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Rpts Soil

NEW DOC

Please provide an updated report, as this one is almost 20 years old

October 5, 2006

United Planning and Engineering
4575 Galley Road, Suite 200
Colorado Springs, CO 80915

Attention: Mr. Tom Keith

Subject: Preliminary Geology and Surface Soils Evaluation and
Sewage Disposal Evaluation
Silverado Ranch Subdivision
El Paso County, Colorado

Dear Mr. Keith:

The following presents a report giving the results of geologic, surface soils, and sewage disposal evaluations on the above referenced site. Information included in this report has been compiled from a visual field reconnaissance of the site, geologic research, interpretation of aerial photographs, and analysis. Personnel of Front Range Geotechnical, Inc. (Front Range) performed 16 percolation tests (with profile holes) on the site for evaluation of sewage disposal characteristics.

The existing acreage (320 acres) is to be divided in to 64 lots ranging in size from 2.5 to 3.9 acres each. The lots will be used for single-family residential purposes. Also planned are two tracts that will be used for storm water detention, and open space buffers and areas. It is proposed to use individual wells for water supply and individual sewage disposal systems to serve the needs of the subdivision.

A general site location map is provided as Figure 1. Geologic units and percolation test locations are shown on the enclosed Figure 2. The USDA Soils Conservation Service mapping units are shown on Figure 3. Figure 4 is a map showing the geographic features

(including wells) within the immediate area of the site.

SITE DESCRIPTION

Location and Previous Land Use

The subject site consists of 320 acres in the north one-half of Section 16, Township 15 South, Range 63 West, of the 6th Principal Meridian (Figure 1). The site is located in an area of farms, ranches and rangelands and is bounded on the west by Peyton Highway and on the north by Drennan Road. One old well is located in the northwest part of the site that apparently provided water for stock purposes. Another well is located near the south boundary of the site. The site has previously been used for grazing.

Topography and Drainage

Topography on the site consists of low rolling hills, gently sloping terrain, and contains two poorly drained (interior drainage) areas. Slopes range from about 1% to a maximum of about 5%. Site drainage is southerly in broad swales and to the poorly drained areas.

Vegetation

The vegetation consists of grasses, cactus and yucca. It does not appear that grazing has affected the site adversely.

GENERAL GEOLOGY

The bedrock underlying the surficial deposits in the area of the subdivision consists of the Cretaceous aged Laramie Formation. Regionally, this formation consists predominantly of a series of shale (claystone), siltstone, sandstone, with a few coal beds, and the rock beds now dip at very shallow angles northerly.

In relatively recent geologic time, the formerly exposed Laramie Formation has been repeatedly covered by alluvial deposits of sand and gravel (the Piney Creek Alluvium and Older Alluvium) as a part of the general basin in filling. Regionally, the Piney Creek and Older Alluvium consists of poorly sorted sand and gravel containing silt and clay lenses and layers locally. In the most recent geologic time, the site and surrounding region has

been overlain by eolian (windblown) sand. This windblown sand characteristically consists of fine to coarse sand and silt (with some clay locally) and has covered the entire site.

Groundwater was not observed in any of the percolation profile test holes on site (drilled to 10 feet). Regional mapping of the limits of the Upper Black Squirrel Creek Alluvial Aquifer indicates the site is not underlain by the Alluvial Aquifer. A 100 feet tape lowered in the old well casing located in the northwest part of the site did not encounter ground water to 100 feet.

The Soil Conservation Service indicates that four soil mapping series units are present on the subject site (see Figures 3 and 3a-3d). These soils are all described as deep and sandy.

GEOLOGIC HAZARDS AND GEOTECHNICAL CONSIDERATIONS

Summary

The subject site is relatively free from serious geologic hazards except as noted. The most significant hazard to the proposed subdivision is the potential for erosion.

Erosion

The site is subject to erosion potential involving both water and wind erosion. Due to the relatively unprotected position of the site on a wide and expansive plain, the potential for damaging wind erosion is apparent (if vegetation is removed). Wind erosion can be mitigated by the windbreaks, such as stands of trees, and by re-vegetating disturbed areas.

The site also possesses erosion potential if vegetation is removed and storm water is concentrated. No accelerated gully erosion was noted on the site; however, if the site is disturbed and erosion controls not implemented, this type of erosion could occur. The protection of property values will require that attention be given to erosion control. Excessive erosion can be minimized or prevented if a few precautions and mitigation measures are employed.

No land should be cleared or disturbed unnecessarily. Disturbed lands should be limited to those required for actual construction, and vehicle traffic is strongly discouraged except on constructed roadways. Site grading should be employed only where needed in the immediate vicinity of houses, driveways, roads, and other structures.

All disturbed lands should be re-vegetated, paved, or otherwise protected at the earliest opportunity. The assistance of agencies such as the Natural Resource Conservation Service may be obtained to determine appropriate seed mixes and re-vegetation techniques. Wind erosion can be controlled prior to the establishment of vegetation by frequent sprinkling of the disturbed ground; this will be particularly important during the high wind months (December to April).

Runoff waters - especially during the thunderstorm months of June, July, and August should not be permitted to flow across cleared areas, and runoff originating on cleared areas should be routed through a temporary sedimentation pond or the areas protected by other means (such as by silt fences).

Any gullies, which may form on the property, should be promptly stabilized by grading, revegetation, and the construction of small check-dams. Any ditches, either temporary or permanent, which may be required for drainage purposes should possess gentle side slopes, a low gradient, and should be provided with any check-dams, profile breaks, and sedimentation basins necessary to control flow velocity and retain sediment. If culverts are installed, they should be properly sized to carry the design flows without increasing the velocity of the flowing water.

Flooding and Surface Drainage

A minor hazard associated with the proposed subdivision is that of flooding. FEMA mapping indicates that there are no 100-year floodplains on the site (FIRM Panels 08041C0825 F and 08041C1025 F). Drainage improvements, site grading, and construction should be used to provide safe paths for site runoff.

Two poorly drained areas (areas with interior drainage) are located on the site. These areas are proposed to be the sites of detention ponds within the open space areas (see Figure 2).

Subsurface drainage

Certain minor problems involving subsurface drainage conditions may be encountered in the lower-lying parts of the site, especially in the area of the swales. Most subsurface drainage problems can be handled by the installation of adequate subsurface drain systems under and around affected buildings. The need for and required capacity of subsurface drains should be determined prior to foundation construction during the recommended on-site investigation.

Slope Stability

Stability problems on the property are limited to deeper excavations and cut slopes. The sandy soils found underlying the site generally lack cohesion and cannot be expected to stand at high angles for more than very short periods of time. Temporary excavations more than about four feet high should be adequately shored or laid back to an angle as established by OSHA Regulations. Permanent slopes should be laid back to an angle of no steeper than 3:1 (three horizontal to one vertical) or supported with a retaining structure.

Soil and Construction Factors

The windblown soils that blanket the site will have variable properties with regard to foundation conditions. The soils commonly possess a rather low density. It is likely that considerable settlement or hydrocompaction may take place in these soils if very heavily loaded structures are placed upon them. Due to the limited loads placed on soils by residential structures, this condition is not likely to constitute a major engineering problem. However, we recommend that the foundations of all structures founded upon these soils be properly designed for the soil conditions present at each building location. This can be easily accomplished by the performance of a site investigation by a qualified soils engineer prior to the construction of foundations. After the investigation, and any

required testing and analysis, the foundation can be designed to minimize problems due to settling and hydrocompaction.

The predominantly sandy soils should have little tendency for expansion. The soils may contain sulfate minerals in detrimental quantities.

Seismicity

A certain degree of seismic risk is associated with the Front Range belt of Colorado. The proposed subdivision lies about 20 miles east of the Ute Pass Fault. This fault is one of the major fault systems of the Front Range. Central and western Colorado are considered to possess a seismic risk equivalent to the Seismic Risk Zone 2, as defined in the Uniform Building Code. Wind loading may govern structural design, however.

Radiation

There are no known radioactive mineral deposits in the area of the proposed subdivision. Although there does not appear to be any unusual radiation hazard associated with this site, Colorado is generally classified as being in the 'high' range for radon gas. It is recommended that radon mitigation be incorporated in to the design of structures.

ECONOMIC GEOLOGY

The El Paso County Aggregate Resource Evaluation (Map 1, 1995) indicates that the eolian sands underlying the proposed subdivision have been classified as a potential source of sand and fine aggregate.

SEWAGE DISPOSAL EVALUATION

The evaluation is provided to address requirements of the El Paso County Code (Chapter V–Section 51.7) for geologic hazard, soil, and other conditions related to sewage disposal on lots between 2.5 and 5.0 acres. Front Range performed 16 percolation tests on the site. These test locations were based on the geologic conditions mapped by Himmelreich & Associates. Additionally we reviewed the Preliminary Plan as part of this evaluation.

