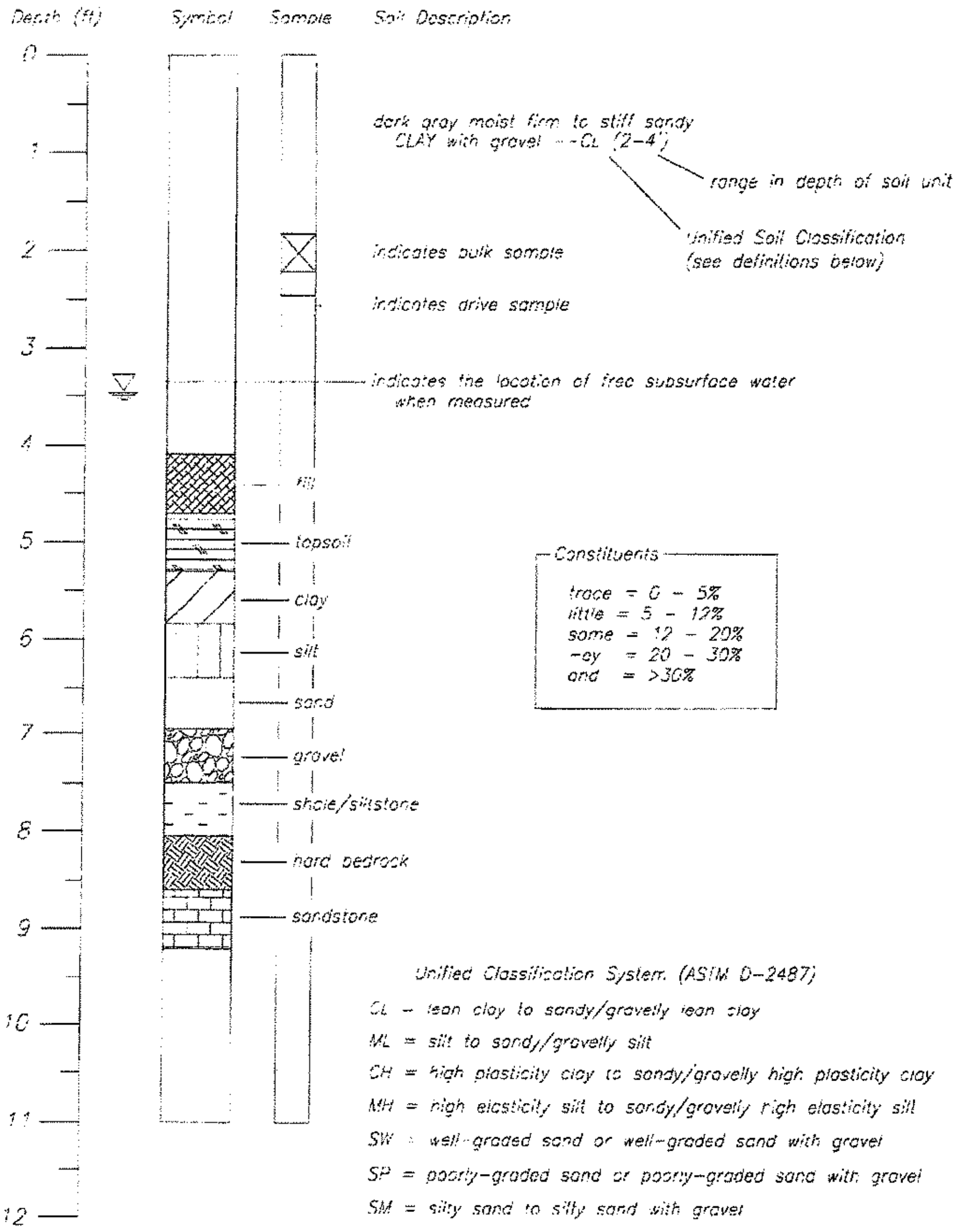
DRAWING NUMBER
1
OF 1

INVESTIGATION TB
DRAFTER IB
DATE April, 2006
JOB NO. 06-023-GEO

Loan Eagle Land Brokerage
MONTROSE 552-ACRE RANCH
MONTROSE COUNTY, COLORADO

BUCKHORN GEOTECH
Civil, Structural, and Geotechnical Engineers, Inc.
222 South Park Avenue
Montrose, Colorado 81401
Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG KEY



Constituents

trace = 0 - 5%
little = 5 - 12%
some = 12 - 20%
-ey = 20 - 30%
and = >30%

Laboratory Test Results

Notes in this column indicate tests performed and test results

DD: dry density
MC: moisture content
LL: Liquid Limit
PL: Plastic Limit
PI: Plasticity Index
GF: gravel fraction (%)
SF: sand fraction (%)
F200: silt/clay (%)
Sh: shear resistance
P: penetration resistance
SP: swelling pressure
TM: total movement under consolidation pressure
pcf: pounds per cubic ft.
psf: pounds per square ft.

Unified Classification System (ASTM D-2487)

CL = lean clay to sandy/gravelly lean clay
ML = silt to sandy/gravelly silt
CH = high plasticity clay to sandy/gravelly high plasticity clay
MH = high elasticity silt to sandy/gravelly high elasticity silt
SW = well-graded sand or well-graded sand with gravel
SP = poorly-graded sand or poorly-graded sand with gravel
SM = silty sand to silty sand with gravel
SC = clayey sand to clayey sand with gravel
GW = well-graded gravel or well-graded gravel with sand
GP = poorly-graded gravel or poorly graded gravel with sand
GM = silty gravel or silty gravel with sand
GC = clayey gravel or clayey gravel with sand

DRAWING NUMBER
1
OF 1

INVESTIGATION
DRAFTING
DATE
JOB NO.

SOIL LOG KEY

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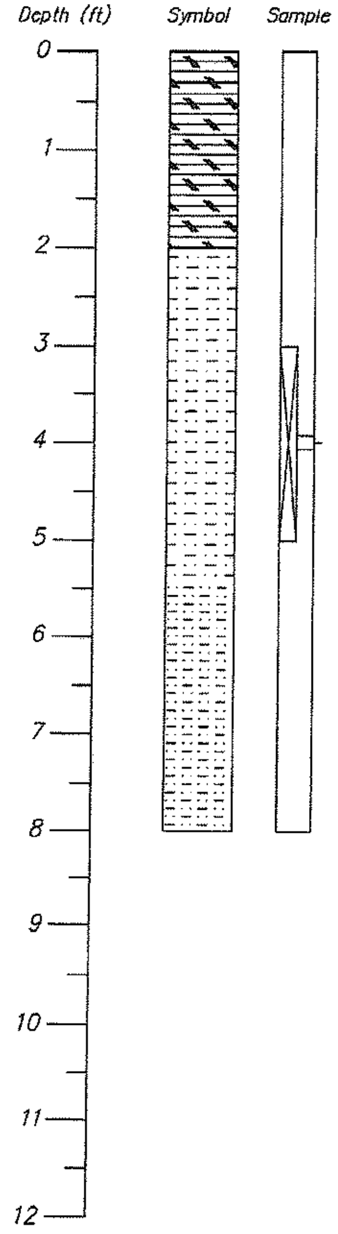
SOIL LOG TEST PIT #1 (TP#1)
South finger



Soil Description

gray-brown, damp, stiff to very stiff, blocky, SILT and CLAY; salts in lower 1' (0-2')

rounded to subrounded cobbles and small to medium-sized boulders on surface

dark gray-brown, damp, highly fractured/highly weathered SHALE, mottled, iron oxide staining, horizontal bedding W5/R1 grading to W3/R3 (becoming less weathered and fractured with depth (2-8')

bulk sample "GS1" @3-5' and drive sample "S" @4'

roots extend to 4-5'

end of excavation @8'
no groundwater encountered

*Standpipe installed

Laboratory Test Results

<u>"S"</u>
15.5% swell@100psf+water
SP=2570 psf
TM=19.8% @8000 psf
DD=101.5 pcf
MC=12.1%

<u>GS1</u>
LL=53 PL=27 PI=26
MC=13.7%

DRAWING NUMBER
1
OF 20

INVESTIGATION TB
DRAFTING JG
DATE 1/31/06
JOB NO. 06-023-GEO

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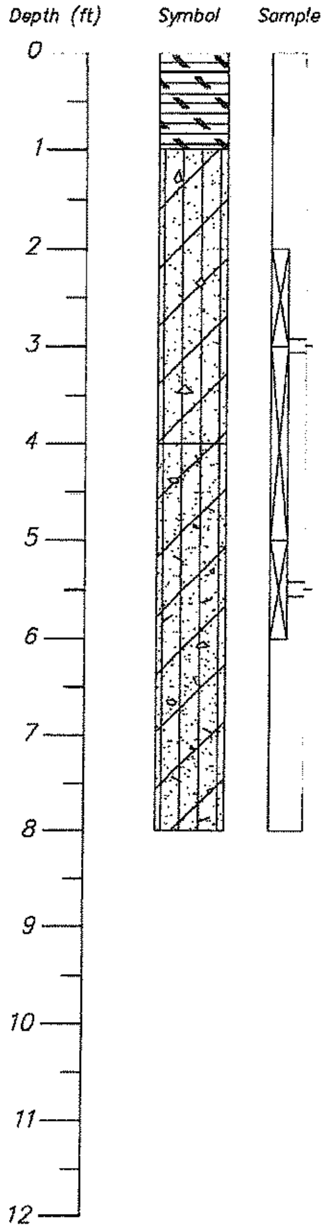
SOIL LOG TEST PIT #2 (TP#2)

Below escarpment pasture (upper)



Soil Description

gray-brown, damp, organic SILT and CLAY [TOPSOIL] with root mat (0-1')

gray-brown, moist, stiff to very stiff, small vesicular pores, mottled SILT and CLAY with trace sand and gravel; iron staining, salts present (1-4')

bulk sample "GS2" @2-3'

drive sample "DJ" @3'

bucket sample "BS1" @2-5'

gray-brown, moist, mottled, residual shale, SILT and CLAY with small shale fragments and occasional gravel and sand; iron staining and salts present (4-8')

bulk sample "GS3" @5-6' and drive sample "AQ" @5.5'

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

GS2
LL=52 PL=20 PI=32
GF=0.0%
SF=8.2%
F200=91.8%
MC=29.6%
Sulfates=0.198%

"AQ"
0.07% cons@100psf+water
TM=2.3% @2000 psf
DD=114.3 pcf
MC=14.7%

GS3
LL=43 PL=23 PI=20
GF=0.0%
SF=37.7%
F200=62.3%
MC=24.0%

DRAWING NUMBER
2
OF 20

INVESTIGATION TB
DRAFTING JG
DATE 1/31/06
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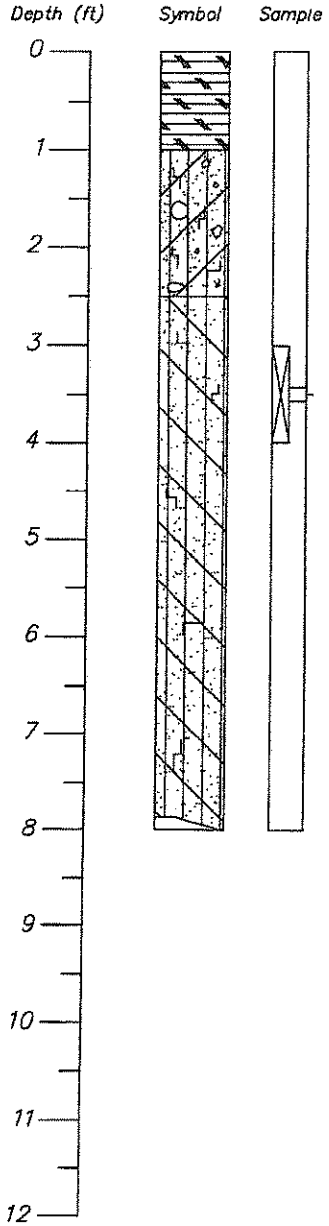
SOIL LOG TEST PIT #3 (TP#3)

Pasture stream terrace



Soil Description

gray–brown, damp, organic SILT and CLAY [TOPSOIL] (0–1')

brown, damp, blocky, stiff to very stiff, SILT and CLAY with gravels, cobbles and sand; small vesicular pores (1–2.5')

brown, damp, stiff, slightly blocky SILT and CLAY with sand (2.5–8')

bulk sample "GS4" @3–4' and drive sample "H" @3.5'

roots extend to 4–5'

end of excavation @8'; large rock at 8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

"H"
0.4% swell@100psf+water
SP=190 psf
TM=5.1% @2000 psf
DD=93.5 pcf
MC=23.3%

GS4
LL=39 PL=20 PI=19
GF=0.0%
SF=23.6%
F200=76.4%
MC=25.1%

DRAWING NUMBER
3
OF 20

INVESTIGATION TB
DRAFTING JG
DATE 1/31/06
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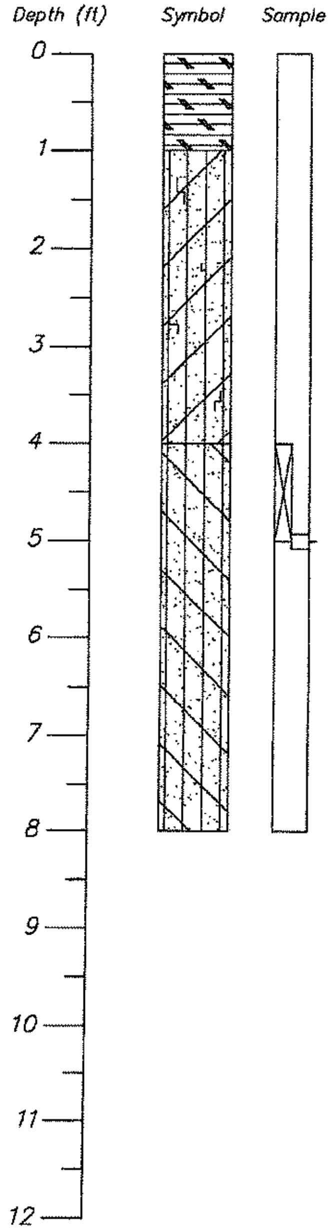
SOIL LOG TEST PIT #4 (TP#4)

N. of corral



Soil Description

dark brown-gray, damp, organic SILT and CLAY [TOPSOIL] with root mat (0-1')

brown, damp to moist, stiff, slightly blocky SILT and CLAY with trace sand and small vesicular pores (1-4')

bulk sample "GS5" @4-5' and drive sample "G" @5'

gray-brown, damp to moist, stiff SILT and CLAY with trace sand; salts present, mottled, very small vesicular pores (4-8')

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

"G"
2.8% swell@100psf+water
SP=920 psf
TM=3.2% @2000 psf
DD=97.6 pcf
MC=24.3%

GS5
LL=54 PL=22 PI=32
GF=0.0%
SF=2.0%
F200=98.0%
MC=24.4%

DRAWING NUMBER
4
OF 20

INVESTIGATION TB
DRAFTING JG
DATE 1/31/06
JOB NO. 06-023-GEO

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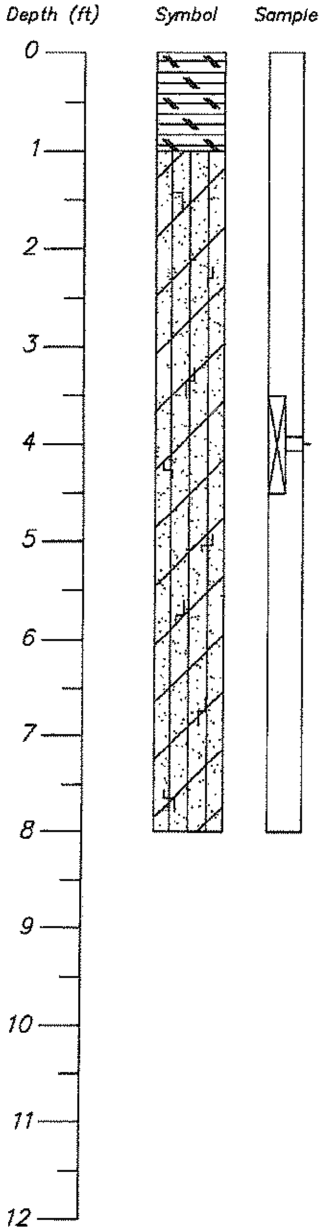
SOIL LOG TEST PIT #5 (TP#5)

Pasture (north by V Rd.) stream terrace



Soil Description

dark brown,, damp, organic, SILT and CLAY [TOPSOIL] and root mat (0-1')

gray-brown, mottled, slightly blocky, damp to moist, SILT and CLAY with trace sand, stiff to very stiff, salts present and very small vesicular pores (1-8')

bulk sample "GS6" @3.5-4.5' and drive sample "NZ" @4'

roots extend to 4-5'; similar to TP#4

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

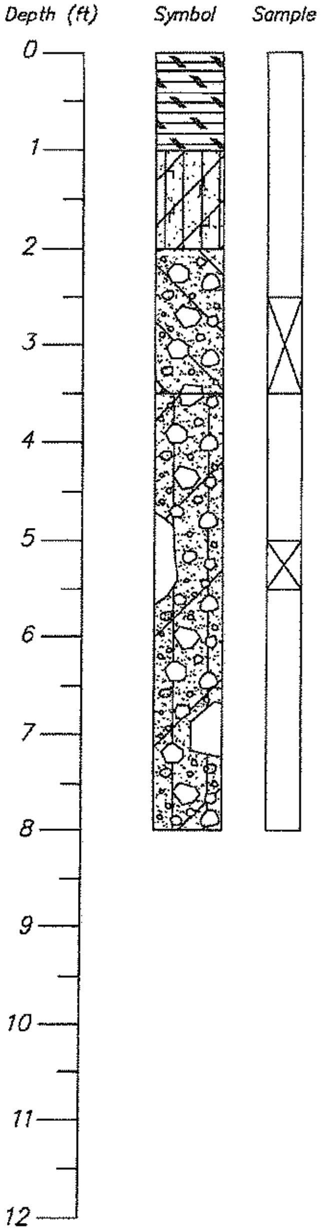
Laboratory Test Results

GS6
LL=50 PL=21 PI=29
GF=0.0%
SF=4.7%
F200=95.3%
MC=23.2%
Sulfates=0.189%

DRAWING NUMBER 5 OF 20	INVESTIGATION TB DRAFTING JG DATE 1/31/06 JOB NO. 06-023-GEO	JOEY BURNS 552 ACRE RANCH MONTROSE, COLORADO	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT #6 (TP#6)

Eastern most pasture, stream terrace



Soil Description

dark brown, damp, organic SILT and CLAY [TOPSOIL] with root mat (0–1')

gray–brown, damp, stiff, blocky, SILT and CLAY with trace sand (1–2')

reddish–brown, damp, compact to dense, clayey SAND, GRAVEL and COBBLES (2–3.5')

bulk sample "GS7" @2.5–3.5'

reddish–brown, damp, compact SAND, GRAVEL and COBBLES with little to trace silt and clay, occasional small boulder; less fines with depth, roots to approximately 4' (3.5–8')

bulk sample "GS8" @5–5.5'

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

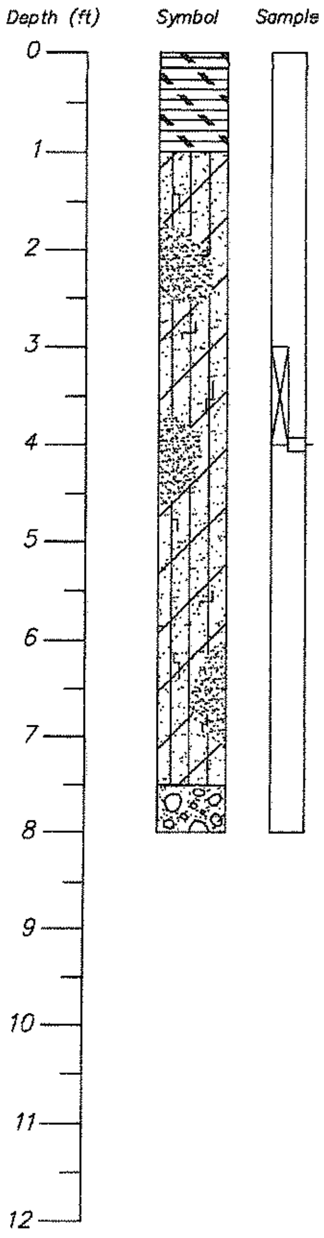
Laboratory Test Results

GS8
NON–PLASTIC
GF=69.1%
SF=27.7%
F200=3.2%
MC=5.3%

DRAWING NUMBER 6 OF 20	INVESTIGATION TB DRAFTING JG DATE 1/31/06 JOB NO. 06–023–GEO	JOEY BURNS 552 ACRE RANCH MONTROSE, COLORADO	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT #7 (TP#7)

Pasture (mideast), stream terrace



Soil Description

dark brown, damp, organic, SILT and CLAY [TOPSOIL] root mat (0–1')

gray–brown, damp, stiff to firm, blocky, slightly mottled SILT and CLAY with sand or sand pockets (1–7.5')

bulk sample "GS9" @3–4' and drive sample "B" @4'

brown, compact, damp, clayey SAND, GRAVEL and COBBLES (7.5–8')

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

DRAWING NUMBER
7
OF 20

INVESTIGATION TB
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DATE 1/31/06
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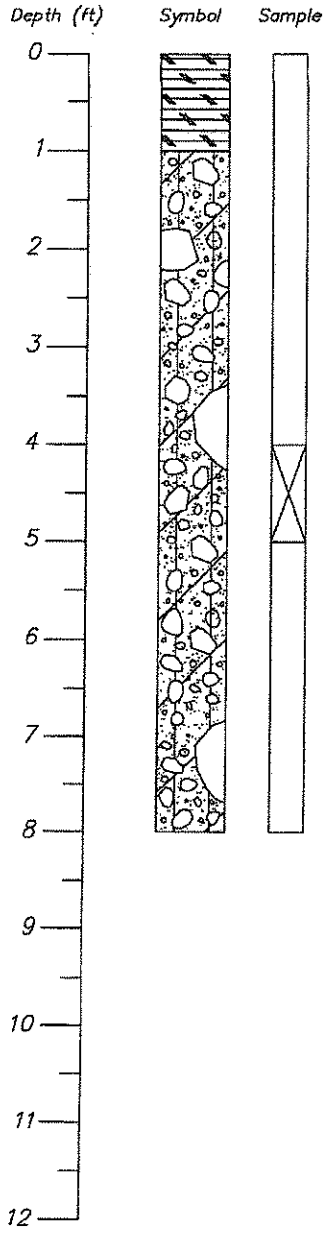
SOIL LOG TEST PIT #8 (TP#8)

approx. 150' west uphill of corral



Soil Description

brown, damp, stiff to very stiff, slightly blocky, SILT and CLAY with sand, gravel and occasional cobble to small boulders (0–1')

brown, dry–damp, compact, sandy GRAVEL and COBBLES with occasional small to medium, subangular to subrounded boulder (1–8')

bulk sample "GS10" @4–5'

void or varmint hole 5.5'

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

<u>GS10</u>
LL=42 PL=19 PI=23
GF=29.3%
SF=19.3%
F200=51.5%
MC=6.8%

DRAWING NUMBER
8
OF 20

INVESTIGATION TB
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JOB NO. 06-C23-GEO

