SOIL SURVEY OF

Union County, New Mexico

United States Department of Agriculture
Soil Conservation Service and Forest Service
in cooperation with
New Mexico Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1956–71. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. This survey was made cooperatively by the Soil Conservation Service, Forest Service, and the New Mexico Agricultural Experiment Station. It is part of the technical assistance furnished to the Northeastern and Ute Creek Natural Resource Conservation Districts.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming and industry.

Locating Soils

All the soils of Union County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by a symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information about the survey. This guide lists all the soils of the county in alphabetic order by map symbol. It shows the page where each soil is described and also gives the capability classification, range site, or any other group in which the soil has been placed.

The classification of some soils in adjoining counties is different from the classification of the soils that they join in Union County, because such characteristics as soil temperature and soil moisture regime change gradually over a distance of many miles. The exact place in the landscape that the characteristics change is difficult to pinpoint. Thus, if this publication is used along with a published soil survey from an adjoining area, the soils may have different names even though they appear to be the same.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and the range sites.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Suitability of the Soils for Wildlife Habitat."

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Union County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the County."

Cover: Rabbit Ear Mountain, local landmark in Union County, New Mexico.

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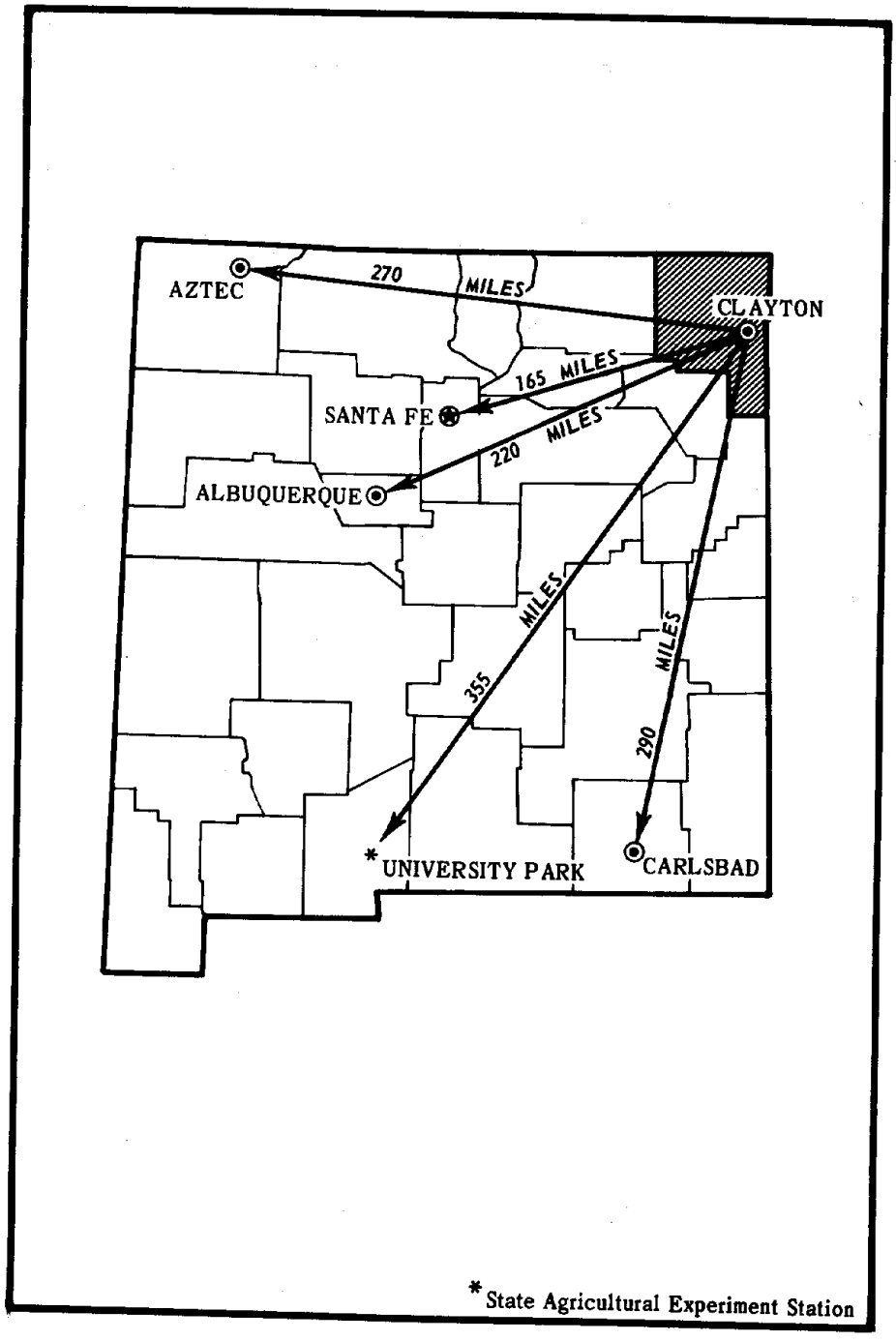

Location of Union County in New Mexico.

SOIL SURVEY OF UNION COUNTY, NEW MEXICO

By Harold B. Maxwell, Steven P. Shade, Hayden D. Rounsaville, and Abe Stevenson, Soil Conservation Service[1]

United States Department of Agriculture, Soil Conservation Service, and Forest Service, in cooperation with New Mexico Agricultural Experiment Station

UNION COUNTY is in the extreme northeastern corner of New Mexico (see facing page.) The land area of the county is 2,442,880 acres, or about 3,817 square miles. Clayton, the county seat, is in the east-central part of the county. The Cimarron River runs west to east across the north end of the county. Many local residents refer to it as the Dry Cimarron River. Other drainage outlets include Ute and Tramperos Creeks to the south.

About 95 percent of the county is used for grassland. Ranching is the main enterprise, and beef cattle is the dominant livestock (*5*).[2] A very few herds of sheep are in the county. Most ranches have a few horses that are used primarily for herding cattle.

About 3.5 percent of the county is used for nonirrigated cropland, and about 1.5 percent is used for irrigated cropland. Most of the cultivated areas are in the eastern part of the county. Most of the water for irrigating is obtained from wells and is applied by sprinklers. The principal crops are grain sorghum, alfalfa hay, corn, and corn silage.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Union County, where they are located, and how they can be used. A detailed investigation of the soils was made over a long period. Existing information was reviewed, field data were collected, detailed observations of the results obtained by farmers and others who work with the soil were made, and characteristics of its soils were interpreted for alternate uses. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in this survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Dallam and Gruver, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Dallam loamy sand, 0 to 5 percent slopes, is one of the phases within the Dallam series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

A mapping unit consists of all those areas shown on a soil map that are identified by the same symbol. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that are within an area that is dominantly a soil of a recognized phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Union County: soil complexes and soil associations.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more

[1] Part of the fieldwork was done by F. DAVID BARTLETT, PAUL N. MILLER, R. EUGENE ROCKEY, PAUL SHIELDS, MAX V. HODSON, DOUGLAS S. PEASE, DAVID S. TOTAH, PHILLIP S. DERR, and W. JAMES ROSS of Soil Conservation Service.

[2] Italic numbers in parentheses refer to Literature Cited, p. 80.

dominant soils, and the pattern and relative proportions are about the same in all areas. Generally the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Guy-Texline complex is an example.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. A considerable degree of uniformity in pattern and relative extent of the dominant soils exists, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils, joined by a hyphen. Ayon-Apache association is an example.

In most areas surveyed there are places where the soil material is so stony, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land areas or are named for a higher category in the soil classification system and are given descriptive names. Ustolls-Rock outcrop association has the name Ustolls from the suborder level of the soil classification system and Rock outcrop is a land area.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up to date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Union County. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use (*6*). Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting a site for a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations as described in Union County have more detail than those of the adjoining counties in Texas and Oklahoma. Because of this, the boundary lines of mapping units in Union County do not always join those in Texas and Oklahoma.

Each of the soil associations in Union County is discussed in the following paragraphs. The terms for texture in the title of several associations apply to the texture of the surface layer. For example, in the title of association 7, the words loam and clay loam refer to the texture of the surface layer.

1. Travessilla-Carnero-Rock outcrop association

Level to very steep, shallow and moderately deep loams and sandy loams and Rock outcrop; on plateaus and canyon sides

This association is in the northern and southern areas of the county along the Cimarron River, Ute Creek, and Tramperos Creek drainageways. It is on broad, level to rolling plateaus and steep to very steep canyon sides (fig. 1).

The soils of this association formed in residuum from sandstone modified by mixed eolian material. The vegetation on plateaus is mainly blue grama, sideoats grama, and small soapweed (yucca). On canyon sides it is oneseed juniper, pinon pine, and oak brush. Elevation ranges from 4,300 to 6,700 feet. The average annual precipitation is 14 to 20 inches, and the mean annual air temperature is 47° to 57° F. The length of the frost free season is 140 to 185 days.

This association makes up about 28 percent of Union County. It is about 50 percent Travessilla soils; 15 percent Carnero soils; 15 percent Rock outcrop; and 20 percent Partri, Escabosa, Rizozo, Manzano, Kim, Spurlock, and Plack soils.

Travessilla soils on plateaus are level to rolling, and Travessilla soils on canyon sides are steep or very steep. Typically, these soils are sandy loam about 8 inches thick over sandstone bedrock.

Carnero soils are on plateaus. They are level to undulating. Typically, Carnero soils have a surface layer of loam and a subsoil of clay loam and clay that rest on sandstone bedrock at a depth of about 28 inches.

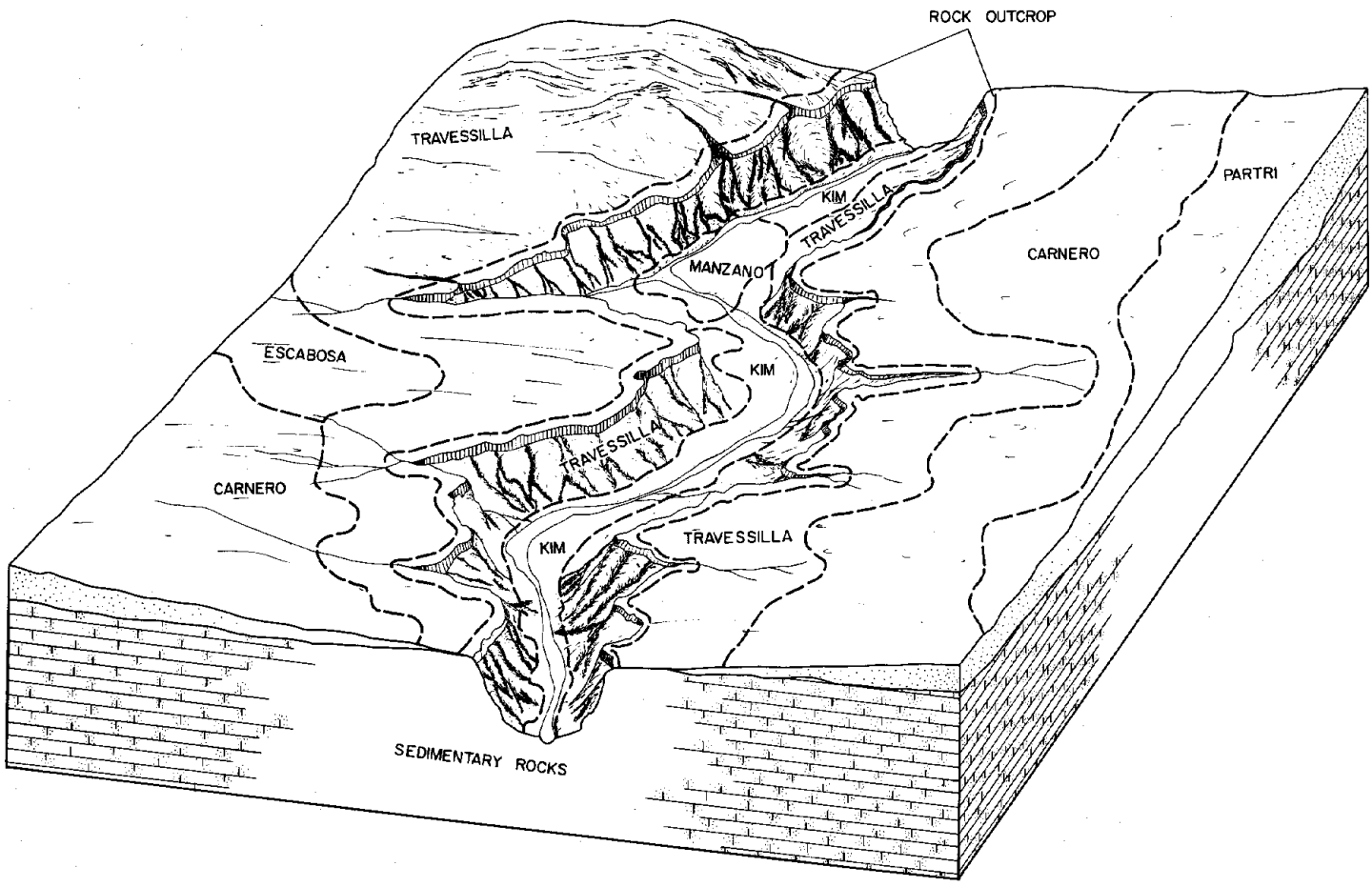

***Figure 1.*—Typical pattern of the soils and Rock outcrop in association 1.**

Rock outcrop is on canyon sides, hilltops, and side slopes.

The soils of this association are used mainly for grazing. In addition to domestic animals, deer and turkey graze in the canyons, and antelope and upland birds graze on the plateaus.

Runoff is medium or rapid, and much of the precipitation quickly runs off to streams and rivers. Soil loss and erosion can be controlled by maintaining the maximum possible amount of vegetative cover.

2. Torreon-Apache association

Level to strongly sloping, deep and shallow silty clay loams and cobbly loams; on basalt capped uplands

This association (fig. 2), except for a small part in the northeast corner of the county, is in a wedge shaped area from Clayton to the northwestern and southwestern corners of the county. It is on broad, level to strongly sloping basalt capped uplands. Steep and very steep escarpments on the edges of the basalt uplands and cinder cones (Capulin Mountain, for example) are within the boundaries of this association.

The soils of this association formed in wind laid silts and in residuum weathered from basalt. The vegetation is mainly blue grama, galleta, and side-oats grama. Elevation ranges from 5,000 to 7,000 feet. The average annual precipitation is 14 to 18 inches, and the mean annual temperature is 46° to 55° F. The length of the frost free season is 140 to 175 days.

This association makes up about 20 percent of the county. It is about 35 percent Torreon soils; 20 percent Apache soils; 15 percent Ayon soils; 15 percent Capulin soils; and 15 percent Fallsam and Bandera soils, Rock outcrop, Ustolls, and La Brier soils.

Torreon soils are on broad basalt uplands. These deep soils are level and nearly level. Typically, the surface layer is silty clay loam, and the subsoil is clay and silty clay loam.

Apache soils are on uplands near the escarpment edge of the uplands and on sides of ridges. They are nearly level to strongly sloping. These soils are cobbly loam and cobbly clay loam. Basalt is at a depth of about 16 inches.

Ayon soils are in areas between areas of Apache soils, or they are on ridges leading away from the Apache soils. They are deep soils that are nearly level to gently rolling. The surface layer of the Ayon soils is cobbly clay loam, the subsoil is very gravelly silty clay loam, and the substratum is very cobbly loam.

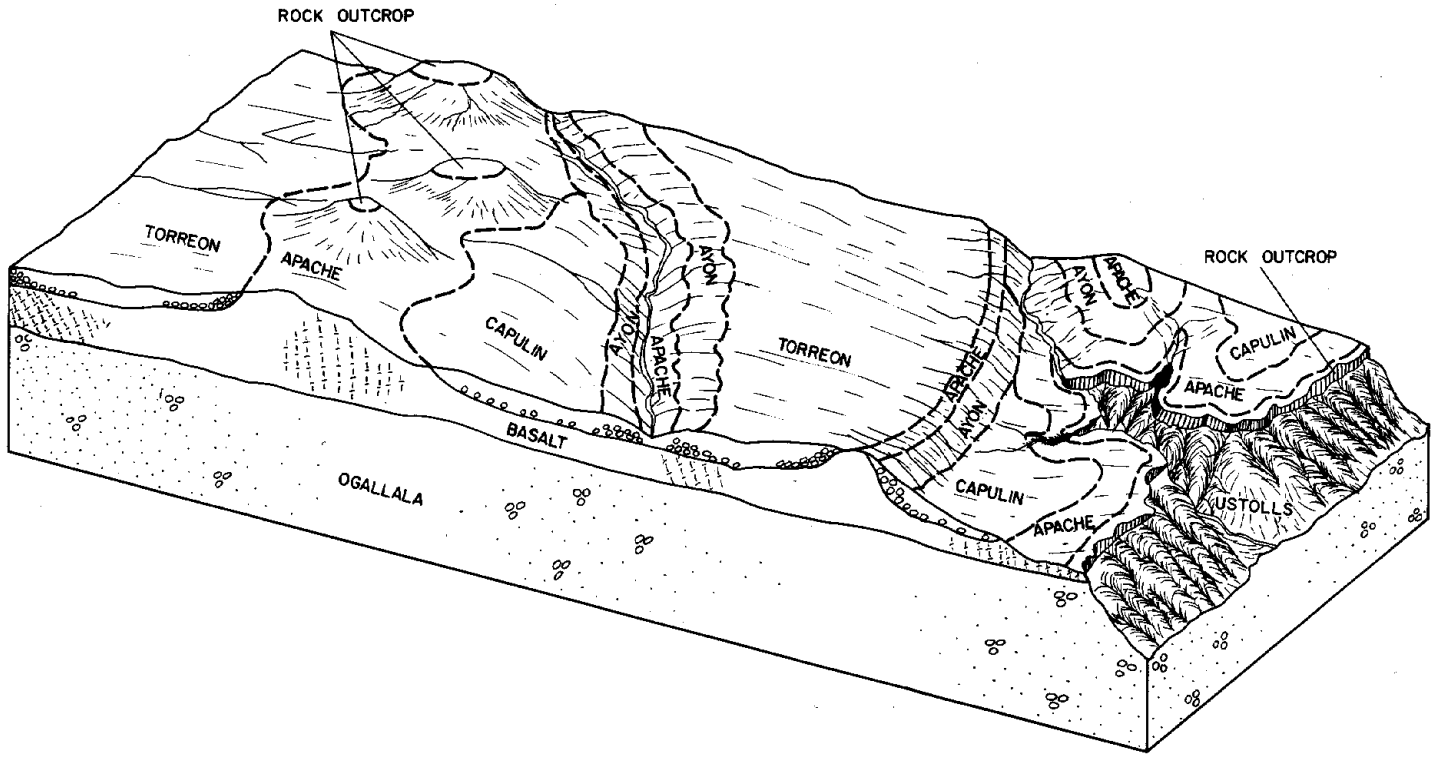

***Figure 2.*—Typical pattern of the soils in association 2.**

Capulin soils are on basalt uplands. These deep soils are level to gently sloping. The surface layer of Capulin soils is loam, the subsoil is clay loam, and the substratum is loam and cobbly loam.

Soils of this association are used mainly for cattle grazing. Also, antelope graze the flat areas, and deer graze the mountains and breaks. Capulin Mountain National Monument and Clayton and Des Moines, the county's two largest towns, are in this association.

Soil blowing and water erosion can be controlled by maintaining the maximum possible amount of vegetative cover.

3. Spurlock-Texline association

Nearly level to gently rolling, deep loams; on uplands and valley fill

This association (fig. 3) is in scattered areas throughout the county. It is on nearly level to gently rolling uplands and valley fill leading away from escarpments.