The geologic characteristics/constraints on this site that will influence the location and design of individual treatment systems for sewage disposal are the percolation rates, and the poorly drained areas. Shallow bedrock, shallow ground water, and slope are not considered constraints on this site. If for some reason areas are found that are unacceptable for 'standard' soil absorption systems, alternate (engineered-designed) systems such as self contained systems, raised systems, or mounded systems could be used.

Percolation Testing

Front Range performed 16 percolation tests (25% of the 64 proposed systems) to evaluate subsurface conditions. Profile hole/percolation test locations are shown on Figure 2. Visual logs of the profile holes, percolation test results, and soil laboratory testing data can be found in Appendix A. The procedure for percolation testing for each location was to drill one four inch diameter profile hole to a depth of 10 feet, and to drill an adjacent hole to a depth of approximately 30 inches for percolation testing. Holes were drilled by a power driven auger drill rig. Visual logs of soil profiles were obtained from drill cuttings, and Standard Penetration Tests (ASTM D-1586) were performed to obtain samples and for visual examination. Selected samples were also tested in the laboratory (see Gradation Test Results with the Drill Logs, Appendix A).

The percolation test holes were filled with water and saturated prior to testing. The test procedure consisted of filling the hole with approximately six inches of water and measuring the drop in water level and corresponding time interval until the percolation rate stabilized. This type of percolation test is for the purpose of defining the overall general, but typical, percolation characteristics. **Site-specific tests (typically three-hole tests) must be made on each lot prior to construction of the individual sewage disposal systems.**

Percolation rates are controlled by soil characteristics that include grain size and gradation, amount of silt and clay, and density. Coarse, clean soils with little or no fine particles have fast percolation rates. Clayey sands, clays, silts and dense materials such as

bedrock commonly have slower percolation rates. The percolation rate measurements and the results of the profile holes are summarized on Table I. No bedrock or groundwater was encountered in any of the profile holes.

TABLE I

Percolation Test Number	Percolation Rate	Depth to Bedrock And Groundwater
P-1	13.3 minutes per inch	>10 feet
P-2	12.3 minutes per inch	>10 feet
P-3	10.0 minutes per inch	>10 feet
P-4	17.8 minutes per inch	>10 feet
P-5	13.3 minutes per inch	>10 feet
P-6	22.9 minutes per inch	>10 feet
P-7	16.0 minutes per inch	>10 feet
P-8	22.9 minutes per inch	>10 feet
P-9	11.4 minutes per inch	>10 feet
P-10	40.0 minutes per inch	>10 feet
P-11	20.0 minutes per inch	>10 feet
P-12	16.0 minutes per inch	>10 feet
P-13	26.7 minutes per inch	>10 feet
P-14	8.9 minutes per inch	>10 feet
P-15	17.8 minutes per inch	>10 feet
P-16	14.5 minutes per inch	>10 feet

All percolation rates are in the acceptable range and ranged from 8.9 to 40 minutes per inch. The subsurface materials encountered in the profile holes consisted of deep sandy soils.

Slopes

No slopes in excess of 30% are located on the site.

Regulations

The Health Department Regulations (Reference 1) indicate that certain conditions must be satisfied for installation of soil absorption systems without special design. These are:

- The minimum depth allowed by the El Paso County Health Department is about 24 inches from the ground surface to the bottom of a seepage bed or absorption trench. Bedrock or water tables must be at least four feet deeper. Therefore, bedrock or groundwater within approximately six feet of the surface constitutes

unacceptable conditions for a standard absorption system.

- Unless designed by a Registered Professional Engineer and approved by the Health Department, no soil absorption system is permitted where the ground slope is in excess of 30%.
- Colorado State and El Paso County Health Department Regulations indicate that percolation rates faster than five minutes per inch or slower than sixty minutes per inch are unacceptable for soil absorption systems without special design.

Site Conditions

Based upon the geologic characteristics and constraints as observed, profile holes, and experience, sewage disposal characteristics and limitations have been evaluated. These various areas are described below.

Area I: Area I consists of all areas of the site (except the poorly drained areas) and is characterized by thick surficial deposits (eolian soils) and acceptable percolation rates. It is felt that in almost all cases it will be possible to locate a 'standard' septic and soil absorption system in Area I, although local slow percolation rates may be encountered in these areas and thus will require some form of alternate system.

Area II: Area II consists of that portion of the site within the poorly drained areas. These areas must be avoided for placement of septic systems.

Evaluation

Preliminary Plan review was conducted to ensure each lot has an acceptable area for a house, well, and two areas (primary and 'replacement') for individual disposal systems utilizing soil absorption. The evaluation considered the lot size, location relative to identified constraints (poorly drained areas), and required setbacks from wells, occupied structures and other setback requirements as contained in the El Paso County Individual Sewage Disposal System Regulations.

It was assumed as part of this evaluation that each house would have a footprint of about 2,800 square feet (40'x70'), include 4 bedrooms (resulting in a discharge of about 600

gallons per day), and the percolation rate would be 40 minutes per inch (the slowest rate measured in the percolation tests performed on the site). Based on these assumptions, our calculations indicate an absorption area of about 1,821 square feet would be required. Using absorption trenches, this translates to about 5,000 square feet for each absorption area. Two areas or sites (primary and 'replacement') for soil absorption purposes were located on each lot, again considering the above assumptions, constraints and required setbacks.

Relationship to On-site Wells

An old well is located in the northwestern part of the site. A windmill likely once powered this well. The existing well should be sealed and abandoned. Individual wells are proposed for each new lot. We understand the new on-site wells will obtain water from the Laramie-Fox Hills Aquifer. Our experience indicates this bedrock aquifer is not recharged by surface or tributary water (like wastewater effluent). As long as adequate surface seals are provided during well design and construction to prevent surface water from impacting the bedrock aquifer, and required setbacks are maintained, it appears that the potential for sewage effluent to contaminate the bedrock aquifer is low. **It is critical that adequate surface seals are provided during well design and construction to prevent surface water and effluent from directly impacting the aquifer down the well bore/gravel pack.**

Relationship to Surrounding Areas

The site's relationship to surrounding areas is shown on Figures 1 and 4. No springs, seeps, or seasonally wet areas indicative of shallow groundwater were observed on the site. The poorly drained area in the northwest corner of the site contained ponded water. Rural ranches and low-density residential development are located north of the site. Streams, lakes and other features in the region of the site are shown on Figures 1 and 4.

On the lots, the closest proposed residence to adjacent properties will likely be a single family dwelling approximately 100 feet (or more) away. Several existing farmhouses or residences (and the Drennan School) are located within about 300 feet of the site. Potential soil absorption systems ('leach fields') across the Silverado Ranch subdivision

can (and should) be located no closer than 100 feet from proposed or existing wells and can maintain other required setbacks from proposed residences and other features (such as property lines) or existing residences. **Care should be taken during the house, well, and leach field location process so that required separation distances are maintained.**

Wastewater effluent will flow in the subsurface then off site in the subsurface soils. The individual sewage disposal systems constructed on the site will add wastewater effluent ('water') to the subsurface. This shallow subsurface water is considered to be 'surface water' and tributary to surface streams, and ultimately, possibly the Upper Black Squirrel Alluvial Aquifer that is located about one-half mile east of the site. The irrigation of landscaping and effluent from the individual sewage disposal systems will serve to recharge the alluvial aquifer. Seasonally wet areas (especially in the swales and poorly drained areas) might appear on and down gradient from the site.

The recharge (return flows) provided by the wastewater effluent is likely to impact the quality of the alluvial aquifer (such as by increased nitrates and phosphates) down gradient from the site. Since at least some of the down-gradient wells are likely alluvial wells, and the Upper Black Squirrel Alluvial Aquifer is utilized by individual domestic wells and for municipal water supplies, the matter of increased nitrates should be discussed further. If necessary, enhanced septic systems that will reduce nitrate concentrations can be installed at the subdivision. These enhanced systems are more costly than a standard system. Information on enhanced systems that reduce nitrate concentrations can be found in Reference 2. Other potential sources of nitrates within the region include natural sources, animal manure applied to croplands as fertilizer, commercial fertilizers, manure in dairies, and effluent from sewage treatment plants and septic systems.

It should be noted that subdivisions (2.5 to 5 acre lots with individual sewage disposal systems) within the Upper Black Squirrel Creek Designated Ground Water Basin have been approved by El Paso County within recent years.

Availability of a Central System

Our research indicates the proposed subdivision is not within one (1) mile of a central sewage system.

Discussion

At the time of house and well placement on each individual lot, it is extremely important that the engineers designing the site plans and performing the percolation tests properly identifies all the geologic/soil related and other design factors that influence the location and type of sewage disposal system. It is a combination of factors that determines the location and general type of individual sewage disposal system best suited for the site. It is also the responsibility of the engineer performing the percolation testing to evaluate soil properties and continuity of the materials for the total depth of the profile hole (and with in the area of the proposed system).