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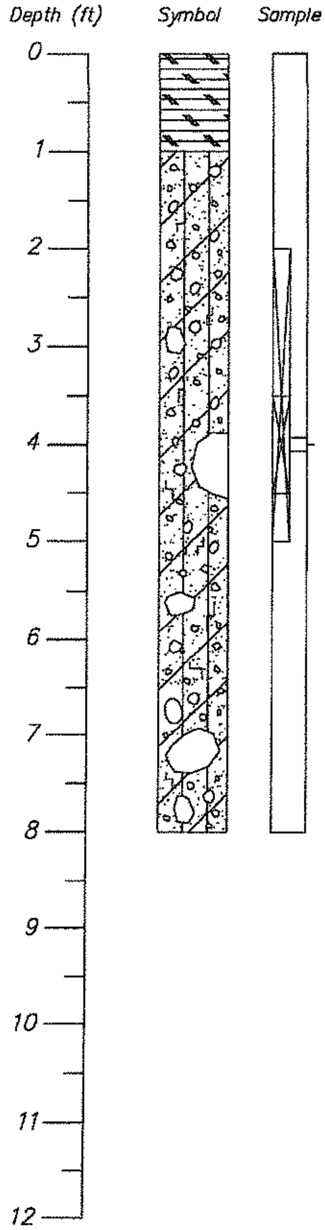
SOIL LOG TEST PIT #9 (TP#9)

pasture below main drainage



Soil Description

dark brown-gray, damp, blocky, very stiff to stiff SILT and CLAY with trace sand and gravel (0-1')

gray-brown, damp, slightly blocky, stiff to very stiff, sandy SILT and CLAY with gravel (1-8')

occasional cobbles and small boulders, vesicular pores

bucket sample "BS2" @2-5'; bulk sample "GS11" @3.5-4.5' and drive sample "DN" @4'

roots extend to 5-6'

end of excavation @8'
no groundwater or bedrock encountered

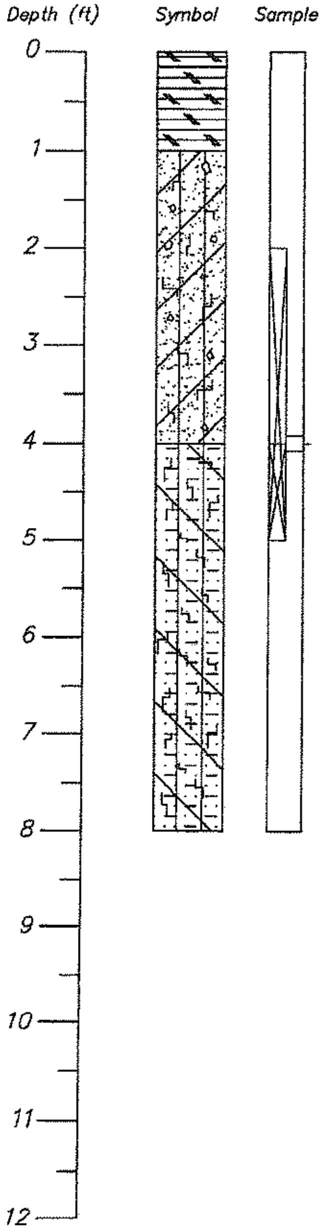
*Standpipe installed

Laboratory Test Results

GS11/BS2
LL=40 PL=20 PI=20
GF=16.4%
SF=18.2%
F200=65.4%
MC=15.2%

DRAWING NUMBER 9 OF 20	INVESTIGATION TB DRAFTING JG DATE 2/1/06 JOB NO. 06-023-GEO	JOEY BURNS 552 ACRE RANCH MONTROSE, COLORADO	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT #10 (TP#10)
Southern part of drainage, East side



Soil Description

dark gray to dark brown, damp, blocky, very stiff SILT and CLAY with trace sand and gravel; root mat [TOPSOIL] (0-1')

gray-brown, dry-damp, blocky, very stiff SILT and CLAY with angular to subangular gravel and sand; salts present (1-4')

bucket sample "BS3" @2-5'

drive sample "GU" @4'
roots extend to 4-4.5'
bulk sample "GS12" @4-5'

dark gray-brown, dry to damp, very blocky, very stiff, very highly fractured/highly weathered SHALE and silty clayey shale residuum, iron staining bands (4-8')

shale is less weathered with depth

end of excavation @8'
no groundwater encountered

*Standpipe installed

Laboratory Test Results

"GU"
4.8% swell@100psf+water
SP=650 psf
TM=7.3% @2000 psf
DD=110.8 pcf
MC=11.6%

BS3
LL=44 PL=25 PI=19
GF=14.3%
SF=33.2%
F200=52.6%

DRAWING NUMBER
10
OF 20

INVESTIGATION TB
DRAFTING JC
DATE 2/1/06
JOB NO. 06-023-GEO

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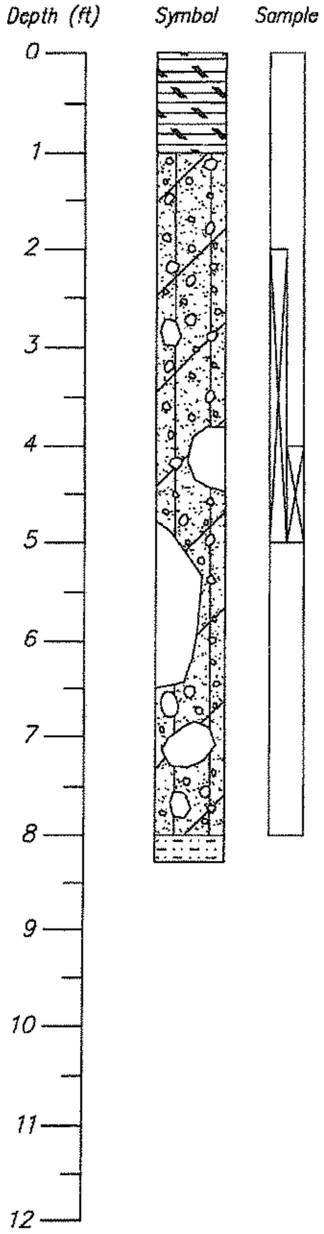
SOIL LOG TEST PIT #11 (TP#11)

northern part of drainage, west side



Soil Description

brown, damp, stiff, blocky, SILT and CLAY with sand and gravel, occasional cobbles and small boulder (0–1')

brown, dry to damp, compact, silty sandy GRAVEL and COBBLES with little clay, occasional small to medium, subangular to subrounded boulders (1–8')

bucket sample "BS4" @2–5'

secondary calcium deposits @4–5', roots extend to 4–5'

bulk sample "GS13" @4–5'

shale contact @8'
end of excavation @8' in shale
no groundwater encountered

*Standpipe installed

Laboratory Test Results

BS4
LL=44 PL=21 PI=23
GF=49.2%
SF=15.5%
F200=35.3%

DRAWING NUMBER 11 OF 20	INVESTIGATION TB DRAFTING JG DATE 2/1/06 JOB NO. 06–023–GEO	JOEY BURNS 552 ACRE RANCH MONTROSE, COLORADO

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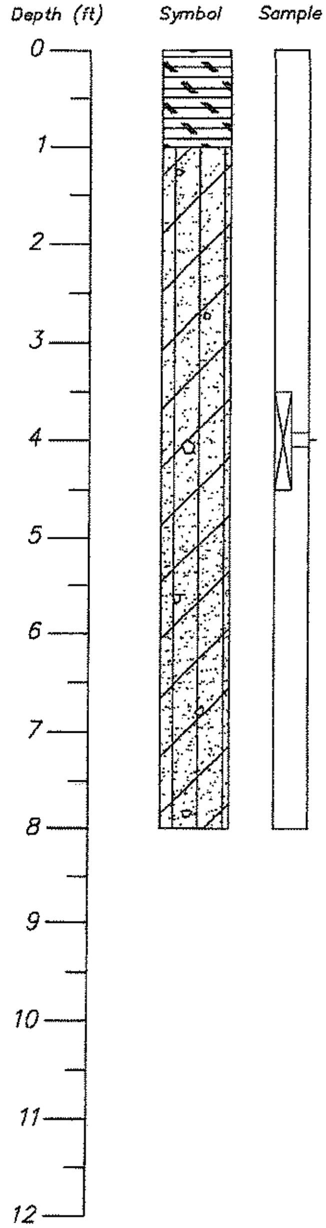
SOIL LOG TEST PIT #12 (TP#12)

pinned pasture, east of corral



Soil Description

dark brown, damp, organic, blocky SILT and CLAY with occasional gravel and little to trace sand; root mat [TOPSOIL] (0–1')

gray-brown, damp, stiff SILT and CLAY with sand and occasional gravel, mottled, softens with depth becomes more sandy (1–8')

roots extend to 2–2.5'

bulk sample "GS14" @3.5–4.5' and drive sample "Y" @4'

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

DRAWING NUMBER
12
OF 20

INVESTIGATION TB
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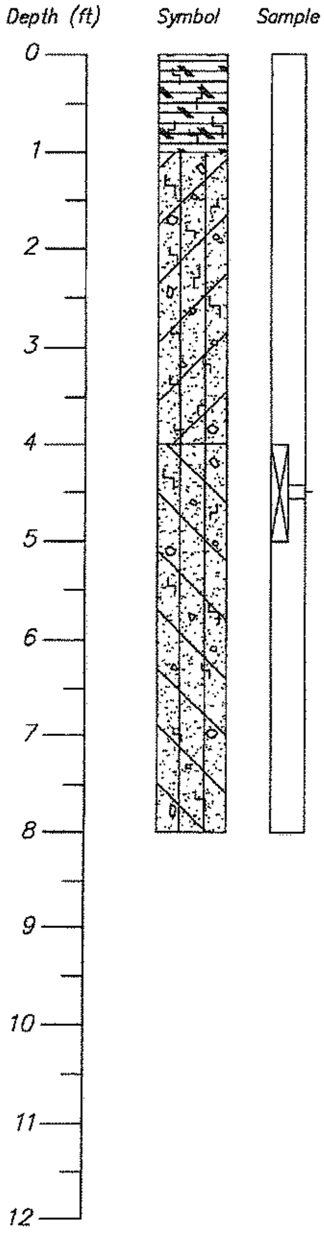
SOIL LOG TEST PIT #13 (TP#13)

11 acers east of corral



Soil Description

dark gray–dark brown, damp, organic SILT and CLAY with root mat and occasional gravel, little to trace sand, blocky, stiff [TOPSOIL] (0–1')

gray–brown, damp to moist, blocky, stiff SILT and CLAY with sand and angular to subangular gravel, salts present (1–4')

roots extend to 4–5'
bulk sample "GS15" @4–5' and drive sample "H46" @4.5'

gray–brown, damp to moist, slightly blocky and mottled, stiff gravelly SILT and CLAY, with sand and some salts (4–8')

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

"H46"
2.3% swell@100psf+water
SP=950 psf
TM=2.8% @2000 psf
DD=105.4 pcf
MC=18.3%

GS15
LL=47 PL=21 PI=26
GF=20.1%
SF=18.3%
F200=61.6%
MC=17.5%

DRAWING NUMBER
13
OF 20

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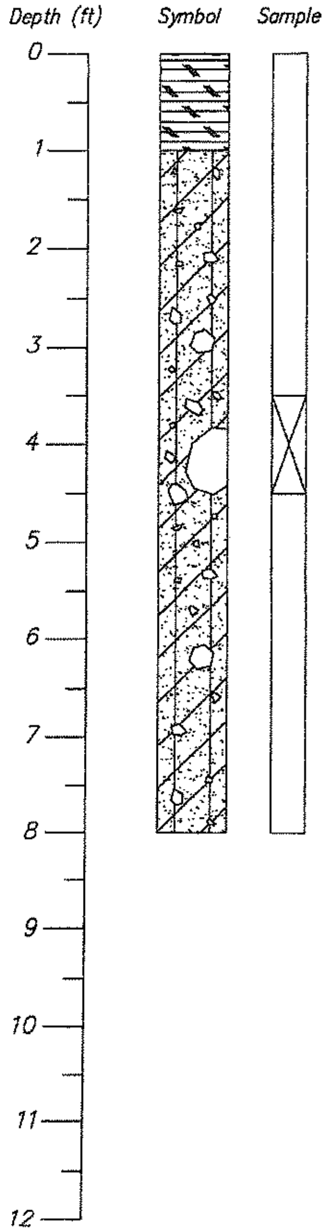
SOIL LOG TEST PIT #14 (TP#14)

West of canal, just W. of "11 acres"



Soil Description

brown, damp, organic, silty, clayey SAND and GRAVEL, root mat (0-1')

light brown-gray, upper 2' is loose then compact to dense, silty, sandy CLAY and GRAVEL, very stiff clay, angular to subrounded cobbles to small boulders (1-8')

roots extend to 3.5'

bulk sample "GS16" @3.5-4.5'
increase in mositure @ approximately 4'

decreased rock content with depth, softens

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

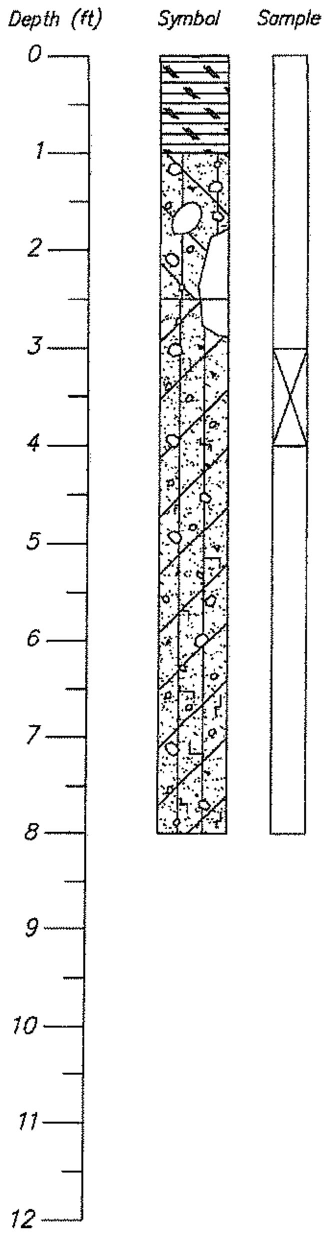
Laboratory Test Results

<u>GS16</u>
LL=49 PL=23 PI=26
GF=26.6%
SF=23.3%
F200=50.0%
MC=13.3%
Sulfates=0.539

DRAWING NUMBER 14 OF 20	INVESTIGATION TB DRAFTING JG DATE 2/1/06 JOB NO. 06-023-GEO	JOEY BURNS 552 ACRE RANCH MONTROSE, COLORADO	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT #15 (TP#15)

Northern most pit, below tunnel



Soil Description

brown, dry to damp, firm, silty, clayey, blocky SAND and GRAVEL [TOPSOIL], root mat (0–1')

light brown–gray, dry to damp, silty, sandy CLAY and GRAVEL, compact, stiff, angular to subrounded cobbles to small boulders (1–2.5')

roots extend to approximately 3'

bulk sample "GS17" @3–4'

gray–brown, damp, stiff to very stiff, gravelly, sandy SILT and CLAY, blocky, salts present (2.5–8')

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

GS17
LL=43 PL=21 PI=22
GF=8.3%
SF=31.2%
F200=60.5%
MC=10.4%

DRAWING NUMBER
15
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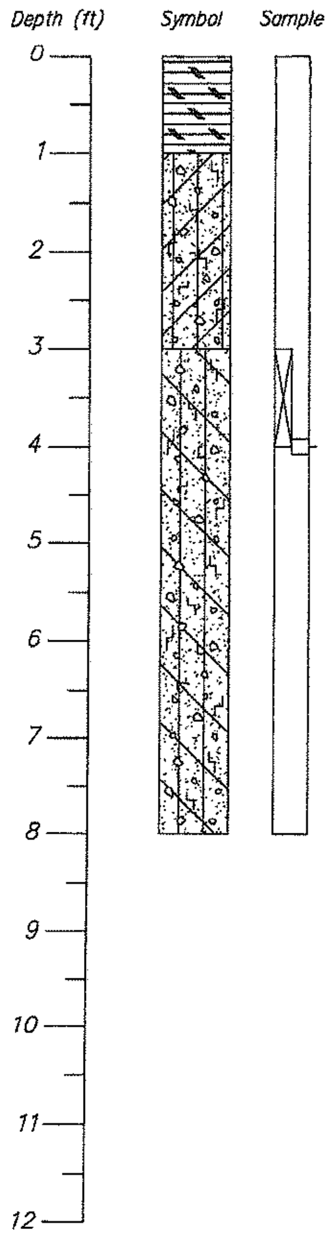
SOIL LOG TEST PIT #16 (TP#16)

Within escarpment, above (west) of blue house



Soil Description

brown, damp, firm, blocky, silty, clayey SAND and GRAVEL [TOPSOIL] root mat (0-1')

gray-brown, dry to damp, stiff to compact, blocky, silty sandy CLAY and GRAVEL; angular to subangular (1-3')

roots extend to 3'

bulk sample "GS18" @3-4'

drive sample "HM" @4'

brown-gray, dry to damp, stiff to very stiff, blocky SILT and CLAY with sand and gravel, lots of salts and secondary calcium deposits (3-8')

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

"HM"
5.3% swell@100psf+water
SP=1280 psf
TM=8.4% @4000 psf
DD=102.9 pcf
MC=12.5%

GS18
LL=45 PL=22 PI=23
GF=0.0%
SF=16.3%
F200=83.7%
MC=12.8%

DRAWING NUMBER
16
OF 20

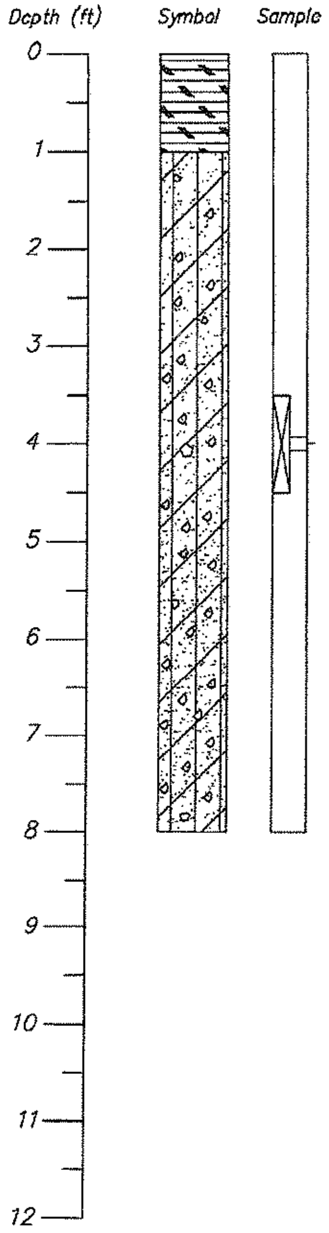
INVESTIGATION TB
DRAFTING JG
DATE 2/2/06
JOB NO. 06-023-GEO

JOEY BURNS
552 ACRE RANCH
MONTROSE, COLORADO

BUCKHORN GEOTECH
Civil, Structural, and Geotechnical Engineers, Inc.
222 South Park Avenue
Montrose, Colorado 81401
Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT #17 (TP#17)

SW on mesa top (next to BH06-1)



Soil Description

brown, damp, organic, compact, silty SAND with clay and occasional gravel (root mat) (0–1')

light brown, dry, compact/blocky, clayey SAND with gravel and little salts present (1–8')

20–30% rock

bulk sample "GS29" @3.5–4.5' and drive sample "PX" @4'

roots extend to approximately 5'

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

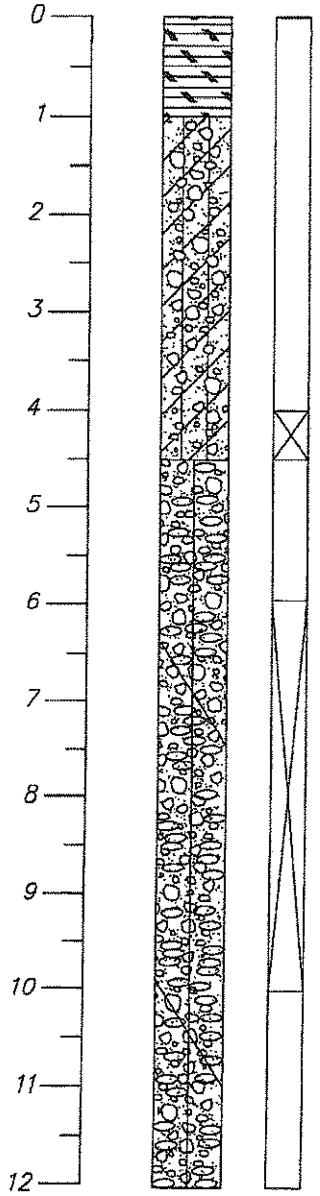
Laboratory Test Results

DRAWING NUMBER 17 OF 20	INVESTIGATION TB DRAFTING TB DATE 3/24/06 JOB NO. 06-023-GEO	JOEY BURNS 552 ACRE RANCH MONTROSE, COLORADO	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT #18 (TP#18)

SE on mesa top (nest to BH06-2)

Depth (ft) Symbol Sample Soil Description Laboratory Test Results



brown, damp, organic, compact, silty SAND with clay and gravel (root mat) (0-1')

light brown, dry-damp, compact, clayey SAND and GRAVEL/COBBLES with silt, calcareous (1-4.5')

70-80% rock

bulk sample "GS30" @4-4.5'

gray-brown, dry, compact, sandy GRAVEL and COBBLES with silt (4.5-12')

80-90% rock

roots extend thoughout pit

bulk sample "GS31" @6-10'

end of excavation @12'
no groundwater or bedrock encountered

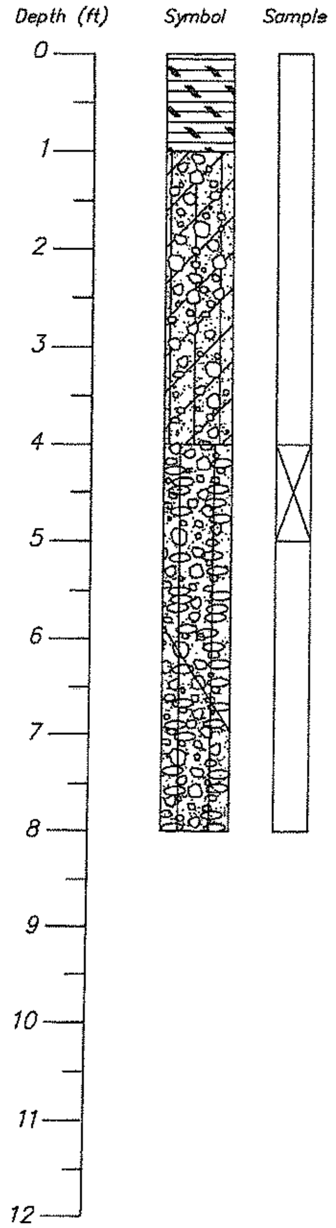
*Standpipe installed

<u>GS31</u>
LL=29 PL=18 PI=18
GF=61.5%
SF=34.1%
F200=4.4%
MC=3.2%

DRAWING NUMBER 18 OF 20	INVESTIGATION TB DRAFTING TB DATE 3/24/06 JOB NO. 06-023-GEO	JOEY BURNS 552 ACRE RANCH MONTROSE, COLORADO	BUCKHORN GEOTECH Civil, Structural, and Geotechnical Engineers, Inc. 222 South Park Avenue Montrose, Colorado 81401 Phone (970) 249-6828 Fax (970) 249-0945

SOIL LOG TEST PIT #19 (TP#19)

NE on mesa top (next to BH06-3)



Soil Description

brown, damp, compact, organic, SAND and GRAVEL with silt and clay (0–1')

light brown, dry–damp, compact, clayey SAND and GRAVEL/COBBLES with silt, calcareous (1–4')

70–80% rock

bulk sample "GS32" @4–5'

roots extend to 5'

gray-brown, dry, compact, sandy GRAVEL and COBBLES with silt (4–8')

80–90% rock

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

GS32
NON–PLASTIC
GF=92.6%
SF=6.2%
F200=1.2%
MC=4.2%

DRAWING NUMBER 19 OF 20	INVESTIGATION TB	JOEY BURNS 552 ACRE RANCH MONTROSE, COLORADO
	DRAFTING TB	
	DATE 3/24/06	
	JOB NO. 06–023–GEO	