The soils of this association formed in mixed alluvium and in weakly consolidated calcareous sediment from the Ogallala Formation. The vegetation is mainly side-oats grama, blue grama, and three-awn. Elevation ranges from 4,300 to 7,300 feet. The average annual precipitation is 14 to 18 inches, and the mean annual temperature is 50° to 57° F. The length of the frost free season is 140 to 185 days.

This association makes up about 13 percent of the county. It is about 45 percent Spurlock soils; 20 percent Texline soils; 10 percent Guy soils; 10 percent Plack soils; and 15 percent Kim, Manzano, Dallam, and Gruver soils.

Spurlock soils are on ridges. They are nearly level to gently rolling. Typically, the surface layer is loam, the subsoil is clay loam, and the substratum is clay loam and sandy clay loam to a depth of 60 inches or more.

Texline soils are in valley fill. They are nearly level to gently sloping. Typically, the surface layer is loam, and the subsoil is clay loam and silty clay loam to a depth of 60 inches or more.

Soils of this association are used mainly for grazing cattle, but they are also used for irrigated crops. Alfalfa hay and grain sorghum are the main crops. The soils of this association are also used for quail, mourning dove, and antelope habitat.

Soil loss can be controlled by maintaining the maximum possible amount of cover on range and by practicing soil and water conservation in areas of cropland.

4. Colmor-Litle association

Level to moderately sloping, moderately deep and deep silty clay loams and clay loams; on uplands

This association is scattered throughout the county on broad, level to moderately sloping uplands that are interspersed with playas.

The soils of this association formed in eolian deposits overlying either sandstone or shale or in residuum weathered from shale. The vegetation is mainly blue grama, galleta, and three-awn. Elevation ranges from 5,000 to 7,000 feet. The average annual precipi-

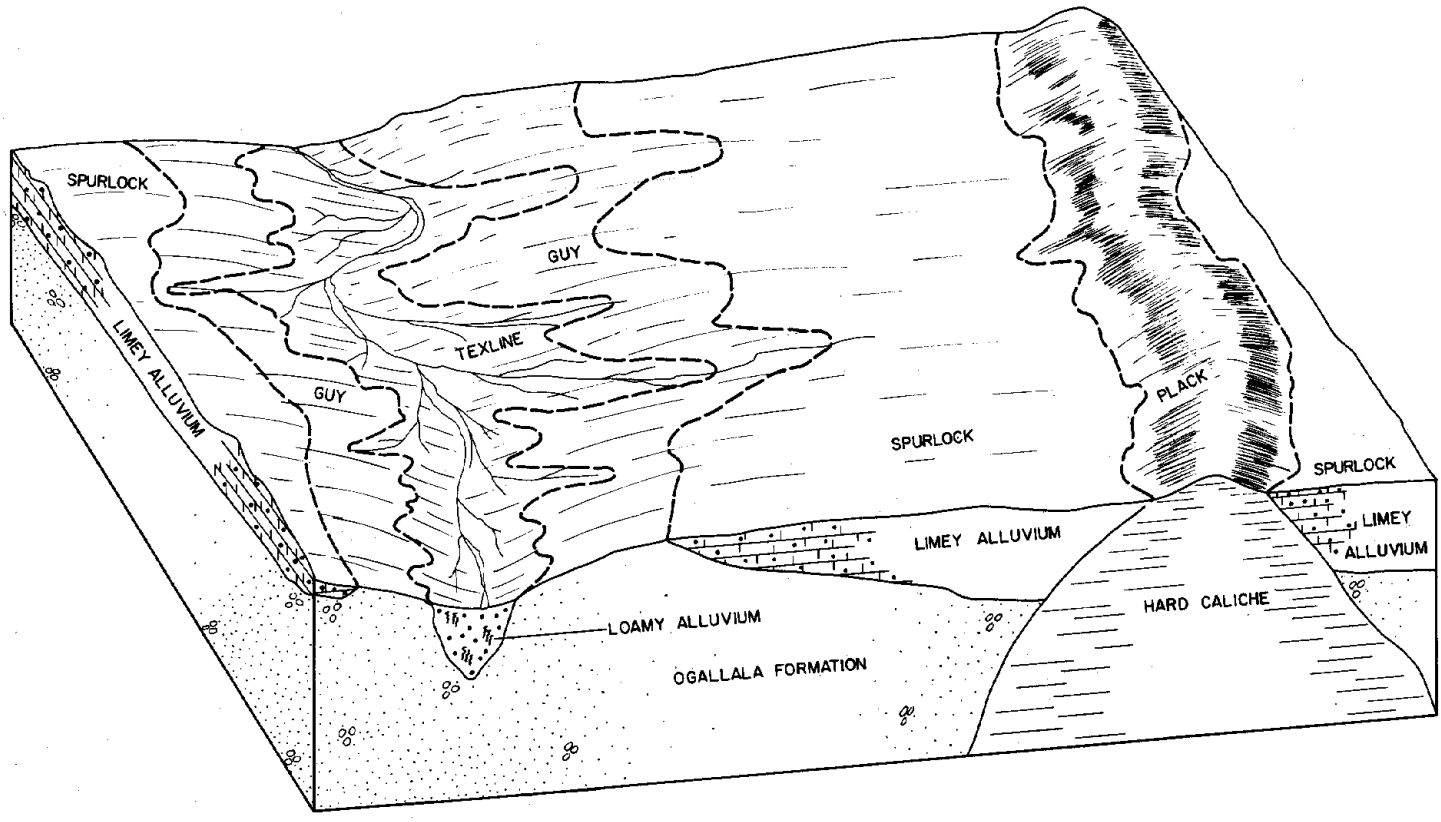

***Figure 3.*—Typical pattern of the soils in association 3.**

tation is 14 to 18 inches, and the mean annual temperature is 46° to 54° F. The length of the frost free season is 140 to 180 days.

This association makes up about 3 percent of the county. It is 40 percent Colmor soils; 30 percent Litle soils; 15 percent Kim soils; and 15 percent Vermejo, La Brier, Manzano, and Travessilla soils and Rubble land.

Colmor soils formed in mixed eolian material over sandstone or shale. These soils are level to gently sloping. Typically, the surface layer and subsoil are silty clay loam, and the substratum is clay loam to a depth of 40 inches or more.

Litle soils are nearly level to moderately sloping. Typically, the surface layer is heavy clay loam, and the subsoil is heavy silty clay loam that rests on soft shale at a depth of about 22 inches.

Kim soils are in positions on the landscape similar to those of Colmor soils. Typically, the surface layer of Kim soils is loam, and the substratum, to a depth of 40 inches or more, is clay loam.

The soils of this association are used for grazing cattle and for wildlife habitat. Soil loss can be controlled by maintaining the maximum possible amount of cover on range.

5. Gruver-La Brier association

Level to gently undulating, deep loams and silty clay loams; on uplands and in swales and valley bottoms

This association (fig. 4) is scattered throughout the county on broad gently undulating uplands and level and nearly level swales and valley bottoms.

The soils of this association formed in mixed alluvium from the High Plains sedimentary formations and in mixed alluvium on swales and valley bottoms. The vegetation is mainly blue grama, galleta, and buffalograss. Elevation ranges from 4,500 to 7,000 feet. The average annual precipitation is 14 to 18 inches, and the mean annual temperature is 47° to 57° F. The length of the frost free season is 140 to 185 days.

This association makes up 16 percent of the county. It is about 60 percent Gruver soils; 20 percent La Brier soils; 10 percent Sherm soils; and 10 percent Dioxice, Manzano, Texline, Spurlock, Guy, and Plack soils.

Gruver soils are on broad uplands. Typically, the surface layer is loam, and the subsoil is clay loam and sandy clay loam to a depth of more than 60 inches.

La Brier soils are on swales and valley bottoms. Typically, the surface layer is silty clay loam, and the subsoil is clay and silty clay loam to a depth of more than 60 inches.

Sherm soils are on broad uplands. The surface layer is clay loam, and the subsoil is clay to a depth of more than 60 inches.

The soils of this association are all used for grazing livestock and for irrigated farming. Gruver soils, however, are used for nonirrigated farming.

Two methods of irrigation are used—sprinkler and surface. Long irrigation runs are in La Brier soils

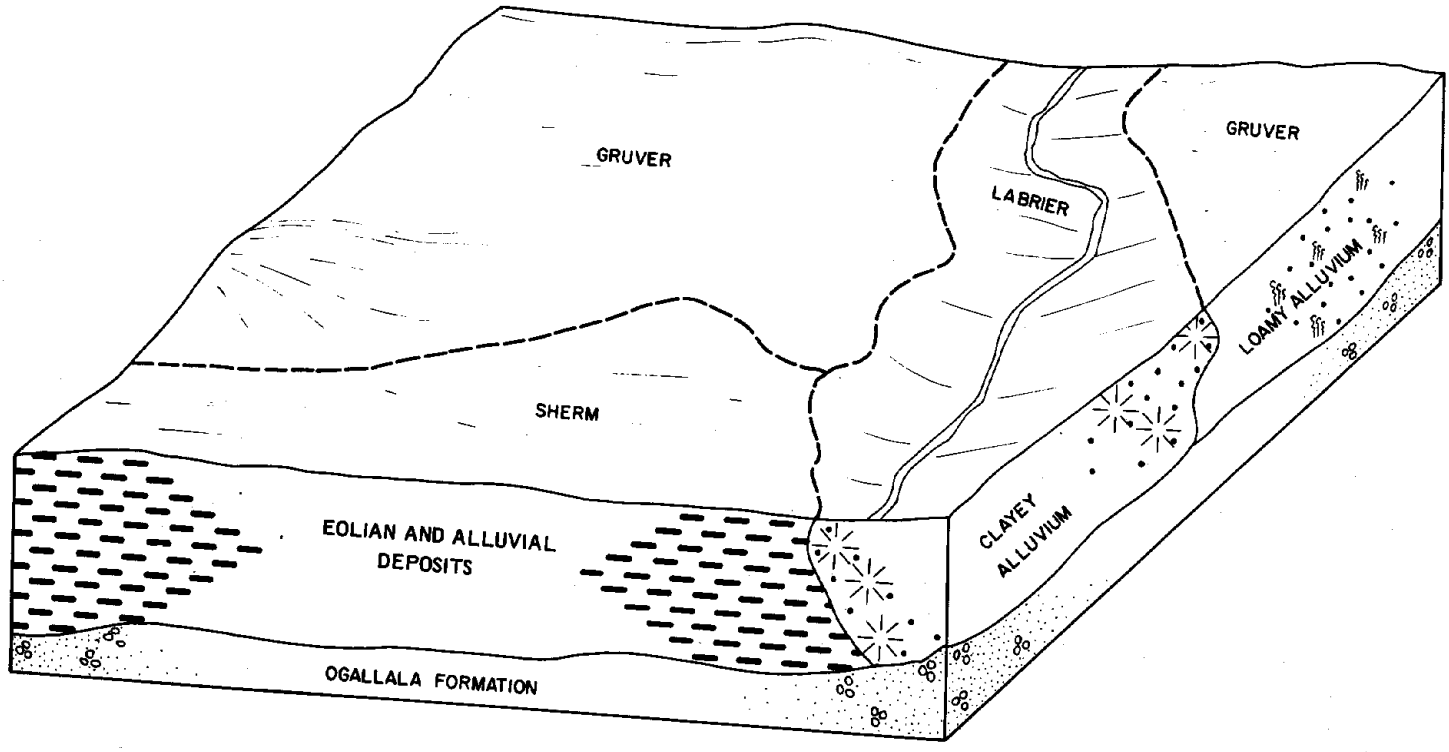

Figure 4.—**Typical pattern of the soils in association 5.**

because of the nearly level slopes and very slow permeability. The principal crops are grain sorghum, alfalfa hay, and corn. In places management that controls runoff and erosion is needed to minimize soil losses.

6. Dallam-Rickmore association

Level to undulating, deep fine sandy loams and sandy loams; on uplands

This association is on broad, level to undulating uplands of the High Plains in the eastern part of the county. A typical pattern of Dallam soils and minor soils in this association is shown in figure 5.

The soils of this association formed in eolian sediment and in mixed alluvium. The vegetation is mainly bluestem, grama grasses, sand sagebrush, and small soapweed (yucca). Elevation ranges from 4,300 to 6,500 feet. The average annual precipitation is 14 to 17 inches, and the mean annual temperature is 49° to 57° F. The length of the frost free season is 160 to 185 days.

This association makes up about 14 percent of Union County. It is about 45 percent Dallam soils; 20 percent Rickmore soils; 15 percent Vingo soils; and 20 percent Spurlock, Valent, Bankard, Guy, and Plack soils.

Dallam soils are on uplands. They are level to undulating. Typically, the surface layer is fine sandy loam or loamy sand, and the subsoil is sandy clay loam to a depth of more than 60 inches.

Rickmore soils are on uplands. They are level to gently undulating. Typically, the surface layer is loamy sand and sandy loam, and the subsoil is clay loam and sandy clay loam to a depth of 60 inches or more.

Vingo soils are on hummocky uplands. They are nearly level to undulating. The surface layer is loamy sand, and the subsoil is sandy loam to a depth of more than 60 inches.

The soils of this association are used for grazing cattle and for wildlife habitat. Dallam and Rickmore soils are also used for nonirrigated and irrigated crops. Sprinklers provide most of the irrigation, but surface irrigation is used in places. The principal crops are grain sorghum, alfalfa hay, corn, and winter wheat for pasture.

Soil loss in areas of range can be controlled by maintaining the maximum possible amount of cover. Soil and water conservation practices are needed to minimize soil losses in areas of cropland. Soil blowing is a severe hazard in many areas of this association.

7. Manzano-Alicia association

Level to moderately sloping, deep loams; on valley floors and alluvial fans

This association is in the northern part of the county along the Cimarron River and its tributaries. It is on broad, level and nearly level valley floors and moderately sloping alluvial fans.

The soils of this association formed in mixed alluvium. The vegetation is mainly blue grama, galleta, and small soapweed (yucca). Elevation ranges from 4,300 to 6,400 feet. The average annual precipitation is 14 to 18 inches, and the mean annual temperature is 48° to 55° F. The length of the frost free season is 140 to 180 days.

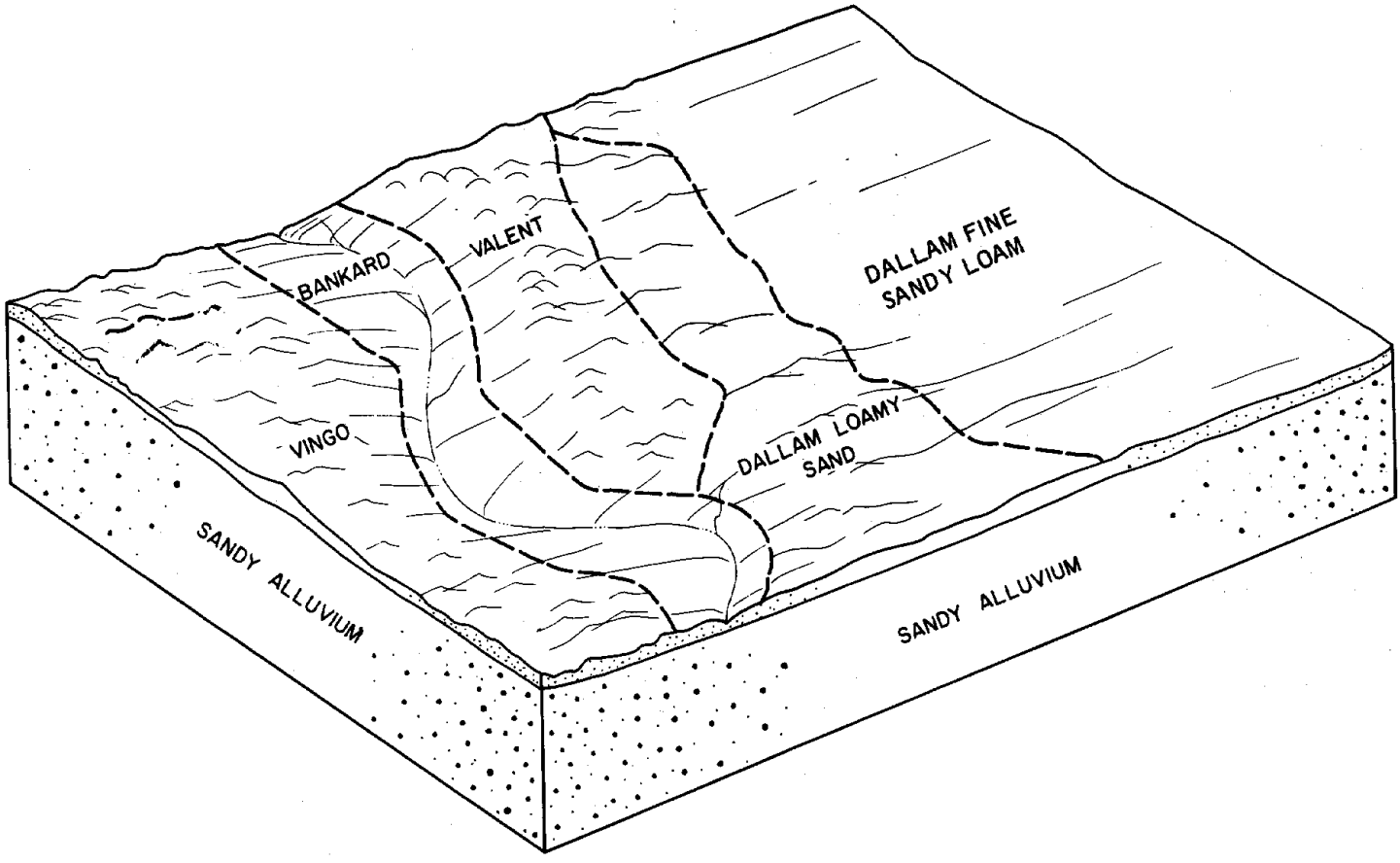

Figure 5.—**Typical pattern of the soils in association 6.**

This association makes up about 4 percent of the area. It is about 45 percent Manzano soils; 20 percent Alicia soils; 20 percent Kim soils; and 15 percent La Brier, Travessilla, Rizozo, Escabosa, Guy, and Gruver soils.

Manzano soils are on valley floors. They are deep and are level or nearly level. Typically, the surface layer is loam and clay loam, the subsoil is silty clay loam and clay loam, and the substratum is clay loam.

Alicia and Kim soils are on alluvial fans. They are gently to moderately sloping. Typically, Alicia soils are deep. The surface layer is loam, and the subsoil and substratum are silty clay loam. Typically, Kim soils are deep. The surface layer is loam, and the substratum is clay loam.

All the soils of this association are used for grazing cattle. Manzano soils are used for limited irrigated and nonirrigated farming. Soil loss can be controlled by maintaining the maximum possible amount of cover on range and by using soil and water conservation practices on crops.

8. Aridic Haplustolls-Ustolls-Rock outcrop association

Nearly level to very steep, shallow to deep, gravelly, cobbly or stony loams to clays; on valley fill and benches. Rock outcrop on basalt capped mesas, escarpments, and mountainsides

This association is in the northwest corner of the county on basalt capped mesas, steep and very steep side slopes that lead away from the mesas, and on mountainsides.

The soils of this association formed in partly weathered basalt on mountainsides and mesa tops and in partly weathered shale and limestone modified by colluvium from shale or basalt on the side slopes below the mesas. The vegetation is mainly blue grama, sideoats grama, oak brush, oneseed juniper, and pinon pine. The elevation ranges from 6,600 to 8,200 feet. The average annual precipitation is 15 to 20 inches, and the mean annual temperature is 45° to 57° F. The length of the frost free season is 120 to 180 days.

This association makes up about 2 percent of Union County. It is about 25 percent Aridic Haplustolls; 20 percent Ustolls; 25 percent Rock outcrop; 10 percent Des Moines soils; 10 percent Raton soils; and 10 percent La Brier, Vermejo, Litle, Dalcan, Fallsam, and Colmor soils.