Sewage Disposal Conclusions

We believe all the lots within the proposed development are suitable for installation of some type of on-site wastewater disposal system utilizing soil absorption. **Strategic placement of the house and well locations will be necessary so that required setbacks are maintained and adequate area is made available for the primary and 'replacement' soil absorption areas.**

Based upon our experience in the area, it is our opinion that the Silverado Ranch property is similar to and typical of many developed subdivision regions in the area. The task of the engineers and builders in the region has become one of matching the disposal process and approved systems with prevalent field conditions and site constraints. With knowledgeable builders, proper site planning (house, well, and septic site placement), proper testing techniques, it is believed that on all lots two disposal fields can be located and will be able to utilize soil absorption type systems for individual sewage disposal in this subdivision. In all cases methods are available for an individual sewage disposal system on each and every lot in the subdivision.

If necessary, enhanced septic systems that will reduce nitrate concentrations can be installed at the subdivision. These enhanced systems are more costly to construct, operate, and maintain than a standard individual sewage disposal system. Buyers and builders should familiarize themselves with the information on enhanced systems contained in Reference 2.

Potential buyers and builders of lots within the subdivision should be provided with a copy of this report so that they can be apprised of site conditions, constraints and recommendations.

LIMITATIONS

The opinions presented in this report were developed from review of aerial photographs, topographic and geologic maps, site reconnaissance, research of published and unpublished information, evaluation of profile holes, percolation tests, laboratory test data, and our experience. Should additional surface or subsurface data become available, the conclusions and recommendations contained in this report shall not be considered valid unless the data are reviewed and the conclusions of this report are modified or approved in writing. If you have questions or require additional information, please contact us.

Respectfully,

FRONT RANGE GEOTECHNICAL, INC.

DRAFT

Jeff Houchin
Geologist

Michael F. Reynolds, P.E.

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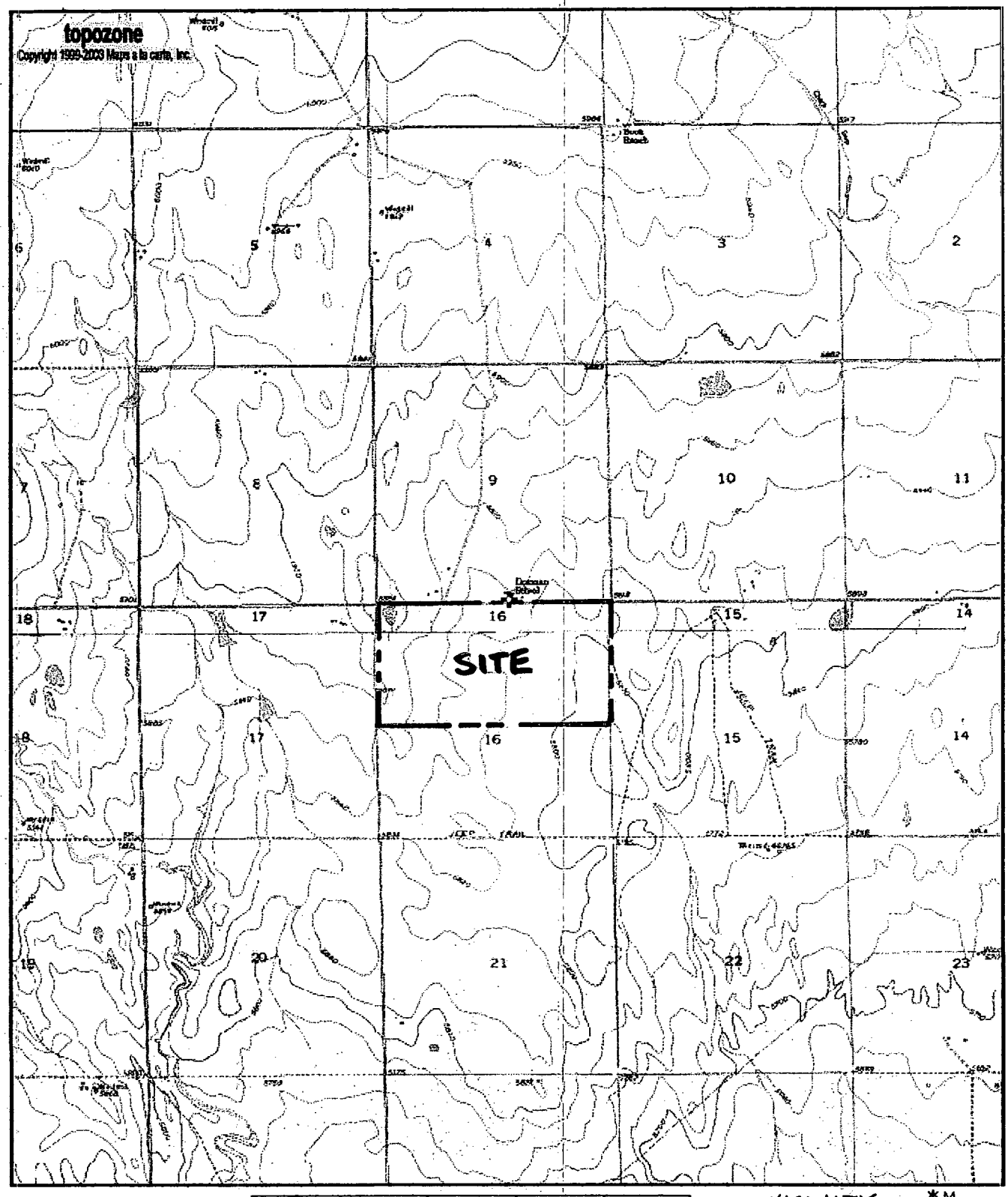
Engineering Geologist

SELECTED REFERENCES

1. El Paso County, Colorado (4-28-04). "Individual Sewage Disposal System (ISDS) Regulations."
2. Washington State Department of Health (June 2005). "Nitrogen Reducing Technologies for Onsite Wastewater Treatment Systems."
3. Brendle, Daniel (1997). "Have Nitrate Concentrations Changed in Water in the Alluvial Aquifer of the Upper Black Squirrel Creek Basin Since 1984?" USGS Fact Sheet FS-072-97.
4. Cochran, D. M. (1977). "El Paso County, Colorado: Potential Geologic Hazards and Surficial Deposits, Environmental and Engineering Geologic Maps and Tables for Land Use". Charles S. Robinson & Associates, Inc.
5. United States Department of Agriculture, Soil Conservation Service (1981). "Soil Survey of El Paso County, Colorado".
6. El Paso County Planning Department (October 1995). "El Paso County Aggregate Resource Evaluation, Map 1".
7. Scott, G. R., Taylor, R. B., Epis, R. C. and Wobus, R. A. (1978). "Geologic Map of the Pueblo 1x2 Quadrangle, South-central Colorado." U. S. Geological Survey Miscellaneous Investigation Series, Map I-1022.