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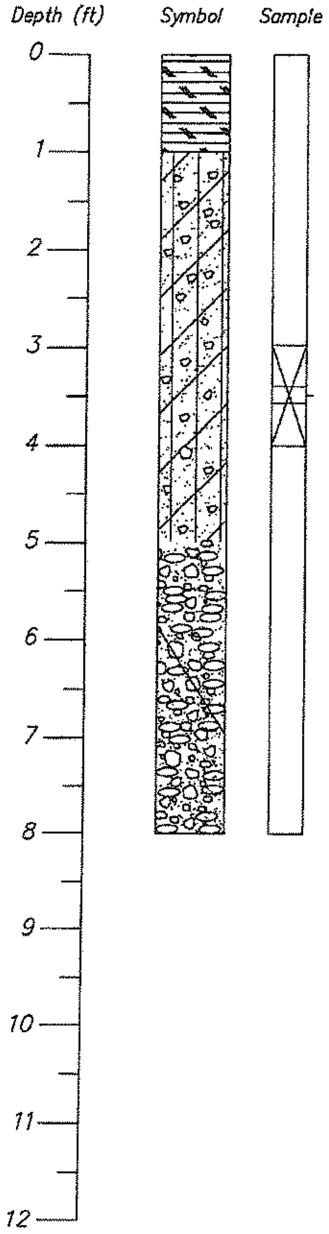
SOIL LOG TEST PIT #20 (TP#20)

NW on mesa top (next to BS06-4)



Soil Description

brown, damp, compact, organic, silty SAND with clay and gravel (0-1')

light brown, dry-damp, blocky/compact, clayey SAND with silt and gravel, calcareous (1-5')

10-20% rock

bulk sample "GS33" @3-4' and drive sample "NX" @3.5'

roots extend to 5'

gray-brown, dry, compact, sandy GRAVEL and COBBLES with silt (4.5-12')

80-90% rock

end of excavation @8'
no groundwater or bedrock encountered

*Standpipe installed

Laboratory Test Results

"NX"
1.6% swell@100psf+water
SP=360 psf
TM=8.6% @2000 psf
DD=77.7 pcf
MC=9.8%

DRAWING NUMBER 20 OF 20	INVESTIGATION	TB
	DRAFTING	TB
	DATE	3/24/06
	JOB NO.	06-023-GEO

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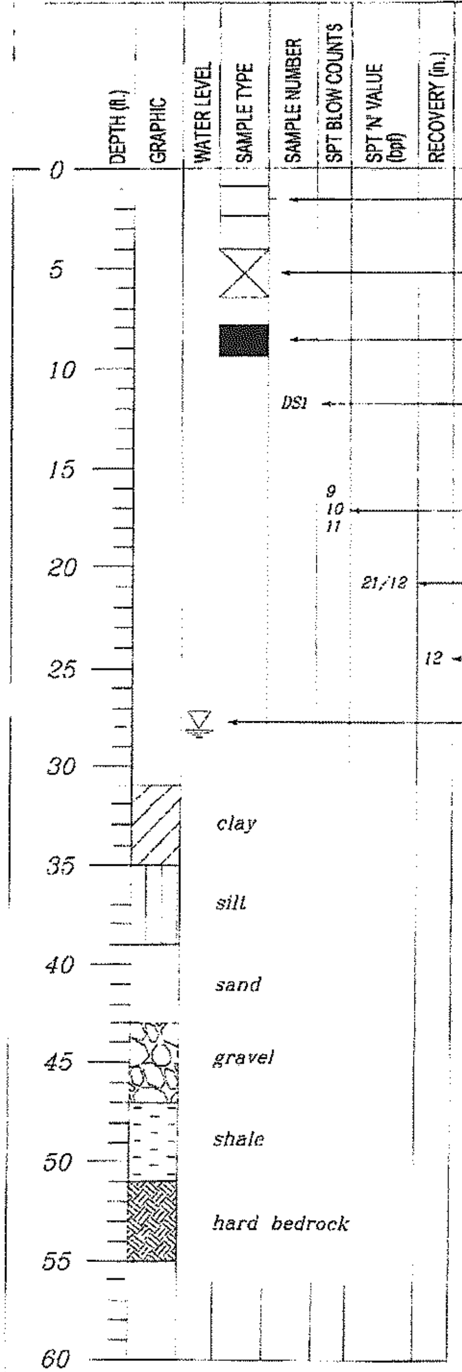
LOG OF EXPLORATORY DRILLING – AUGER HOLE #X

SURFACE ELEVATION:
DRILLER:
DRILL RIG:

DRILL STEM:
SAMPLER:
CASING:

NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers commens



SOIL DESCRIPTION

indicates drive sample

indicates bulk sample

indicates core sample

Sample identifier: DS=Drive sample
AS=Auger sample from auger flights
CS=Core sample

Blows required to drive sampler 6 inches each. The first six inches is considered to be the "seating" drive.

indicates seven blows required to drive the sampler twelve inches with a 140-lb hammer falling 30 inches

length of intact soil plug recovered from the sampler

indicates free water surface at time of drilling

FIELD & LABORATORY TEST RESULTS

Notes in this column indicate tests performed and test results

DD: dry density in cubic pounds per foot (pcf)
MC: % moisture content
LL: Liquid Limit
PL: Plastic Limit
PI: Plasticity Index
GF: Gravel fraction (%)
SF: Sand fraction (%)
F200: Silt/Clay (%)
Sh: Shear resistance
P: Penetration resistance
CBR: California Bearing Ratio
psf: pounds per sq. ft.
pcf: pounds per cu. ft.

Unified Classification System (ASTM D-2487)

CL = lean clay to sandy/gravelly lean clay
ML = silt to sandy/gravelly silt
CH = high plasticity clay to sandy/gravelly high plasticity clay
MH = high elasticity silt to sandy/gravelly high elasticity silt
SW = well-graded sand or well graded sand with gravel
SP = poorly graded sand or poorly graded sand with gravel
SM = silty sand to silty sand with gravel
SC = clayey sand to clayey sand with gravel
GW = well-graded gravel or well-graded gravel with sand
GP = poorly graded gravel or poorly graded gravel with sand
GM = silty gravel or silty gravel with sand
GC = clayey gravel or clayey gravel with sand

Sheet
1
OF 1

Field Testing
Lab/Drafting
DATE
PROJECT #

KEY
Test Boring
and Lab Test Results

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LOG OF EXPLORATORY DRILLING – BORE HOLE #1 (BH06-1)

SURFACE ELEVATION:
DRILLER: McCracken
DRILL RIG: Simco 2800
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft)	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0	GS19				light brown, dry-damp, compact, silty SAND and GRAVEL with clay (0-5')	
5					occasional cobble	
	GS20 BD	12 13 10	23	12/18	driller added water @6.5'	GS20 LL=39 PL=23 PI=16 GF=22.8% SF=39.5% F200=37.7% MC=7.9%
10					increase in density to very dense	
	GS21	21 41	62	12/12	same as above (tan), almost no rock from 11-19'	GS21 LL=37 PL=18 PI=19 GF=16.1% SF=43.3% F200=40.7% MC=5.4%
15					one rock @14'	
					increase in clay content	
20	GS22	50	50/3"	3/3	brown, damp, very dense, clayey, sandy GRAVEL and COBBLES	
25						
30						
					end of bore hole @32' no groundwater or bedrock encountered	
35						
40						
45						
50						
55						
60						

DRAWING NUMBER	1 OF 4
INVESTIGATION	TB
DRAFTING	JG
DATE	2/23/06
JOB NO.	06-023-GEO

JOEY BURNS
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LOG OF EXPLORATORY DRILLING – BORE HOLE #2 (BH06-2)

SURFACE ELEVATION:
DRILLER: McCracken
DRILL RIG: Simco 2800

DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used

NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft.)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0									
			☒	GS23				tan, dry, silty SAND and GRAVEL with clay; very dense (0–5')	
5			☒	GS24	15 25 27	52	12/ 18	driller hit water @5' same as above	GS24 LL=26 PL=18 PI=8 GF=37.0% SF=54.6% F200=8.4% MC=2.4%
10								dark gray, thinly bedded, jumbled SHALE; highly fractured/highly weathered @11' R1–R2/W3–W4	
15									
								end of bore hole @17' in dark gray, thinly bedded, formational SHALE R3/W4 no groundwater	
20								*Standpipe installed to 12'	
25									
30									
35									
40									
45									
50									
55									
60									

DRAWING NUMBER
2
OF 4

INVESTIGATION TB
DRAFTING JG
DATE 2/23/06
JOB NO. 06-023-GEO

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LOG OF EXPLORATORY DRILLING – BORE HOLE #3 (BH06-3)

SURFACE ELEVATION:
DRILLER: McCracken
DRILL RIG: Simco 2800
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments

DEPTH (ft.)	GRAPHIC	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0			☒	GS25				tan, dry, silty GRAVEL with clay to gravelly SILT with clay and trace fine sand (0–5') increased gravel content @4'	
5				GS26	18 23 34	57	12/ 18	tan, dry, very dense, silty SAND and GRAVEL with little clay	
10									
15								increase in gravel and cobbles	
20								refusal @21' in gravels and cobbles no groundwater or bedrock encountered	
25									
30									
35									
40									
45									
50									
55									
60									

DRAWING NUMBER			
3	INVESTIGATION	TB	JOEY BURNS
OF 4	DRAFTING	JG	552 ACRE RANCH
	DATE	2/23/06	MONTROSE, COLORADO
	JOB NO.	06–023–GEO	

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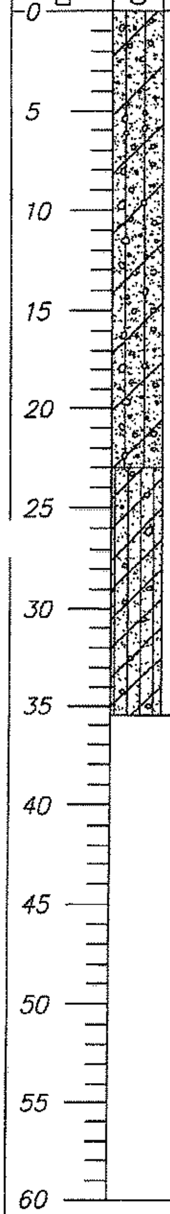
LOG OF EXPLORATORY DRILLING – BORE HOLE #4 (BH06–4)

SURFACE ELEVATION:
DRILLER: McCracken
DRILL RIG: Simco 2800
DRILL STEM: 4" Solid-stem continuous flight auger
SAMPLER: 1.375" I.D. Standard and 2" I.D. California split spoon
CASING: None used
NOTES: SPT N-values not corrected for energy or depth; stratigraphic transitions are approximate and are inferred from cuttings and drillers comments



DEPTH (ft.)	WATER LEVEL	SAMPLE TYPE	SAMPLE NUMBER	SPT BLOW COUNTS	SPT 'N' VALUE (bpf)	RECOVERY (in.)	SOIL DESCRIPTION	FIELD & LABORATORY TEST RESULTS
0			GS27				light brown, dry, silty SAND and GRAVEL with clay (0–5')	
5			GS28	10 17 24	41	15/ 18	driller added water @5' same as above	
15								GS28 LL=29 PL=21 PI=8 GF=40.7% SF=43.4% F200=15.9% MC=3.8%
23							brown, dry–damp, sandy SILT and CLAY with little gravel @23' driller commented that it became stiff after 23'	
33							very little rock from 33–35.5', possible shale contact	
35.5							end of bore hole @35.5' no groundwater encountered	

DRAWING NUMBER
4
OF 4

INVESTIGATION	TB
DRAFTING	JG
DATE	2/23/06
JOB NO.	06–023–GEO

JOEY BURNS
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MONTROSE, COLORADO

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Summary of Laboratory Test Results

Soil Identification						Index			Gradation			Atterberg Limits		Heave Potential			Consolidation (%)		
Location	Depth (ft.)	Sample	CBR value	USCS	Soil Description	Moisture Content (%)	Dry Density (pcf)	Water-soluble Sulfates (%)	Gravel (%)	Sand (%)	Fines (silt and clay) (%)	Liquid Limit (%)	Plasticity Index (%)	Swell Pressure (psf)	Confining Pressure (psf)	Swell Potential (%)	Initial Collapse (%)	Consolidation (%)	Final Pressure (psf)
TP#1	3-5'	GS1		CH	dk. gray-brown clay SHALE	13.7						53	26						
	4'	"S"		CH	dk. gray-brown clay SHALE	12.1	101.5							2570	8000	15.5			
TP#2	2-3'	GS2		CH	gray-brown fat CLAY	29.6		0.198	0	8.2	91.8	52	32						
	5-6'	GS3		CL	gray-brown sandy lean CLAY	24			0	37.7	62 3	43	20						
	5.5'	"AQ"		CL	gray-brown sandy lean CLAY	14.7	114.3										1 4	2.3	2000
TP#3	3-4'	GS4		CL	brown lean CLAY with sand	25.1			0	23.6	76.4	39	19						
	3.5'	"H"		CL	brown lean CLAY with sand	23.3	93.5							190	2000	0.4			
TP#4	4-5'	GS5		CH	gray-brown fat CLAY	24.4			0	2	98	54	32						
	5'	"G"		CH	gray-brown fat CLAY	24.3	97.6							920	2000	2.8			
TP#5	3.5-4.5'	GS6		CH	gray-brown fat CLAY	23.2		0.189	0	4.7	95.3	50	29						
TP#6	5-5.5'	GS8		GW	red brwn GRAVEL with sand	5.3			69.1	27.7	3.2	NP	NP						
TP#8	4-5'	GS10		CL	brwn gravelly CLAY with sand	6.8			29.3	19.3	51.5	42	23						
TP#9	3.5-4.5'	GS11		CL	gry-brwn sndy CLAY w/ gravel	15.2			16.4	18.2	65.4	40	20						
	2-5'	BS2	2	CL	gry-brwn sndy CLAY w/ gravel	15.2			16.4	18.2	65.4	40	20						
TP#10	5'	"GU"			dk. gray-brown CLAY (shale)	11.6	110.8							650	2000	4.8			
	2-5'	BS3	2	CL	dk. gray-brown CLAY (shale)				14.3	33.2	52	44	19						
TP#11	2-5'	BS4	5	GC	lt. brown clayey GRAVEL w/sand				49.2	15.5	35.3	44	23						
TP#13	4-5'	GS15		CL	gry-brwn gravelly CLAY w/ sand	17.5			20 1	18 3	51.6	47	26						
	4.5'	"H46"		CL	gry-brwn gravelly CLAY w/ sand	18.3	105.4							950	2000	2 3			
TP#14	3.5-4.5'	GS16		CL	lt.brwn-gry gravelly CLAY w/ sand	13 3		0.539	26.6	23 4	50	49	26						
TP#15	3-4'	GS17		CL	gray-brown sandy lean CLAY	10.4			8.3	31.2	60.5	43	22						
TP#16	3-4'	GS18		CL	lt.brown-gray lean CLAY w/ sand	12.8			0	16.3	83.7	45	23						
	4'	"HM"		CL	lt.brown-gray lean CLAY w/ sand	12.5	102.9							1280	4000	5.3			
TP#18	6-10'	GS31		GW	gry-brwn w-g GRAVEL w/ sand	3.2			61.5	34.1	4.4	29	11						
TP#19	4-5'	GS32		GW	gray well-graded GRAVEL	4.2			92.6	6.2	1.2	NP	NP						
TP#20	3 5'	"NX"			light brown CLAYwith sand	9.8	77.7							360	2000	1.6			
BH06-1	5-6 5'	GS20		SC	brown clayey SAND with gravel	7.9			22.8	39.5	37.7	39	16						
	10-11'	GS21		SC	brown clayey SAND with gravel	5.4			16.1	43.3	40.7	37	19						
	5-6 5'	"BD"		SC	brown clayey SAND with gravel	9.6	87.6										0.6	8	2000
	10-11'	"DD"		SC	brown clayey SAND with gravel	6.7	109.9							1610	4000	7.4			
BH06-2	5-6.5'	GS24		SW-SC	lt. brwn w-g SAND w/ clay & gravel	2.4			37	54.6	8.4	26	8						
BH06-4	5-6.5'	GS28		SC	lt. brwn clayey SAND with gravel	3.8			40.7	43.4	15.9	29	8						

BUCKHORN GEOTECH

Civil, Structural & Geotechnical Engineers

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Project Name Montrose 552-Acre Ranch
Project Location Government Springs Rd
Client Joey Burns
Test Location TP#1 @3-5'
Sample # GS1

Date 2/2/2006
Project # 06-023-GEO
Sample by TB
Tested by SM

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	97.1
3/8"	9.5	91.3
#4	4.75	54.2
#10	2.0	22.6
#40	0.425	5.0
#200	0.075	0.5

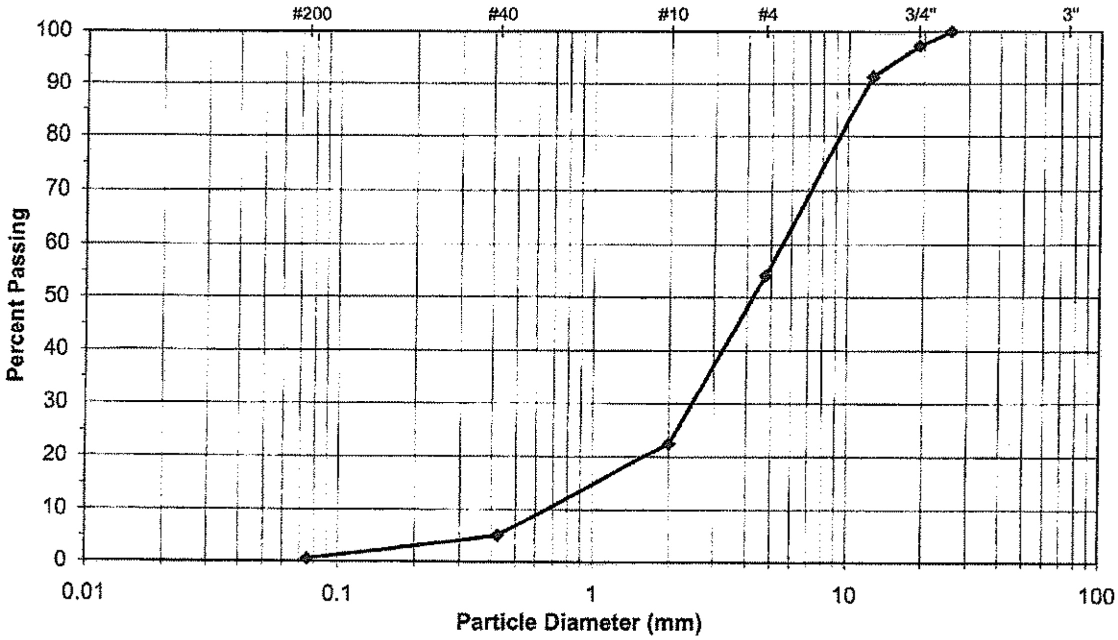
Atterberg Limits

ASTM D4318

Liquid Limit (LL) 53
Plastic Limit (PL) 27
Plasticity Index (PI) 26

Natural Moisture Content (%) = 13.7%

Soil Description dk. gray-brown fat clayey SHALE *all clay shale*
USCS Classification SW



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 0.4
% Sand = 53.7
% Gravel = 45.8

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Project Name: Montrose 552-Acre Ranch
Project Location: Government Springs Rd
Client: Joey Burns
Test Location: TP#2 @2-3'
Sample #: GS2

Date: 2/2/2006
Project #: 06-023-GEO
Sample by: TB
Tested by: SM

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.0	99.0
#40	0.425	96.6
#200	0.075	91.8

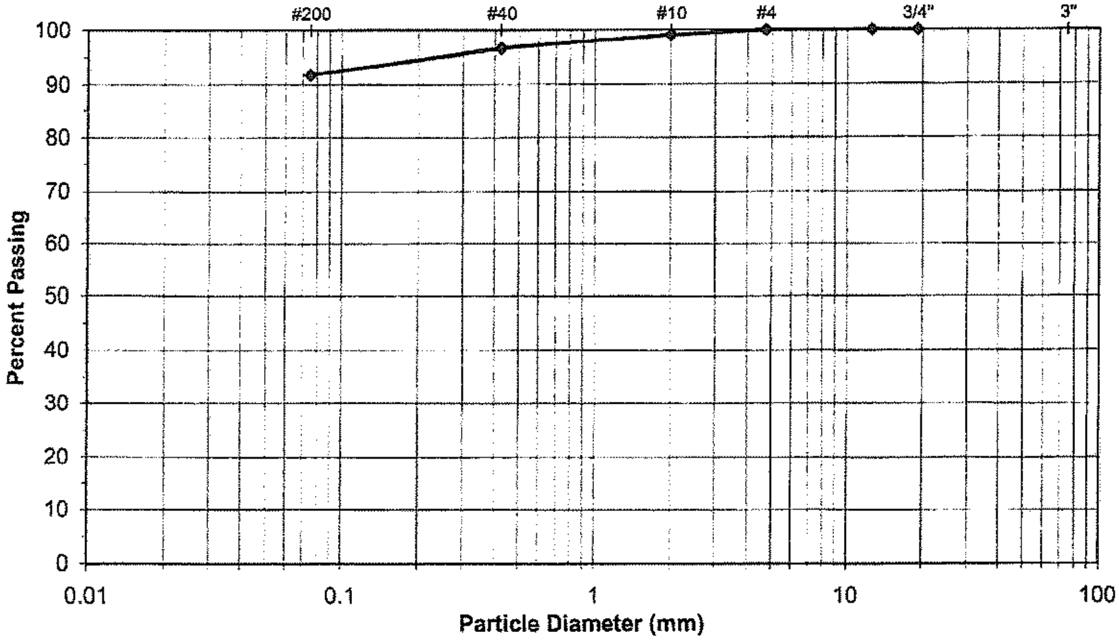
Atterberg Limits

ASTM D4318

Liquid Limit (LL)	52
Plastic Limit (PL)	20
Plasticity Index (PI)	32

Natural Moisture Content (%) = 29.6%

Soil Description: gray-brown fat CLAY
USCS Classification: CH



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	**SAND**			**GRAVEL**	

% Fines = 91.8

% Sand = 8.2

% Gravel = 0.0

BUCKHORN GEOTECH

Civil, Structural & Geotechnical Engineers

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Project Name Montrose 552-Acre Ranch

Project Location Government Springs Rd

Client Joey Burns

Test Location TP#2 @5-6'

Sample # GS3

Date 2/2/2006

Project # 06-023-GEO

Sample by TB

Tested by VB

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.0	96.9
#40	0.425	79.3
#200	0.075	62.3