Aridic Haplustolls are on benches and side slopes. They are nearly level to steep. These soils are stony silty clay loam to stony clay throughout. In places Aridic Haplustolls are underlain by shale or limestone at a depth of 4 to 25 inches.

Ustolls are on valley fill. They are steep to very steep. Typically, the surface layer is gravelly, cobbly, or stony loam or clay loam, and the substratum is loam to clay.

Rock outcrop is on edges of mesas and on side slopes.

The Des Moines soils are on mountainsides and sides of ridges. They are moderately steep to very steep. Typically, these deep soils have a surface layer that is cobbly silt loam and a subsoil that is very cobbly silty clay.

The Raton soils are on sides of basalt ridges. They are gently to strongly sloping. Typically, the surface layer is cobbly silt loam, and the subsoil is very cobbly clay that rests on bedrock at a depth of about 18 inches.

The soils of this association are used for cattle grazing and wildlife habitat.

Soil loss can be controlled in areas of range by maintaining the maximum possible amount of cover.

Descriptions of the Soils

The soil series and mapping units in Union County are described in this section. Each soil series is described in detail, and then each mapping unit in that series is described briefly. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping unit and the description of the soil series to which it belongs.

Some of the soils described in reports of adjoining counties may appear to be the same as soils in Union County, yet they have a different name. Reading the section on Formation and Classification of the Soils will clarify this.

An important part of the description of each soil series is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are either stated in describing the mapping unit or are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Ustolls, for example, do not belong to a soil series, but nevertheless are listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and range site in which the mapping unit has been placed. The page on which the map unit is described and the assigned capability unit, range site, or windbreak group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*15*).

Alicia series

The Alicia series consists of deep, well drained soils on alluvial fans. These soils formed in alluvium weathered from red-bed sandstone. Slopes are 3 to 9 percent. Elevation is 4,300 to 5,000 feet. Vegetation is mainly blue grama, galleta, small soapweed (yucca), and cholla. The average annual precipitation is 15 to 18 inches, and the average annual air temperature is 49° to 55° F. The length of the frost free season is 160 to 180 days.

In a representative profile the surface layer is brown and reddish brown loam about 6 inches thick. The subsoil is reddish brown and light reddish brown silty clay loam about 26 inches thick. The substratum to a depth of 73 inches is reddish yellow silty clay loam. The soil material is calcareous throughout. It is moderately alkaline in the upper 32 inches and strongly alkaline below.

Permeability is moderately slow. Runoff is medium. Available water capacity is 8.5 to 10 inches. Effective rooting depth is 60 inches or more. The hazards of water erosion and soil blowing on bare soil are moderate.

These soils are used mostly for range and wildlife habitat.

Representative profile of Alicia loam, 3 to 9 percent slopes, 195 feet west and 234 feet north of the southeast corner of sec. 30, T. 31 N., R. 37 E.:

A11—0 to 2 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 3/2) when moist; weak thin platy structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; many very fine pores; slightly calcareous; moderately alkaline; abrupt smooth boundary. 0 to 5 inches thick.

A12—2 to 6 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) when moist; moderate medium granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; common fine pores; strongly calcareous; moderately alkaline; abrupt smooth boundary. 4 to 12 inches thick.

B1—6 to 16 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) when moist; weak fine granular structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; common fine roots; common fine and many very fine pores; strongly calcareous; moderately alkaline; abrupt smooth boundary. 5 to 20 inches thick.

B2—16 to 32 inches; light reddish brown (5YR 6/4) silty clay loam, reddish brown (5YR 5/4) when moist; moderate coarse

TABLE 1.—*Approximate acreage and proportionate extent of soils*

Soil	Acres	Percent	Soil	Acres	Percent
Alicia loam, 3 to 9 percent slopes	18,074	0.7	Litle clay loam, 1 to 9 percent slopes	18,414	.8
Apache-Rock outcrop complex	34,343	1.4	Manzano loam	52,581	2.2
Aridic Haplustolls-Rubble land complex	14,108	.6	Plack loam, 0 to 9 percent slopes	49,858	2.0
Ayon-Apache association	116,167	4.8	Raton-Rock outcrop complex	10,143	.4
Bandera association	2,288	.1	Rickmore sandy loam	68,777	2.8
Bankard loamy sand	11,412	.5	Rizozo-Rock outcrop complex	7,919	.3
Capulin loam, 0 to 5 percent slopes	28,239	1.2	Sherm clay loam	50,546	2.1
Capulin-Apache complex	55,956	2.3	Spurlock loamy sand, 1 to 9 percent slopes	39,156	1.6
Carnero loam, 0 to 5 percent slopes	39,702	1.6	Spurlock loam, 1 to 5 percent slopes	132,550	5.4
Carnero-Partri complex	95,415	3.9	Spurlock-Plack complex	81,704	3.3
Colmor silty clay loam, 0 to 5 percent slopes	27,426	1.1	Texline loam, 1 to 5 percent slopes	72,720	3.0
Dalcan-Rock outcrop complex	6,140	.3	Torreon silty clay loam	159,819	6.5
Dallam loamy sand, 0 to 5 percent slopes	46,947	1.9	Travessilla-Rock outcrop complex, 0 to 15 percent slopes	265,815	10.9
Dallam fine sandy loam, 0 to 5 percent slopes	92,700	3.8	Travessilla-Rock outcrop complex, 30 to 75 percent slopes	156,631	6.4
Des Moines-Rock outcrop complex	11,157	.5	Ustolls-Rock outcrop association	32,969	1.4
Dioxice loam, 0 to 5 percent slopes	34,375	1.4	Valent loamy sand, 3 to 9 percent slopes	9,114	.4
Escabosa loam, 3 to 5 percent slopes	36,842	1.5	Vermejo silty clay loam	2,513	.1
Fallsam-Rock outcrop complex	10,369	.4	Vingo-Dallam complex	63,940	2.6
Gruver loam	240,533	9.8	Lakes	189	(1)
Guy-Texline complex	46,213	1.9	Pits (Gravel pits, caliche pits, cinder pits)	299	(1)
Kim sandy loam, 1 to 9 percent slopes	9,037	.4	Playas	8,058	.3
Kim-Manzano association	88,482	3.6			
La Brier silty clay loam	80,491	3.3			
La Brier-Rock outcrop complex	12,749	.5	Total	2,442,880	100.0

[1] Less than 0.05 percent.

prismatic structure parting to weak fine subangular blocky; hard when dry, friable when moist, slightly sticky and plastic when wet; common very fine roots; common fine pores; strongly calcareous; moderately alkaline; clear smooth boundary. 15 to 30 inches thick.

Cca—32 to 73 inches; reddish yellow (5YR 6/6) silty clay loam, yellowish red (5YR 5/6) when moist; weak fine granular structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine roots; common fine pores; few fine soft masses and threads of lime; strongly calcareous; strongly alkaline.

The solum is 30 to 40 inches thick. Bedrock or gravel layers are at a depth of 40 to 80 inches in some places. The content of gravel or cobbles is 0 to 10 percent throughout.

The A horizon is brown or reddish brown when dry and dark brown, reddish brown, or dark reddish brown when moist. It is loam, clay loam, or sandy loam; is mildly or moderately alkaline; and is slightly to strongly calcareous.

The B2 horizon is reddish brown or light reddish brown when dry and reddish brown or yellowish red when moist. It is silty clay loam or silt loam, is mildly or moderately alkaline, and is moderately to strongly calcareous.

The Cca horizon is reddish yellow, light reddish brown, pink, or yellowish red when dry and yellowish red, reddish yellow, or light reddish brown when moist. It is loam, silty clay loam, or clay loam. It is moderately or strongly alkaline.

AcD—Alicia loam, 3 to 9 percent slopes. This soil is on alluvial fans in long, narrow or fan-shaped areas of 10 to 160 acres.

Included with this soil in mapping, and making up about 5 percent of the mapped acreage, are Kim soils that are intermingled with the Alicia soils. Also included, and making up about 5 percent, is a soil that is similar to this Alicia soil but that has a clay subsoil; it is in less sloping areas. Also included are Travessilla and Rizozo soils near outcrops of sandstone; together they make up about 5 percent of the mapped acreage.

This soil is used for range and wildlife habitat. Irrigated capability unit IVe–6, nonirrigated capability subclass VIe; Loamy range site.

Apache series

The Apache series consists of shallow, well drained soils on basalt-capped mesas and uplands. These soils formed in material weathered from basalt modified by eolian material derived from mixed sources. Slopes are 1 to 15 percent. Elevation is 5,000 to 7,000 feet. Vegetation is mainly blue grama, side-oats grama, and broom snakeweed. The average annual precipitation is 14 to 17 inches, and the average annual air temperature is 46° to 55° F. The length of the frost free season is 140 to 175 days.

In a representative profile (fig. 6) the surface layer is dark grayish brown cobbly loam about 8 inches thick. The subsoil is brown cobbly light clay loam about 4 inches thick. The substratum is mixed white and very pale brown cobbly light clay loam. Fractured basalt bedrock is at a depth of 16 inches. The soil material is moderately alkaline and calcareous throughout.

Figure 6.—Roadcut, showing Apache cobbly loam underlain by basalt bedrock.

Permeability is moderate. Runoff is medium. Available water capacity is 0.5 to 2.5 inches. Effective rooting depth is 4 to 20 inches. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Apache soils are used for range, wildlife habitat, water supply, and community development.

Representative profile of Apache cobbly loam, from an area of Ayon-Apache association, 720 feet north and 1,664 feet west of the intersection of ranch road and the railroad track, in the NE¼ sec. 24, T. 26 N., R. 34 E:

A1—0 to 8 inches; dark grayish brown (10YR 4/2) cobbly heavy loam, very dark grayish brown (10YR 3/2) when moist; weak medium subangular blocky structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; common very fine and few fine pores; strongly calcareous; moderately alkaline; clear smooth boundary. 4 to 9 inches thick.

B2—8 to 12 inches; brown (10YR 5/3) cobbly light clay loam, dark brown (10YR 4/3) when moist; moderate fine subangular blocky structure; slightly hard when dry, firm when moist, slightly sticky and slightly plastic when wet; common fine roots; common very fine and few fine pores; strongly calcareous; moderately alkaline; clear boundary. 0 to 5 inches thick.

Cca—12 to 16 inches; mixed white (10YR 8/2) and very pale brown (10YR 8/3) cobbly light clay loam; massive; few fine roots; few fine pores; strongly calcareous; moderately alkaline; abrupt wavy boundary. 0 to 6 inches thick.

R—16 inches; fractured, hard, carbonate-coated basalt bedrock.

The depth to bedrock is 4 to 20 inches. The soil is 0 to 15 percent gravel and 5 to 25 percent cobblestones. The cobblestones and gravel combined make up 5 to 35 percent of the soil material.

The A horizon is brown, grayish brown, or dark grayish brown when dry and dark brown or very dark grayish brown when moist. It is loam, clay loam, or cobbly or gravelly loam or clay loam.

The B horizon has the same textural range as the A horizon, and it is brown or grayish brown when dry and brown, dark brown, or dark grayish brown when moist.

Ap—Apache-Rock outcrop complex (1 to 15 percent slopes). Apache cobbly loam, 1 to 15 percent slopes, makes up about 40 percent of this complex; Rock outcrop makes up 25 percent; and Ayon cobbly clay loam, 1 to 9 percent slopes, makes up 15 percent. Included soils make up the remaining 20 percent. Areas are 40 to more than 640 acres in size.

The Apache soil is on the sides of hills and ridges. Rock outcrop is on hilltops, ridgetops, and escarpments. The Ayon soil is between ridges and at the bases of hills.

Included with these soils in mapping, and making up 10 percent of the mapped acreage, are Capulin, La Brier, and Torreon soils. These soils are on broad, flat ridgetops and along drainage channels. Also included in transitional areas between Rock outcrop and Apache soils is a soil that is less than 4 inches deep to bedrock. This included soil makes up about 10 percent of the mapped acreage.

These soils are used for water supply, range, and wildlife habitat. Nonirrigated capability subclass VIIs; Apache cobbly loam in Malpais range site, Rock outcrop not assigned to a range site.

Aridic Haplustolls

In certain types of terrain, separation of soils at the level of phases of soil series was not feasible. In such areas the soils were mapped and named at a category in the soil classification system broader than the series. Aridic Hapustolls, for example, is a subgroup. See the section "Formation and Classification of the Soils" for a more complete explanation of the system.

Aridic Haplustolls are shallow to deep, well drained soils on side slopes and on benches and terraces leading away from basalt-capped mesas. These soils formed in residuum weathered from mixed shale, limestone, and basalt rubble. Slopes are 1 to 45 percent. Elevation is 6,800 to 7,500 feet. Vegetation is mainly oak brush, pinon pine, oneseed juniper, and mixed grama grasses. The average annual precipitation is 17 to 19 inches, and the average annual air temperature is 45° to 50° F. The length of the frost free season is 120 to 160 days.

The surface layer is dark colored loam to clay. On the benches and terraces, the soil is deep and the substratum is silty clay loam or clay. On side slopes lead-

ing away from the benches, the soil is underlain by shale, mixed clay and shale, or limestone at a depth of 4 to 25 inches. The soils are noncalcareous to strongly calcareous and are mildly or moderately alkaline. Basalt stones make up 10 to 50 percent of the soil material.

Permeability is moderately slow to very slow. Runoff is rapid. Available water capacity is mostly 0.5 to 2.5 inches in steep areas and more than 6 inches on benches. Effective rooting depth is variable. The hazard of water erosion is severe, and the hazard of soil blowing is slight.

These soils are used for range, wildlife habitat, and water supply.

Ar—Aridic Haplustolls-Rubble land complex (1 to 45 percent slopes). Aridic Haplustolls make up about 80 percent of this complex, and Rubble land makes up 20 percent. Areas of this unit are in the northwestern corner of the county in areas of more than 300 acres. Aridic Haplustolls are on hills and benches. Rubble land is colluvium from the basalt-capped mesas upslope. It is scattered throughout areas of the unit.

These soils are used for range, wildlife habitat, and water supply. Nonirrigated capability subclass VIIs; Aridic Haplustolls in Breaks range site, Rubble land not assigned to a range site.

Ayon series

The Ayon series consists of deep, well drained soils below basalt-capped mesas and terraces. These soils formed in colluvium and alluvium weathered from basalt and eolian material derived from mixed sources. Slopes are 1 to 9 percent. Elevation is 5,000 to 7,000 feet. Vegetation is mainly blue grama, side-oats grama, and woolly indianwheat. The average annual precipitation is 14 to 17 inches, and the average annual air temperature is 46° to 55° F. The length of the frost free season is 140 to 175 days.

In a representative profile the surface layer is dark grayish brown cobbly clay loam 11 inches thick. The subsoil is brown very gravelly silty clay loam about 5 inches thick. The substratum to a depth of 42 inches is light gray, strongly calcareous very cobbly loam. The soil material is calcareous throughout. It is mildly alkaline in the upper 11 inches and moderately alkaline below.

Permeability is moderate. Runoff is medium. Available water capacity is 3.5 to 5 inches. Effective rooting depth is 40 to 60 inches. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

Ayon soils are used for range, wildlife habitat, water supply, and community development.

Representative profile of Ayon cobbly loam in an area of Ayon-Apache association, in the SW¼SE¼ sec. 5, T. 26 N., R. 35 E:

A1—0 to 11 inches; dark grayish brown (10YR 4/2) cobbly clay loam, very dark grayish brown (10YR 3/2) when moist; moderate medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; common fine and very fine roots; few fine and many very fine pores; 25 percent cobblestones and gravel; slightly calcareous; mildly alkaline; clear smooth boundary. 2 to 11 inches thick.

B2—11 to 16 inches; brown (10YR 5/3) very gravelly silty clay loam, dark brown (10YR 4/3) when moist; weak fine and medium subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; common fine and very fine roots; many very fine pores; 50 percent gravel and cobblestones; strongly calcareous; moderately alkaline; clear smooth boundary. 5 to 12 inches thick.

C1ca—16 to 22 inches; light gray (10YR 7/2) very cobbly loam, pale brown (10YR 6/3) when moist; massive; soft when dry, very friable when moist, nonsticky and slightly plastic when wet; common fine and very fine roots; many very fine pores; 70 percent cobblestones, stones, and gravel; strongly calcareous, 40 percent of the soil mass is strongly cemented; moderately alkaline; clear, wavy boundary. 0 to 12 inches thick.

C2ca—22 to 42 inches; light gray (10YR 7/2) very cobbly loam, pale brown (10YR 6/3) when moist; massive; soft when dry, very friable when moist, nonsticky and slightly plastic when wet; few fine and very fine roots; few fine and very fine pores; 50 percent cobblestones, gravel, and stones; strongly calcareous; moderately alkaline.

The thickness of the solum and the depth to a horizon of concentrated lime is 10 to 22 inches. The A horizon is brown or dark grayish brown when dry and very dark grayish brown or dark brown when moist. It is loam or clay loam. It is mildly to moderately alkaline and has fine granular or subangular blocky structure.

The B2 horizon is brown, pale brown, or dark grayish brown when dry and brown or dark brown when moist. The B2 horizon is clay loam, silty clay loam, or loam and is 20 to 45 percent cobblestones and 20 to 50 percent gravel.

The Cca horizon is clay loam or loam and is 20 to 45 percent cobbles and 20 to 50 percent gravel. The upper part of the Cca horizon is strongly cemented in some areas, and it is as much as 60 percent indurated caliche fragments. Basalt bedrock or rubble is below a depth of 40 to 60 inches.

Ay—Ayon-Apache association (1 to 9 percent slopes). Ayon cobbly clay loam, 1 to 5 percent slopes, makes up about 50 percent of this association, and Apache cobbly loam, 1 to 9 percent slopes, makes up 35 percent. Included soils make up the remaining 15 percent. Areas are more than 640 acres in size in most places.

The Ayon soil is in valleys between basalt ridges, and the Apache soils are on basalt ridges and along the upper edges of basalt-capped mesas. Each soil has the profile described as representative of its respective series.

Included with these soils in mapping, and making up about 5 percent of the mapped acreage, are Rock

outcrop and Rubble land. Also included, and making up about 5 percent each, are Torreon and Capulin soils. Rock outcrop is on ledges and ridges, and Rubble land is at the bases of ledges and small hills. Torreon and Capulin soils are in flat areas on uplands.

These soils are used for range, wildlife habitat, water supply, and community development. Nonirrigated capability subclass VIIs; Malpais range site.

Bandera series

The Bandera series consists of deep, somewhat excessively drained soils in areas below volcanic cinder cones. These soils are underlain by a continuous layer of gravel-sized cinders at a depth of 12 to 26 inches. They formed in eolian and colluvial material of volcanic origin. Slopes are 0 to 25 percent. Elevation is 6,900 to 7,900 feet. Vegetation is mainly blue grama, side-oats grama, and big and little bluestem. The average annual precipitation is 16 to 19 inches, and the average annual air temperature is 42° to 45° F. The length of the frost free season is 110 to 120 days.

In a representative profile the surface layer is dark grayish brown gravelly silt loam 12 inches thick. The next layer is grayish brown gravelly sandy loam. Gravel-sized cinders are at a depth of 19 inches. The soil material is neutral to a depth of 12 inches and moderately alkaline below.

Permeability is moderate. Runoff is slow. Available water capacity is 1.5 to 3 inches. Effective rooting depth is 12 to 26 inches. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

These soils are used for range, wildlife habitat, and recreation and as a source of material for railroad ballast and cinder blocks.

Representative profile of Bandera gravelly silt loam in an area of Bandera association, 0.25 mile west and 0.2 mile north of the southeast corner sec. 33, T. 30 N., R. 28 E.:

A1—0 to 12 inches; dark grayish brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; many fine and very fine interstitial pores; 35 percent gravel-sized cinders; noncalcareous; neutral; clear smooth boundary. 6 to 14 inches thick.