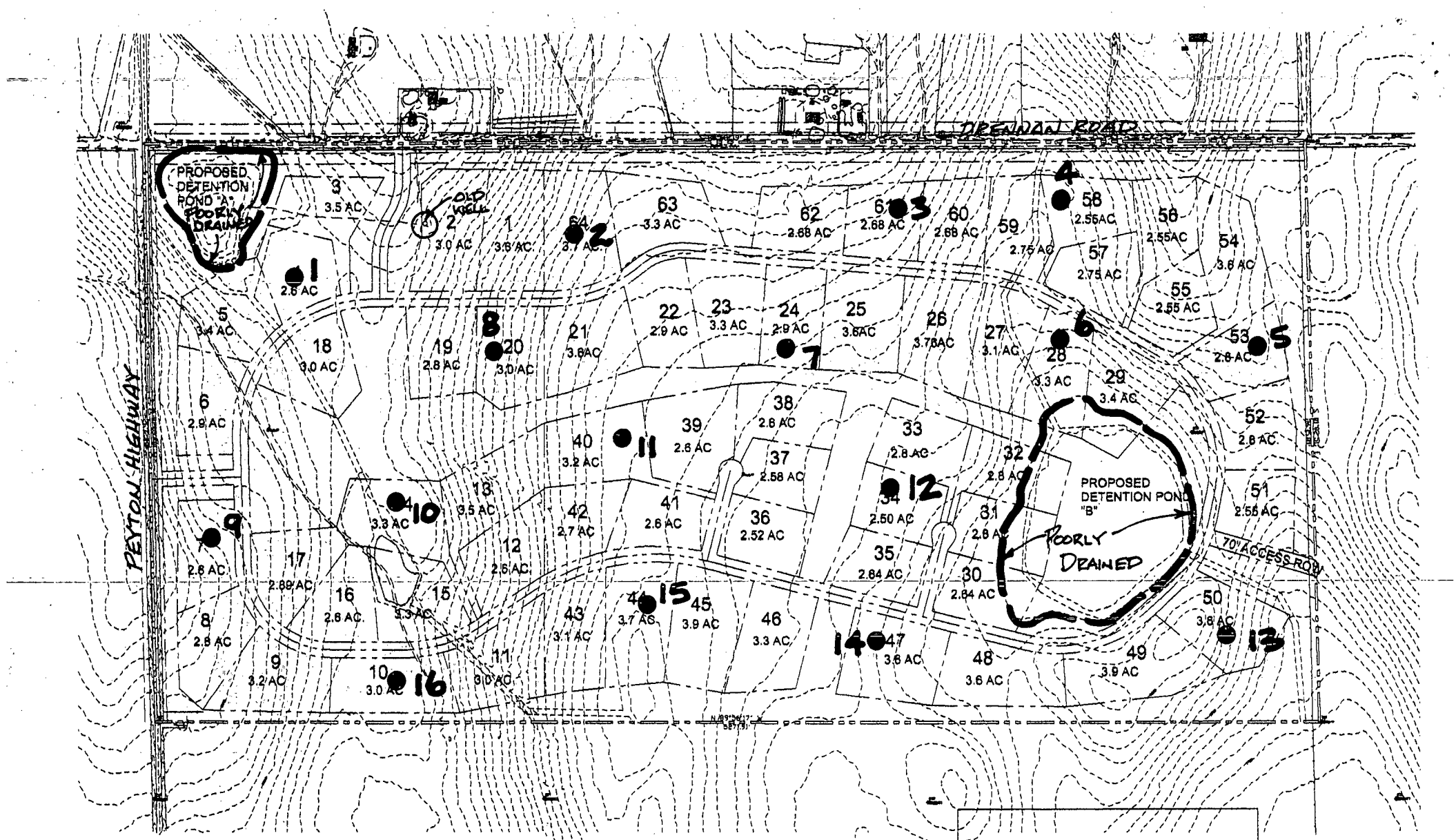


UTM 13 547889E 4289186N (NAD27)

Drennan School, USGS Ellicott (CO) Quadrangle

Projection is UTM Zone 13 NAD83 Datum

FIGURE 1

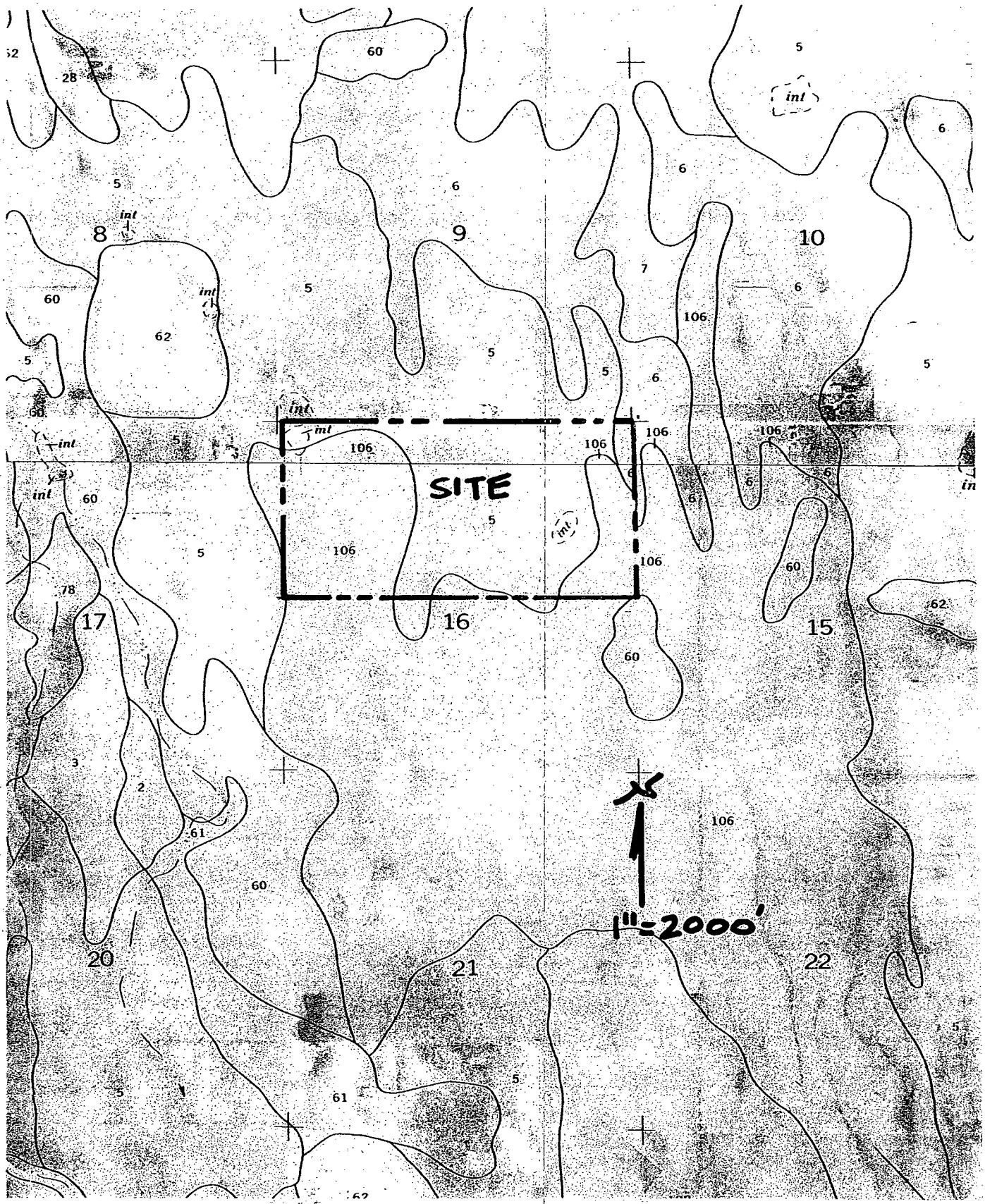


NOTE: ENTIRE SITE UNDERLAIN BY EOLIAN SAND

● - APPROX. LOCATION OF PERCOLATION TEST

PRELIMINARY GEOLOGIC MAP

FIGURE 2



SCS SOILS MAP

FIGURE 3

5—Bijou loamy sand, 1 to 8 percent slopes. This deep, somewhat excessively drained soil is on flood plains, terraces, and uplands. It formed in sandy alluvium and eolian material derived from arkose deposits. Elevation ranges from 5,400 to 6,200 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown loamy sand 8 inches thick. The subsoil is grayish brown sandy loam about 20 inches thick. The substratum is pale brown loamy coarse sand.

Included with this soil in mapping are small areas of Olney sandy loam, 3 to 5 percent slopes; Valent sand, 1 to 9 percent slopes; Vona sandy loam, 3 to 9 percent slopes, and Wigton loamy sand, 1 to 8 percent slopes.

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

Most areas of this soil are used for range. A small acreage is used for crops grown under sprinkler irrigation.

This soil is not suited to dryfarming, because of the soil blowing hazard. Corn, pasture, and alfalfa are the principal crops grown under irrigation. Corn and pasture require moderate to heavy applications of nitrogen. Alfalfa generally responds to phosphate fertilizer. Some zinc deficiency has been noted on corn. Crop residue management must be used at all times to control soil blowing. Crops that produce little or no residue are not suited to this soil.

Native vegetation is mainly sandreed, sand bluestem, blue grama, and needleandthread. Sand sagebrush makes up only a small part of the total ground cover.

In overgrazed areas mechanical and chemical sagebrush control may be needed. This soil is highly susceptible to soil blowing, and water erosion occurs when the plant cover is inadequate. Interseeding should be used in overgrazed areas. Proper location of livestock watering facilities helps to control grazing.

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

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

This soil has good potential for homesites. Shallow excavation is severely limited because cut banks cave in. This soil requires special management practices to reduce water erosion and soil blowing because it is sandy. Capability subclasses VIe, nonirrigated, and IVe, irrigated.

FIGURE 3a

6—Bijou sandy loam, 1 to 3 percent slopes. This deep, well drained soil is on flood plains, terraces, and uplands. It formed in sandy alluvium and in eolian material derived from arkose deposits. Elevation ranges from 5,400 to 6,200 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown sandy loam about 4 inches thick. The subsoil is brown or grayish brown sandy loam about 24 inches thick. The substratum is pale brown loamy coarse sand.