Atterberg Limits

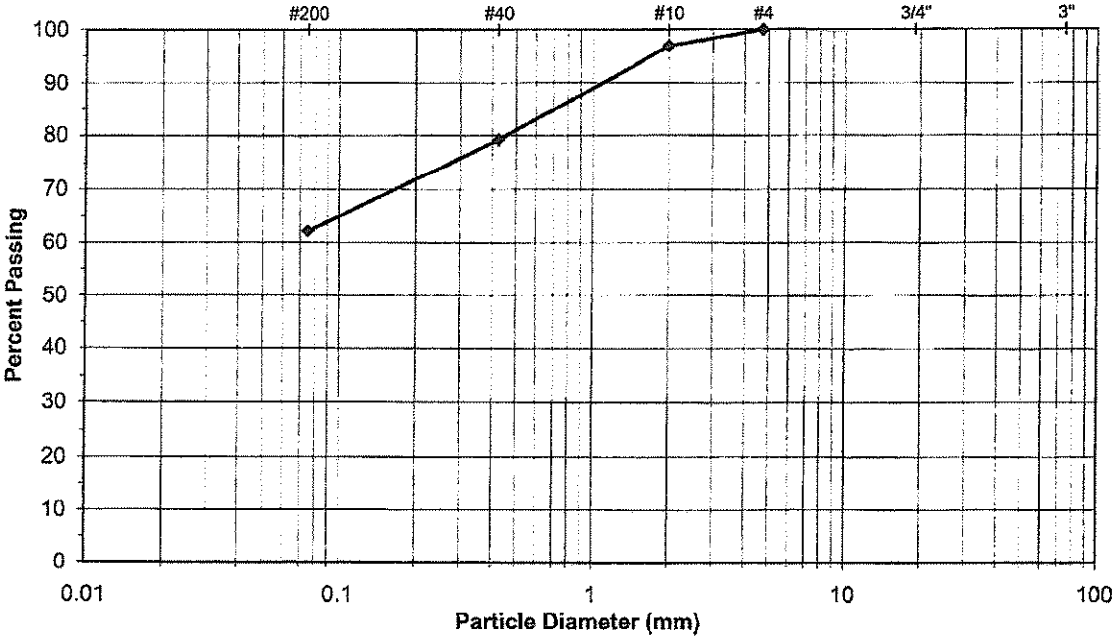
ASTM D4318

Liquid Limit (LL)	43
Plastic Limit (PL)	23
Plasticity Index (PI)	20

Natural Moisture Content (%) = 24.0%

Soil Description gray-brown sandy lean CLAY

USCS Classification CL



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 62.3

% Sand = 37.7

% Gravel = 0.0

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Project Name	Montrose 552-Acre Ranch	Date	2/2/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#3 @3-4'	Tested by	SM
Sample #	GS4		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.0	99.0
#40	0.425	95.1
#200	0.075	76.4

Atterberg Limits

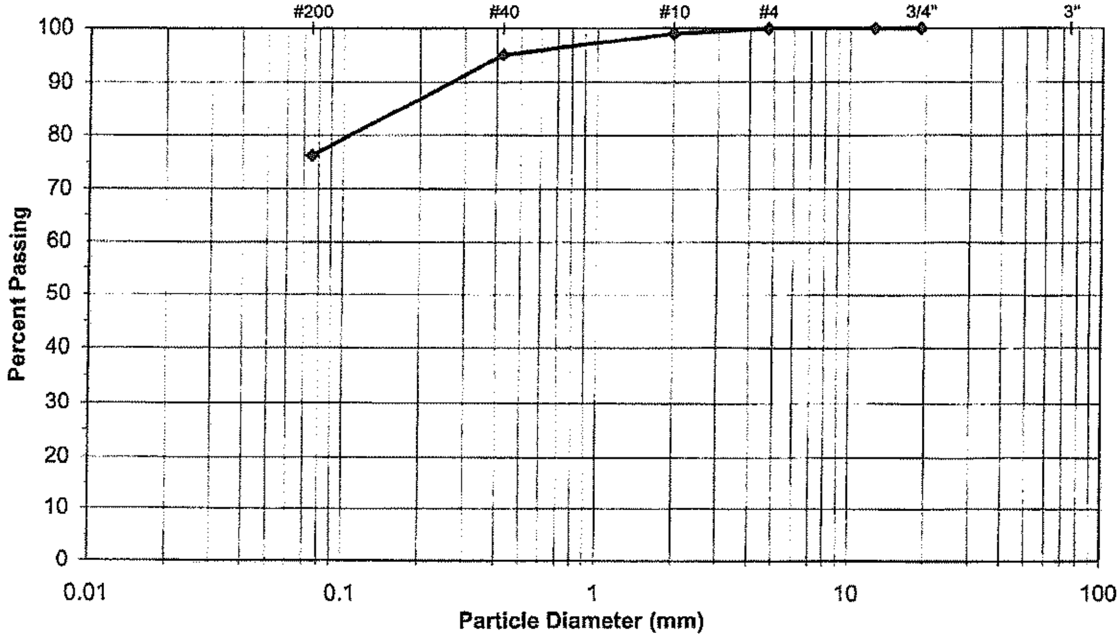
ASTM D4318

Liquid Limit (LL)	39
Plastic Limit (PL)	20
Plasticity Index (PI)	19

Natural Moisture Content (%) = 25.1%

Soil Description brown lean CLAY with sand

USCS Classification CL



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	**SAND**			**GRAVEL**	

% Fines = 76.4 % Sand = 23.6 % Gravel = 0.0

Project Name Montrose 552-Acre Ranch

Project Location Government Springs Rd

Client Joey Burns

Test Location TP#4 @4-5'

Sample # GS5

Date 2/6/2006

Project # 06-023-GEO

Sample by TB

Tested by SM

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.0	100.0
#40	0.425	99.8
#200	0.075	98.0

Atterberg Limits

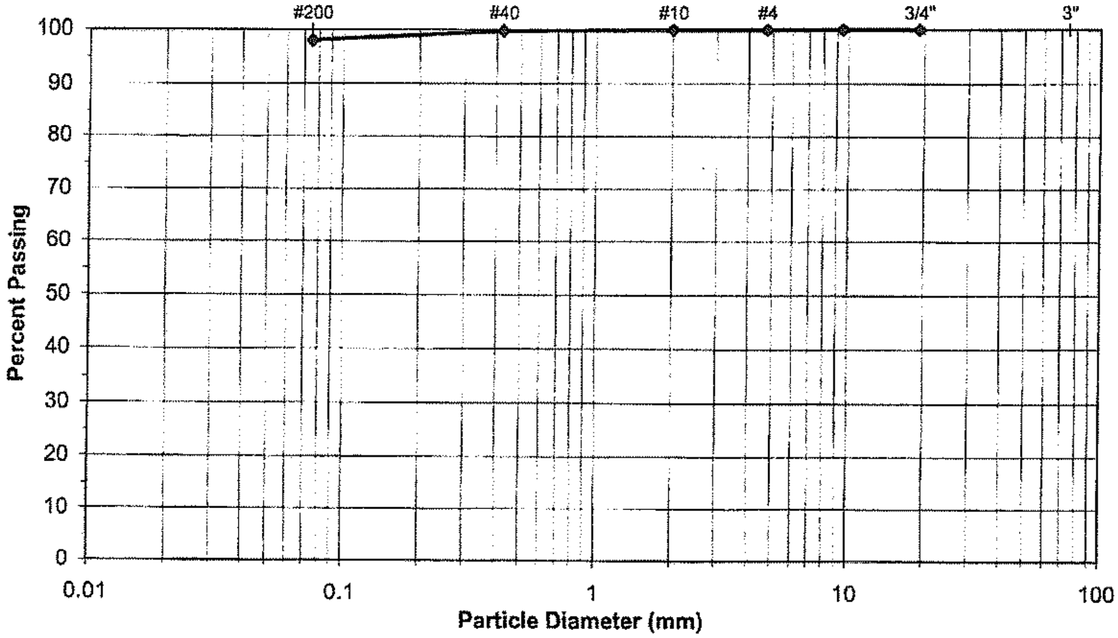
ASTM D4318

Liquid Limit (LL)	54
Plastic Limit (PL)	22
Plasticity Index (PI)	32

Natural Moisture Content (%) = 24.4%

Soil Description gray-brown fat CLAY

USCS Classification CH



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 98.0

% Sand = 2.0

% Gravel = 0.0

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Project Name	Montrose 552-Acre Ranch	Date	2/6/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#5 @3.5-4.5'	Tested by	LS/SM
Sample #	GS6		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.0	99.7
#40	0.425	99.1
#200	0.075	95.3

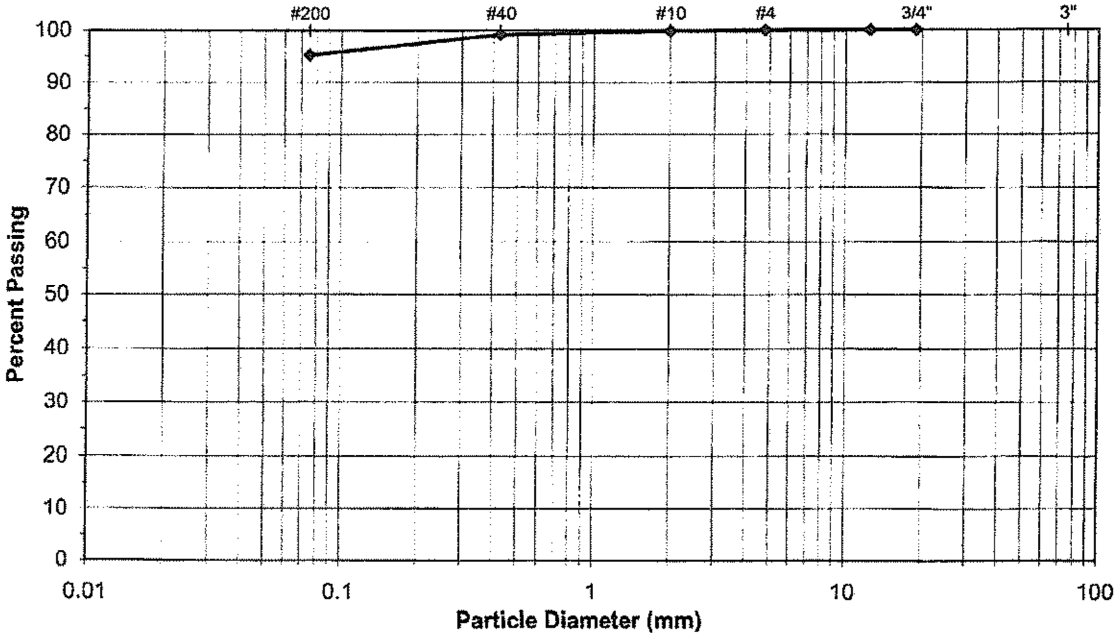
Atterberg Limits

ASTM D4318

Liquid Limit (LL)	50
Plastic Limit (PL)	21
Plasticity Index (PI)	29

Natural Moisture Content (%) = 23.2%

Soil Description gray-brown fat CLAY
USCS Classification CH



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	**SAND**			**GRAVEL**	

% Fines = 95.3
% Sand = 4.7
% Gravel = 0.0

Project Name	Montrose 552-Acre Ranch	Date	2/2/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#6 @5-5.5'	Tested by	SM/LS
Sample #	GS8		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	52.8
3/8"	9.5	38.6
#4	4.75	30.9
#10	2.0	25.5
#40	0.425	10.7
#200	0.075	3.2

Atterberg Limits

ASTM D4318

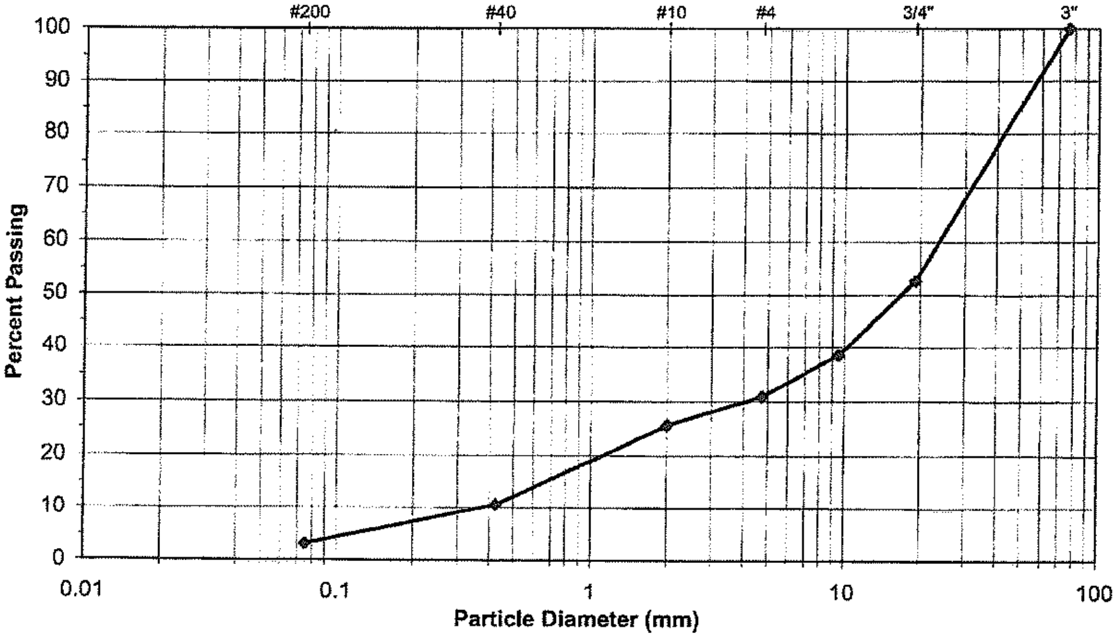
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

NP = Non-Plastic

Natural Moisture Content (%) = 5.3%

Soil Description reddish-brown well-graded GRAVEL with sand

USCS Classification GW



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 3.2 % Sand = 27.7 % Gravel = 69.1

Project Name Montrose 552-Acre Ranch
Project Location Government Springs Rd
Client Joey Burns
Test Location TP#8 @4-5'
Sample # GS10

Date 2/7/2006
Project # 06-023-GEO
Sample by TB
Tested by BAU

Sieve Analysis
ASTM C136 / C117

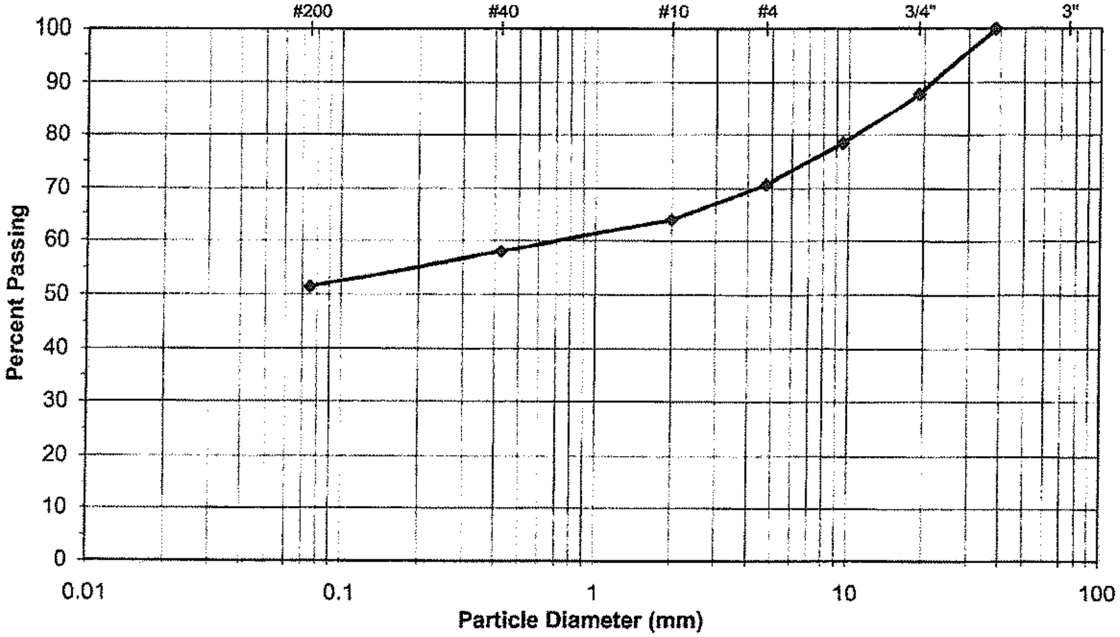
Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	87.9
3/8"	9.5	78.6
#4	4.75	70.7
#10	2.0	63.9
#40	0.425	58.1
#200	0.075	51.5

Atterberg Limits
ASTM D4318

Liquid Limit (LL) 42
Plastic Limit (PL) 19
Plasticity Index (PI) 23

Natural Moisture Content (%) = 6.8%

Soil Description brown gravelly lean CLAY with sand
USCS Classification CL



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 51.5
% Sand = 19.3
% Gravel = 29.3

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Project Name	Montrose 552-Acre Ranch	Date	2/9/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#9 @3.5-4.5'	Tested by	SM
Sample #	GS11		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	90.1
3/8"	9.5	88.0
#4	4.750	83.6
#10	2.000	80.6
#40	0.425	76.8
#200	0.075	65.4

Atterberg Limits

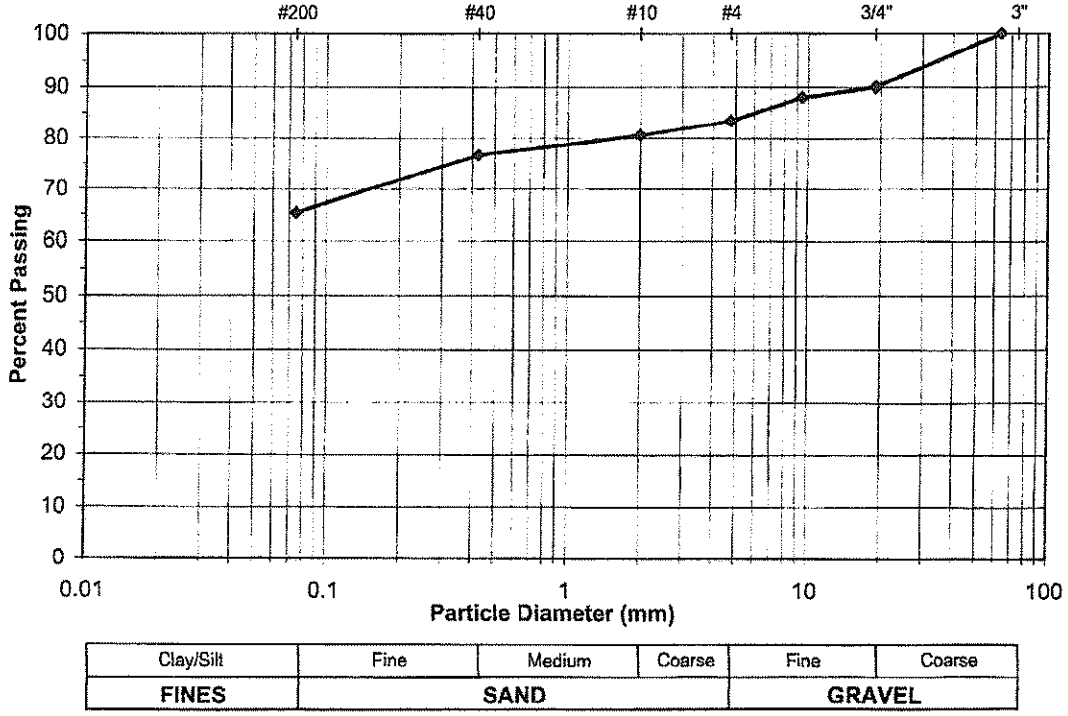
ASTM D4318

Liquid Limit (LL)	40
Plastic Limit (PL)	20
Plasticity Index (PI)	20

Natural Moisture Content (%) = 15.2%

Soil Description: gray-brown sandy lean CLAY with gravel

USCS Classification: CL



% Fines = 65.4 % Sand = 18.2 % Gravel = 16.4

Project Name	Montrose 552-Acre Ranch	Date	2/9/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#13 @4-5'	Tested by	SM
Sample #	GS15		

Sieve Analysis
ASTM C136 / C117

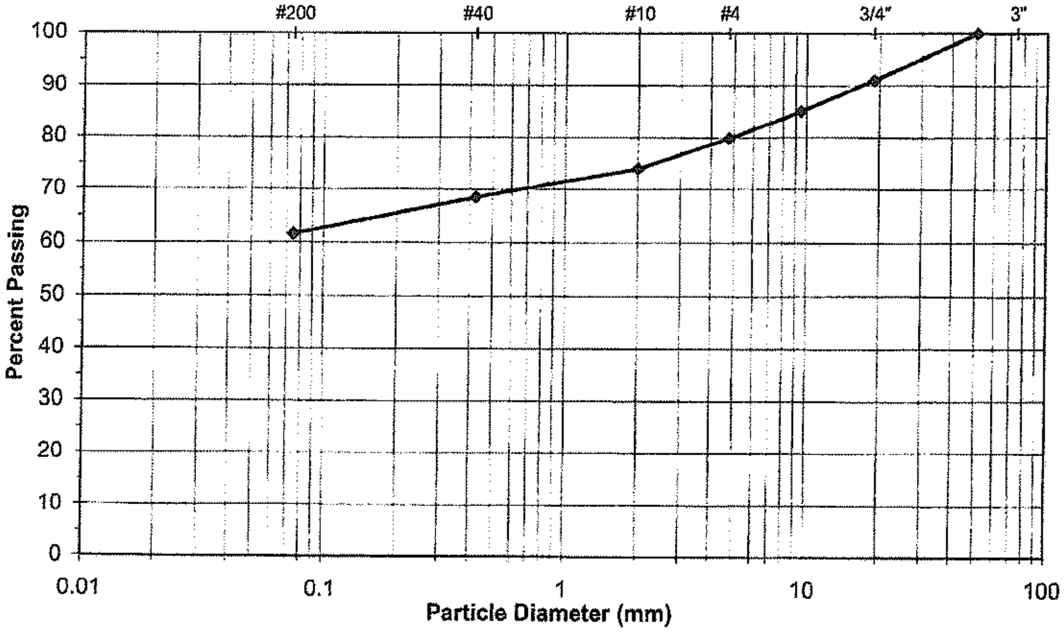
Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	91.0
3/8"	9.5	85.1
#4	4.750	79.9
#10	2.000	73.9
#40	0.425	68.5
#200	0.075	61.6

Atterberg Limits
ASTM D4318

Liquid Limit (LL)	47
Plastic Limit (PL)	21
Plasticity Index (PI)	26

Natural Moisture Content (%) = 17.5%

Soil Description: gray brown gravelly lean CLAY with sand
USCS Classification: CL



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 61.6 % Sand = 18.3 % Gravel = 20.1

Project Name	Montrose 552-Acre Ranch	Date	2/9/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#14 @3.5-4.5'	Tested by	SM
Sample #	GS16		

Sieve Analysis
ASTM C136 / C117

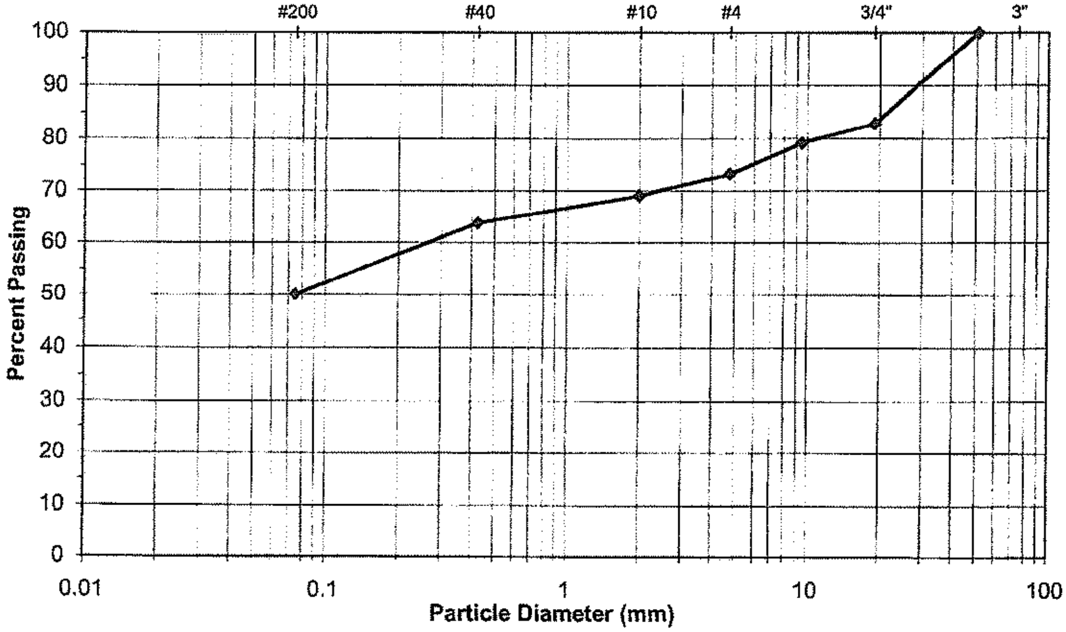
Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	82.9
3/8"	9.5	79.2
#4	4.750	73.4
#10	2.000	69.1
#40	0.425	63.8
#200	0.075	50.0