AC—12 to 19 inches; grayish brown (10YR 5/2) gravelly heavy sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate fine granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; common fine roots; many fine and very fine pores; 35 percent gravel-sized cinders; strongly calcareous; moderately alkaline; gradual smooth boundary. 0 to 16 inches thick.

C—19 to 120 inches; gravel-sized cinders; less than 5 percent soil.

Depth to cinders ranges from 12 to 26 inches. The A1 horizon is dark gray, dark grayish brown, very dark grayish brown, or dark brown when dry and dark brown, very dark brown, or very dark grayish brown when moist. It is gravelly silt loam or gravelly loam.

The AC horizon is grayish brown, dark grayish brown, dark gray, or brown when dry and dark brown or very dark grayish brown when moist. It is gravelly sandy loam or gravelly loam and is 25 to 35 percent cinder gravel. The AC horizon is mildly or moderately alkaline and slightly to strongly calcareous. A discontinuous layer of cemented calcium carbonate is directly below the AC horizon in some areas.

Bd—Bandera association (0 to 25 percent slopes). Bandera gravelly silt loam, 0 to 25 percent slopes, makes up 60 percent of this association; a soil that is similar to this Bandera gravelly silt loam except that it is 4 to 12 inches thick over cinder gravel makes up 15 percent; and Cinder land makes up 15 percent. Included soils make up the remaining 10 percent. Areas are 60 to 400 acres in size.

The Bandera soil is at the bases of volcanic cones on the northern and eastern sides of the cones. It has the profile described as representative of the series. The soil that is similar to the Bandera soil is transitional between the Bandera soil and the cinder land and is interspersed between them in the landscape. Cinder land is on cinder cones; it is very similar to the Bandera soil except that 0 to 4 inches of soil material overlies the cinders. Slopes of the cinder land range from 10 to 80 percent.

Included with these soils in mapping are Apache, Ayon, and Fallsam soils on basalt flows and Capulin and La Brier soils in depressions. The included soils on basalt flows make up about 5 percent of the mapped acreage; those in depressions also make up about 5 percent.

This association is used for range, wildlife habitat, and recreation and as a source of material used for railroad ballast and cinder blocks. Bandera gravelly silt loam in nonirrigated capability subclass VIe, Cinder land in nonirrigated capability subclass VIIIs; Bandera soils in Cinder range site.

Bankard series

The Bankard series consists of deep, well drained soils on flood plains or stream terrances. These soils are subject to flooding from ephemeral streams. They formed in river-worked alluvium. Slopes are 0 to 3 percent. Elevation is 4,300 to 5,300 feet. Vegetation is mainly sand sagebrush, big bluestem, and blue grama. The average annual precipitation is 14 to 17 inches, and the average annual air temperature is 50° to 57° F. The length of the frost free season is 175 to 185 days.

In a representative profile the surface layer is brown loamy sand about 7 inches thick. The substratum to a depth of 77 inches is yellowish brown and light yellowish brown sand with a few thin strata of sandy loam or loam. The soil material is neutral and noncalcareous to a depth of 7 inches and mildly alkaline and calcareous below.

Permeability is rapid. Runoff is slow. Available water capacity is 3 to 6 inches. Effective rooting depth is 60 inches or more. Seasonal overflow is variable according to local conditions; it occurs once every five

years to twice a year. The hazard of soil blowing on bare soil is severe. The hazard of water erosion is slight.

These soils are used for range and wildlife habitat.

Representative profile of Bankard loamy sand in the NW¼SW¼ sec. 17, T. 28 N., R. 37 E.:

A1—0 to 7 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) when moist; very weak medium subangular blocky structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; few coarse and fine roots; many interstitial pores; noncalcareous; neutral; gradual wavy boundary. 3 to 19 inches thick.

C1—7 to 50 inches; yellowish brown (10YR 5/4) sand, brown (10YR 4/3) when moist; single grained; loose when dry and moist, nonsticky and nonplastic when wet; few fine roots; many interstitial pores; 5 percent fine gravel; a few thin strata of sandy loam and loam mostly at depths of 24 to 27 inches; slightly calcareous; mildly alkaline; gradual smooth boundary. 30 to 90 inches thick.

C2—50 to 77 inches; light yellowish brown (10YR 6/4) sand, yellowish brown (10YR 5/4) when wet; single grained; loose when dry and moist, nonsticky and nonplastic when wet; few very fine roots; many interstitial pores; 10 percent fine gravel; slightly calcareous; mildly alkaline.

The soil is neutral to moderately alkaline. The A horizon is brown or pale brown when dry and brown or dark brown when moist. Texture is loamy sand or sand.

The C horizon is loamy sand or sand with thin strata of sandy loam or loam. Gravel content ranges from 0 to 25 percent; pebbles are fine to medium in size and are water rounded.

Bk—Bankard loamy sand (0 to 3 percent slopes). This soil is in river-worked alluvium on flood plains and stream terraces in long, narrow areas of 40 to 200 acres.

Included with this soil in mapping, and making up about 15 percent of the mapped acreage, is a soil that is similar to this Bankard soil but that does not have thin strata of loam or sandy loam. This included soil is in stream channels. Also included in the same landscape position as this Bankard soil are Manzano and Valent soils. These soils each make up about 5 percent of the mapped acreage.

This soil is used for range and wildlife habitat. Nonirrigated capability subclass VIe; Deep Sand range site.

Capulin series

The Capulin series consists of deep, well drained soils on alluvial fans and valley fill around basalt cones and volcanic vents. These soils formed in a mixture of residuum and alluvium weathered from basalt and eolian material. Slopes are 0 to 5 percent. Elevation is 5,000 to 7,000 feet. Vegetation is mainly blue grama, galleta, and side-oats grama. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 47° to 53° F. The length of the frost free season is 140 to 180 days.

In a representative profile (fig. 7) the surface layer is dark grayish brown heavy loam about 10 inches thick. The subsoil is grayish brown and brown clay loam 21 inches thick. The substratum to a depth of 41 inches is very pale brown loam. Below this to a depth of 66 inches, it is white cobbly loam. The soil material is slightly calcareous and mildly alkaline to moderately alkaline to a depth of 31 inches and strongly calcareous and moderately alkaline below.

Permeability is moderate. Runoff is medium. Available water capacity is 6 to 9 inches. Effective rooting

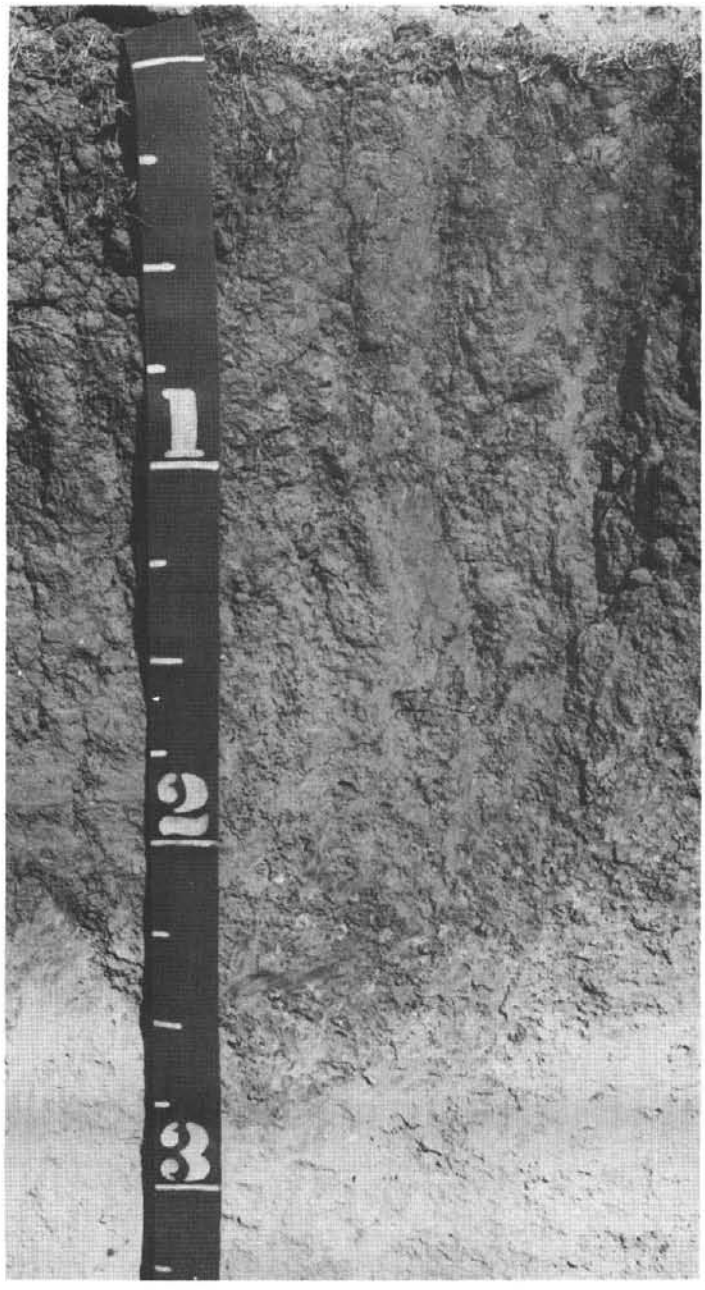

Figure 7.—**Profile of Capulin loam, 0 to 5 percent slopes.**

depth is 40 to 60 inches. The hazards of soil blowing and water erosion on bare soil are moderate.

These soils are used for range and wildlife habitat.

Representative profile of Capulin loam, from an area of Capulin-Apache complex, 4 miles west of Clayton on U.S. Highway 64; 1,450 feet west and 200 feet north of the southeast corner of sec. 11, T. 26 N., R. 33 E.:

A1—0 to 3 inches; dark grayish brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; many very fine pores; many dark mineral grains in the sand- and silt-sized fractions; slightly calcareous; mildly alkaline; abrupt smooth boundary. 3 to 10 inches thick.

A3—3 to 10 inches; dark grayish brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to weak fine subangular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; few fine and many very fine pores; many dark mineral grains in the sand- and silt-sized fractions; moderately calcareous; mildly alkaline; clear smooth boundary. 0 to 10 inches thick.

B21t—10 to 18 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to strong medium subangular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; common fine and very fine pores; many insect cavities lined with clay films; few thin clay films on peds; many dark mineral grains in the sand- and silt-sized fractions; 5 to 10 percent basalt pebbles; moderately calcareous; few fine lime nodules; moderately alkaline; clear irregular boundary. 5 to 10 inches thick.

B22t—18 to 31 inches; brown (10YR 5/3) light clay loam, dark brown (10YR 4/3) when moist; strong medium subangular blocky structure; very hard when dry, friable when moist; slightly sticky and slightly plastic when wet; few fine and coarse roots; few very fine pores; few thin clay films; many dark mineral grains in the sand- and silt-sized fractions; 5 to 10 percent basalt pebbles; moderately calcareous; few concretions of segregated lime; moderately alkaline; clear irregular boundary. 12 to 20 inches thick.

C1ca—31 to 41 inches; very pale brown (10YR 7/3) loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; common fine and very fine pores; many dark mineral grains in the sand- and silt-sized fractions; 15 percent basalt fragments, mostly pebbles and a few cobblestones; strongly calcareous; lime segregated in concretions and on outside of basalt fragments; moderately alkaline; clear irregular boundary. 6 to 12 inches thick.

C2ca—41 to 66 inches; white (10YR 8/2) cobbly loam, very pale brown (10YR 7/3) when moist; massive; very hard when dry, firm when moist, weakly cemented when wet; many very fine pores; many dark mineral grains in the sand- and silt-sized fractions; 30 percent basalt fragments typically more than 3 inches in diameter; strongly calcareous; moderately alkaline.

The thickness of the solum and the depth of the C1ca horizon is 20 to 40 inches. Basalt bedrock is at a depth of more than 40 inches. Cobblestones or gravel make up 5 to 15 percent of the soil above a depth of 40 inches.

The A horizon is dark grayish brown or brown when dry and dark brown or very dark grayish brown when moist. It is loam, silt loam, or clay loam and is neutral to moderately alkaline.

The B horizon is brown, grayish brown, or pale brown when dry and brown, dark brown, very dark grayish brown, or dark grayish brown when moist. It is clay loam or silty clay loam. Rock fragments make up less than 15 percent of the Cca horizon above a depth of 40 inches, but they commonly make up 15 to 75 percent of that horizon below.

CaC—Capulin loam, 0 to 5 percent slopes. This soil is on valley-filling slopes above basalt-capped terraces. Areas are mostly 10 to 100 acres in size.

Included with this soil in mapping are Torreon soils as slickspots in depressions and Apache and Ayon soils on ridges of basalt and near basalt flows. The Torreon soils make up about 10 percent of the mapped acreage, and the Apache and Ayon soils each make up about 5 percent. Also included near basalt flows is a soil that is similar to this Capulin soil except that basalt bedrock is at a depth of 20 to 40 inches. It makes up about 10 percent of the mapped acreage.

This soil is used for range and wildlife habitat. Irrigated capability unit IIe–6, nonirrigated capability unit IVe–2; Loamy range site.

Ch—Capulin-Apache complex (1 to 9 percent slopes). Capulin loam, 1 to 5 percent slopes, makes up about 50 percent of this complex; Apache cobbly loam, 1 to 9 percent slopes, makes up 15 percent; and Ayon cobbly clay loam, 1 to 5 percent slopes, makes up 15 percent. These soils are in areas of 40 to 640 acres.

The Capulin soil is on alluvial fans and valley sides above basalt-capped terraces. The Apache soil is on ridges, narrow breaks, and fingers of basalt. The Ayon soil is on alluvial-colluvial fans at the mouths of arroyos and at the bases of colluvial slopes. The Capulin and Apache soils have the profiles described as representative for their respective series. The Ayon soil

has a profile similar to the one described as representative of its series except that cobbles make up 25 to 60 percent of the surface layer.

Included with these soils in mapping are Torreon and La Brier soils and a soil that is similar to these Capulin and Apache soils except that bedrock is at a depth of 20 to 40 inches. These included soils each make up about 5 percent of the mapped acreage. The Torreon and La Brier soils are in depressions, and the included moderately deep soil is in transitional areas between the Apache and Capulin soils.

These soils are used for range and wildlife habitat. Nonirrigated capability subclass VIs; Capulin loam in Loamy range site, Apache cobbly loam and Ayon cobbly clay loam in Malpais range site.

Carnero series

The Carnero series consists of well drained soils that are moderately deep over sandstone bedrock. These soils are on upland plateaus. They formed in mixed eolian deposits and residuum weathered from sandstone. Slopes are 0 to 5 percent. Elevation is 4,500 to 6,700 feet. Vegetation is mainly blue grama, sideoats grama, hairy grama, three-awn, galleta, wolftail, winterfat, and broom snakeweed. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 49° to 57° F. The length of the frost free season is 140 to 180 days.

In a representative profile the surface layer is brown loam about 3 inches thick. The subsoil is about 25 inches thick. It is brown clay loam in the upper part and brown clay in the lower part. It rests on sandstone bedrock at a depth of 28 inches. The soil material is noncalcareous and neutral throughout.

Permeability is slow. Runoff is medium. Available water capacity is 3.5 to 5 inches. Effective rooting depth is 20 to 40 inches. The hazards of water erosion and soil blowing are moderate.

These soils are used for range, wildlife, habitat, and water supply.

Representative profile of Carnero loam, from an area of Carnero-Partri complex, in the center of sec. 14, T. 23 N., R. 31 E.:

A1—0 to 3 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 3/2) when moist; weak medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few medium and common fine and very fine roots; many very fine pores; neutral; clear smooth boundary. 2 to 6 inches thick.

B1t—3 to 9 inches; brown (7.5YR 5/4) light clay loam, dark brown (7.5YR 3/3) when moist; weak medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few medium and common fine and very fine roots; common very fine pores; many thin clay films on peds; neutral; clear smooth boundary. 4 to 7 inches thick.

B21t—9 to 13 inches; brown (7.5YR 5/4) heavy clay loam, dark brown (7.5YR 4/3) when moist; moderate medium subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few medium and common fine and very fine roots; few fine and very fine pores; continuous thin clay films on peds; neutral; clear smooth boundary. 3 to 6 inches thick.

B22t—13 to 22 inches; brown (7.5YR 5/4) clay, dark brown (7.5YR 4/4) when moist; strong medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few medium and common fine and very fine roots; few very fine pores; continuous moderately thick clay films on peds; neutral; clear wavy boundary. 6 to 12 inches thick.

B23t—22 to 28 inches; brown (7.5YR 5/4) clay, dark brown (7.5YR 4/4) when moist; strong medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few medium and common fine and very fine roots; few very fine pores; continuous moderately thick clay films on peds; 10 percent subangular gravel; neutral; abrupt wavy boundary. 3 to 9 inches thick.

R—28 inches; fractured sandstone with carbonate coatings on undersides of rocks.

The solum extends to bedrock and ranges from 20 to 40 inches in thickness. Coarse fragments make up 0 to 5 percent of the soil material.

The A horizon is loam, sandy loam, or light clay loam. Structure is weak granular or weak subangular blocky.

The B2t horizon is pale brown, brown, or dark yellowish brown when dry and brown, dark brown, or dark yellowish brown when moist. It is heavy clay loam or clay. The B2t horizon is noncalcareous in the upper part and noncalcareous to moderately calcareous in the lower part. It is neutral to moderately alkaline throughout.

CnC—Carnero loam, 0 to 5 percent slopes. This soil is in areas of 120 to more than 640 acres. These areas are parallel to drainageways and are on uplands.

Included with this soil in mapping, and making up about 10 percent of the mapped acreage, are Travessilla soils and Rock outcrop. A soil that is similar to this Carnero loam but that has less than 35 percent clay in the subsoil is also included. This soil makes up 10 percent of the mapped acreage. Also included are Partri soils, which make up 10 percent, and slickspots from which all of the surface layer has been removed, which make up 5 percent. Travessilla soils and Rock outcrop are around the edges of sandstone breaks and near drainage channels. All other included soils are in flat or concave areas.

This soil is used for range, wildlife habitat, and water supply. Irrigated capability unit IIIe–9, nonirrigated capability subclass VIe; Loamy range site.

Cp—Carnero-Partri complex (0 to 5 percent slopes). Carnero loam, 0 to 5 percent slopes, makes up about

52 percent of this complex, and Partri silty clay loam, 0 to 3 percent slopes, makes up 40 percent. Included soils make up the remaining 8 percent. Areas are 160 acres or more.

The Carnero soil is on low ridges and is intermediate between areas of sandstone ridges and ledges and areas of the Partri soil, which is in flatter areas away from exposures of sandstone in most places. The Carnero and Partri soils each have the profile described as representative of their respective series.

Included with these soils in mapping, and making up about 2 percent each of the mapped acreage, are Escabosa and Travessilla soils, slickspots, and Rock outcrop. Escabosa and Travessilla soils and Rock outcrop are on or near sandstone ridges and ledges. Slickspots, areas in which the subsoil is exposed at the surface, are in depressions.

These soils are used for range and wildlife habitat. Irrigated capability unit IIIe–9, nonirrigated capability subclass VIe; Loamy range site.

Colmor series

The Colmor series consists of deep, well drained soils on uplands. These soils formed in mixed eolian material that was deposited over sandstone or shale. Slopes are 0 to 5 percent. Elevation is 5,400 to 7,000 feet. Vegetation is mainly blue grama, galleta, threeawn, and broom snakeweed. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 46° to 54° F. The length of the frost free season is 140 to 170 days.