Included with this soil in mapping are small areas of Olney sandy loam, 0 to 3 percent slopes; Vona sandy loam, 1 to 3 percent slopes; and Wigton loamy sand, 1 to 8 percent slopes.

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

Most areas of this soil are used for range, but some areas are used for dryland or irrigated farming.

Corn, sorghum, and wheat are the principal nonirrigated crops. Corn, alfalfa, and pasture are the main crops grown under irrigation. Irrigated crops respond to phosphate and nitrogen fertilizer. Dryfarmed corn and sorghum generally respond to nitrogen fertilizer. Management of crop residue is necessary to control soil blowing. Stripcropping helps to control soil blowing. Sprinkler irrigation is the most suitable and widely practiced method of applying water.

Native vegetation is dominantly blue grama, sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is advisable if the range has deteriorated. Seeding the native grasses is a good practice. If the range is severely eroded and blowouts have developed, the new seeding should be fertilized.

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

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, the provision of undisturbed nesting cover is vital and should be included in plans for habitat development. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for use as homesites. Shallow excavation is severely limited because cut banks cave in. This sandy soil requires special management practices to reduce water erosion and soil blowing. Capability subclasses IIIe, irrigated, and IVe, nonirrigated.

FIGURE 3b

60—Olney sandy loam, 0 to 3 percent slopes. This deep, well drained soil formed in calcareous sandy sediment on uplands. Elevation ranges from 5,200 to 6,000 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is grayish brown sandy loam about 6 inches thick. The subsoil, about 21 inches thick, is brown sandy clay loam in the upper 7 inches and pale brown sandy clay loam grading to sandy loam in the lower 14 inches. The substratum to a depth of 60 inches is very pale brown sandy loam that grades to loamy sand. The lower part of the subsoil and the substratum have visible lime in the form of soft masses and seams.

Included with this soil in mapping are small areas of Olney and Vona soils, eroded; Vona sandy loam, 1 to 3 percent slopes; and soils that are similar to this Olney soil in the upper 40 inches but that are very dark brown and loamy below a depth of 40 inches. Also included are several wet-weather lakes, usually less than 2 acres in size.

Permeability of this Olney soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow. The hazard of erosion generally is moderate, but it is high where this soil is under dryland cultivation.

This soil is used for nonirrigated crops and for range. Sorghum, sudangrass, and millet grown for forage and hay are the main crops. Pinto beans and grain sorghums are also grown. All of these crops except pinto beans respond to nitrogen fertilizer. This soil is very susceptible to soil blowing. Use of crop residue, stripcropping, and emergency tillage helps to control soil blowing.

This soil is suited to the production of native vegetation suitable for grazing. The native vegetation is mainly blue grama, which has a typical bunchgrass growth form and makes up one-third to one-half of the cover. Other species are sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is a suitable practice if the range has deteriorated. Seeding of native grasses is a good practice. If the range is severely eroded and blowouts have developed, fertilizing the new seeding is a good practice. Brush control may be needed, and grazing management may help to improve the depleted range. Grazing should be managed so that enough forage is left standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

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

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by providing nesting areas and escape cover. For pheasant, undisturbed nesting cover is vital and should be provided for in plans for habitat development, especially in areas of intensive farming. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations for urban development on this soil are the frost-action potential, the shrink-swell potential of the subsoil, and the hazard of soil blowing. Roads, streets, and buildings need to be designed to minimize the effects of the shrink-swell potential and frost-heave damage. Erosion control practices are needed to reduce soil blowing when the soil surface is bare during construction. Capability subclass IVe.

FIGURE 3C

106—Wigton loamy sand, 1 to 8 percent slopes. This deep, excessively drained soil formed in noncalcareous, sandy eolian material on dunelike uplands. Elevation ranges from 5,300 to 6,000 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown loamy sand about 8 inches thick. The next layer is brown loamy sand about 11 inches thick. The underlying material is very pale brown sand to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Bijou loamy sand, 1 to 8 percent slopes; Bijou sandy loam, 1 to 3 percent slopes; Bijou sandy loam, 3 to 8 percent slopes; and Valent sand, 1 to 9 percent slopes.

Permeability of this Wigton soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Surface runoff is low, the hazard of erosion is moderate to high, and the hazard of soil blowing is high.

This soil is used mostly as rangeland.

If sprinkler irrigation is used, this soil is suited to limited use as cropland and pasture if crop residue is maintained on the surface. Only a very small acreage of this soil is cultivated, and it is used for alfalfa and grasses that are harvested for hay or are grazed by livestock. Nitrogen and phosphorus fertilizer is required for satisfactory yields. The soil is unsuited to nonirrigated crops.

Rangeland vegetation on this soil is mainly sand reedgrass, and bluestem, and needleandthread. Sand sagebrush is present in the stand, but it makes up only a small part of the total ground cover.

Mechanical and chemical methods of sagebrush control may be needed in overgrazed areas. This soil is highly susceptible to soil blowing, and it is subject to water erosion when the plant cover is inadequate. Interseeding is needed in overgrazed areas. Properly locating livestock watering facilities helps to control grazing.

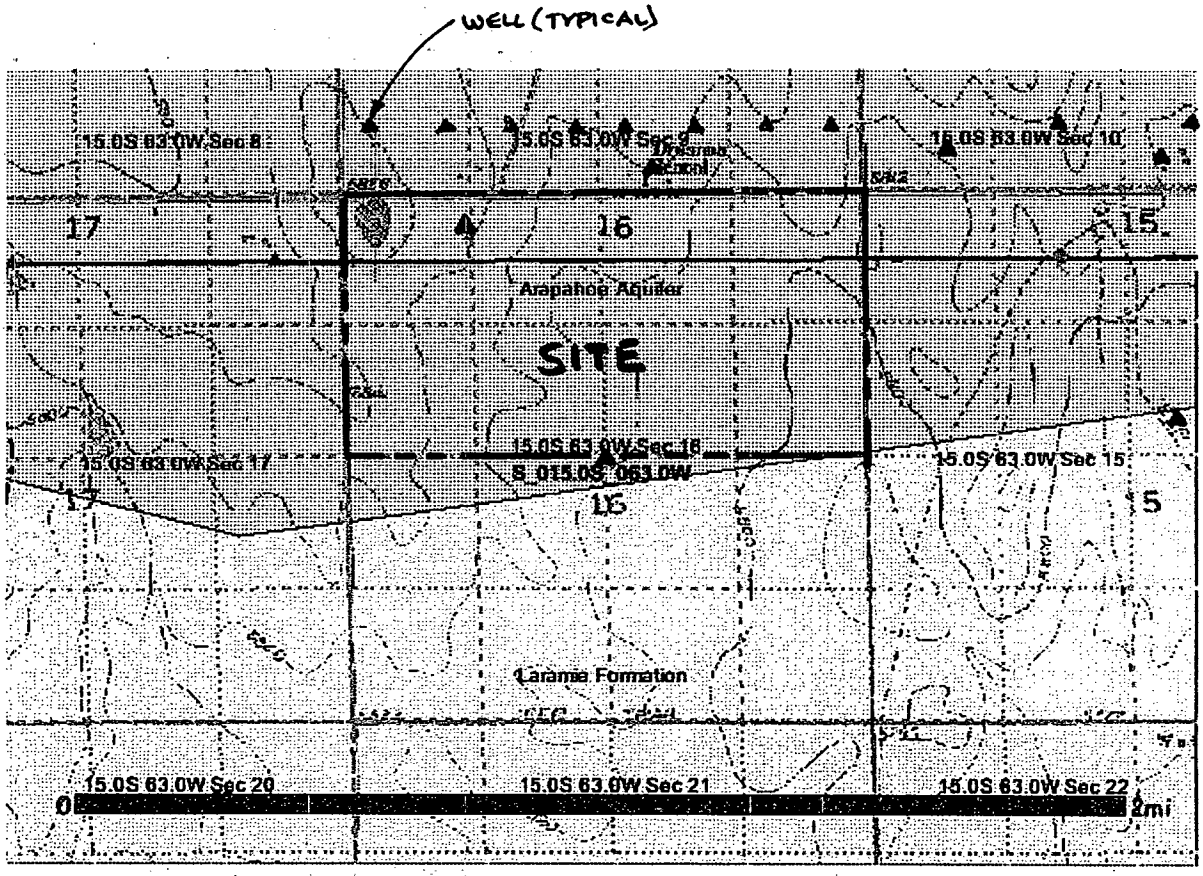
Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the main limitations for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between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

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

The main limitations of this soil for homesites are unstable cut banks during excavation and the hazard of soil blowing. Trenches for pipelines and shallow excavations must be made in such a way that cut banks remain stable, thus providing proper protection for workmen. Special practices must be used to control soil blowing. Only small areas of this soil should be disturbed at a time during construction in order to leave as much vegetation on the surface as possible. Capability subclasses VIe, nonirrigated, and IVe, irrigated.