Atterberg Limits
ASTM D4318

Liquid Limit (LL)	49
Plastic Limit (PL)	23
Plasticity Index (PI)	26

Natural Moisture Content (%) = 13.3%

Soil Description: light brown-gray gravelly lean CLAY with sand
USCS Classification: CL



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 50.0 % Sand = 23.3 % Gravel = 26.6

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Project Name	Montrose 552-Acre Ranch	Date	2/8/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#15 @3-4'	Tested by	SM/BAU
Sample #	GS17		

Sieve Analysis

ASTM C136

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	96.7
#4	4.750	91.7
#10	2.000	85.7
#40	0.425	72.9
#200	0.075	0.0

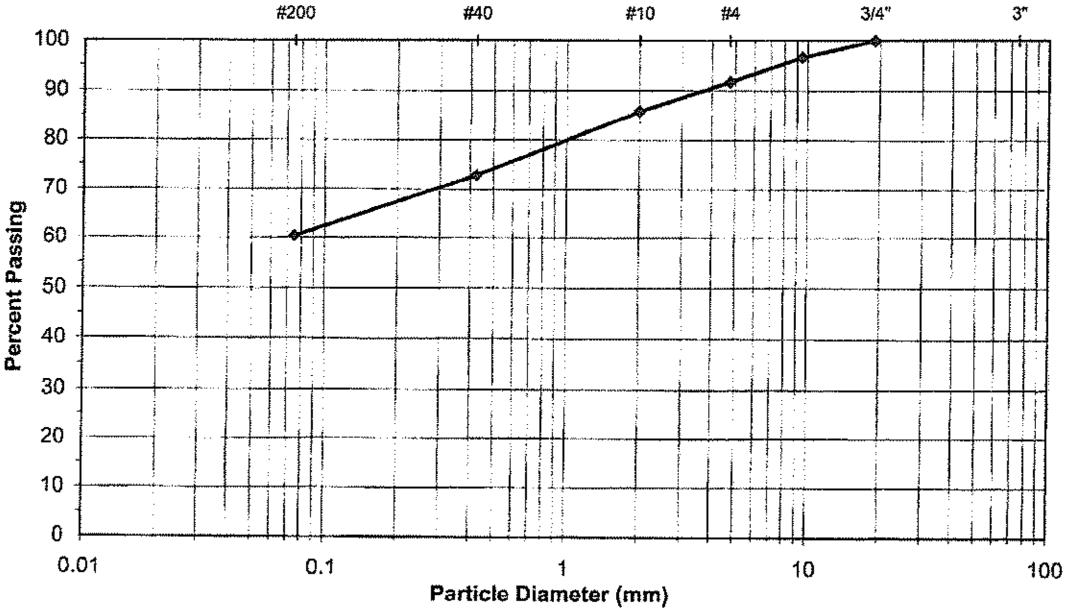
Atterberg Limits

ASTM D4318

Liquid Limit (LL)	43
Plastic Limit (PL)	21
Plasticity Index (PI)	22

Natural Moisture Content (%) = 10.4%

Soil Description gray-brown sandy lean CLAY
USCS Classification CL



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 60.5 % Sand = 31.2 % Gravel = 8.3

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Project Name	Montrose 552-Acre Ranch	Date	2/8/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#16 @3-4'	Tested by	SM
Sample #	GS18		

Sieve Analysis
ASTM C136 / C117

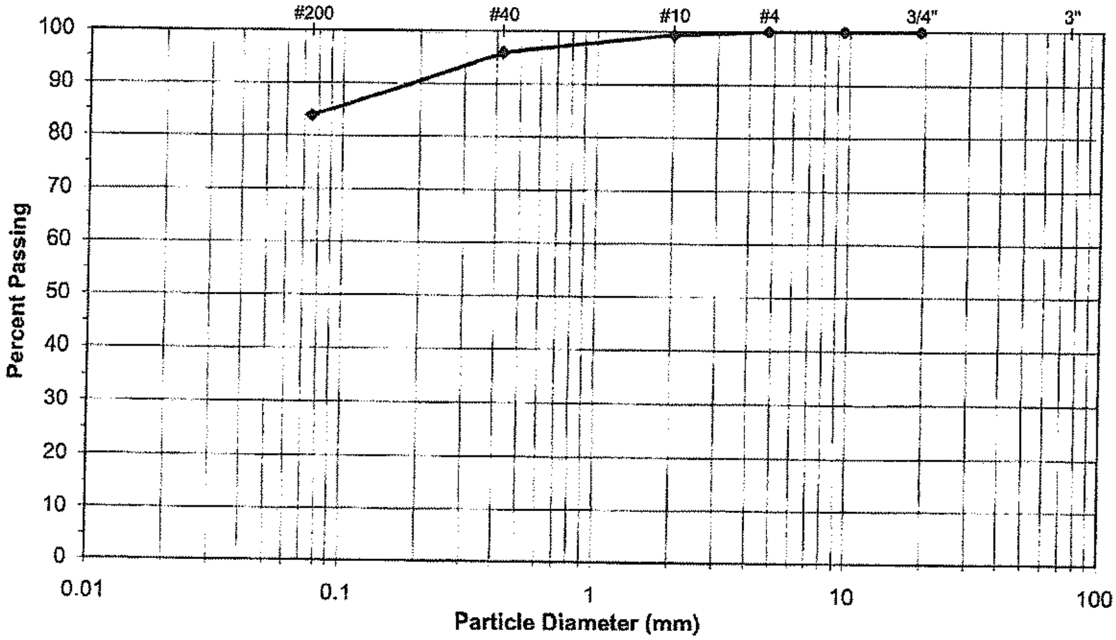
Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.0	99.3
#40	0.425	95.8
#200	0.075	83.7

Atterberg Limits
ASTM D4318

Liquid Limit (LL) 45
Plastic Limit (PL) 22
Plasticity Index (PI) 23

Natural Moisture Content (%) = 12.8%

Soil Description light brown-gray lean CLAY with sand
USCS Classification CL



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 83.7 % Sand = 16.3 % Gravel = 0.0

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Project Name	Montrose 552 Acre Ranch	Date	2/27/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	BH06-1 @5-6.5'	Tested by	VB/SM
Sample #	GS20		

Sieve Analysis
ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	96.5
3/8"	9.5	86.4
#4	4.750	77.2
#10	2.000	70.2
#40	0.425	57.8
#200	0.075	37.7

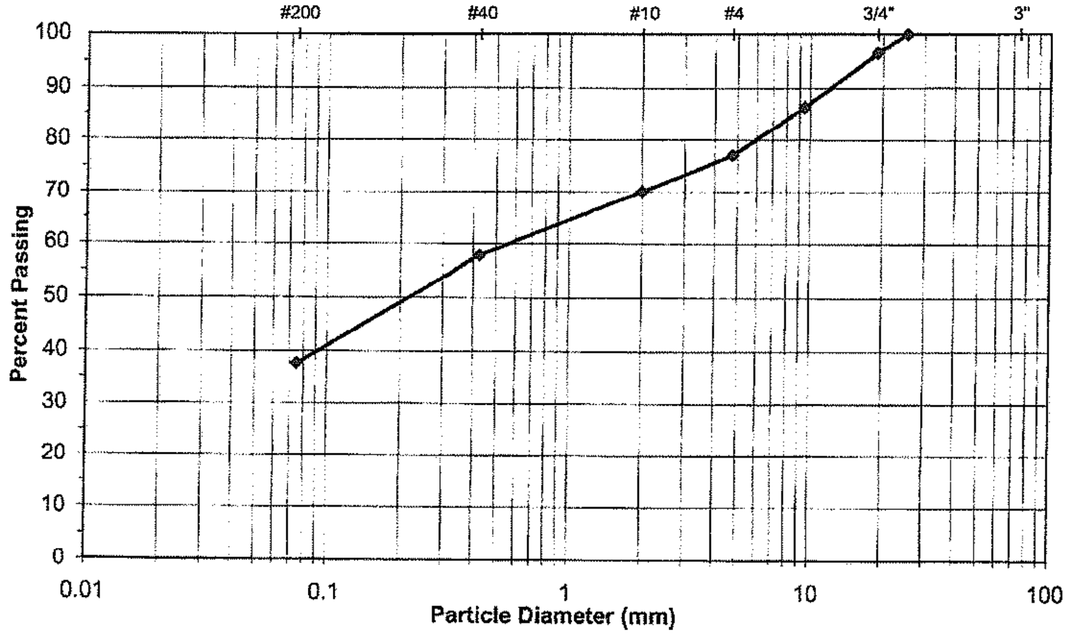
Atterberg Limits
ASTM D4318

Liquid Limit (LL)	39
Plastic Limit (PL)	23
Plasticity Index (PI)	16

Natural Moisture Content (%) = 7.9%

Soil Description: brown clayey SAND with gravel

USCS Classification: SC



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 37.7 % Sand = 39.5 % Gravel = 22.8

Project Name	Montrose 552 Acre Ranch	Date	2/28/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	BH06-1 @10-11'	Tested by	SM
Sample #	GS21		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	95.2
3/8"	9.5	91.0
#4	4.750	83.9
#10	2.000	75.0
#40	0.425	60.1
#200	0.075	40.7

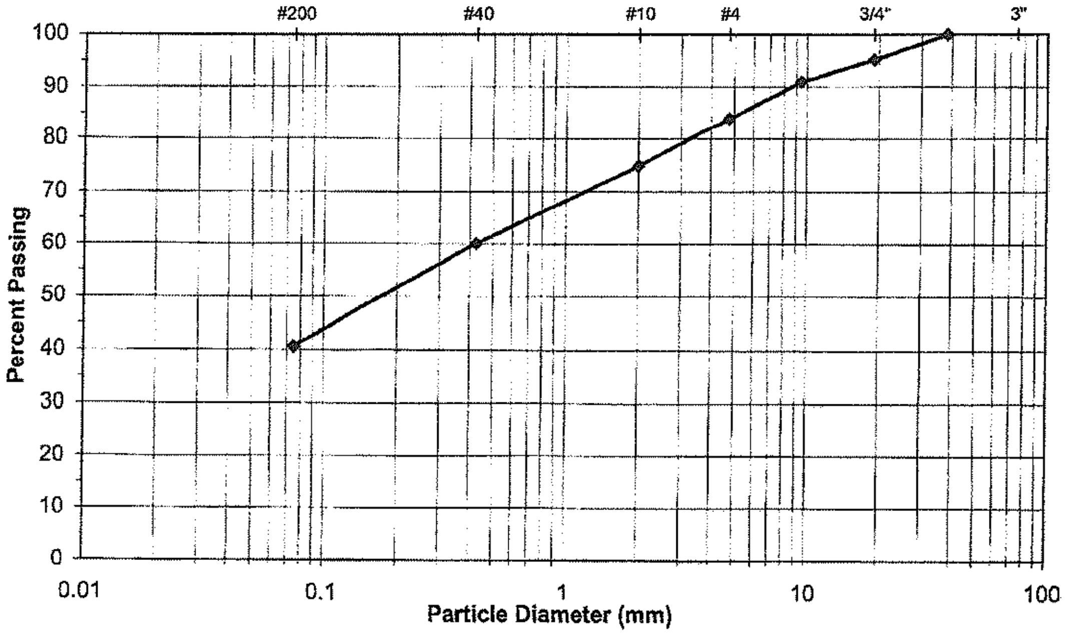
Atterberg Limits

ASTM D4318

Liquid Limit (LL)	37
Plastic Limit (PL)	18
Plasticity Index (PI)	19

Natural Moisture Content (%) = 5.4%

Soil Description: brown clayey SAND with gravel
USCS Classification: SC



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	**SAND**			**GRAVEL**	

% Fines = 40.7 % Sand = 43.3 % Gravel = 16.1

Project Name	Montrose 552 Acre Ranch	Date	2/28/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	BH06-2 @5-6.5'	Tested by	SM
Sample #	GS24		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	83.4
3/8"	9.5	74.0
#4	4.750	63.0
#10	2.000	48.2
#40	0.425	21.3
#200	0.075	8.4

Atterberg Limits

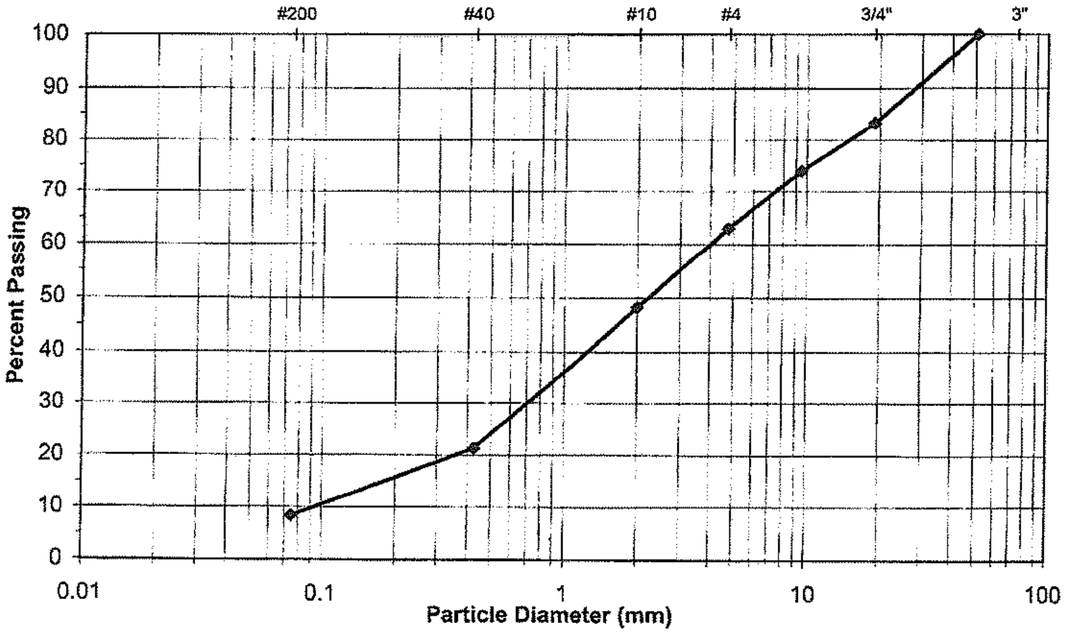
ASTM D4318

Liquid Limit (LL)	26
Plastic Limit (PL)	18
Plasticity Index (PI)	8

Natural Moisture Content (%) = 2.4%

Soil Description light brown well-graded SAND with clay and gravel

USCS Classification SW-SC



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 8.4 % Sand = 54.6 % Gravel = 37.0

Project Name	Montrose 552 Acre Ranch	Date	2/28/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	BH06-4 @5-6.5'	Tested by	VB/BAU
Sample #	GS28		

Sieve Analysis
ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	84.2
3/8"	9.5	71.7
#4	4.750	59.3
#10	2.000	46.2
#40	0.425	27.3
#200	0.075	15.9

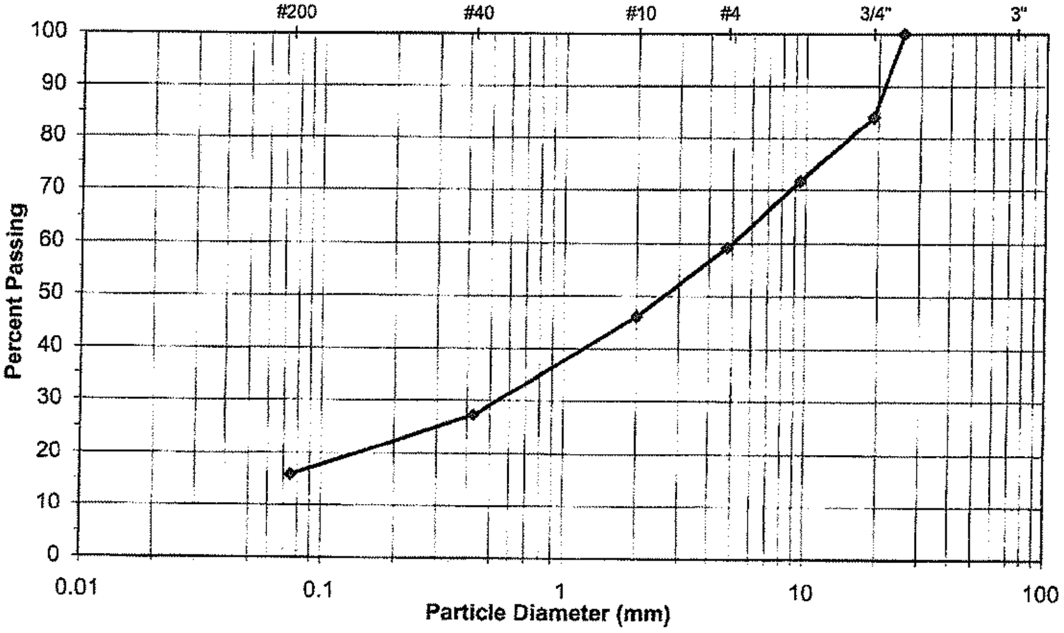
Atterberg Limits
ASTM D4318

Liquid Limit (LL)	29
Plastic Limit (PL)	21
Plasticity Index (PI)	8

Natural Moisture Content (%) = 3.8%

Soil Description light brown clayey SAND with gravel

USCS Classification SC



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 15.9 % Sand = 43.4 % Gravel = 40.7

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Sieve Analysis and Atterberg Limits

Project Name	Montrose 552 Acre Ranch	Date	3/29/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#18 @6-10'	Tested by	VB
Sample #	GS31		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	72.2
3/8"	9.5	53.0
#4	4.750	38.5
#10	2.000	24.3
#40	0.425	10.3
#200	0.075	4.4

Atterberg Limits

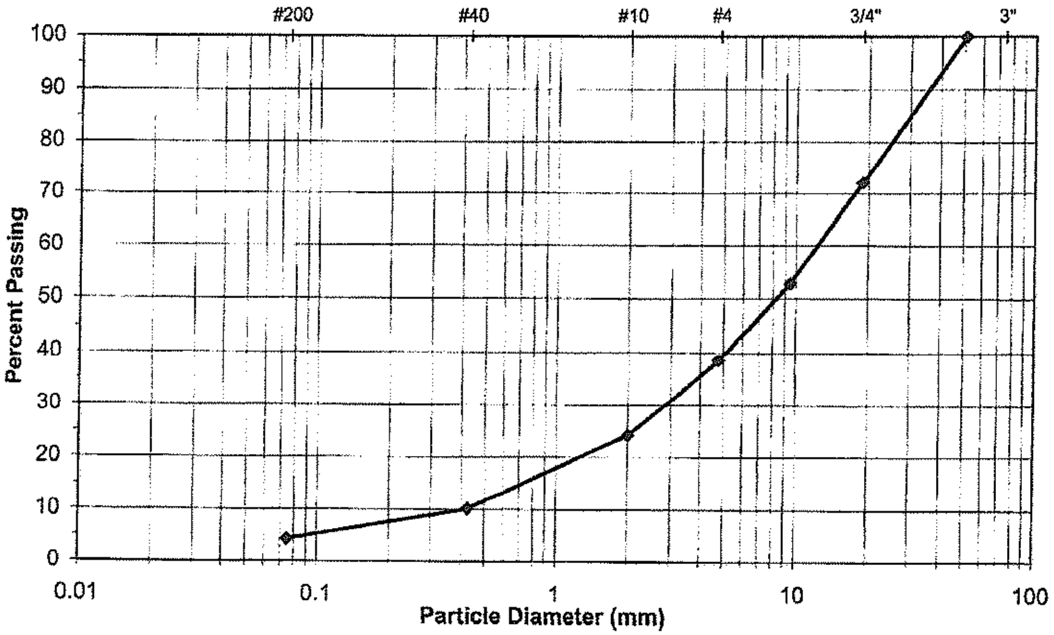
ASTM D4318

Liquid Limit (LL)	29
Plastic Limit (PL)	18
Plasticity Index (PI)	11

Natural Moisture Content (%) = 3.2%

Soil Description gray-brown well-graded GRAVEL with sand

USCS Classification GW



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	**SAND**			**GRAVEL**	

% Fines = 4.4 % Sand = 34.1 % Gravel = 61.5

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Sieve Analysis and Átterberg Limits

Project Name Montrose 552 Acre Ranch
Project Location Government Springs Rd
Client Joey Burns
Test Location TP#19 @4.0-5.0'
Sample # GS32

Date 4/3/2006
Project # 06-023-GEO
Sample by TB
Tested by VB

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	23.8
3/8"	9.5	11.6
#4	4.75	7.4
#10	2.0	5.5
#40	0.425	3.0
#200	0.075	1.2

Atterberg Limits

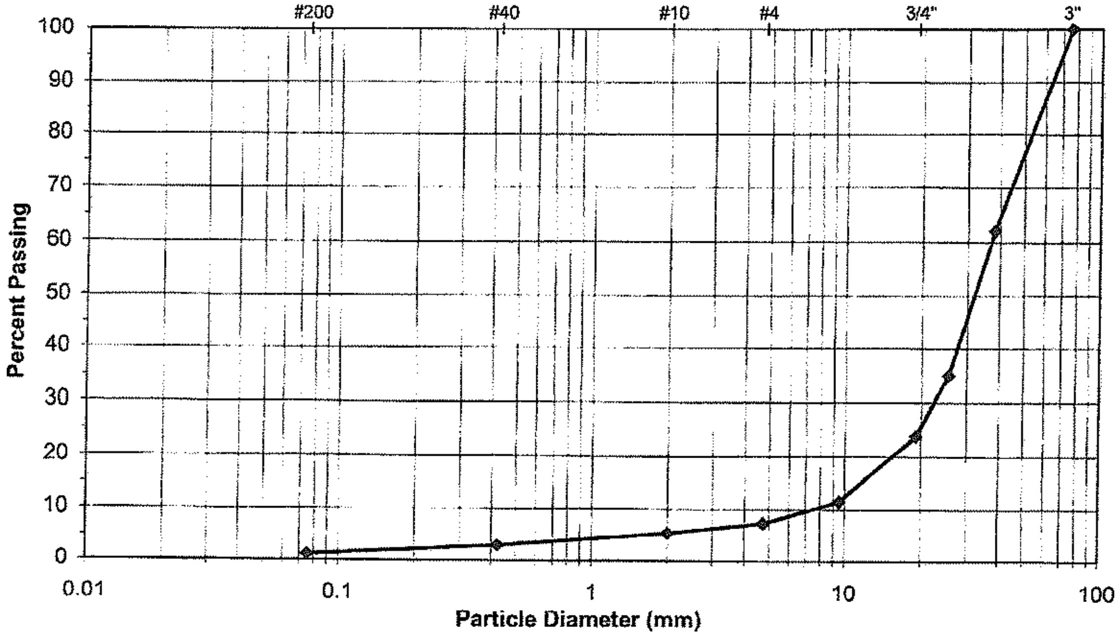
ASTM D4318

Liquid Limit (LL) NP
Plastic Limit (PL) NP
Plasticity Index (PI) NP

NP = Non-Plastic

Natural Moisture Content (%) = 4.2%

Soil Description gray well-graded GRAVEL
USCS Classification GW



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	**SAND**			**GRAVEL**	

% Fines = 1.2
% Sand = 6.2
% Gravel = 92.6

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Sieve Analysis and Atterberg Limits

Project Name	Montrose 552 Acre Ranch	Date	4/11/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#10 @2-5'	Tested by	VB/BAU
Sample #	BS3		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	99.6
3/8"	9.5	98.2
#4	4.750	85.7
#10	2.000	79.9
#40	0.425	68.5
#200	0.075	52.6