In a representative profile the surface layer is brown light silty clay loam about 10 inches thick. The subsoil is brown silty clay loam 20 inches thick. The substratum is pale brown clay loam. Sandstone bedrock is at a depth of 44 inches. The soil material is moderately alkaline and strongly calcareous throughout.

Permeability is moderately slow. Runoff is medium. Available water capacity is 6 to 10 inches. Effective rooting depth is 40 to 60 inches or more. The hazards of soil blowing and water erosion are moderate.

These soils are used for range, wildlife habitat, and water supply.

Representative profile of Colmor silty clay loam, 0 to 5 percent slopes, 50 feet east of gate in the NW¼ SW¼ sec. 3, T. 24 N., R. 30 E.:

A1—0 to 10 inches; brown (10YR 4/3) light silty clay loam, dark brown (10YR 3/3) when moist; weak fine granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; common fine and very fine pores; common fine insect casts; strongly calcareous; moderately alkaline; clear smooth boundary. 9 to 17 inches thick.

B2—10 to 18 inches; brown (10YR 5/3) silty clay loam, brown (10YR 4/3) when moist; weak medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; many fine roots; many fine pores; common fine insect casts; strongly calcareous; moderately alkaline; clear wavy boundary. 6 to 16 inches thick.

B3ca—18 to 30 inches; brown (10YR 5/3) silty clay loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; many fine roots; many fine pores; few fine insect casts; few fine soft lime masses; strongly calcareous; moderately alkaline; clear wavy boundary. 7 to 14 inches thick.

C1ca—30 to 44 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine roots; common fine and very fine pores; few fine threads and soft lime masses; strongly calcareous; moderately alkaline; abrupt wavy boundary. 10 to 20 inches thick.

R—44 inches; sandstone bedrock.

Depth to sandstone or shale bedrock is more than 40 inches. Texture is heavy loam, silt loam, clay loam, or silty clay loam throughout. These soils are moderately to strongly calcareous in the A and B horizons, and higher concentrations of carbonates are in the lower part of the B horizon and in the C horizon.

The A horizon is brown or dark brown when dry. The B horizon is brown, pale brown, or yellowish brown when dry and brown or dark yellowish brown when moist. The Cca horizon is pale brown or very pale brown when dry and pale brown or brown when moist.

CrC—Colmor silty clay loam, 0 to 5 percent slopes. This soil is on uplands around playa lakes in areas of 100 to more than 1,000 acres.

Included with this soil in mapping, and making up 10 percent of the mapped acreage, are Gruver and Sherm soils in depressions. Included Litle and Travessilla soils make up 5 percent. Also included are small areas of Vermejo soils.

This soil is used for range, wildlife habitat, and water supply. Irrigated capability unit IVe–6, nonirrigated capability subclass IVe–2; Clayey range site.

Dalcan series

The Dalcan series consists of well drained soils that are moderately deep to andesite bedrock. These soils are on the sides of ridges and mountains (fig. 8). They formed in residuum and colluvium weathered from andesite. Slopes are 9 to 45 percent. Elevation is 7,200 to 8,700 feet. Vegetation is mainly mountain muhly, pine dropseed, fringed sagebrush, and indiangrass. The average annual precipitation is 18 to 22 inches, and the average annual air temperature is 40° to 45° F. The length of the frost free season is 80 to 110 days.

In a representative profile the surface layer is about 18 inches thick. It is dark gray cobbly silt loam in the upper 6 inches and dark grayish brown cobbly silty clay loam in the lower 12 inches. The subsoil is brown very cobbly clay about 13 inches thick. It rests on fractured andesite bedrock at a depth of 31 inches.

Figure 8.—**View of Dalcan-Rock outcrop complex near the top of Sierra Grande.**

The soil material is noncalcareous and neutral throughout.

Permeability is slow. Runoff is rapid. Available water capacity is 1.5 to 3 inches. Effective rooting depth is 20 to 40 inches. The hazard of water erosion is severe, and the hazard of soil blowing is slight.

These soils are used for range, wildlife habitat, and water supply.

Representative profile of Dalcan cobbly silt loam from an area of Dalcan-Rock outcrop complex, in the SE¼SE¼SE¼ sec. 30, T. 29 N., R. 29 E.:

A1—0 to 6 inches; dark gray (10YR 4/1) cobbly silt loam, black (10YR 2/1) when moist; moderate medium granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; many fine pores; 15 percent angular stones and cobblestones; neutral; clear smooth boundary. 3 to 17 inches thick.

A3—6 to 18 inches; dark grayish brown (10YR 4/2) cobbly silty clay loam, very dark brown (10YR 2/2) when moist; moderate medium granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; many fine pores; 50 percent angular cobblestones and stones; neutral; clear wavy boundary. 0 to 18 inches thick.

B2t—18 to 31 inches; brown (10YR 5/3) very cobbly clay, dark brown (10YR 3/3) when moist; moderate fine granular structure; hard when dry, friable when moist, sticky and plastic when wet; common fine and very fine roots; common fine pores; 70 percent angular cobblestones and stones; neutral; abrupt wavy boundary. 5 to 18 inches thick.

R—31 inches; fractured andesite bedrock.

The depth to bedrock is 20 to 40 inches. The content of rock fragments increases with depth. The profile is mostly noncalcareous, but in places the material directly above or in fractures in the bedrock is slightly calcareous.

The A horizon is silt loam, silty clay loam, loam, or clay loam. It is 10 to 60 percent coarse fragments.

The B2t horizon is pale brown or brown when dry and brown or dark brown when moist. It is clay or silty clay. It is 50 to 90 percent rock fragments.

Da—Dalcan-Rock outcrop complex (9 to 45 percent slopes). Dalcan cobbly silt loam, 9 to 45 percent slopes, makes up about 50 percent of this complex; Rock outcrop makes up 15 percent; and Rubble land makes up

10 percent. The remaining 25 percent is included soils. Areas are more than 640 acres in size and are on Sierra Grande.

Dalcon soils are on the sides and Rock outcrop is on the tops of mountains and ridges. Rubble land is on talus slopes. The Dalcan soil has the profile described as representative of the series.

Included with this complex in mapping, and making up about 15 and 10 percent, respectively, of the mapped acreage, are Raton soils near the top of Sierra Grande and Des Moines soils in less sloping areas.

This complex is used for range, wildlife habitat, and water supply. Nonirrigated capability subclass VIIs; Dalcan cobbly silt loam in Mountain Grassland range site, Rock outcrop not assigned to a range site.

Dallam series

The Dallam series consists of deep, well drained soils on uplands of the High Plains. These soils formed in eolian sediment. Slopes are 0 to 5 percent. Elevation is 4,300 to 6,000 feet. Vegetation is mainly blue grama, side-oats grama, bluestem grasses, small soapweed (yucca), and sand sagebrush. The average annual precipitation is 14 to 17 inches, and the average annual temperature is 49° to 57° F. The length of the frost free season is 165 to 185 days.

In a representative profile the surface layer is brown fine sandy loam 11 inches thick. The subsoil extends to a depth of 72 inches. It is brown, yellowish red, and light reddish brown sandy clay loam. The soil material is noncalcareous in the upper 26 inches, slightly calcareous to a depth of 53 inches, and strongly calcareous below. It is mildly alkaline to a depth of 53 inches and moderately alkaline below.

Permeability is moderate. Runoff is slow or medium. Available water capacity is 7.5 to 10 inches. Effective rooting depth is 60 inches or more.

These soils are used for range, irrigated crops, pasture, nonirrigated crops, and wildlife habitat.

Representative profile of Dallam fine sandy loam, 0 to 5 percent slopes, 880 feet north and 350 feet west of the south quarter corner of sec. 35, T. 19 N., R. 36 E.:

A1—0 to 11 inches; brown (7.5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak fine granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; many very fine interstitial pores; mildly alkaline; clear smooth boundary. 5 to 14 inches thick.

B21t—11 to 26 inches; brown (7.5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) when moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard when dry, friable when moist, sticky and plastic when wet; many fine and very fine roots; few fine and many very fine pores; continuous thin clay films on peds; mildly alkaline; clear wavy boundary. 8 to 18 inches thick.

B22tca—26 to 36 inches; yellowish red (5YR 5/6) heavy sandy clay loam, reddish brown (5YR 4/4) when moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard when dry, firm when moist, sticky and plastic when wet; many fine and very fine roots; few fine and many very fine pores; continuous thin clay films on peds; slightly calcareous; mildly alkaline; gradual wavy boundary. 6 to 20 inches thick.

B23tca—36 to 53 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) when moist; weak medium subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; few very fine pores; few thin clay films on peds; few small soft masses and threads of lime; slightly calcareous; mildly alkaline; clear wavy boundary. 12 to 20 inches thick.

B24tca—53 to 72 inches; light reddish brown (5YR 6/4) sandy clay loam, reddish yellow (5YR 6/6) when moist; weak medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many fine pores; many medium and large soft masses of lime; strongly calcareous; moderately alkaline.

Depth to a horizon of lime accumulation is 16 to 32 inches. The solum is more than 60 inches thick.

The A horizon is brown or reddish brown when dry and dark brown or dark reddish brown when moist. It is loamy sand or fine sandy loam.

The B2t horizon is brown, reddish brown, light reddish brown, or yellowish red when dry and reddish brown, reddish yellow, or yellowish red when moist. It is sandy clay loam or clay loam and is mildly or moderately alkaline.

DhC—Dallam loamy sand, 0 to 5 percent slopes. This soil is in areas of dunes. Mapped areas are 160 to 640 acres in size and vary in shape. This soil has a profile similar to the one described as representative of the series except that the surface layer is loamy sand as much as 20 inches thick or more.

Included with this soil in mapping, and making up 10 percent of the mapped acreage, is a soil that is similar to this Dallam soil except that it is calcareous to the surface. Also included are Spurlock loamy sand, which makes up 5 percent; Valent and Vingo soils, which together make up 5 percent; and Rickmore soils, which make up less than 1 percent. The soil that is similar to this Dallam soil is in smoother areas. Spurlock, Valent, and Vingo soils are in areas of dunes. Rickmore soils are in depressions.

The hazard of soil blowing is severe, and the hazard of water erosion is slight. Runoff is slow. These soils are used for range, wildlife habitat, and irrigated and nonirrigated crops. Irrigated capability unit IIIe–10, nonirrigated capability unit IVe–3; Deep Sand range site.

DmC—Dallam fine sandy loam, 0 to 5 percent slopes. This soil is in areas of 160 to 640 acres. It has the profile described as representative of the series.

Included with this soil in mapping, and making up

10 percent of the mapped acreage, is a soil that is similar to this Dallam soil except that it is calcareous to the surface. Also included are Dallam loamy sand and Vingo loamy sand, which together make up 5 percent, and Rickmore soils, which make up 5 percent. The included Dallam and Vingo soils are in areas of dunes and on the leeward sides of dunes. Included soils of limited extent are Valent loamy sand and Spurlock loamy sand.

Runoff is slow or medium. The hazards of water erosion and soil blowing are moderate. The soil is used for irrigated and nonirrigated crops, range, and wildlife habitat. Irrigated capability unit IIIe–4, nonirrigated capability unit IVe–1; Sandy range site.

Des Moines series

The Des Moines series consists of deep, well drained soils on the sides of mountains and ridges. These soils formed in alluvium, colluvium, and residuum weathered from mixed igneous rocks. Slopes are 15 to 70 percent. Elevation is 7,000 to 8,200 feet. Vegetation is mainly mountain muhly, blue grama with an overstory of oneseed juniper, pinon pine, and ponderosa pine. The average annual precipitation is 18 to 22 inches, and the average annual air temperature is 42° to 45° F. The length of the frost free season is 90 to 142 days.

In a representative profile the surface layer is very dark grayish brown cobbly silt loam about 4 inches thick. The subsoil is about 32 inches thick. It is very dark grayish brown very cobbly silty clay in the upper part and dark grayish brown very cobbly silty clay in the lower part. The substratum to a depth of 48 inches is light yellowish brown very stony sandy clay loam. The soil material is noncalcareous and neutral to a depth of 36 inches and slightly calcareous and mildly alkaline below.

Permeability is slow. Runoff is rapid. Available water capacity is 2.5 to 5 inches. Effective rooting depth is more than 40 inches. The hazard of water erosion is severe, and the hazard of soil blowing is slight.

These soils are used for range, wildlife habitat, and water supply.

Representative profile of Des Moines cobbly silt loam, from an area of Des Moines-Rock outcrop complex, 2,300 feet north and 700 feet east of the southwest corner of sec. 30, T. 29 N., R. 29 E.:

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) cobbly silt loam, black (10YR 2/1) when moist; weak fine granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; common very fine pores; 20 percent gravel, cobblestones, and stones; neutral; clear smooth boundary. 4 to 18 inches thick.

B1—4 to 18 inches; very dark grayish brown (10YR 3/2) very cobbly silty clay loam, very dark gray (10YR 3/1) when moist; moderate fine subangular blocky structure; hard when dry, very friable when moist, sticky and plastic when wet; many fine roots; many very fine pores; 60 percent gravel, cobblestones, and stones; neutral; abrupt irregular boundary. 4 to 14 inches thick.

B2t—18 to 36 inches; dark grayish brown (10YR 4/2) very cobbly silty clay, very dark grayish brown (10YR 3/2) when moist; strong fine angular and subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; few fine and very fine roots; few very fine pores; 30 percent gravel and cobblestones and 30 percent stones; many moderately thick clay films on peds; neutral; abrupt irregular boundary. 13 to 40 inches thick.

C—36 to 48 inches; light yellowish brown (10YR 6/4) very stony sandy clay loam, dark yellowish brown (10YR 4/4) when moist; massive; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; few fine and very fine pores; 50 percent stones and boulders and 40 percent cobblestones and gravel; slightly calcareous; mildly alkaline.

The solum is 24 to 60 inches thick. Depth to bedrock is more than 40 inches. Some profiles have an organic surface horizon 1 to 3 inches thick.

The A horizon is very dark grayish brown, very dark gray, or dark grayish brown when dry and dark brown, very dark brown, or black when moist. Stones, cobblestones, and gravel make up 20 to 75 percent of the A horizon. Texture is loam, silt loam, or light clay loam.

The B2t horizon is brown, dark brown, or dark grayish brown when dry and dark brown, very dark grayish brown, or very dark brown when moist. It is 40 to 90 percent cobblestones, stones, and gravel. Texture is clay, silty clay, or heavy silty clay loam.

The profile does not include a C horizon in some places where bedrock is directly below the B2t horizon. The C horizon, when present, is 75 to 90 percent gravel, cobblestones, stones, and boulders.

Dr—Des Moines-Rock outcrop complex (15 to 70 percent slopes). Des Moines cobbly silt loam, 15 to 70 percent slopes, makes up 60 percent of this complex, and Rock outcrop makes up 15 percent. The remaining 25 percent is included soils. Areas are 160 to 640 acres in size.

Des Moines soils are on the sides of mountains and ridges, and Rock outcrop is on ridgetops and in areas of the Des Moines soils. The Des Moines soil has the profile described as representative of the series.

Included with this complex in mapping, and making up 10 percent each of the mapped acreage, are Dalcan and Raton soils. These soils are in areas of transition between Des Moines soils and Rock outcrop. Also included is an undifferentiated colluvial soil in waterways and near recent slides. This soil makes up 5 percent of the mapped acreage.

This complex is used for range, wildlife habitat, and water supply. Nonirrigated capability subclass VIIs; Des Moines cobbly silt loam in Mountain Grassland range site, Rock outcrop not assigned to a range site.

Dioxice series

The Dioxice series consists of deep, well drained soils on uplands. These soils formed in mixed alluvial and eolian material over old caliche beds. Slopes are 0 to 5 percent. Elevation is 5,000 to 7,000 feet. Vegetation is mainly blue grama, side-oats grama, and buffalograss. The average annual precipitation is 15 to 18 inches, and the average annual air temperature is 49° to 54° F. The length of the frost free season is 140 to 180 days.

In a representative profile the surface layer is grayish brown loam 4 inches thick. The subsoil is about 20 inches thick. It is grayish brown silty clay loam in the upper part and pale brown clay loam in the lower part. The substratum is very pale brown loam. Indurated caliche is at a depth of 46 inches. The soil material is slightly calcareous in the upper 13 inches, moderately calcareous in the next 11 inches, and strongly calcareous below. Reaction is mildly alkaline in the upper 4 inches and moderately alkaline below.

Permeability is moderate. Runoff is medium. Available water capacity is 5 to 10 inches. Effective rooting depth is 40 inches or more. The hazards of water erosion and soil blowing are moderate.

These soils are used for range and wildlife habitat.

Representative profile of Dioxice loam, 0 to 5 percent slopes, 0.3 mile north and 0.1 mile west of the southeast corner of sec. 8, T. 24 N., R. 31 E.:

A1—0 to 4 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; many fine and very fine roots; few very fine pores; slightly calcareous; mildly alkaline; clear smooth boundary. 2 to 6 inches thick.

B21—4 to 13 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard when dry, friable when moist, sticky and plastic when wet; many very fine and fine roots; few fine and common very fine pores; slightly calcareous; moderately alkaline; gradual smooth boundary. 5 to 15 inches thick.

B22ca—13 to 24 inches; pale brown (10YR 6/3) clay loam, dark brown (10YR 4/3) when moist; moderate medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; common fine and very fine roots; few fine and very fine pores; moderately calcareous; moderately alkaline; clear smooth boundary. 6 to 22 inches thick.

C1ca—24 to 46 inches; very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; common very fine pores; 15 percent caliche fragments; strongly calcareous; moderately alkaline. 7 to 26 inches thick.

C2cam—46 inches; fractured indurated caliche.

The solum is 24 to 40 inches thick above the Cca horizon. Depth to indurated caliche is more than 40 inches.

The A1 horizon is grayish brown, brown, or dark brown when dry and very dark grayish brown or dark brown when moist. It is loam or clay loam. The A horizon is mildly or moderately alkaline and slightly calcareous.

The B horizon is pale brown, grayish brown, or brown when dry and dark brown, very dark grayish brown, or brown when moist. It is clay loam or silty clay loam.

Caliche fragments make up 5 to 35 percent of the Cca horizon.

DxC—Dioxice loam, 0 to 5 percent slopes. This soil is gently sloping on uplands in areas of 40 to 400 acres. It has the profile described as representative of the series.

Included with this soil in mapping are Spurlock and Colmor soils in no regular pattern and Plack soils on ridges and hills. These soils make up 10, 5, and 5 percent, respectively, of the mapped acreage.

This soil is used for range and wildlife habitat. Irrigated capability unit IIIe–6, nonirrigated capability unit IVe–1; Loamy range site.

Escabosa series

The Escabosa series consists of well drained soils that are moderately deep over bedrock. These soils are on uplands. They formed in residuum and alluvium derived from sandstone mixed with eolian material. Slopes are 3 to 5 percent. Elevation is 4,500 to 7,200 feet. Vegetation is mainly blue grama, side-oats grama, and scattered small soapweed (yucca). The average annual precipitation is 14 to 17 inches, and the average annual air temperature is 49° to 56° F. The frost free season is 150 to 180 days.

In a representative profile (fig. 9) the surface layer is brown loam about 8 inches thick. The subsoil is brown loam and clay loam 10 inches thick. The substratum is very pale brown gravelly loam that rests on dense sandstone bedrock at a depth of 36 inches. The profile is slightly calcareous in the upper 8 inches and strongly calcareous below. It is moderately alkaline throughout. Lime has accumulated below a depth of about 13 inches.

Permeability is moderate. Runoff is medium. Available water capacity is 3 to 6 inches. Effective rooting depth is 20 to 40 inches. The hazards of soil blowing and water erosion if the soil is left bare are moderate.

These soils are used for range and wildlife habitat.