FIGURE 3d

Colorado Division of Water Resources



WELL MAP FIGURE 4

APPENDIX A

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-1

DATE: 08-24-06

0"-4" SANDY LOAM

4"-10' SAND

fine-medium grained

low density

low moisture content

low clay content

non-plastic

buff color

Perc rate: 1" in 13.3 minutes

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2			10/12"	4.7	SM
4					
6					
8					
10					
12					
14					
16					
18					
20					

JOB#: 15365

TEST BORING NO.: P-2

DATE: 08-24-06

0"-6" SANDY LOAM

6"-10' SAND

fine grained

low density

low-mod moisture content

low clay content

low plasticity slight inc. w/depth

light-brown color becomes buff @ 7'

Perc rate: 1" in 12.3 minutes

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2					
4					
6					
8					
10					
12					
14					
16					
18					
20					

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-3

DATE: 08-24-06

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE

0"-6" SANDY LOAM

6"-10' SAND

fine grained

low density

low-mod moisture content

low clay content

low plasticity
slight inc. w/depth

light-brown color
becomes buff @ 7'

Perc rate:
1" in 10 minutes

JOB#: 15365

TEST BORING NO.: P-4

DATE: 08-24-06

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
			7/12"	8.5	SC

0"-4" SANDY LOAM

4"-9' SAND

fine grained

low density

moderate moisture content

moderate clay content

moderate plasticity

brown color

9'-12' SAND

fine grained

low-mod density

moderate moisture content

low-mod clay content

low-mod plasticity

buff color
weakly oxidized

Perc rate:
1" in 17.8 minutes

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-5

DATE: 08-24-06

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
0"-4" SANDY LOAM 4"-6' SAND fine grained low density low-mod moisture content low clay content low plasticity light-brown color 6'-12' SAND fine-medium grained low-mod density low-mod moisture content low clay content low plasticity buff color					

Perc rate: 1" in 13.3 minutes

JOB#: 15365

TEST BORING NO.: P-6

DATE: 08-24-06

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
0"-3" SANDY LOAM 3"-3.5' SAND fine grained low density low moisture content low clay content low plasticity brown color 3.5'-10' SAND fine-medium grained low-mod density low-mod moisture content moderate clay content moderate plasticity buff color					

Perc rate: 1" in 22.9 minutes

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-7

DATE: 08-24-06

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
0"-4" SANDY LOAM					
4"-3' SAND					
fine grained					
low density					
low moisture content					
low clay content					
low plasticity					
brown color					
3'-10' SAND					
fine-medium grained					
low density					
low moisture content					
low clay content					
low plasticity					
buff color					

Perc rate: 1" in 16 minutes

JOB#: 15365

TEST BORING NO.: P-8

DATE: 08-24-06

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
0"-4" SANDY LOAM					
4"-3' SAND					
fine grained					
low density					
low moisture content					
low clay content					
low plasticity					
brown color					
3'-10' SAND					
fine-medium grained					
low density					
low moisture content					
low clay content					
low plasticity					
buff color					

Perc rate: 1" in 22.9 minutes

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-9

DATE: 08-24-06

0"-6" SANDY LOAM

6"-10' SAND

fine-medium grained

low density

low moisture content

low clay content

low plasticity

buff color

Perc rate: 1" in 11.4 minutes

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2					
4					
6					
8					
10					
12					
14					
16					
18					
20					

JOB#: 15365

TEST BORING NO.: P-10

DATE: 08-24-06

0"-6" SANDY LOAM

6"-11' SAND

fine-coarse grained

low density

low moisture content

low clay content

non-plastic

tan color becomes buff @ 8'

Perc rate: 1" in 40 minutes

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2					
4			9/12"	4.2	SM
6					
8					
10					
12					
14					
16					
18					
20					

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-11

DATE: 08-24-06

0"-6" SANDY LOAM

6"-8' SAND

fine-medium grained

low density

low moisture content

low clay content

low plasticity

brown color

8'-12' SAND

fine grained

low density

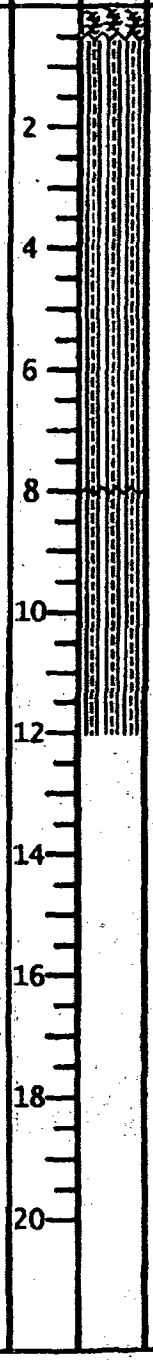
low moisture content

low clay content

low plasticity

buff color

Perc rate:
1" in 20 minutes



JOB#: 15365

TEST BORING NO.: P-12

DATE: 08-24-06

0"-6" SANDY LOAM

6"-11' SAND

fine grained

low density

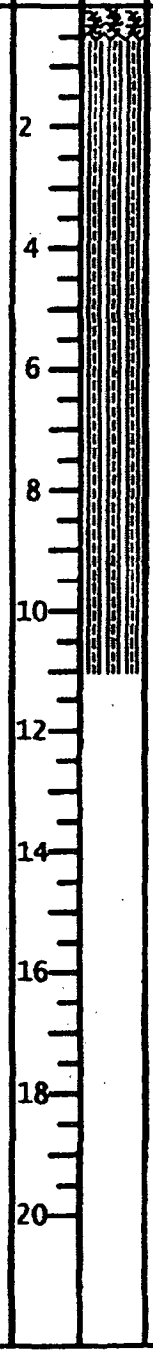
low-mod moisture content
increases w/depth

low clay content

low plasticity

brown color
becomes buff @ 6'
becomes brown @ 8'
weakly oxidized @ 8'

Perc rate:
1" in 16 minutes



FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-13

DATE: 08-24-06

0"-4" SANDY LOAM

4"-12' SAND

fine grained

low-moderate density

low-mod moisture content

low clay content

non-plastic

tan color

Perc rate:
1" in 26.7 minutes

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2					
4			12/12"	4.0	SM
6					
8					
10					
12					
14					
16					
18					
20					

JOB#: 15365

TEST BORING NO.: P-14

DATE: 08-24-06

0"-4" SANDY LOAM

4"-11' SAND

fine grained

low density

low-mod moisture content

low clay content

low plasticity

tan color
oxidized @ 3'

Perc rate:
1" in 8.9 minutes

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2					
4					
6					
8					
10					
12					
14					
16					
18					
20					

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-15

DATE: 08-24-06

0"-4" SANDY LOAM

4"-9' SAND

fine grained

low density

moderate moisture content

moderate clay content

moderate plasticity

light-brown color

9'-10' SAND

fine grained

low density

low moisture content

low clay content

low plasticity

buff color

Perc rate: 1" in 17.8 minutes

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2					
4					
6					
8					
10					
12					
14					
16					
18					
20					