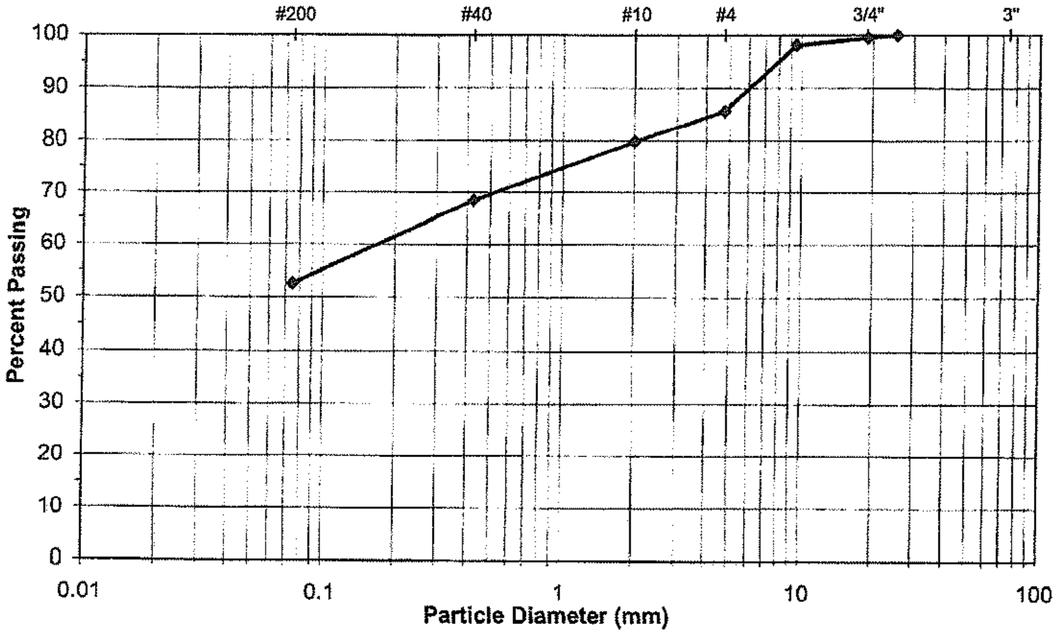
Atterberg Limits

ASTM D4318

Liquid Limit (LL)	44
Plastic Limit (PL)	25
Plasticity Index (PI)	19

Soil Description dark gray sandy lean CLAY (shale)

USCS Classification CL



Clay/Silt	Fine	Medium	Coarse	Fine	Coarse
FINES	SAND			GRAVEL	

% Fines = 52.6 % Sand = 33.2 % Gravel = 14.3

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Sieve Analysis and Atterberg Limits

Project Name	Montrose 552 Acre Ranch	Date	4/11/2006
Project Location	Government Springs Rd	Project #	06-023-GEO
Client	Joey Burns	Sample by	TB
Test Location	TP#11 @2-5'	Tested by	BAU
Sample #	BS4		

Sieve Analysis

ASTM C136 / C117

Sieve	Opening (mm)	% Passing
3"	76.2	100.0
3/4"	19.0	62.8
3/8"	9.5	56.0
#4	4.750	50.8
#10	2.000	45.1
#40	0.425	39.6
#200	0.075	35.3

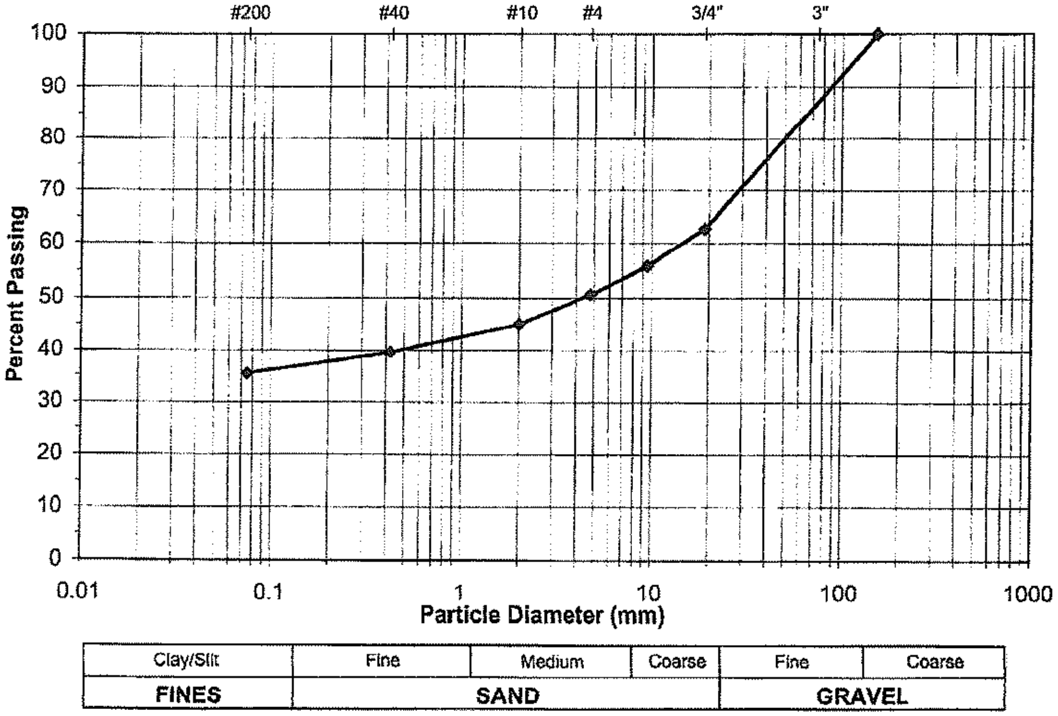
Atterberg Limits

ASTM D4318

Liquid Limit (LL)	44
Plastic Limit (PL)	21
Plasticity Index (PI)	23

Soil Description light brown clayey GRAVEL with sand

USCS Classification GC



% Fines = 35.3 % Sand = 15.5 % Gravel = 49.2

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Swell/Consolidation Test

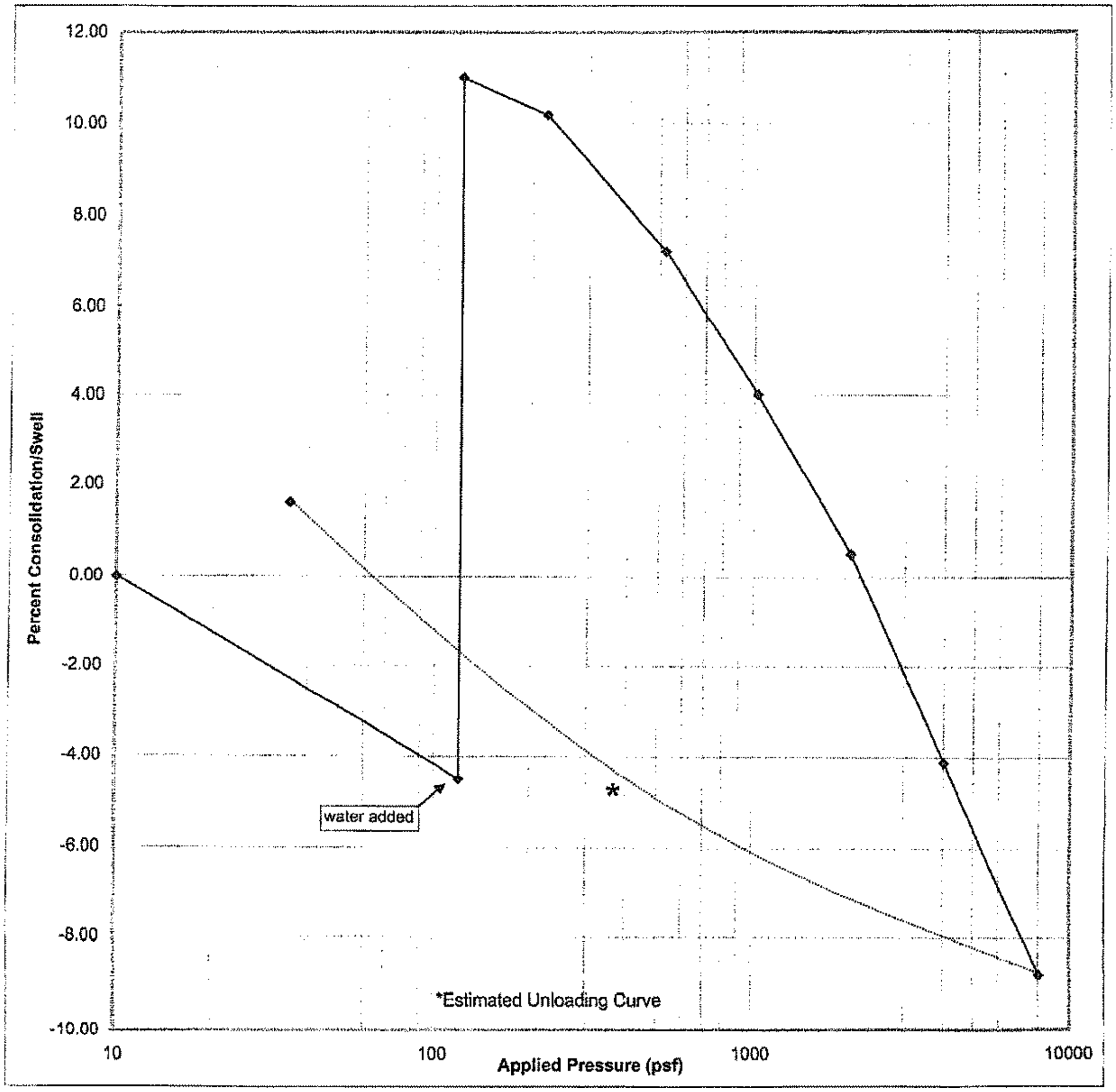
ASTM D4546

Project Name Montrose 552 Acre Ranch
Location TP#1 @4'
Sample # S
Soil Description dark gray clayey SHALE
Comments

Date 02/01/06
Project # 06-023-GEO
Sample by TB
Test by BAU
Test for TB
Drafting by BAU

Initial compression (Due to 100 psf pressure) =4.49%
Initial swell (Due to water & 100 psf pressure) =15.50%
Total consolidation (Due to water & 8000 psf pressure) =19.80%
Estimated swelling pressure =2570 psf

Initial Moisture Content	12.1 %	Final Moisture Content	28.3 %
Initial Dry Density	101.5 pcf	Final Dry Density	98.0 pcf
Initial Wet Density	113.9 pcf	Final Saturated Density	125.8 pcf



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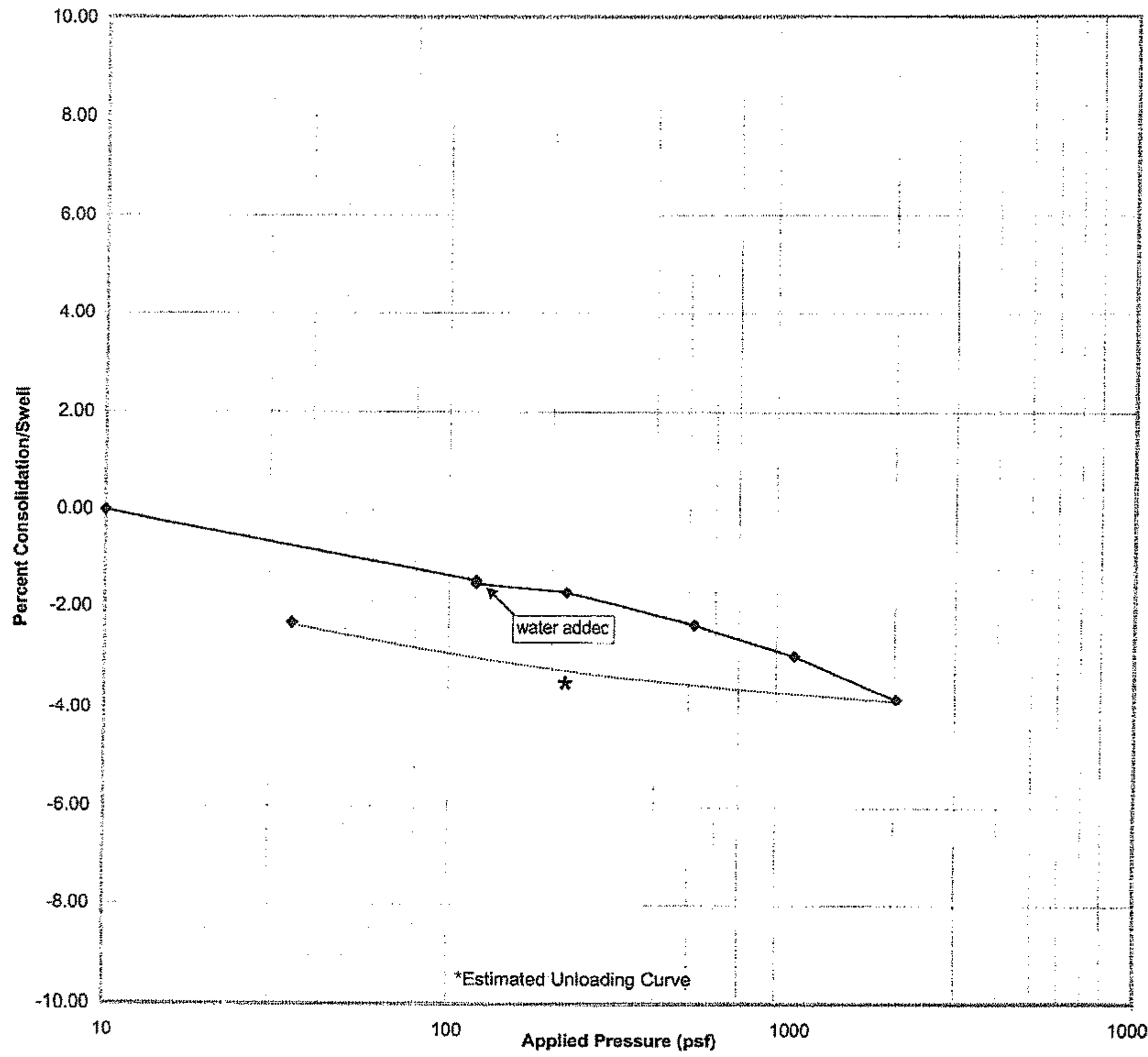
Swell/Consolidation Test

ASTM D4546

Project Name	Montrose 552 Acre Ranch	Date	02/02/06
Location	TP#2 @5.5'	Project #	06-023-GEO
Sample #	AQ	Sample by	TB
Soil Description	gray-brown sandy lean CLAY (CL)	Test by	SM
Comments		Test for	TB
		Drafting by	BAU

Initial compression (Due to 100 psf pressure) =1.44%
Initial consolidation (Due to water & 100 psf pressure) = 0.07%
Total consolidation (Due to water & 2000 psf pressure) =2.29%

Initial Moisture Content	14.7 %	Final Moisture Content	15.0 %
Initial Dry Density	114.3 pcf	Final Dry Density	120.1 pcf
Initial Wet Density	131.0 pcf	Final Saturated Density	138.1 pcf



Swell/Consolidation Test

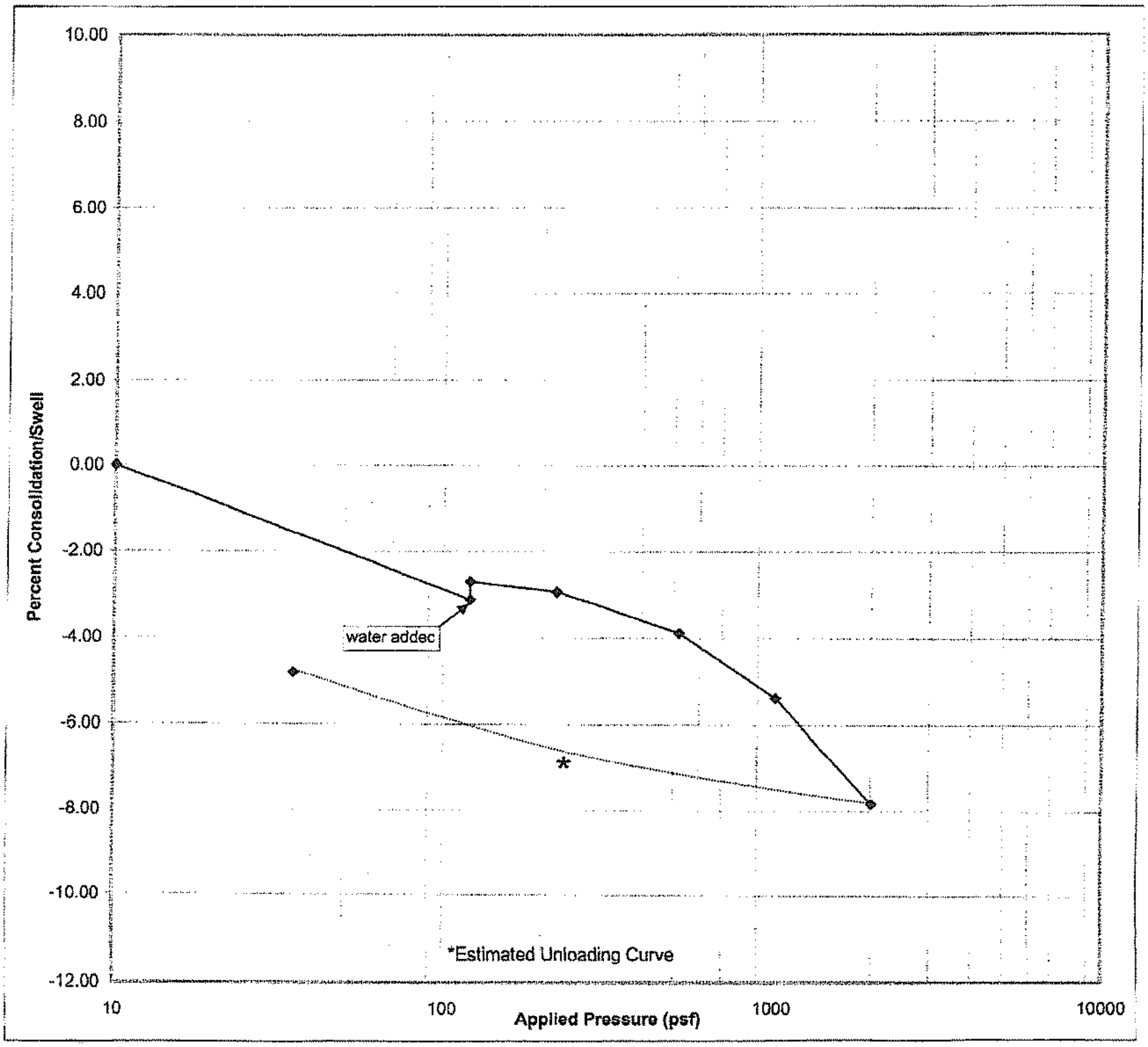
ASTM D4546

Project Name Montrose 552 Acre Ranch
Location TP#3 @3.5'
Sample # H
Soil Description brown lean CLAY with sand (CL)
Comments

Date 02/02/06
Project # 06-023-GEO
Sample by TB
Test by SM
Test for TB
Drafting by BAU

Initial compression (Due to 100 psf pressure) =3.10%
Initial swell (Due to water & 100 psf pressure) =0.41%
Total consolidation (Due to water & 2000 psf pressure) =5.12%
Estimated swelling pressure =190 psf

Initial Moisture Content	23.3 %	Final Moisture Content	26.6 %
Initial Dry Density	93.5 pcf	Final Dry Density	97.4 pcf
Initial Wet Density	115.3 pcf	Final Saturated Density	123.3 pcf



Swell/Consolidation Test

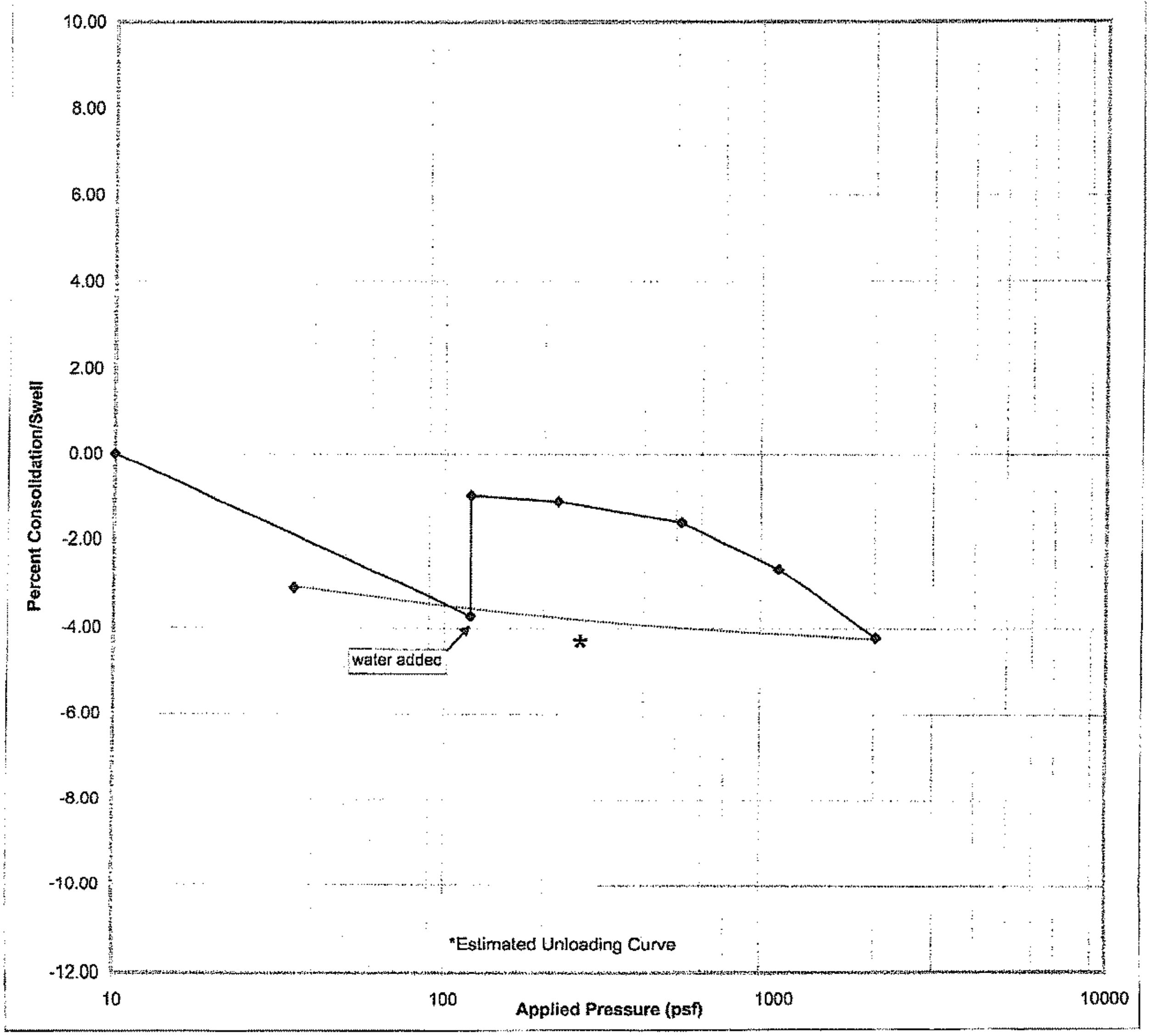
ASTM D4546

Project Name Montrose 552 Acre Ranch
Location TP#4 @5'
Sample # G
Soil Description gray-brown fat CLAY (CH)
Comments

Date 02/02/06
Project # 06-023-GEO
Sample by TB
Test by SM
Test for TB
Drafting by BAU

Initial compression (Due to 100 psf pressure) =3.73%
Initial swell (Due to water & 100 psf pressure) =2.76%
Total consolidation (Due to water & 2000 psf pressure) =3.24%
Estimated swelling pressure =920 psf

Initial Moisture Content	24.3 %	Final Moisture Content	25.6 %
Initial Dry Density	97.6 pcf	Final Dry Density	100.6 pcf
Initial Wet Density	121.4 pcf	Final Saturated Density	126.3 pcf