Representative profile of Escabosa loam, 3 to 5 percent slopes, 0.2 mile east and 0.2 mile south of the northwest corner of sec. 34, T. 29 N., R. 34 E.:

A1—0 to 8 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) when moist; weak medium subangular blocky structure; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; many fine roots; few fine and many very fine pores; slightly calcareous; mod-

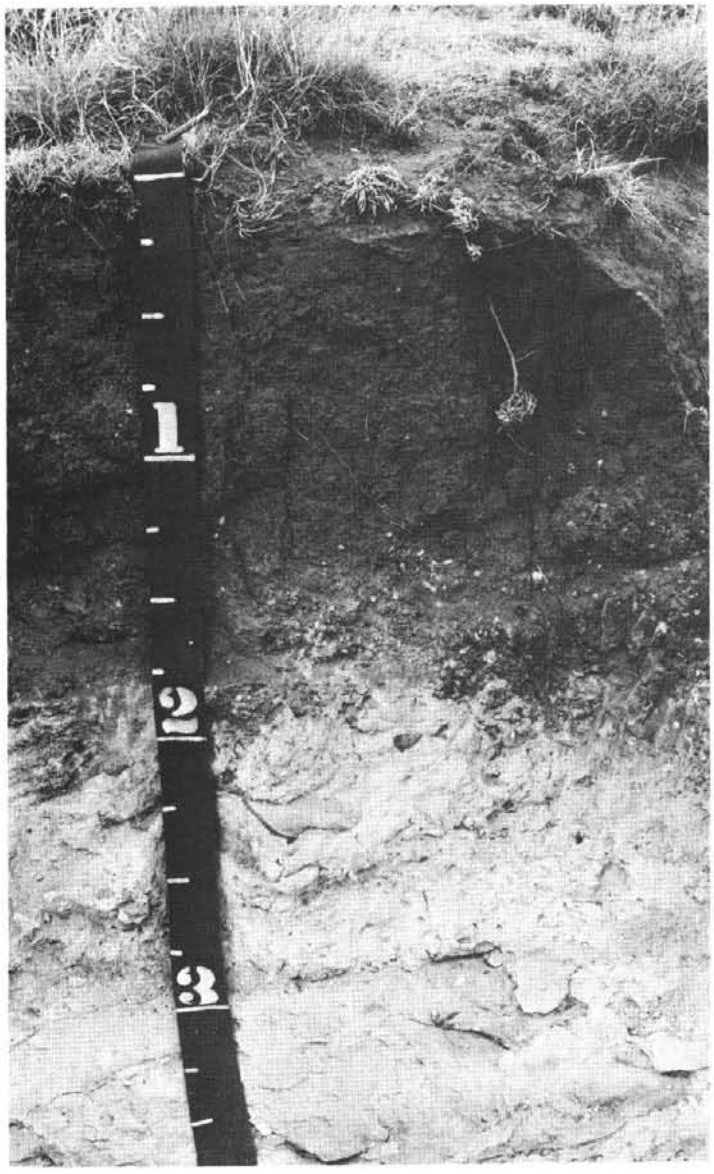

Figure 9.—**Profile of Escabosa loam, 3 to 5 percent slopes.**

erately alkaline; clear smooth boundary. 5 to 12 inches thick.

B2—8 to 13 inches; brown (10YR 4/3) loam, brown (10YR 4/3) when moist; weak medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine and many very fine pores; strongly calcareous; moderately alkaline; clear smooth boundary. 5 to 12 inches thick.

B3ca—13 to 18 inches; brown (10YR 5/3) clay loam, dark yellowish brown (10YR 4/4) when moist; weak medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; few fine and many very fine pores; strongly calcareous; moderately alkaline; abrupt smooth boundary. 3 to 10 inches thick.

Cca—18 to 36 inches; very pale brown (10YR 8/4) gravelly loam, very pale brown (10YR 7/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine roots; many fine and very fine pores; 20 percent lime-coated gravel; strongly calcareous; moderately alkaline; abrupt smooth boundary. 7 to 20 inches thick.

R–36 inches; sandstone bedrock.

Depth to bedrock is 20 to 40 inches. Depth to the Cca horizon is 12 to 30 inches.

The A horizon is sandy loam, loam, or clay loam. The B horizon is loam or clay loam and is 0 to 15 percent coarse fragments. The Cca horizon is 5 to 35 percent gravel or cobblestones—usually fragments of the underlying bedrock. Bedrock is sandstone in most places but is hard shale or limestone in some places.

EsC—Escabosa loam, 3 to 5 percent slopes. This soil is on rounded hills and uplands in areas of 40 to 400 acres.

Included with this soil in mapping, and making up about 10 percent each of the mapped acreage, are Spurlock and Travessilla soils. Also included, and making up about 5 percent each, are Carnero and Partri soils and Rock outcrop. Spurlock soils are in no regular pattern on the landscape. Travessilla soils and Rock outcrop are along drainage channels and on ridgetops. Partri and Carnero soils are in flatter areas and along old drainage channels. Small areas of Litle, Plack, and Texline soils are also included.

Escabosa soils are used for range and wildlife habitat. Nonirrigated capability subclass VIe; Shallow range site.

Fallsam series

The Fallsam series consists of deep, well drained soils on the sides of basalt squeeze-ups and ridges. These soils formed in residuum weathered from basalt modified by eolian material. Slopes are 1 to 9 percent. Elevation is 6,400 to 7,800 feet. Vegetation is mainly blue grama, side-oats grama, western wheatgrass, bluestem grasses, skunkbush sumac, and oneseed juniper. The average annual precipitation is 15 to 18 inches, and the average annual air temperature is 45° to 49° F. The length of the frost free season is 120 to 150 days.

In a representative profile the surface layer is about 9 inches thick. It is dark grayish brown cobbly silt loam in the upper part and dark brown cobbly silty clay loam in the lower part. The subsoil to a depth of 38 inches is brown very cobbly clay. To a depth of 46 inches it is brown very cobbly clay loam. The soil material is noncalcareous and neutral throughout.

Permeability is slow. Runoff is medium. Available water capacity is 2 to 5 inches. Effective rooting depth is 40 inches or more. The hazards of soil blowing and water erosion are slight.

These soils are used for range and wildlife habitat.

Representative profile of Fallsam cobbly silt loam,

from an area of Fallsam-Rock outcrop complex, 2,600 feet west and 2,450 feet south of the northeast corner of sec. 27, T. 30 N., R. 28 E.:

A1—0 to 5 inches; dark grayish brown (10YR 4/2) cobbly silt loam, very dark grayish brown (10YR 3/2) when moist; weak fine subangular blocky structure; soft when dry, very friable when moist, slightly sticky and plastic when wet; many fine roots; few very fine pores; 20 percent basalt cobblestones and gravel; neutral; clear irregular boundary. 3 to 10 inches thick.

A3—5 to 9 inches; dark brown (10YR 4/3) cobbly silty clay loam, dark brown (10YR 3/3) when moist; moderate, fine, subangular blocky and blocky structure; hard when dry, very friable when moist, slightly sticky and plastic when wet; common fine roots; few fine and very fine pores; few thin clay films; 30 percent basalt cobblestones and gravel; neutral; abrupt irregular boundary. 0 to 6 inches thick.

B2t—9 to 38 inches; brown (10YR 5/3) very cobbly clay, dark brown (10YR 3/3) when moist; strong fine blocky structure; very hard when dry, extremely firm when moist, sticky and plastic when wet; few fine roots; few very fine pores; many thin clay films on peds and coating coarse fragments; 70 percent cobblestones and gravel; neutral; gradual irregular boundary. 15 to 40 inches thick.

B3t—38 to 46 inches; brown (7.5YR 5/4) very cobbly clay loam, dark brown (7.5YR 4/4) when moist; strong fine granular structure; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; very few fine roots; few very fine pores; 80 to 90 percent gravel, cobblestones, and stones; neutral.

The solum ranges from 25 to 50 inches in thickness, and depth to bedrock is more than 40 inches.

The A horizon is brown, dark grayish brown, or dark brown when dry and dark brown or very dark grayish brown when moist. It is loam, silt loam, or silty clay loam and is 15 to 75 percent rock fragments.

The B2t horizon is brown, dark grayish brown, or grayish brown when dry and dark brown or very dark grayish brown when moist. It is very cobbly clay or very cobbly silty clay and is neutral or mildly alkaline. The B3t horizon is pale brown or brown when dry and brown or dark brown when moist. It is 70 to 90 percent rock fragments. The B3t horizon is noncalcareous or slightly calcareous and neutral or mildly alkaline.

Fr—Fallsam-Rock outcrop complex (1 to 9 percent slopes). Fallsam cobbly silt loam, 1 to 9 percent slopes, makes up 50 percent of this complex, and Rock outcrop makes up 25 percent. Included soils make up the remaining 25 percent. Areas are larger than 500 acres.

The Fallsam soil is on the sides of basalt squeeze-ups and ridges, and Rock outcrop is on the tops.

Included with this complex in mapping are Apache soils, which make up 10 percent of the mapped acreage; La Brier soils, which make up 10 percent; and Raton soils, which make up 5 percent. Apache soils are near Rock outcrop, La Brier soils are in small valleys and drainage channels, and Raton soils are on the edges of the basalt flows or on small hills.

This complex is used for range and wildlife habitat. Nonirrigated capability subclass VIIs; Fallsam cobbly silt loam in Malpais range site, Rock outcrop not assigned to a range site.

Gruver series

The Gruver series consists of deep, well drained soils on uplands. These soils formed in mixed alluvium weathered from High Plains sedimentary formations. Slopes are 0 to 3 percent. Elevation is 4,500 and 6,500 feet. Vegetation is mainly blue grama, hairy grama, and buffalograss. The average annual precipitation is 14 to 17 inches, and the average annual air temperature is 50° to 57° F. The length of the frost free season is 140 to 185 days.

In a representative profile (fig. 10) the surface layer is brown loam about 6 inches thick. The subsoil extends to a depth of 80 inches or more. To a depth of 26 inches it is brown heavy clay loam and brown sandy clay loam. To a depth of 74 inches it is light brown and reddish yellow sandy clay loam. Below this it is reddish yellow clay. The soil material is noncalcareous and neutral to moderately alkaline in the upper 26 inches and calcareous and moderately alkaline below.

Permeability is moderately slow. Runoff is medium. Available water capacity is 7.5 to 10 inches. Effective rooting depth is 60 inches or more. The hazards of water erosion and soil blowing are moderate.

These soils are used for range, irrigated and nonirrigated crops, and wildlife habitat.

Representative profile of Gruver loam in the center of the SE¼SE¼NE¼ sec. 35, T. 28 N., R. 35 E.:

A1—0 to 6 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) when moist; weak very fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; few fine and very fine pores; neutral; clear smooth boundary. 4 to 10 inches thick.

B21t—6 to 12 inches; brown (10YR 4/3) heavy clay loam, dark brown (10YR 3/3) when moist; moderate medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many very fine roots; few fine and very fine pores; common thin clay films on peds; neutral; clear smooth boundary. 4 to 10 inches thick.

B22t—12 to 18 inches; brown (10YR 5/3) heavy clay loam, brown (10YR 4/3) when moist; moderate medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; many very fine roots; few fine and very fine pores; many thin clay films on peds; mildly alkaline; clear smooth boundary. 5 to 14 inches thick.

Figure 10.—**Profile of Gruver loam.**

B23t—18 to 26 inches; brown (7.5YR 5/4) sandy clay loam, brown (7.5YR 4/4) when moist; moderate medium subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few fine roots; few fine and common very fine pores; mildly alkaline; clear smooth boundary. 6 to 16 inches thick.

B24tca—26 to 43 inches; light brown (7.5YR 6/4) sandy clay loam; brown (7.5YR 4/4) when moist; moderate coarse subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few fine roots; common fine and many very fine pores; thin patchy clay films; common threads and soft masses of lime; moderately calcareous; moderately alkaline; clear smooth boundary. 10 to 20 inches thick.

B25tca—43 to 59 inches; reddish yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 4/6) when moist; moderate coarse prismatic structure; slightly hard when dry, friable when moist, sticky and plastic when wet; few very fine roots; common fine and very fine pores; thin patchy clay films; common threads and soft masses of lime; moderately calcareous; moderately alkaline; clear wavy boundary. 0 to 20 inches thick.

B26tca—59 to 74 inches; light brown (7.5YR 6/4) heavy sandy clay loam, yellowish red (5YR 4/6) when moist; weak coarse prismatic structure; slightly hard, friable when moist, slightly sticky and plastic when wet; very few very fine roots; common very fine pores; thin patchy clay films; common threads and soft masses of lime; strongly calcareous; moderately alkaline; clear wavy boundary. 7 to 20 inches thick.

B27t—74 to 80 inches; reddish yellow (5YR 6/6) clay, yellowish red (5YR 4/8) when moist; weak coarse prismatic structure; slightly hard when dry, friable when moist, sticky and plastic when wet; no roots; few very fine pores; slightly calcareous; moderately alkaline.

The solum is more than 60 inches thick in most places. The A horizon is brown or grayish brown when dry and dark brown or very dark grayish brown when moist. It is fine sandy loam, loam, or clay loam and it is neutral or mildly alkaline.

The upper few inches of the B21t horizon typically have the same colors as the A horizon. Below this, the B2t horizon is light brown, reddish yellow, or brown when dry and dark yellowish brown, brown, or yellowish red when moist. Texture of the upper part of the B2t horizon is heavy clay loam and is 35 to 40 percent clay. The lower part of the B2t horizon is clay loam or sandy clay loam. The B2t horizon is dominantly mildly or moderately alkaline. Calcium carbonate equivalent in the B24tca horizon ranges from 5 to 20 percent. Calcium carbonate equivalent in the B25tca horizon is 15 to 30 percent.

Gr—Gruver loam (0 to 3 percent slopes). This soil is in areas of 10 to 400 acres on uplands. Slopes are 0 to 3 percent.

Included with this soil in mapping are Dallam soils on low hills and ridges and La Brier and Sherm soils in depressions and along water channels. These soils each make up 5 percent of the mapped acreage. Also included, and making up about 10 percent, is a soil that is similar to this Gruver loam but in which the upper part of the subsoil is light clay loam.

This soil is used for range, irrigated and nonirrigated crops, and wildlife habitat. Irrigated capability unit IIIe–8, Nonirrigated capability unit IIIe–2; Loamy range site.

Guy series

The Guy series consists of deep, well drained soils on gravelly hills. These soils formed in eroded High Plains sediment derived mainly from the Ogallala Formation. Slopes are 1 to 9 percent. Elevation is 4,300 to 5,800 feet. Vegetation is mainly blue grama, sand dropseed, three-awn, small soapweed (yucca), and broom snakeweed. The average annual precipitation is 14 to 17 inches, and the average annual air temperature is 49° to 55° F. The length of the frost free season is 160 to 180 days.

In a representative profile (fig. 11) the surface layer is dark grayish brown and grayish brown gravelly loam about 15 inches thick. The substratum is white gravelly sandy loam to a depth of 24 inches, pale brown sandy loam to a depth of 40 inches, and pale brown gravelly loamy sand to a depth of 60 inches or more. The soil material is moderately alkaline and calcareous throughout. Lime is concentrated in the upper part of the substratum.

Permeability is moderately rapid. Runoff is medium. Available water capacity is 3 to 6 inches. Effective rooting depth is 60 inches or more. The hazards of soil blowing and water erosion are moderate.

These soils are used for range and wildlife habitat.

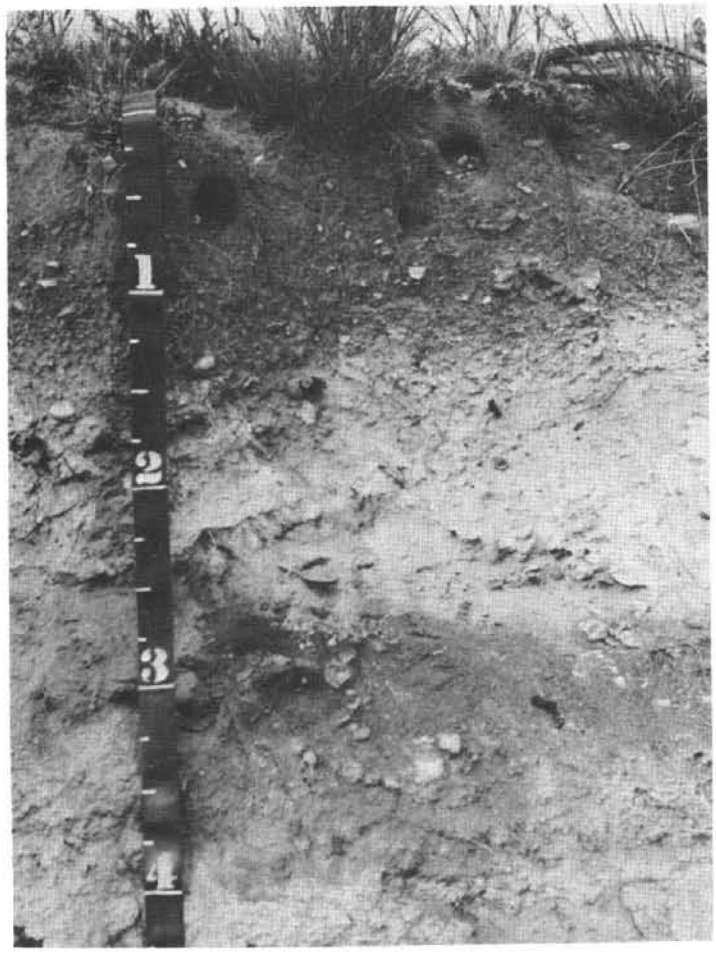

Figure 11.—Profile of Guy gravelly loam in an area of the Guy-Texline complex.

Representative profile of Guy gravelly loam from an area of Guy-Texline complex, 0.05 mile north and 0.05 mile west of the SE corner of sec. 34, T. 28 N., R. 33 E.:

A11—0 to 7 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak and moderate medium subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; few fine and very fine pores; 15 percent gravel with 30 percent of the surface covered with gravel; moderately calcareous; moderately alkaline; abrupt smooth boundary. 5 to 12 inches thick.

A12—7 to 15 inches; grayish brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak and moderate medium subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; few fine and very fine pores; 30 percent gravel; common hard lime masses; strongly calcareous; moderately alkaline; clear wavy boundary. 5 to 10 inches thick.

C1ca—15 to 24 inches; white (10YR 8/2) gravelly sandy loam, very pale brown (10YR 7/3) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; few fine and common very fine pores; 40 percent gravel; strongly calcareous; moderately alkaline; abrupt wavy boundary. 8 to 24 inches thick.

C2—24 to 40 inches; pale brown (10YR 6/3) heavy sandy loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; no roots; few fine and very fine pores; 10 percent gravel; strongly calcareous; moderately alkaline; clear wavy boundary. 0 to 20 inches thick.

C3—40 to 60 inches; very pale brown (10YR 7/3) gravelly loamy sand, pale brown (10YR 6/3) when moist; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; many fine pores; 35 percent gravel; strongly calcareous; moderately alkaline.

Guy soils have a veneer of water-worn gravel, cobblestones, and a few stones covering about 10 to 40 percent of the surface in most places. Depth to the C1ca horizon is 10 to 20 inches. Texture between depths of 10 and 40 inches averages sandy loam with 10 to 35 percent gravel.

The A horizon is brown, dark grayish brown, or grayish brown when dry and dark brown, very dark brown, or very dark grayish brown when moist. It is sandy loam or loam and is 5 to 40 percent gravel.

The Cca horizon is light gray or white when dry and light brownish gray or very pale brown when moist. It is gravelly loam, gravelly sandy loam, sandy loam, or gravelly loamy sand. The calcium

carbonate equivalent of the Cca horizon ranges from 15 to 40 percent.