JOB#: 15365

TEST BORING NO.: P-16

DATE: 08-24-06

0"-4" SANDY LOAM

4"-7' SAND

fine grained

moderate density

low moisture content

low clay content

non-plastic

tan color

7'-12' SAND

fine-medium grained

moderate density

low moisture content

low clay content

low plasticity

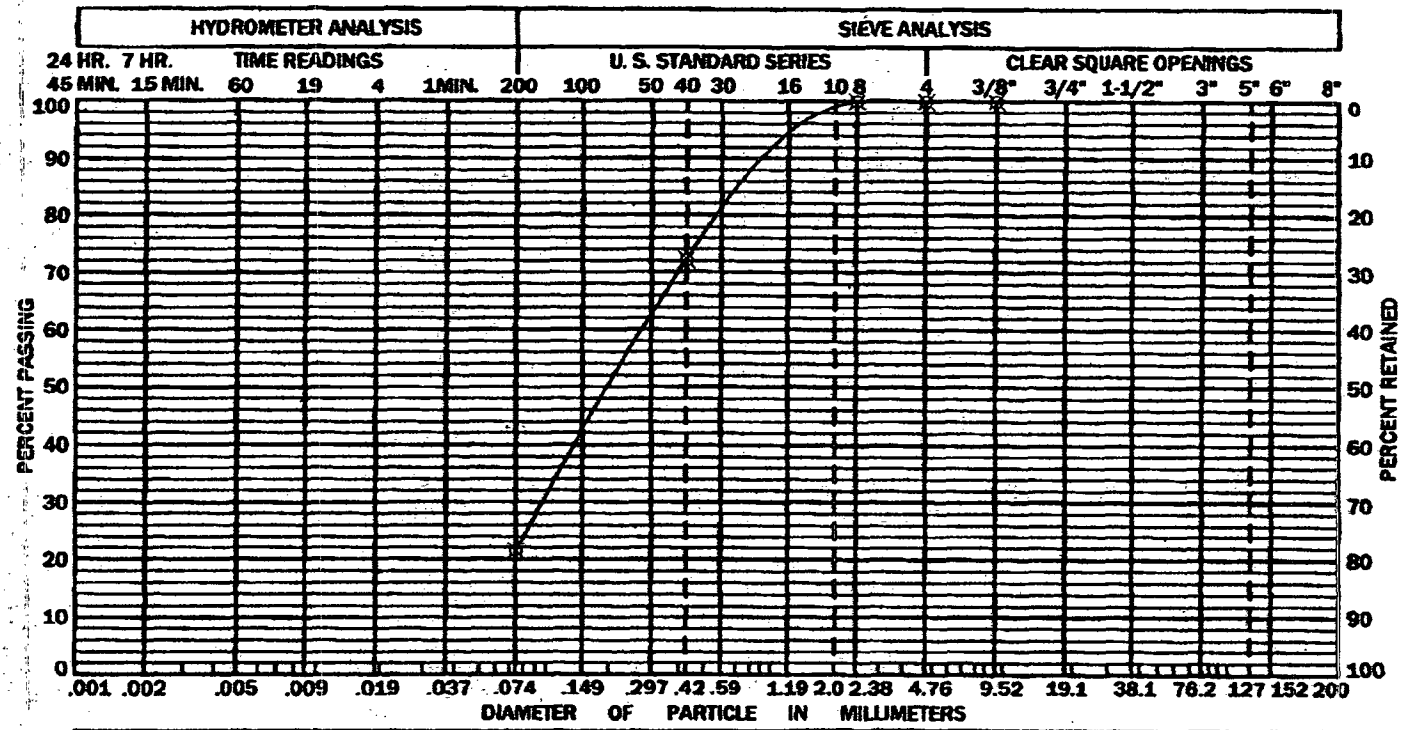
buff color

Perc rate: 1" in 14.5 minutes

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2					
4			12/12"	3.2	SM
6					
8					
10					
12					
14					
16					
18					
20					

FRONT RANGE GEOTECHNICAL INC.

GRADATION TEST RESULTS



CLAY TO SILT	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	

CLASSIFICATION SM

GRAVEL 0.0 %

SAND 78.5 %

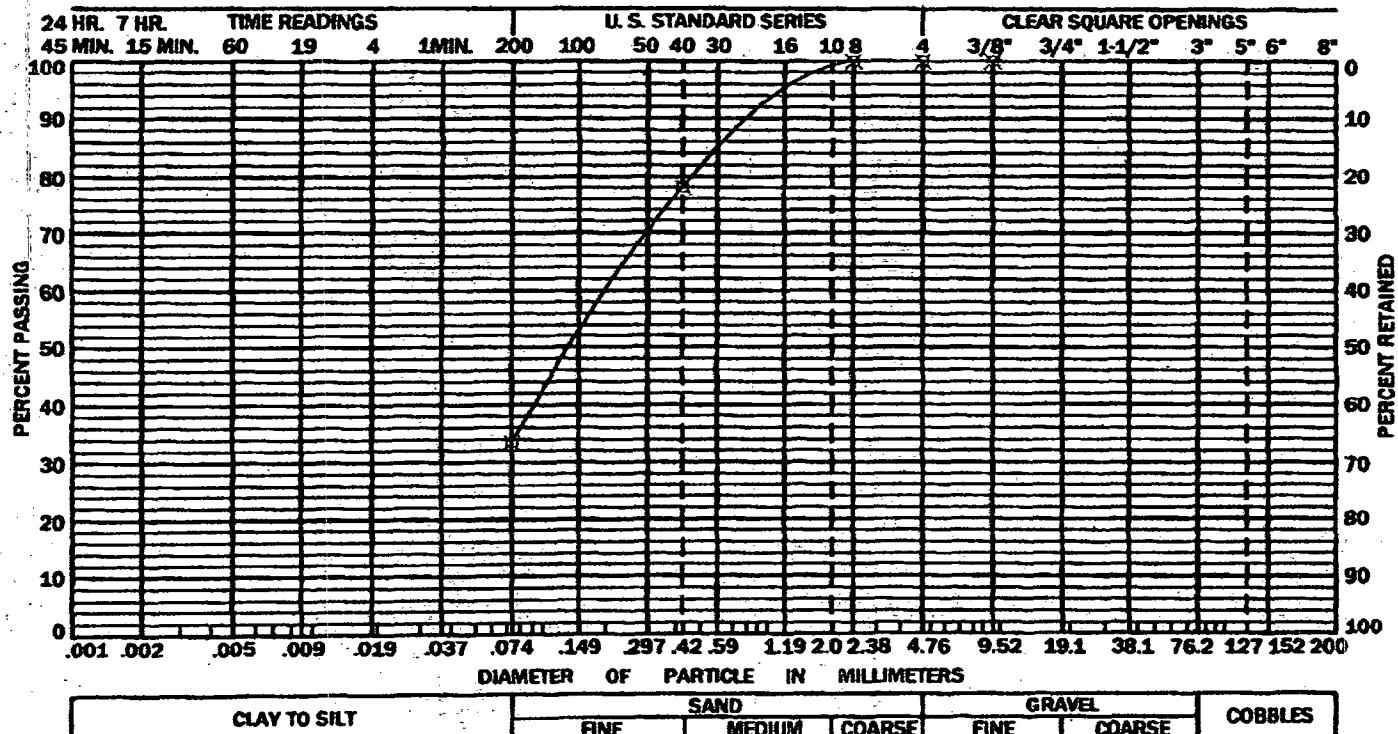
FINES 21.5 %

SAMPLE# 1 HOLE# P-1 DEPTH 3 FEET

NOTES: 4.7 % Moisture content

LL = could not be determined

PL = non-plastic



CLAY TO SILT	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	

CLASSIFICATION SC

GRAVEL 0.0 %

SAND 66.6 %

FINES 33.4 %

SAMPLE# 1 HOLE# P-4 DEPTH 3 FEET

NOTES: 8.5 % Moisture content

LL = 23.1 %

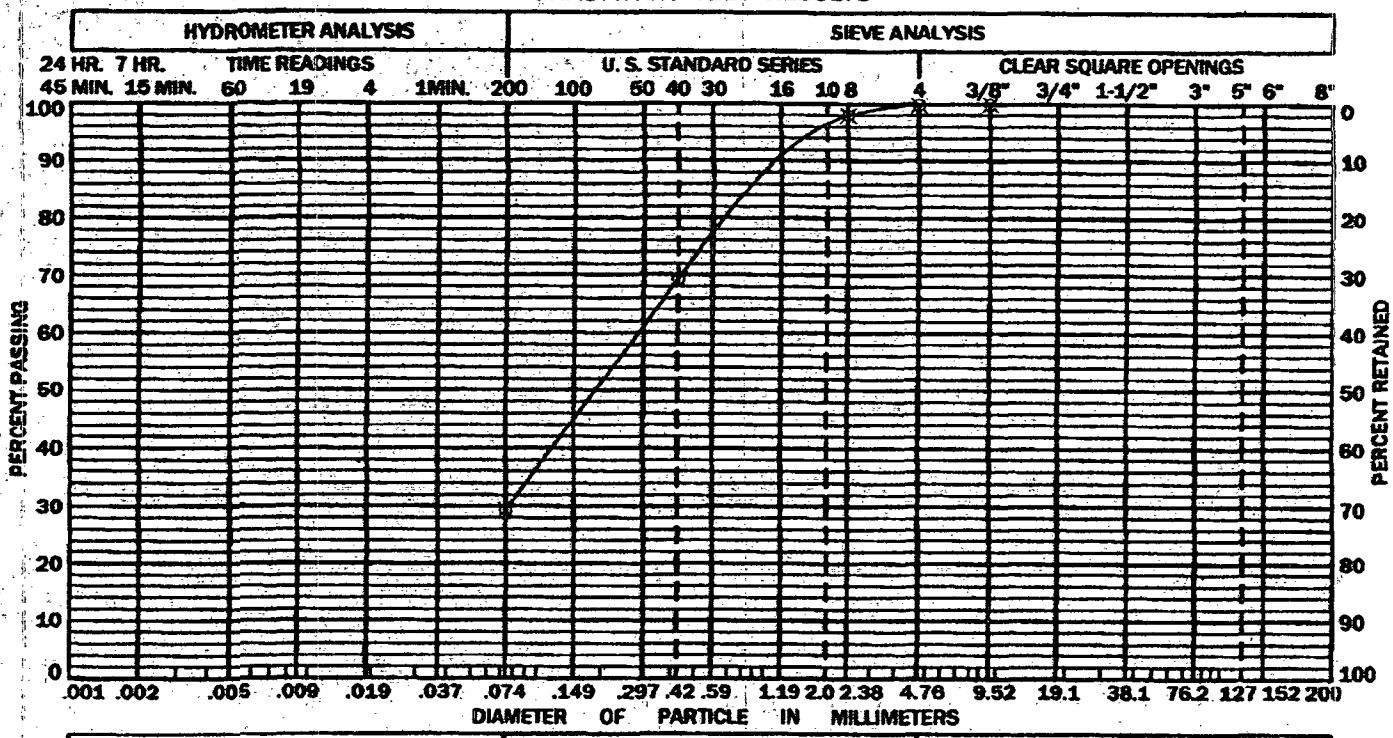
PL = 15.7 %

PI = 7.4 %

Job: #15365 By: BY 08/25/2006

FRONT RANGE GEOTECHNICAL INC.