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Swell/Consolidation Test

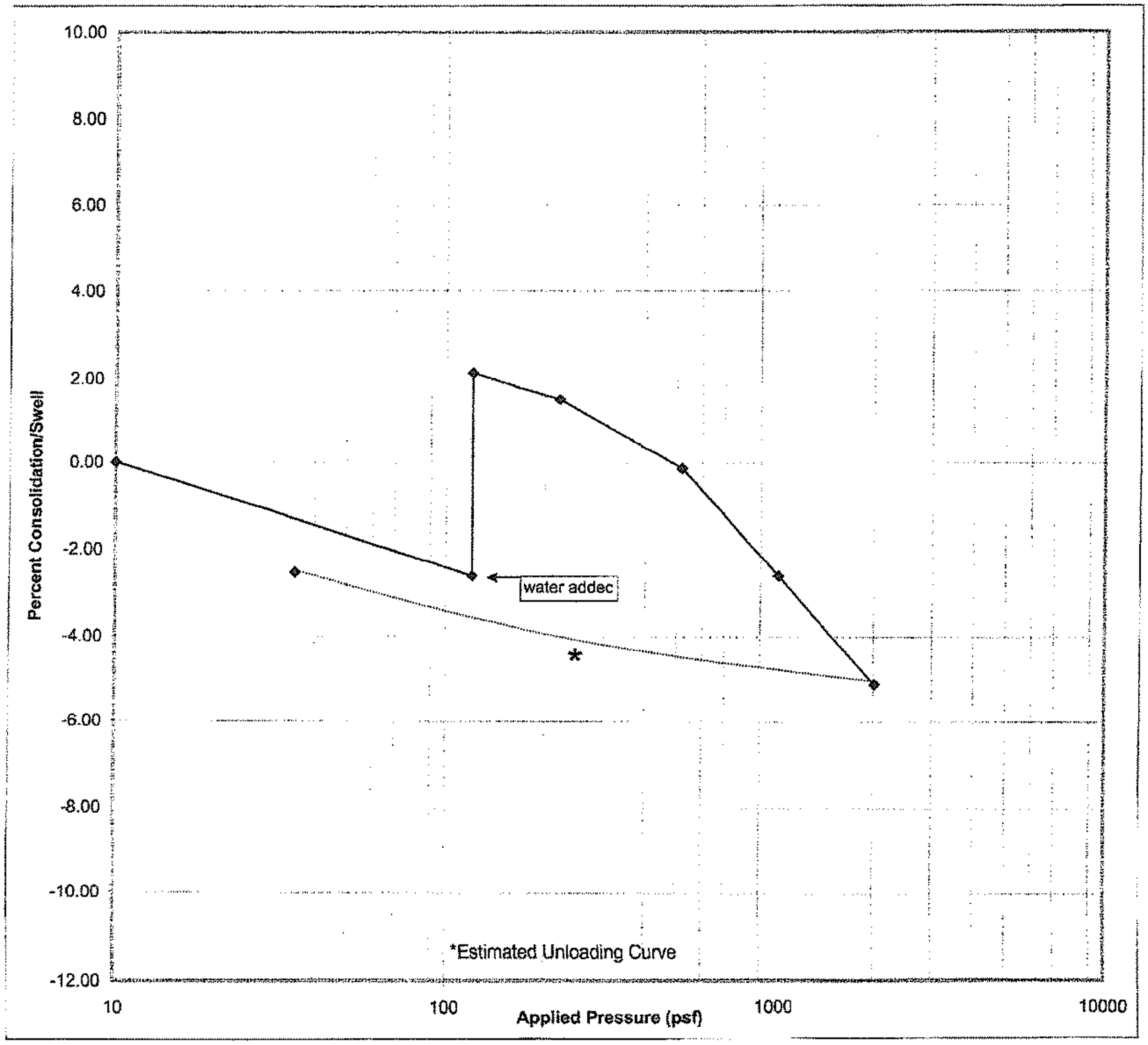
ASTM D4546

Project Name: Montrose 552 Acre Ranch
Location: TP#10 @5'
Sample #: GU
Soil Description: dark gray-brown CLAY
Comments: clay shale

Date: 02/06/06
Project #: 06-023-GEO
Sample by: TB
Test by: SM
Test for: TB
Drafting by: BAU

Initial compression (Due to 100 psf pressure) =2.60%
Initial swell (Due to water & 100 psf pressure) =4.75%
Total consolidation (Due to water & 2000 psf pressure) =7.26%
Estimated swelling pressure =650 psf

Initial Moisture Content	11.6 %	Final Moisture Content	23.8 %
Initial Dry Density	110.8 pcf	Final Dry Density	102.6 pcf
Initial Wet Density	123.7 pcf	Final Saturated Density	127.0 pcf



*Estimated Unloading Curve

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Swell/Consolidation Test

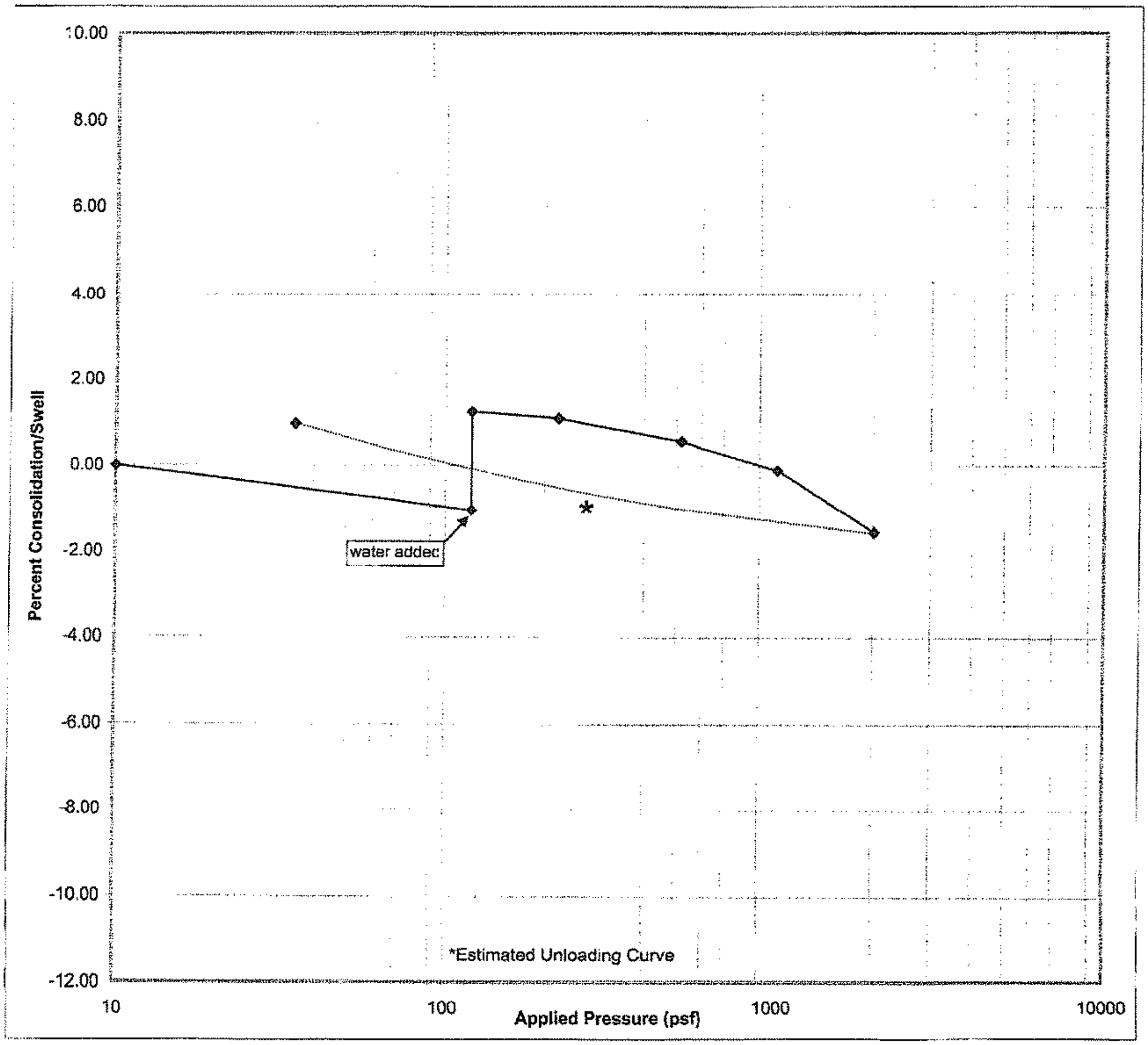
ASTM D4546

Project Name Montrose 552 Acre Ranch
Location TP#13 @4.5'
Sample # H46
Soil Description gray brown gravelly lean CLAY with sand (CL)
Comments

Date 02/06/06
Project # 06-023-GEO
Sample by TB
Test by SM
Test for TB
Drafting by BAU

Initial compression (Due to 100 psf pressure) =1.03%
Initial swell (Due to water & 100 psf pressure) =2.27%
Total consolidation (Due to water & 2000 psf pressure) =2.77%
Estimated swelling pressure =950 psf

Initial Moisture Content	18.3 %	Final Moisture Content	22.4 %
Initial Dry Density	105.4 pcf	Final Dry Density	104.1 pcf
Initial Wet Density	124.7 pcf	Final Saturated Density	127.5 pcf



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Swell/Consolidation Test

ASTM D4546

Project Name	Montrose 552 Acre Ranch	Date	02/06/06
Location	TP#16 @4'	Project #	06-023-GEO
Sample #	HM	Sample by	TB
Soil Description	light brown-gray lean CLAY with sand (CL)	Test by	SM
Comments		Test for	TB
		Drafting by	BAU

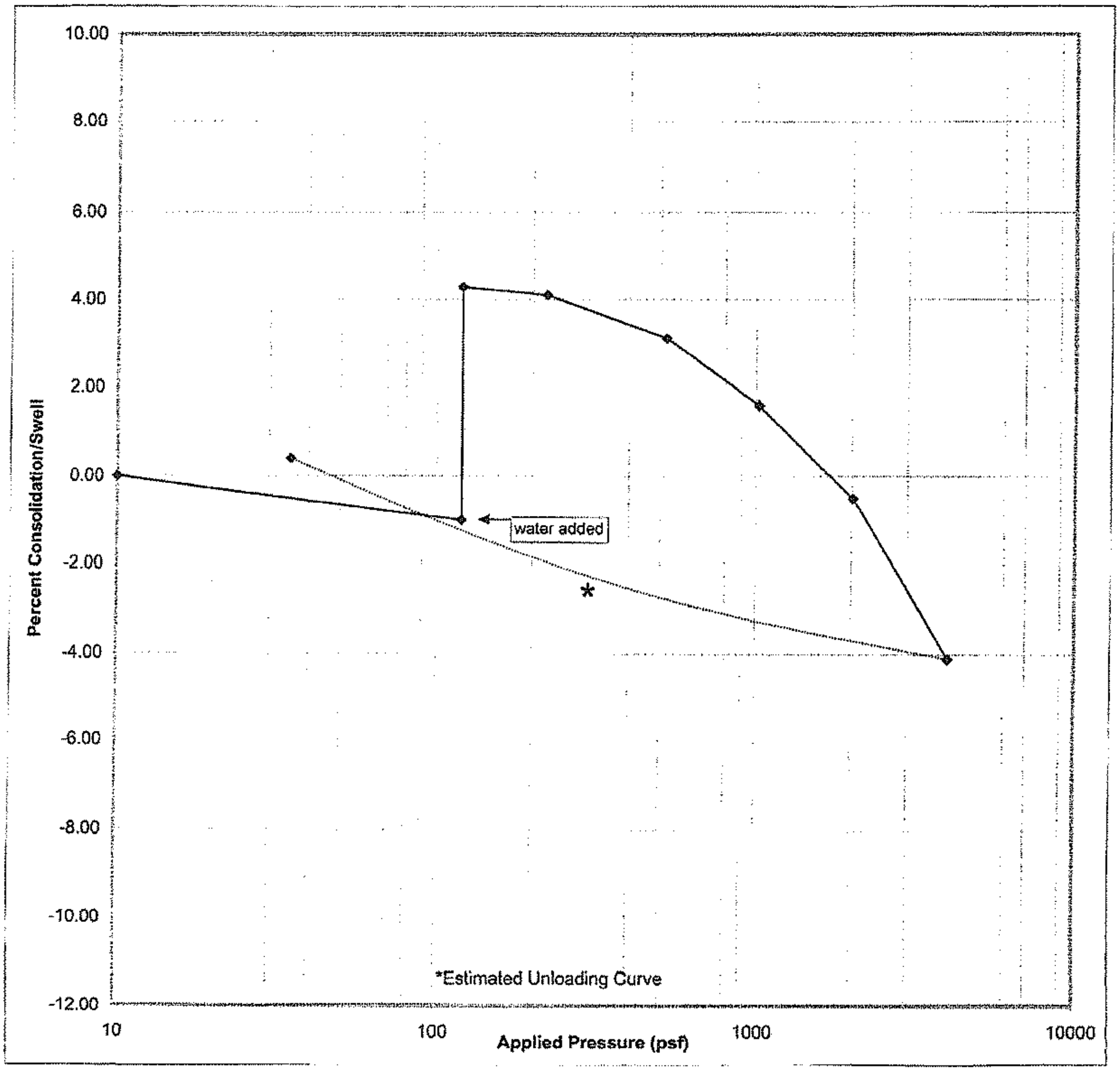
Initial compression (Due to 100 psf pressure) =0.99%

Initial swell (Due to water & 100 psf pressure) =5.30%

Total consolidation (Due to water & 4000 psf pressure) =8.41%

Estimated swelling pressure =1280 psf

Initial Moisture Content	12.5 %	Final Moisture Content	23.5 %
Initial Dry Density	102.9 pcf	Final Dry Density	101.8 pcf
Initial Wet Density	115.8 pcf	Final Saturated Density	125.7 pcf



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Swell/Consolidation Test

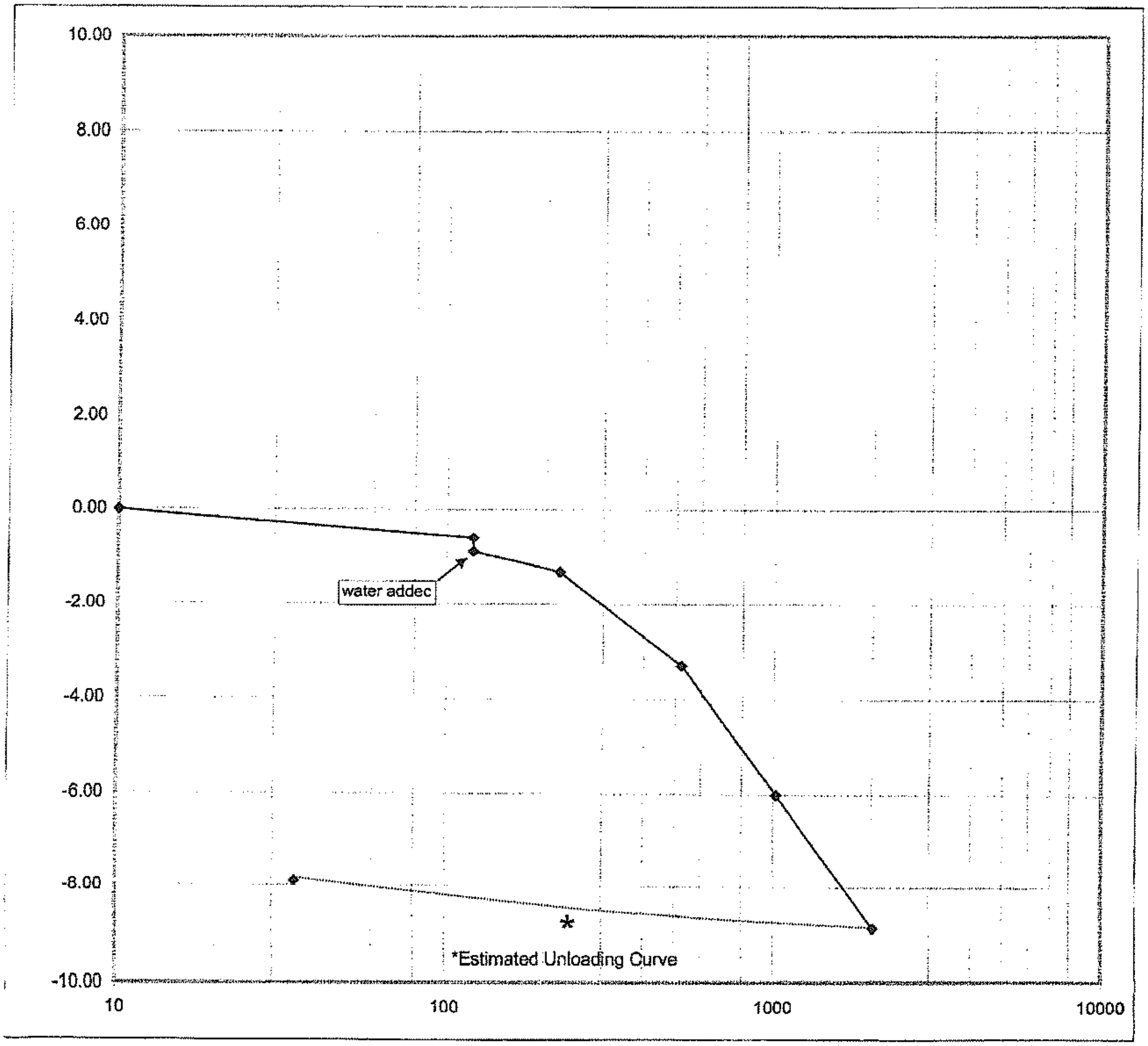
ASTM D4546

Project Name Montrose 552 Acre Ranch
Location BH06-1 @5-6.5'
Sample # BD
Soil Description reddish yellow clayey SAND with gravel (SC)
Comments

Date 02/27/06
Project # 06-023-GEO
Sample by TB
Test by SM
Test for TB
Drafting by BAU

Initial compression (Due to 100 psf pressure) -0.59%
Initial consolidation (Due to water & 100 psf pressure) -0.29%
Total consolidation (Due to water & 2000 psf pressure) -7.97%

Initial Moisture Content	9.6 %	Final Moisture Content	28.8 %
Initial Dry Density	87.6 pcf	Final Dry Density	94.3 pcf
Initial Wet Density	96.0 pcf	Final Saturated Density	121.5 pcf



*Estimated Unloading Curve

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Swell/Consolidation Test

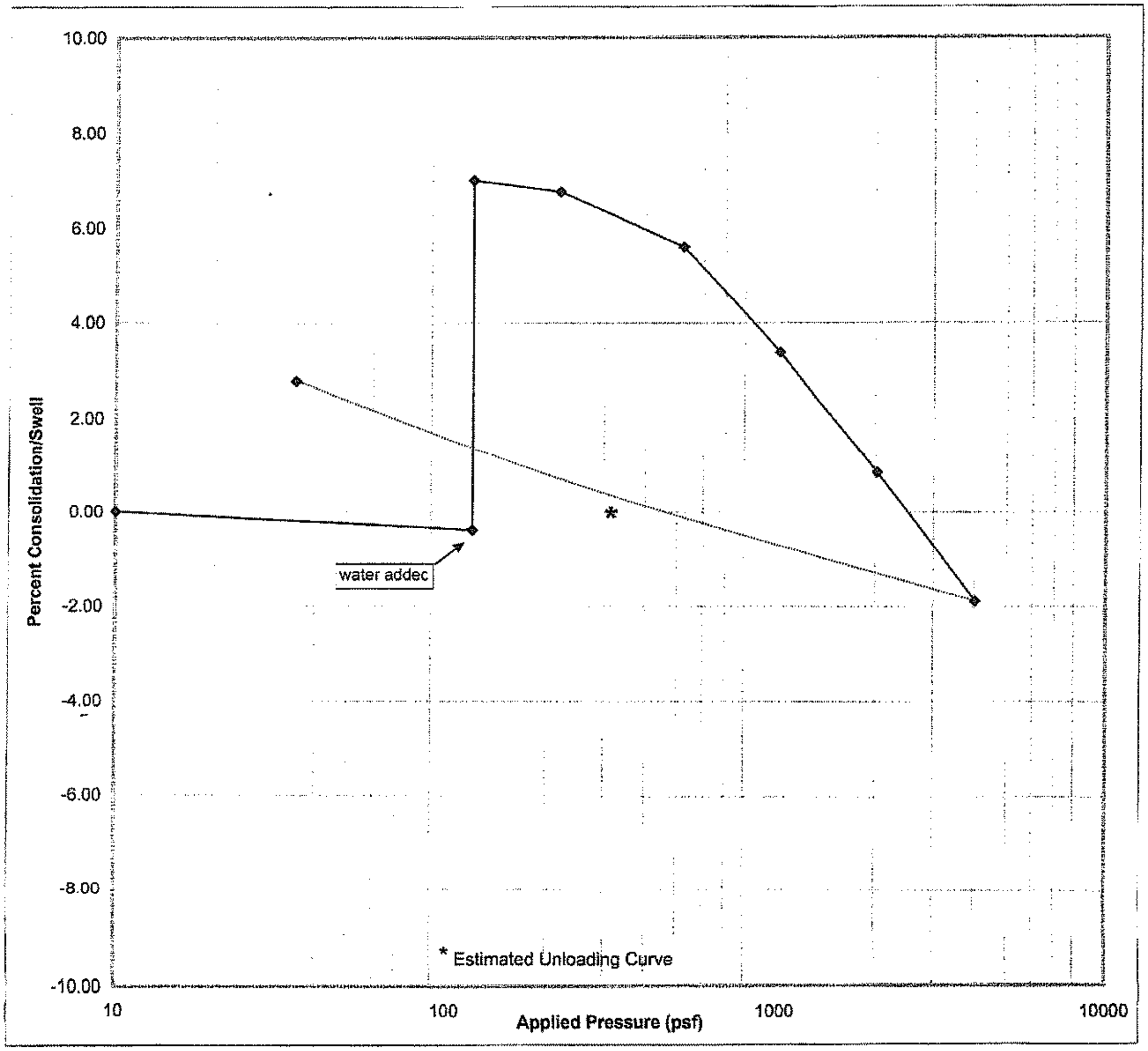
ASTM D4546

Project Name Montrose 552 Acre Ranch
Location BH06-1 @10-11'
Sample # DO
Soil Description brown clayey SAND with gravel (SC)
Comments

Date 02/27/06
Project # 06-023-GEO
Sample by TB
Test by SM
Test for TB
Drafting by BAU

Initial compression (Due to 100 psf pressure) =0.39%
Initial swell (Due to water & 100 psf pressure) =7.40%
Total consolidation (Due to water & 4000 psf pressure) =8.89%
Estimated swelling pressure = 1610 psf

Initial Moisture Content	6.7 %	Final Moisture Content	23.7 %
Initial Dry Density	109.9 pcf	Final Dry Density	103.1 pcf
Initial Wet Density	117.2 pcf	Final Saturated Density	127.6 pcf