Gt—Guy-Texline complex (1 to 9 percent slopes). Guy gravelly loam, 1 to 9 percent slopes, makes up about 50 percent of this complex, and Texline loam, 1 to 5 percent slopes, makes up 30 percent. Included soils make up the remaining 20 percent. Most areas are larger than 300 acres.

The Guy soil is on low gravelly hills and ridges. The Texline soil is on alluvial fans in valleys between ridges and hills. The Guy soil has the profile described as representative of its series, and the Texline soil has a profile similar to the one described as representative of its series.

Included with these soils in mapping, and making up about 10 percent of the mapped acreage, are soils that are similar to this Texline soil except that they have a sandy loam subsoil. They are on alluvial fans. Also included, and making up about 10 percent, are Dallam and Spurlock soils on low hills and ridges.

These soils are used for range and wildlife habitat. Nonirrigated capability subclass VIe; Guy soil in Shallow range site, Texline soil in Loamy range site.

Kim series

The Kim series consists of deep, well drained soils on foot slopes and alluvial fans. These soils formed in mixed deposits of alluvium. Slopes are 1 to 9 percent. Elevation is 4,400 to 6,400 feet. Vegetation is mainly blue grama, side-oats grama, galleta, three-awn, sand dropseed, small soapweed (yucca), and cholla. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 49° to 57° F. The length of the frost free season is 140 to 185 days.

In a representative profile (fig. 12) the surface layer is brown loam about 8 inches thick. The substratum is brown and light brown clay loam to a depth of 60 inches. The soil material is slightly calcareous in the upper 8 inches and strongly calcareous below. It is mildly alkaline to a depth of 13 inches and moderately alkaline below.

Permeability is moderate. Runoff is medium. Available water capacity is 8 to 10 inches. Effective rooting depth is 60 inches or more. The hazards of water erosion and soil blowing are moderate.

These soils are used for range, wildlife habitat, and water supply.

Representative profile of Kim loam from an area of Kim-Manzano association, SE¼NE¼SW¼ sec. 23, T. 29 N., R. 33 E.:

A1—0 to 8 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak fine granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; few fine and very fine pores; slightly calcareous; mildly alkaline; clear smooth boundary. 6 to 12 inches thick.

C1—8 to 13 inches; brown (7.5YR 5/4) light clay loam, dark brown (7.5YR 4/4) when moist; weak medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; few fine and common very fine pores; strongly calcareous; mildly alkaline; abrupt smooth boundary. 4 to 20 inches thick.

C2—13 to 28 inches; light brown (7.5YR 6/4) clay loam, dark brown (7.5YR 4/4) when moist; weak medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; common fine and very fine roots; few fine and common very fine pores; 5 percent fine soft lime masses; strongly calcareous; moderately alkaline; abrupt wavy boundary. 8 to 16 inches thick.

C3—28 to 60 inches; light brown (7.5YR 6/4) clay loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine and very fine roots; few fine and many very

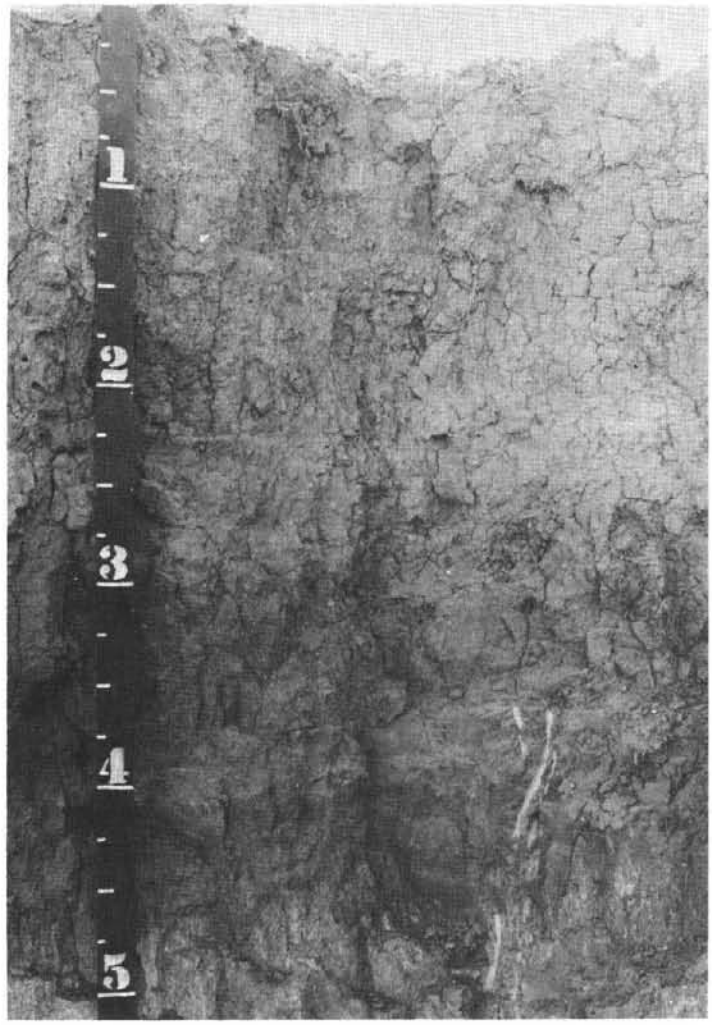

Figure 12.—**Profile of Kim loam in an area of the Kim-Manzano association.**

fine pores; few thin lime filaments; strongly calcareous; moderately alkaline.

Gravel makes up 0 to 5 percent of this profile. Reaction is mildly alkaline to moderately alkaline throughout the profile.

The A1 horizon is grayish brown or brown when dry and brown, dark brown, or dark grayish brown when moist. It is sandy loam to heavy loam.

The C horizon is light gray, gray, light brown, pale brown, or brown when dry and brown, light grayish brown, grayish brown, or dark brown when moist. It is loam, clay loam, or sandy clay loam. Calcium carbonate masses make up 0 to 15 percent, by volume, of the C horizon.

KaD—Kim sandy loam, 1 to 9 percent slopes. This soil is on uplands surrounding playa lakes in areas of 40 to 300 acres. This soil has a profile that is similar to the one described as representative of the series except that the surface layer is sandy loam and the soil is more olive throughout.

Included with this soil in mapping are Colmor, Dioxice, and Spurlock soils in no regular pattern. These soils make up, respectively, about 10, 5, and 5 percent of the mapped acreage. Also included, and making up about 1 percent each, are Vermejo and Litle soils around the playa lakes.

These soils are used for range, wildlife habitat, and water supply. Nonirrigated capability subclass VIe; Sandy range site.

Km—Kim-Manzano association (0 to 9 percent slopes). Kim loam, 3 to 9 percent slopes, makes up about 60 percent of this association, and Manzano loam, 0 to 3 percent slopes, makes up about 20 percent. Included soils make up the remaining 20 percent. Areas are long and narrow and 60 to 300 acres in size in most places.

The Kim soil is on alluvial fans leading to stream channels. The Manzano soil is along stream channels on flood plains. The Kim and Manzano soils each have the profile described as representative of their respective series.

Included with these soils in mapping are Texline soils on alluvial fans and Gruver soils in depressions. These soils make up, respectively, about 10 and 5 percent of the mapped acreage. Also included, and making up about 5 percent, are Carnero, La Brier, and Travessilla soils.

These soils are used for range, wildlife habitat, and water supply. A few small areas are used for irrigated crops. Kim loam in irrigated capability unit IVe–6, nonirrigated capability unit IVe–2; Manzano loam in irrigated capability unit IIe–6, nonirrigated capability unit IVe–2; Loamy range site.

La Brier series

The La Brier series consists of deep, well drained soils in concave swales in valley fill and on valley bottoms. These soils formed in alluvium weathered from mixed sources. Slopes are 0 to 3 percent. Elevation is 4,500 to 7,000 feet. The vegetation is mainly blue grama, western wheatgrass, alkali sacaton, and galleta. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 47° to 57° F. The length of the frost free season is 140 to 180 days.

In a representative profile (fig. 13) the surface layer is very dark grayish brown silty clay loam about 13 inches thick. The subsoil is grayish brown clay and heavy silty clay loam 36 inches thick. The substratum is grayish brown silty clay loam to a depth of 77 inches. The soil material is noncalcareous in the upper 13 inches and calcareous below. Lime content increases with depth. The soil material is moderately alkaline throughout.

Permeability is very slow. Runoff is medium. Available water capacity is 8.5 to 10 inches. Effective rooting depth is more than 60 inches. The hazards of soil blowing and water erosion are moderate.

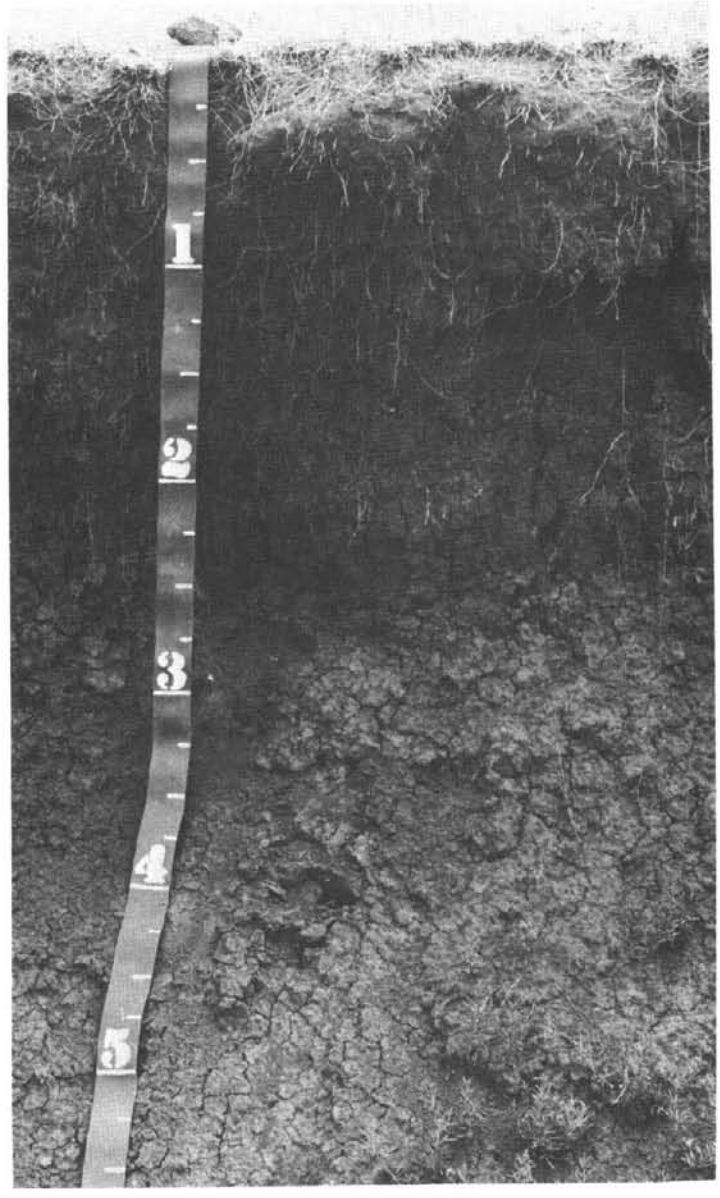

Figure 13.—Profile of La Brier silty clay loam in an area of the La Brier-Rock outcrop complex.

These soils are used for range, irrigated and nonirrigated crops, and wildlife habitat.

Representative profile of La Brier silty clay loam, 1,500 feet north and 315 feet west of the SE corner of sec. 7, T. 26 N., R. 36 E.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate medium granular structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; few very fine pores; moderately alkaline; clear smooth boundary. 0 to 9 inches thick.

A3—9 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak medium prismatic structure parting to moderate, fine, subangular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; common very fine pores; moderately alkaline; clear smooth boundary. 4 to 13 inches thick.

B21t—13 to 22 inches; grayish brown (10YR 5/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak medium prismatic structure parting to moderate, medium and fine, subangular blocky; hard when dry, firm when moist, sticky and slightly plastic when wet; common very fine roots; common very fine pores; many thin clay films on prism surfaces; slightly calcareous; moderately alkaline; clear smooth boundary. 5 to 12 inches thick.

B22t—22 to 34 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; weak medium prismatic structure parting to moderate, medium, subangular blocky; very hard when dry, firm when moist, sticky and plastic when wet; few very fine roots; few very fine pores; thin continuous clay films; slightly calcareous; moderately alkaline; gradual smooth boundary. 5 to 15 inches thick.

B3tca—34 to 49 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; weak medium subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; common very fine pores; few thin clay films; moderately calcareous, lime is in few fine threads and few medium soft masses; moderately alkaline; gradual smooth boundary. 10 to 15 inches thick.

Cca—49 to 77 inches; grayish brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; massive; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; many very fine pores; strongly calcareous, lime is in irregularly shaped soft masses; moderately alkaline.

The solum is 30 to 60 inches thick. The A horizon is very dark grayish brown, dark grayish brown, dark brown, or brown when dry and dark brown, very dark brown, or very dark grayish brown when moist. It is silty clay loam or clay loam and is neutral to moderately alkaline.

The Bt horizon is light brownish gray, grayish brown, brown, or pale brown when dry and is very dark grayish brown, dark grayish brown, brown, or yellowish brown when moist. It is silty clay loam, heavy clay loam, or clay, and clay content averages from 35 to 60 percent. The Bt horizon is noncalcareous or slightly calcareous in the upper part, and slightly or moderately calcareous in the lower part. It is mildly or moderately alkaline.

The C horizon has chroma of 4 or less to a depth of 80 inches. There is no horizon of strong lime accumulation within 60 inches of the surface. Bedrock is deeper than 60 inches in most places, but in a few places bedrock is at a depth of 40 to 60 inches.

La—La Brier silty clay loam (0 to 3 percent slopes). This soil is in small valleys and on low areas of valley fill in areas of 100 to more than 640 acres. This soil has the profile described as representative of the series.

Included with this soil in mapping, and making up 5 percent each of the mapped acreage, are Sherm and Manzano soils. Also included, and making up less than 1 percent, are Vermejo and Gruver soils. None of these included soils is in a regular pattern on the landscape.

This soil is used for range, irrigated crops and nonirrigated crops, and wildlife habitat. Irrigated capability unit IIs–1, nonirrigated capability unit IVe–1; Clayey range site.

Lr—La Brier-Rock outcrop complex (0 to 9 percent slopes). La Brier silty clay loam, 0 to 3 percent slopes, makes up about 40 percent of this complex; Fallsam cobbly silty clay loam, 1 to 9 percent slopes, makes up 30 percent; and Rock outcrop makes up 15 percent. The remaining 15 percent is included soils. This complex is on broad lava flows in areas of more than 300 acres (fig. 14).

The La Brier soil is in small valleys between basalt ridges and squeeze-ups, and the Fallsam soil is on the sides and Rock outcrop is on the tops of the ridges and squeeze-ups. The La Brier soil has a profile similar to the one described as representative of its series except that basalt cobblestones and stones are below a depth of 40 inches and the surface is covered with basalt cobblestones in some places. The Fallsam soil has a profile similar to the one described as representative of its series.

Included with this complex in mapping, and making up about 5 percent each of the mapped acreage, are Torreon soils, Raton soils near the Fallsam soils, and Apache soils on sides of ridges.

This complex is used for range and wildlife habitat. Nonirrigated capability subclass VIs; La Brier silty clay loam in Clayey range site, Rock outcrop not assigned to a range site.

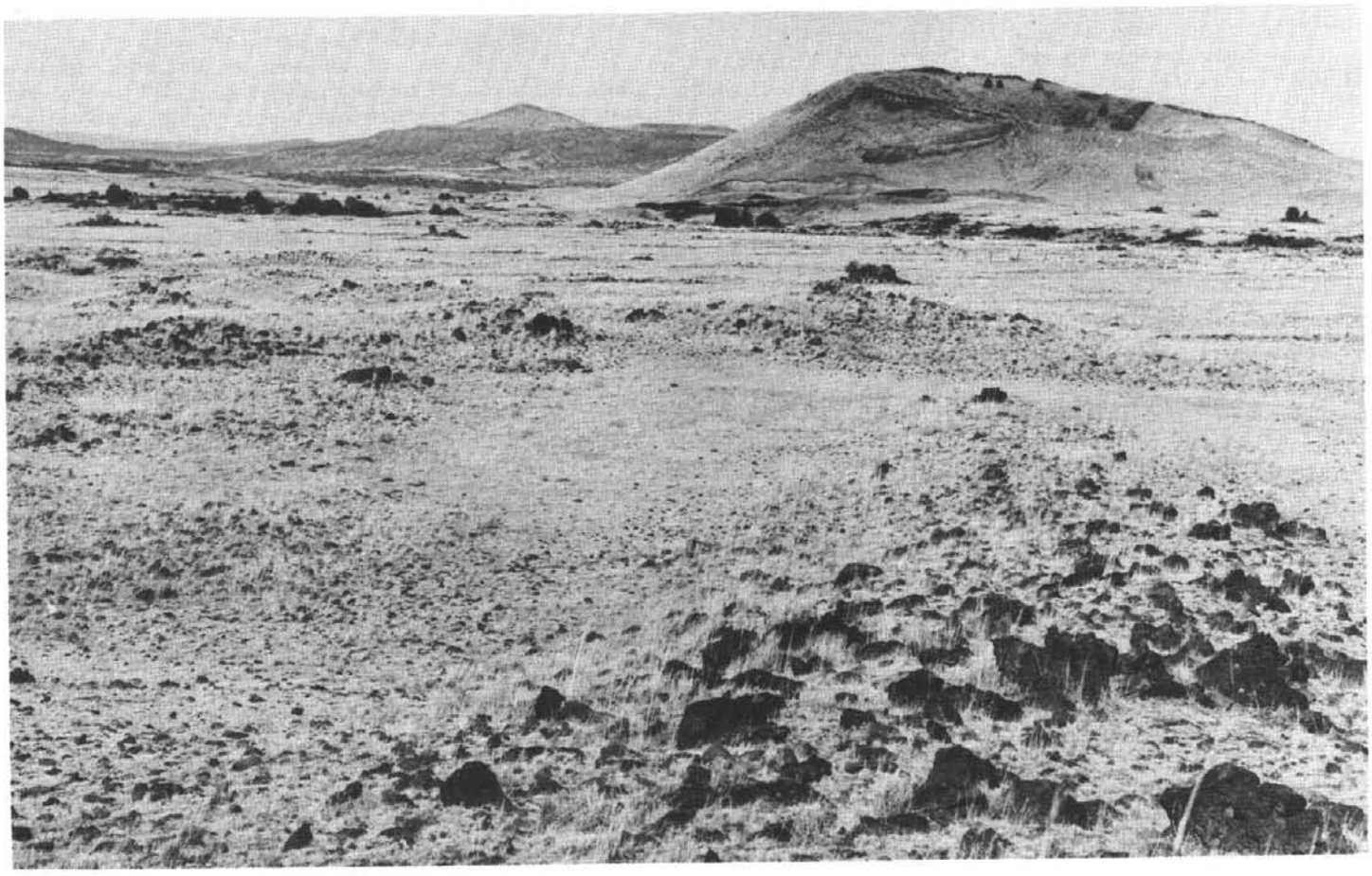

Figure 14.—Landscape of La Brier-Rock outcrop complex.

Litle series

The Litle series consists of well drained soils that are moderately deep to soft shale. These soils are on uplands. They formed in calcareous residuum weathered from shale. Slopes are 1 to 9 percent. Elevation is 5,000 to 6,500 feet. Vegetation is mainly blue grama, side-oats grama, three-awn, small soapweed (yucca), and scattered oneseed juniper. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 50° to 54° F. The length of the frost free season is 140 to 180 days.

In a representative profile the surface layer is brown heavy clay loam about 10 inches thick. The subsoil is pale brown heavy silty clay loam 12 inches thick. Soft shale is at a depth of 22 inches. The soil material is slightly calcareous in the upper 10 inches and strongly calcareous below. It is moderately alkaline throughout.