GRADATION TEST RESULTS



CLAY TO SILT	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	

CLASSIFICATION SM

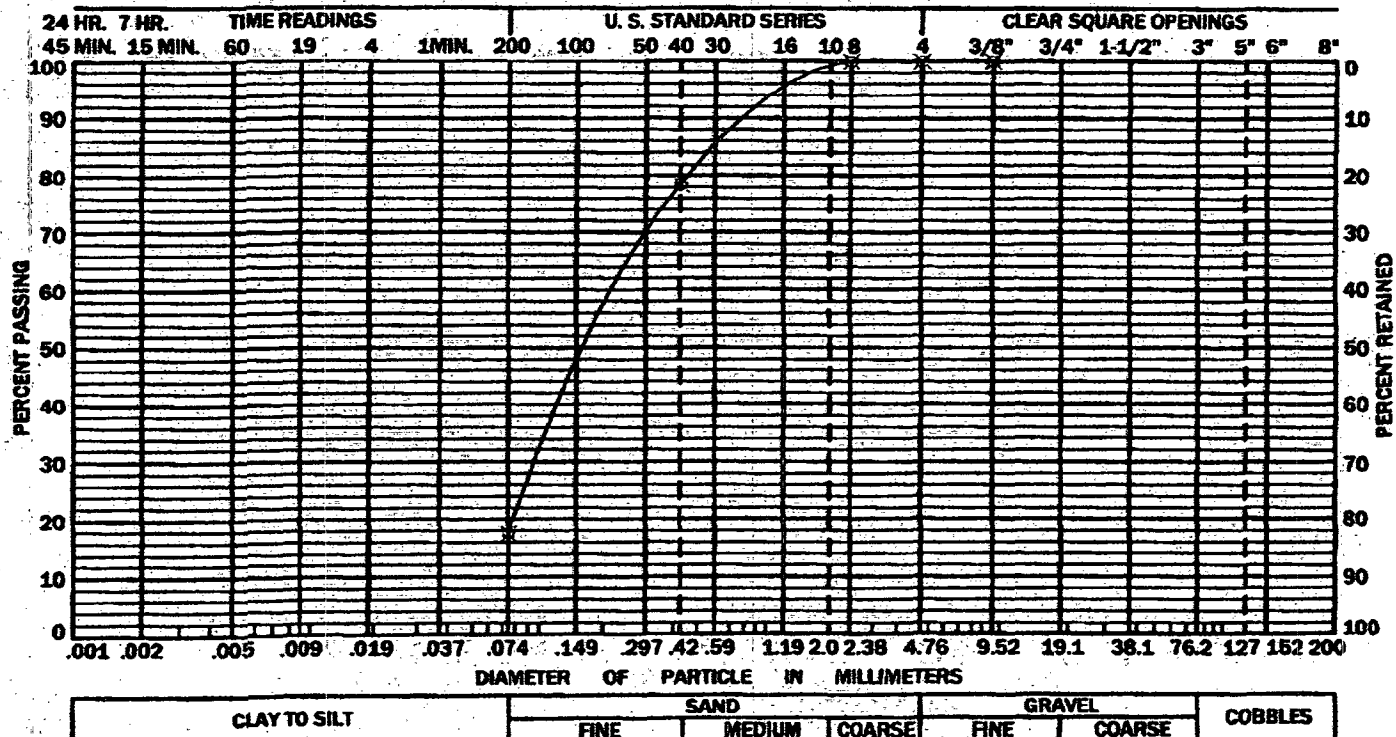
GRAVEL 0.1 %

SAND 70.6 %

FINES 29.3 %

SAMPLE# 1 HOLE# P-10 DEPTH 4 FEET

NOTES: 4.2 % Moisture content
LL = could not be determined
PL = non-plastic



CLAY TO SILT	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	

CLASSIFICATION SM

GRAVEL 0.0 %

SAND 82.5 %

FINES 17.5 %

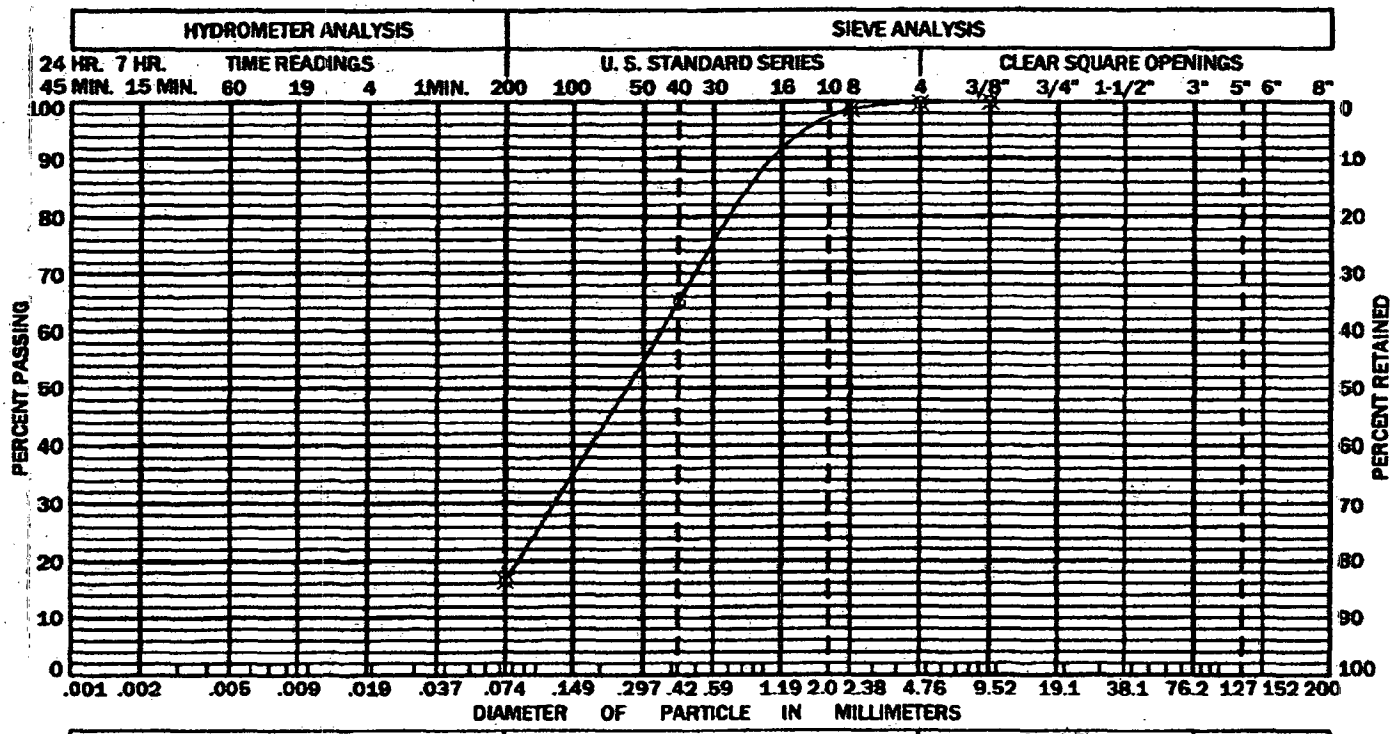
SAMPLE# 1 HOLE# P-13 DEPTH 3 FEET

NOTES: 4.0 % Moisture content
LL = could not be determined
PL = non-plastic

Job: #15365 By: BY 08/25/2006

FRONT RANGE GEOTECHNICAL INC.

GRADATION TEST RESULTS



CLAY TO SILT	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	

CLASSIFICATION SM

GRAVEL 0.2 %

SAND 83.4 %

FINES 16.4 %

SAMPLE# 1 HOLE# P-16 DEPTH 3 FEET

NOTES: 3.2 % Moisture Content

LL = could not be determined

PL = non-plastic

Job: #15365 By: BY 08/25/2006