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Swell/Consolidation Test

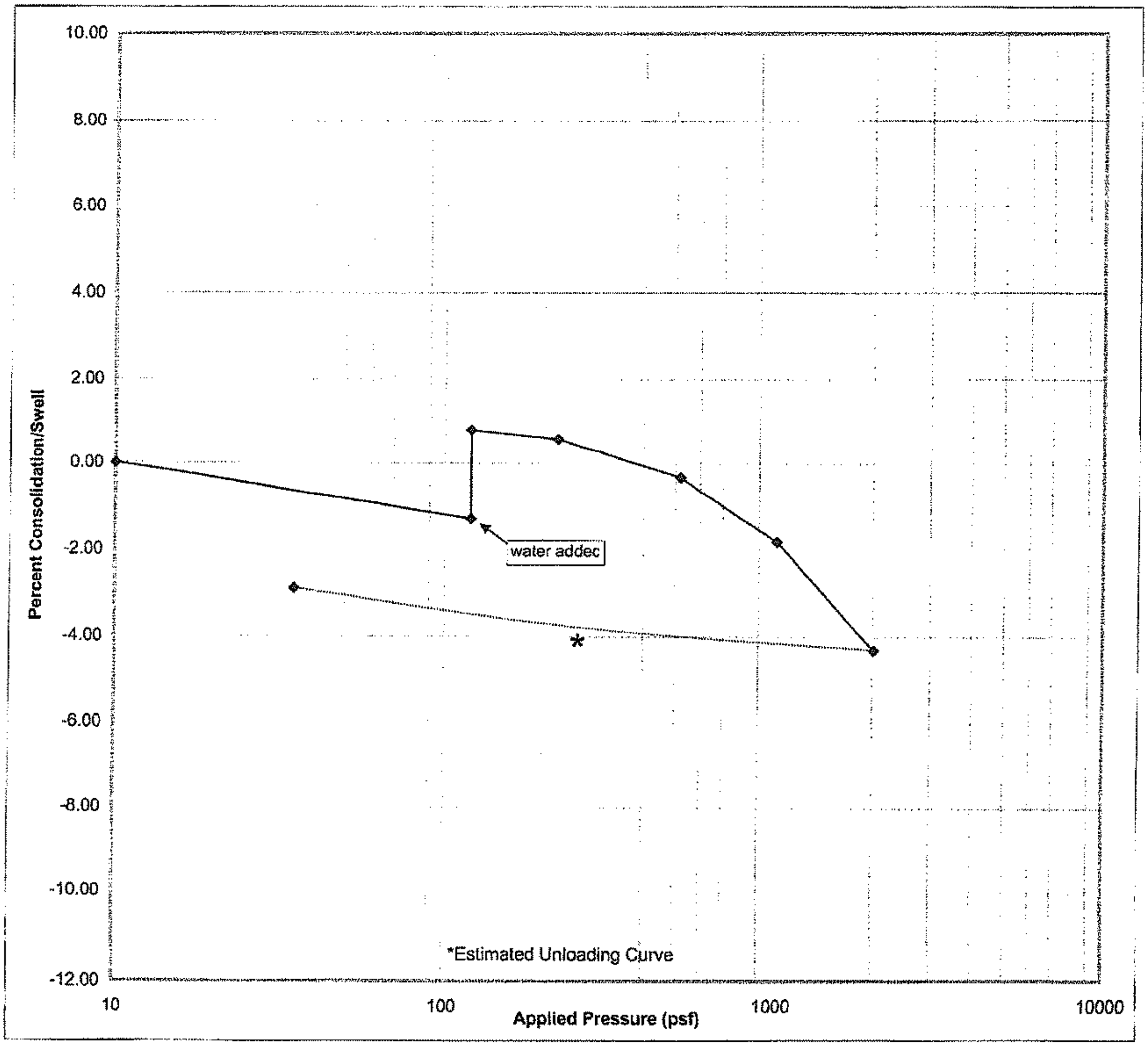
ASTM D4546

Project Name Montrose 552-Acre Ranch
Project Location Government Springs Rd.
Client Burns
Test Location TP#17 @4.0'
Sample # PX
Soil Description yellow brown CLAY with sand

Date 04/03/06
Project # 06-023-GEO
Sample by TB
Test by BAU

Initial compression (Due to 100 psf pressure) =1.28%
Initial swell (Due to water & 100 psf pressure) =2.09%
Total consolidation (Due to water & 2000 psf pressure) =5.12%
Estimated swelling pressure =530 psf

Initial Moisture Content	10.8 %	Final Moisture Content	25.8 %
Initial Dry Density	97.0 pcf	Final Dry Density	99.2 pcf
Initial Wet Density	107.5 pcf	Final Saturated Density	124.8 pcf



*Estimated Unloading Curve

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Swell/Consolidation Test

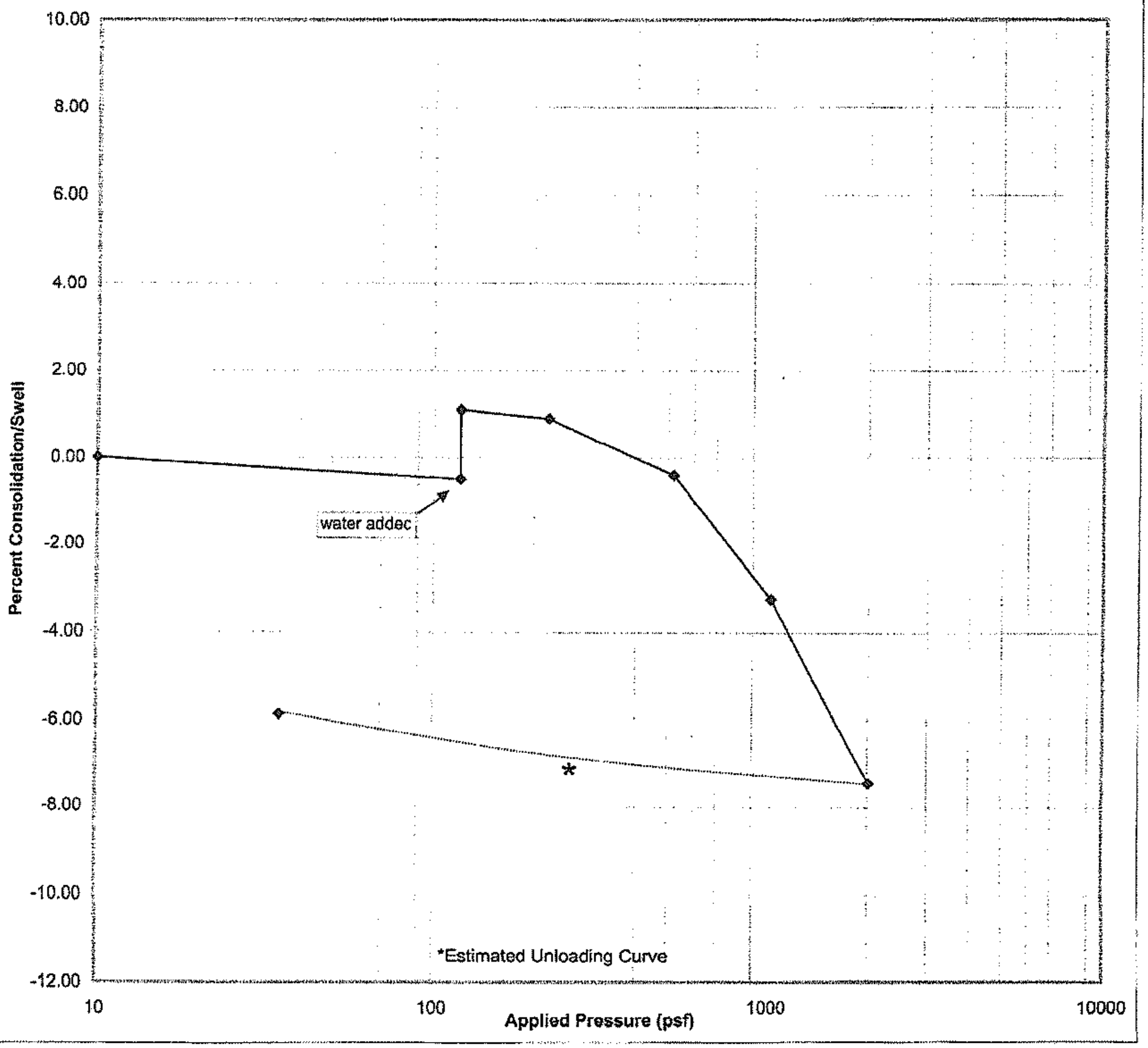
ASTM D4546

Project Name Montrose 552-Acre Ranch
Project Location Government Springs Rd.
Client Burns
Test Location TP#20 @3.5'
Sample # NX
Soil Description light yellow brown CLAY

Date 04/03/06
Project # 06-023-GEO
Sample by TB
Test by BAU

Initial compression (Due to 100 psf pressure) =0.50%
Initial swell (Due to water & 100 psf pressure) =1.61%
Total consolidation (Due to water & 2000 psf pressure) =8.56%
Estimated swelling pressure =360 psf

Initial Moisture Content	9.8 %	Final Moisture Content	36.6 %
Initial Dry Density	77.7 pcf	Final Dry Density	80.8 pcf
Initial Wet Density	85.3 pcf	Final Saturated Density	110.4 pcf



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Montrose 552-Acre Ranch
Summary of Percolation Tests

TEST PIT	Depth (inches)	Percolation Rate (mpi)	Soil Description	Setting
TP#1	14	240	brown gray SILT and CLAY	escarpment
	25	160	dk. gray brown SHALE	
	33	320	dk. gray brown SHALE	
	47	160	dk. gray brown SHALE	
TP#2	13	80	dk. brown SILT and CLAY	agricultural fields
	38	>320	gray-brown SILT and CLAY	
	53	160	gray-brown SHALE RESIDUUM	
TP#3	26	40	brown SILT and CLAY	agricultural fields
	41	40	brown SILT and CLAY	
	53	80	brown SILT and CLAY	
TP#4	13	53	dk. brown SILT and CLAY	agricultural fields
	41	>320	brown SILT and CLAY	
	54	>320	gray-brown SILT and CLAY	
	61	>320	gray-brown SILT and CLAY	
TP#5	12	80	dk. brown SILT and CLAY	agricultural fields
	28	>320	gray-brown SILT and CLAY	
	36	>320	gray-brown SILT and CLAY	
	52	>320	gray-brown SILT and CLAY	
TP#6	26	80	gray-brown SILT and CLAY	agricultural fields
	37	15	reddish-brown clayey GRAVEL	
	61	8	reddish-brown GRAVEL and COBBLES	
TP#7	13	16	dk. brown SILT and CLAY	agricultural fields
	37	>320	gray brown SILT and CLAY	
	51	80	gray brown SILT and CLAY w/ sand	
	64	80	gray brown SILT and CLAY w/ sand	
TP#8	36	16	brown sandy GRAVEL w/ clay	escarpment
	48	20	brown sandy GRAVEL w/ clay	
	57	16	brown sandy GRAVEL w/ clay	
TP#9	38	160	gray brown gravelly SILT and CLAY	agricultural fields
	52	160	gray brown gravelly SILT and CLAY	
	66	160	gray brown gravelly SILT and CLAY	
TP#10	14	>320	dk. gray-dk. brown SILT and CLAY	escarpment
	39	80	dk. brown SILT and CLAY	
	47	160	gray brown SILT and CLAY (residuum)	
	60	5	gray brown SHALE	
TP#11	36	32	brown sandy GRAVEL w/ clay	escarpment
	50	20	brown sandy GRAVEL w/ clay	
	62	32	brown sandy GRAVEL w/ clay	
TP#12	12	160	dk.brown SILT and CLAY	agricultural fields
	46	>320	gray brown SILT and CLAY	
	53	160	gray brown SILT and CLAY	
	66	>320	gray brown SILT and CLAY	
TP#13	14	160	dk gray-dk.brown SILT and CLAY	agricultural fields
	38	>320	gray brown SILT and CLAY	
	44	160	gray brown SILT and CLAY w/ sand	
	52	320	gray brown SILT and CLAY w/ sand	
TP#14	48	160	brown sandy GRAVEL w/ clay	agricultural fields
	57	160	brown sandy GRAVEL w/ clay	
	70	23	brown sandy GRAVEL w/ clay	
TP#15	15	53	brown silty clayey SAND and GRAVEL	escarpment
	38	>320	gray brown SILT and CLAY w/ gravel	
	51	160	gray brown SILT and CLAY	
	61	>320	gray brown SILT and CLAY	
TP#16	14	53	brown clayey GRAVEL w/ sand and silt	escarpment
	42	160	brown sandy CLAY and GRAVEL w/ silt	
	59	5	lt. brown gray SILT and CLAY w/ gravel	
	77	53	lt. brown gray SILT and CLAY w/ gravel	
TP#17	38	16	lt. brown clayey SAND w/ gravel	mesa top
	51	32	lt. brown clayey SAND w/ gravel	
	68	40	lt. brown clayey SAND w/ gravel	
TP#18	37	53	lt. brown clayey SAND and GRAVEL	mesa top
	59	20	gray brown sandy GRAVEL & COBBLES	
	76	70	gray brown sandy GRAVEL & COBBLES	
TP#19	44	23	brown clayey SAND w/ gravel	mesa top
	68	27	gray brown sandy GRAVEL & COBBLES	
	76	5	gray brown sandy GRAVEL & COBBLES	
TP#20	44	11	lt. brown clayey SAND w/ gravel	mesa top
	60	4	gray brown sandy GRAVEL & COBBLES	
	71	10	gray brown sandy GRAVEL & COBBLES	

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Glossary of Engineering & Soils Terms

Active Earth Pressure	The pressure that a soil exerts against a vertical surface which is allowed a certain degree of flexure or rotational freedom.
Allowable soil bearing capacity	The recommended maximum contact stress developed at the interface of the foundation and the supporting soil. Given in psf (pounds per square foot).
Alluvial Fan	A cone-shaped deposit of water-transported material (alluvium). They typically form at the base of topographic features where there is a distinct decrease in gradient. Consequently, alluvial fans tend to be coarse-grained near their mouths and relatively fine-grained at their edges.
Alluvium	Rock and soil material deposited by moving water. Rocks are generally rounded and sorted by size as they are worked by water. Found in river channels or alluvial fans.
ASTM	American Society for Testing and Materials (a national non-profit organization which writes testing standards for materials, products, systems and services).
At-Rest Earth Pressure	The pressure that soil exerts upon a vertical surface which is restrained from any movement.
Atterberg Limits	Named for a Swedish scientist, Atterberg Limits are defined by the water content that produces a specified soil consistency. See *Liquid Limit* and *Plastic Limit.*
Backfill	A specified material placed and compacted in a confined area.
Backslope Zone	The area in which loads applied to the ground surface or increase in slope angle will increase the total lateral force against a retaining wall.
Base Course	A layer of specified material placed on a subgrade or subbase.
Bedrock	Sedimentary, igneous, or metamorphic rock that has not been weathered or broken down by the elements of water, ice, wind, or gravity. Also referred to as "formational" material, as bedrock is known as a particular formation for the region.
Bench	A horizontal or near-horizontal surface in a sloped deposit.
Calcareous	Containing calcium carbonate (lime). A distinct layer of calcium carbonate hardpan is called caliche.
Clay	A fine-grained soil (finer than 0.002 mm) composed of very small platy (flat) particles that are smaller than silt particles. It forms lumps or clods when dry and is plastic (Plasticity Index greater than 4) and sticky when wet.
Cohesionless Soil	Non-plastic granular soils (silt, sand, gravel) composed of bulky grains that are not attracted to each other with the addition of water.
Cohesive Soil	Soils (i.e., clays and some silts) in which adsorbed water and particle attraction work together to produce a mass which holds together and deforms plastically.
Colluvium	Rock and soil material deposited by gravity. Rocks are generally angular to subangular, loose and not sorted. Found below steep slopes and at the mouth of canyons; talus and cliff debris are included.

Compaction	The decrease in volume of an unsaturated soil mass due to a decrease in the void spaces, usually by mechanical means.
Consolidation	The decrease in soil volume due to a release of water within a saturated soil volume. As a soil consolidates, its void ratio decreases. Loosely, the term is used to describe the result of collapse of a loose soil structure.
Crawlspace	The space beneath the house that has a raised stemwall foundation and is typically 18 to 36 inches in height.
Creep	A slow, nearly continuous movement of soil caused by changes in soil moisture and the downhill force of gravity.
Dead Load	Static loads transferred to the foundation, usually the weight of building materials, but can also be the loads imposed by retained soil or a constructed slope.
Debris Flow	Debris flows are rapid flood-like events consisting of mud, water, rock and organic debris and that have 20 to 80% particles coarser than sand sizes. Steep slopes, weak or weathered rock, a lack of vegetative cover, and abnormal precipitation contribute to debris flows. (See mud flow)
Differential Settlement	Unequal settlement between or within foundation elements of a structure.
Dispersive Soils	Fine-grained soils whose clays have been neutralized by an abundance of cations which are then susceptible to removal (dispersion) from the soil matrix. This weakens soil strength; piping and gullying are common features in this soil.
Drilled Caisson	A deep foundation system that consists of reinforced concrete piers cast into a drilled hole that extends into bedrock or other suitable material.
Driven Pile	A deep foundation system that consists of steel, concrete, or timber that is driven into bedrock or other suitable material.
Existing Fill	Materials deposited through the action of man prior to geotechnical exploration of the site.
Existing Grade	The ground surface at the time of field exploration.
Expansive Soil	A soil containing clay which expands (increases in volume) when exposed to an increase in moisture.
Fine Grained Soil	Soils composed of silt and/or clay-sized particles.
Flowing Avalanche	The turbulent cascade of slabs and blocks of relatively high-density (>25 pcf) snow and air down a slope.
Fluvial	Deposited or transported by a stream or river.
Fluvioglacial	Alluvial deposits derived from the rivers originating from the melting of glaciers. Glacial outwash is the term used to describe fluvioglacial deposits.
Formational Material	See bedrock. Also known as the "R" horizon.
Grade Beam	Typically, concrete beams that are constructed at or just below ground elevation that are used to transfer building loads to deep foundation elements. Walls and floor systems are then built upon the grade beams.

Groundwater	Water that is resident beneath the ground surface in porous soil and rock material. This level can fluctuate due to seasonal changes and irrigation.
Heave	Upward movement of soil or foundation components.
Hinge Point	Toe of excavated wall without footing or outside edge of concrete if footing is used.
Hummocky	The bumpy or chaotic terrain on the slumped material typically resulting from a landslide or glacial deposit. The rock and soil materials are unsorted and unsystematic.
Hydrocompactive Soils	Soils that have considerable voids, thus making it susceptible to consolidation in the presence of water.
Jumping Jack	A construction machine, used to compact both cohesive and cohesionless soils, that consists of a curved shoe that tamps the soil in an up and down motion.
Landslide	The general term for the rapid downward and outward movement (flow, slide or fall) of slope-forming bedrock, rock debris and "earth" (fine-grained fragmental debris). See "slump," a type of landslide.
Lifts	Horizontal layers of fill, generally in 6 to 8-inch increments.
Liquid Limit (LL)	The water content above which a soil behaves as a liquid.
Live Load	Transient loads introduced onto a structure and its foundation due to occupancy, wind, snow and rain, earthquakes, changes in groundwater, and other environmental factors.
Loam	An mixture of sand, silt and clay. It is easily crumbled when dry and has a slightly gritty, yet fairly smooth feel, and is often slightly plastic.
Monolithic Slab	A shallow foundation system that consists of a single unit of reinforced concrete with downturned edges and may include thickened ribs on the underside of the slab.
Moraine	Deposits formed by direct glacial action. There are many forms of moraines, but they generally consist of unsorted, unstratified, subrounded to subangular materials deposited by glacial ice. Also generally known as "drift" or "till."
Mottling	The discoloration of a soil due to the reaction of water with clay minerals during prolonged periods of saturation. Red colors indicate the presence of iron oxides in an oxidized state and gray indicate the removal of free iron in reducing conditions.
Mud Flow	Mud flows are flood-like events that have 80% or more mud and sand. Over-saturation of fine-grained soils triggers mud flows, which are a rapid failure or slippage of mud and other debris entrained in the movement. (See debris flow)
Native Grade	The naturally occurring ground surface (before disturbance).
Native Soil	Naturally occurring on-site soil.
Parent Material	The formational material from which a soil is derived.
Passive Earth Pressure	The resistance of a soil against movement when a lateral force is exerted upon it.

Piping	A feature in fine-grained soils whereby water preferentially follows root zones, animal burrows and surface soil cracks, and carries soil particles downwards through voids, leaving behind weak vertical planes, voids, and/or tunnels in the soil structure.
Pistol Butting	When the base of tree trunk is widened and bent upwards due to soil creep or slope movement. The tree continues to grow vertically despite the ground moving downslope, thus creating a shape like a "pistol butt" in the expanded trunk.
Plastic Index (PI)	The difference between Liquid and Plastic Limits (LL - PL). This represents the moisture content range that the soil is in the plastic state. The larger the PI, the more plastic a soil is.
Plastic Limit (PL)	The water content at which a soil becomes brittle after being in the plastic state. The soil breaks apart or crumbles when its moisture content is equal to or less than its PL.
Plastic Soil	A predominately silt or clay soil that exhibits plastic (deformable) behavior.
Powder Avalanche	The relatively low-density (12.5 pcf), high velocity, turbulent force of snow, air and entrained debris that precedes and extends beyond a dry-snow avalanche. The powder and air blast can travel at speeds in excess of 100 mph.
Proctor Density (Standard & Modified)	A laboratory compaction procedure to determine the maximum dry density and optimum moisture content of soil. The Standard Proctor procedure uses a 5.5-lb hammer and 3 lifts, while the Modified Proctor procedure uses a 10-lb hammer and 5 lifts.
Refusal	When very dense native material is encountered which cannot be excavated or penetrated further by whatever equipment is being used.
Rock	A natural aggregate of mineral grains connected by strong cohesive forces, usually requiring heavy equipment, drilling, wedging, blasting or other methods of extraordinary force for excavation.
Scarify	To mechanically loosen or break down existing soil structure.
Settlement	Downward movement of foundation components due to compression of a soil mass.
Shale	A thinly-bedded rock formation composed of clay or silt muds that have been solidified into rock. The Mancos Shale Formation in Colorado is of marine origin.
Silt	Fine-grained soil particles measuring 0.002 to 0.075mm, which are larger than clay but smaller than sand. Silt can exhibit plastic characteristics.
Slab-on-Grade	A concrete layer cast directly upon a base, subbase or subgrade.
Slope	The angle of a hillside, usually expressed in degrees or percent (elevation drop per given distance).
Slump	The rotational slip along a concave-up surface of rupture. A "main scarp" is the crescent shaped failure plane formed at the source of the slump. A slump is a form of landslide most common in thick, homogeneous, cohesive materials such as clay.
Soil	Any unconsolidated, excavatable earth material composed of discrete solid particles, with air or liquids between, that is the result of the chemical and mechanical weathering of rock.
Soil Log	A graphic representation of a column of soil indicating textural changes and general properties of soil or rock types encountered in a test pit or boring.

Spread Footing	A shallow foundation system that consists of a wide (typically from 12 to 48 inches) "foot" of reinforced concrete upon which vertical wall components are built.
Stemwall	A vertical concrete foundation component, normally 6 to 12 inches wide, that rests on the spread footing and extends up to the floor level.
Subbase	A layer of specified material between the subgrade and base course.
Subbase Grade	Top of subbase elevation.
Subgrade	Prepared native soil surface.
Subsoil	The layer of soil below the topsoil and above the substratum, that has undergone pedogenesis (soil formation). The "B" horizons.
Substratum	The layer of soil below the subsoil that has not undergone soil genesis. It contains weathered parent material. The "C" horizons.
Swell Potential	The potential of a soil to expand (increase in volume) due to absorption of moisture.
Tension Cracks	Transverse cracks (linear openings) in the soil due to soil movement.
Topsoil	The surface layer of soil containing organic material and roots. The "A" horizons.
Transverse	A feature (like a crack or ridge) that is at right angles to the slope of a hillside or the general trend of a valley.
Vesicular Pores	Sponge-like openings in a fine-grained soil that are the result of the solution and dispersal of clay particles. The pores are discontinuous and vary in size. These pores are often found in soils that have been irrigated.
Vibratory Roller	A construction machine, used to compact soil and aggregate material, that consists of a heavy vibrating drum that is rolled across a surface.
Void Ratio	A ratio of the volume of voids (pore spaces) to the volume of mass of a soil.
Water Table	The relatively continuous and consistent level of groundwater below the ground surface.
Weathering	The breakdown of intact masses of rock into smaller pieces by mechanical, chemical or solution processes.