Permeability is slow in the solum and very slow in the underlying shale. Runoff is medium or rapid. Available water capacity is 3 to 5 inches. Effective rooting depth is 20 to 30 inches. The hazard of water erosion is severe, and the hazard of soil blowing is slight.

These soils are used for range and wildlife habitat.

Representative profile of Litle clay loam, 1 to 9 percent slopes, SE¼SE¼NE¼ sec. 4. T. 22 N., R. 30 E.:

A1—0 to 10 inches; brown (10YR 5/3) heavy clay loam, dark brown (10YR 4/3) when moist; moderate fine subangular blocky structure; slightly hard when dry, firm when moist, slightly sticky and slightly plastic when wet; many fine roots; few very fine pores; slightly calcareous; moderately alkaline; clear smooth boundary. 5 to 15 inches thick.

B2—10 to 22 inches; pale brown (10YR 6/3) heavy silty clay loam, dark brown (10YR 4/3) when moist; weak fine subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few very fine roots; few fine and very fine pores; strongly calcareous; moderately alkaline; clear smooth boundary. 6 to 15 inches thick.

Cr—22 to 60 inches; variegated soft shale with lime coatings in fractures.

The solum is 18 to 24 inches thick. Depth to shale is 20 to 30 inches.

The A1 horizon is brown, light olive brown, or pale brown when dry and dark brown, brown, or olive brown when moist. It is clay or clay loam and mildly alkaline or moderately alkaline.

The B2 horizon is pale brown, brown, light olive brown, or yellowish brown when dry and brown, dark

brown, or olive brown when moist. It is silty clay loam or clay. Content of gypsum or salts in the B and C horizons ranges from none to moderate.

In places a B3 or C1 horizon is between the B2 and Cr horizons. It has the same textures and colors as the A and B2 horizons, but soft shale fragments make up 10 to 40 percent of the horizon.

LtD—Litle clay loam, 1 to 9 percent slopes. This soil is along drainage channels on uplands in areas of 20 to 2,000 acres.

Included with this soil in mapping, and making up 5 percent each of the mapped acreage, are Travessilla soils; bare sandstone or shale on hilltops, ridgetops, and along breaks near drainage channels; and Colmor soils in level areas.

This soil is used for range and wildlife habitat. Nonirrigated capability subclass VIe; Clayey range site.

Manzano series

The Manzano series consists of deep, well drained soils along drainageways and on valley floors, stream terraces, and the lower parts of alluvial fans. Slopes are 0 to 3 percent. Elevation is 4,400 and 6,400 feet. Vegetation is mainly blue grama, galleta, buffalograss, and three-awn. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 49° to 57° F. The length of the frost free season is 140 to 180 days.

In a representative profile the surface layer is dark grayish brown loam and clay loam about 16 inches thick. The subsoil is brown and dark grayish brown clay loam and silty clay loam about 38 inches thick. The substratum is brown clay loam to a depth of 63 inches. The soil material is mainly noncalcareous to a depth of 54 inches and slightly calcareous below. Reaction is neutral to moderately alkaline.

Permeability is moderately slow. Runoff is medium. Available water capacity is 8 to 10 inches. Effective rooting depth is 60 inches or more. The hazards of water erosion and soil blowing are moderate.

These soils are used for range, wildlife habitat, and nonirrigated and irrigated crops in places.

Representative profile of Manzano loam, from an area of Kim-Manzano association, SE¼NE¼SW¼ sec. 23, T. 29 N., R. 33 E.:

A11—0 to 5 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak medium subangular blocky structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; few very fine pores; neutral; clear smooth boundary. 4 to 10 inches thick.

A12—5 to 16 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak coarse subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and very fine roots; common very fine pores; mildly alkaline; clear smooth boundary. 6 to 16 inches thick.

B2—16 to 23 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) when moist; weak medium subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and very fine roots; many very fine pores; slightly calcareous; moderately alkaline; clear smooth boundary. 6 to 20 inches thick.

B3—23 to 54 inches; dark grayish brown (10YR 4/2) slightly clay loam, very dark grayish brown (10YR 3/2) when moist; weak medium subangular blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; few fine and very fine roots; few fine and many very fine pores; neutral; clear smooth boundary. 10 to 34 inches thick.

C–54 to 63 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; few fine and very fine roots; common very fine pores; slightly calcareous; neutral.

The soil is loam, light clay loam, or silty clay loam, and rock fragments make up 4 to 5 percent of the upper 40 inches.

The A and B2 horizons are brown, dark brown, or dark grayish brown when dry and dark brown or very dark grayish brown when moist. They are neutral or mildly alkaline and noncalcareous or slightly calcareous. The B3 and C horizons are brown, dark grayish brown, grayish brown, or pale brown when dry and brown, dark brown, dark grayish brown, or very dark grayish brown when moist. They are noncalcareous to strongly calcareous and neutral to moderately alkaline.

Mn—Manzano loam (0 to 3 percent slopes). This soil is in long, narrow areas of 100 to 640 acres. It is rarely flooded.

Included with this soil in mapping, and making up 10 percent of the mapped acreage, are La Brier soils in depressions. Also included, and making up 10 percent, are Kim and Texline soils on side slopes. Small areas of Travessilla soils are included along drainageways.

This soil is used for range, wildlife habitat, and nonirrigated and irrigated crops in places. Irrigated capability unit IIe–6, nonirrigated capability unit IVe–2; Loamy range site.

Partri series

The Partri series consists of deep, well drained soils on uplands. These soils formed in eolian sediment and alluvium that were deposited over residuum from sandstone. Slopes are 0 to 3 percent. Elevation is 4,300 to 6,700 feet. Vegetation is mainly blue grama, three-awn, and galleta. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 49° to 57° F. The length of the frost free season is 140 to 180 days.

In a representative profile the surface layer is brown silty clay loam about 4 inches thick. The upper part of the subsoil is brown heavy clay loam 10 inches thick, and the lower part is brown clay 16 inches thick. The substratum is strongly calcareous, pinkish white silty

clay and very pale brown clay. Sandstone bedrock is at a depth of 48 inches. The soil material is neutral in the upper 14 inches, mildly alkaline in the next 16 inches, and moderately alkaline below.

Permeability is moderately slow. Runoff is medium. Available water capacity is 5 to 9 inches. Effective rooting depth is more than 40 inches. The hazards of water erosion and soil blowing are moderate.

These soils are used for range, wildlife habitat, and water supply. In this survey, Partri soils are mapped only in complex with Carnero soils.

Representative profile of Partri silty clay loam, from an area of Carnero-Partri complex, in the SW¼NW¼ SE¼ sec. 17, T. 23 N., R. 31 E.:

A1—0 to 4 inches; brown (10YR 4/3) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate medium subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many fine and very fine roots; few fine and very fine pores; neutral; clear smooth boundary. 2 to 9 inches thick.

B21t—4 to 14 inches; brown (7.5YR 4/3) heavy clay loam, dark brown (7.5YR 3/3) when moist; strong coarse and medium subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; many fine and very fine roots; few fine and very fine pores; few thin clay films on peds; neutral; clear smooth boundary. 5 to 13 inches thick.

B22t—14 to 30 inches; brown (7.5YR 5/3) clay, brown (7.5YR 4/3) when moist; strong medium subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; common fine and very fine roots; few very fine pores; many clay films on peds; slightly calcareous with a few soft lime masses; mildly alkaline; abrupt irregular boundary. 6 to 18 inches thick.

C1ca—30 to 40 inches; pinkish white (7.5YR 8/2) silty clay, pink (7.5YR 7/4) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; few very fine roots; few very fine pores; a few tongues of the B22t horizon extend into this horizon; strongly calcareous; moderately alkaline; abrupt wavy boundary. 7 to 20 inches thick.

C2ca—40 to 48 inches; very pale brown (10YR 7/3) clay, yellowish brown (10YR 5/6) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; few very fine roots; many very fine pores; strongly calcareous; moderately alkaline; abrupt wavy boundary. 0 to 12 inches thick.

R–48 inches; sandstone bedrock.

The depth to the C1ca horizon is 20 to 36 inches. Depth to rock is more than 40 inches.

The A horizon is brown, dark brown, or dark grayish brown when dry and dark brown or very dark grayish brown when moist. It is loam, silt loam, silty clay loam, or clay loam.

The B21t horizon has the same colors as the A horizon. The B22t horizon is brown or reddish brown when dry or moist. The B2t horizon is silty clay, clay, or heavy clay loam.

The Cca horizon is loam to clay.

Plack series

The Plack series consists of well drained soils that are shallow to indurated caliche. They are on narrow ridgetops. They formed in mixed materials. Slopes are 0 to 9 percent. Elevation is 4,500 to 6,700 feet. Vegetation is mainly blue grama, side-oats grama, and buffalograss. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 48° to 57° F. The length of the frost-free season is 140 to 185 days.

In a representative profile the soil is brown loam about 12 inches thick over indurated caliche. The soil is strongly calcareous and moderately alkaline.

Permeability is moderate. Runoff is medium. Available water capacity is 0.5 to 3.0 inches. Effective rooting depth is 4 to 20 inches. The hazards of water erosion and soil blowing are moderate.

These soils are used for range and wildlife habitat.

Representative profile of Plack loam, from an area of Spurlock-Plack complex in the NW¼SE¼ sec. 11, T. 23 N., R. 31 E.:

A1—0 to 4 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) when moist; weak medium and fine subangular blocky structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; many fine and very fine roots; many very fine pores; strongly calcareous; moderately alkaline; clear smooth boundary. 4 to 20 inches thick.

AC—4 to 12 inches; brown (10YR 4/3) heavy loam, dark brown (10YR 3/3) when moist; weak medium and fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; many very fine pores; strongly calcareous; moderately alkaline; clear smooth boundary. 0 to 9 inches thick.

Ccam—12 inches; indurated caliche.

The soil is 4 to 20 inches deep over indurated caliche, and it is moderately calcareous or strongly calcareous.

The A1 horizon is dark grayish brown or brown when dry and dark brown or very dark grayish brown when moist. It is sandy loam to heavy loam and is 0 to 5 percent caliche fragments. The AC horizon has the same colors as the A1 horizon. It is loam or clay loam and is 0 to 10 percent caliche fragments. In places the AC horizon is not in the profile, and the A1 horizon rests directly on indurated caliche.

PkD—Plack loam, 0 to 9 percent slopes. This soil is on long, narrow ridgetops in areas of 20 to 100 acres.

Included with this soil in mapping, and making up 10 percent each of the mapped acreage, are Dioxice

and Spurlock soils. These included soils are in depressions or level areas.

This soil is used for range and wildlife habitat. Nonirrigated capability subclass VIIs; Shallow range site.

Raton series

The Raton series consists of shallow, well drained soils on the sides of basalt ridges. These soils formed in residuum weathered from basalt. Slopes are 3 to 15 percent. Elevation is 6,600 to 7,600 feet. Vegetation is mainly blue grama, western wheatgrass, fringed sagebrush, and oak brush. The average annual precipitation is 15 to 18 inches, and the average annual air temperature is 42° to 45° F. The length of the frost free season is 100 to 120 days.

In a representative profile the surface layer is dark gray cobbly heavy silt loam about 9 inches thick. The subsoil is dark brown very cobbly clay 9 inches thick. Basalt bedrock is at a depth of 18 inches. The soil material is noncalcareous and neutral throughout.

Permeability is slow. Runoff is rapid. Available water capacity is 0.5 to 1 inch. Effective rooting depth is 8 to 20 inches. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

These soils are used for range, wildlife habitat, and water supply.

Representative profile of Raton cobbly silt loam from an area of Raton-Rock outcrop complex, 1,200 feet north and 500 feet west of the southeast corner of sec. 8, T. 31 N., R. 28 E.:

A1—0 to 9 inches; dark gray (10YR 4/1) cobbly heavy silt loam, very dark gray (10YR 3/1) when moist; strong fine granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; few very fine pores; 60 percent basalt boulders on surface; about 15 percent basalt cobblestones; neutral; abrupt irregular boundary. 6 to 12 inches thick.

B2t—9 to 18 inches; dark brown (7.5YR 4/2) very cobbly clay, dark brown (7.5YR 3/2) when moist; strong very fine subangular blocky and angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; many fine roots; common very fine pores; common thin clay films; 50 percent basalt cobblestones; neutral. 2 to 10 inches thick.

R—18 inches; basalt bedrock.

Depth to bedrock and thickness of the solum are 8 to 20 inches. Cobblestones or stones cover 40 to 70 percent of the surface.

The A horizon is dark gray or dark grayish brown when dry and very dark gray, very dark grayish brown, or very dark brown when moist. It is silt loam or silty clay loam and is 15 to 70 percent cobblestones, stones, or boulders.

The B2t horizon is brown, dark brown, or dark grayish brown when dry and dark brown or very dark grayish brown when moist. It is mostly displaced bedrock that has soil and clay films in its fractures. Coarse fragments make up 50 to 70 percent of the B2t horizon.

Ra—Raton-Rock outcrop complex (3 to 15 percent slopes). Raton cobbly silt loam, 3 to 15 percent slopes, makes up about 60 percent of this complex, and Rock outcrop makes up 20 percent. Included soils make up the remaining 20 percent. Areas are 100 to 500 acres in size.

The Raton soil is on the sides and Rock outcrop is on the tops of basalt ridges (fig. 15).

Included with this complex in mapping, and making up about 10 and 5 percent, respectively, of the mapped acreage, are Dalcan and Des Moines soils. Also included, and making up 5 percent, are undifferentiated soils and land types. The inclusions follow no definite pattern.

This complex is used for range, wildlife habitat, and water supply. Nonirrigated capability subclass VIIs; Raton cobbly silt loam in Malpais range site, Rock outcrop not assigned to a range site.

Rickmore series

The Rickmore series consists of deep, well drained

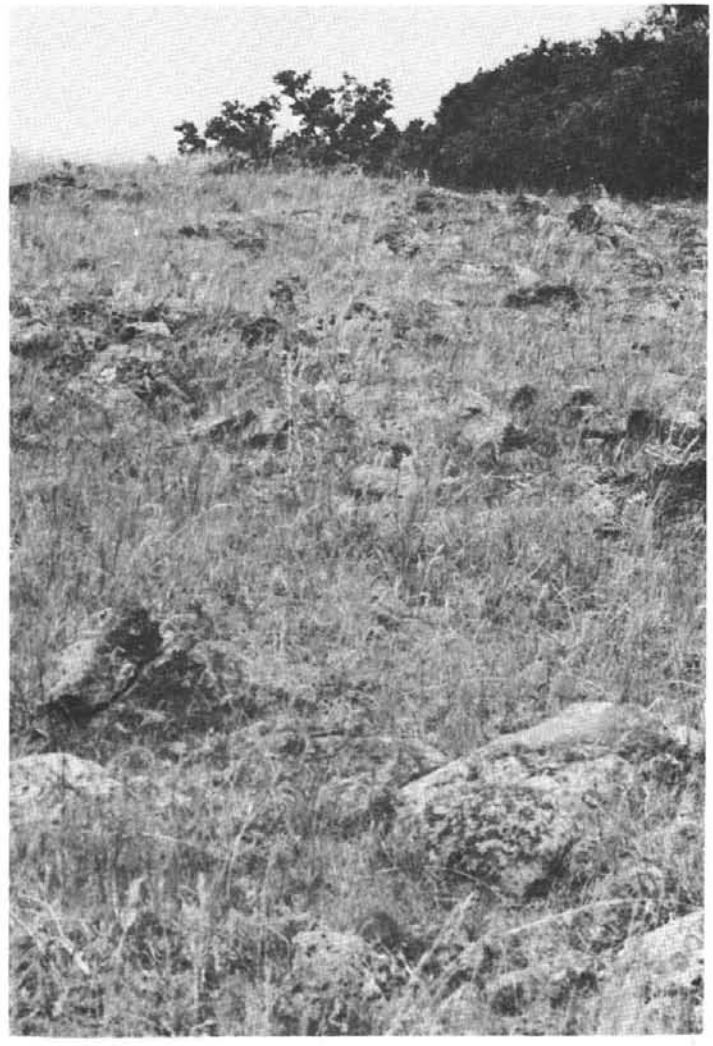

Figure 15.—Landscape of Raton-Rock outcrop complex.

soils on uplands. These soils formed in mixed alluvium weathered from High Plains sedimentary formations. Slopes are 0 to 3 percent. Elevation is 4,500 to 6,500 feet. Vegetation is mainly blue grama, hairy grama, and little bluestem. The average annual precipitation is 14 to 17 inches, and the average annual air temperature is 50° to 57° F. The length of the frost-free season is 160 to 185 days.

In a representative profile the surface layer is brown loamy sand and sandy loam about 13 inches thick. The subsoil extends to a depth of 93 inches or more. It is brown, light brown, pink, and reddish yellow clay loam and sandy clay loam. The soil material is noncalcareous to a depth of 30 inches and slightly to strongly calcareous below. Reaction is mildly to moderately alkaline.

Permeability is moderately slow. Runoff is slow. Available water capacity is 7.5 to 9.5 inches. Effective rooting depth is 60 inches or more. The hazard of water erosion is slight, and the hazard of soil blowing is moderate.

These soils are used for range, irrigated and nonirrigated crops and wildlife habitat.

Representative profile of Rickmore sandy loam, SW¼NW¼ sec. 2, T. 24 N., R. 36 E.:

A11—0 to 3 inches; brown (7.5YR 5/4) heavy loamy sand, brown (10YR 4/3) when moist; weak fine subangular blocky structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; many fine roots; many very fine pores; mildly alkaline; clear smooth boundary. 0 to 10 inches thick.

A12—3 to 13 inches; brown (7.5YR 5/4) light sandy loam, brown (10YR 4/3) when moist; weak coarse subangular blocky structure; soft when dry, very friable when moist, nonsticky and slightly plastic when wet; many fine roots; many very fine pores; mildly alkaline; clear smooth boundary. 5 to 14 inches thick.

B1t—13 to 20 inches; brown (7.5YR) clay loam, brown (7.5YR 4/3) when moist; moderate medium and coarse subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; common fine roots; many very fine pores; many thin clay films on peds; mildly alkaline; clear smooth boundary. 0 to 9 inches thick.

B21t—20 to 30 inches; brown (7.5YR 5/4) clay loam, brown (10YR 4/3) when moist; strong medium prismatic structure; very hard when dry, very firm when moist, sticky and plastic when wet; common fine roots; few very fine pores; thin continuous clay films on peds; mildly alkaline; clear smooth boundary. 10 to 25 inches thick.

B22t—30 to 34 inches; light brown (7.5YR 6/4) heavy sandy clay loam, brown (7.5YR 4/4) when moist; moderate medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few fine roots; common very fine pores; common thin clay films on peds; slightly calcareous; mildly alkaline; gradual smooth boundary. 0 to 20 inches thick.

B23tca—34 to 43 inches; pink (7.5YR 7/4) clay loam, brown (7.5YR 5/4) when moist; moderate coarse subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few fine roots; many very fine pores; few thin clay films on peds; strongly calcareous; moderately alkaline; gradual smooth boundary. 7 to 24 inches thick.

B24tca—43 to 48 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 4/4) when moist; moderate coarse subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few fine roots; many very fine pores; common thin clay films on peds; moderately calcareous; moderately alkaline; gradual smooth boundary. 0 to 20 inches thick.

B25t—48 to 70 inches; reddish yellow (5YR 6/6) heavy sandy clay loam, yellowish red (5YR 4/6) when moist; weak coarse prismatic structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine pores; few thin clay films; slightly calcareous; mildly alkaline; gradual smooth boundary. 10 to 40 inches thick.

B26t—70 to 93 inches; reddish yellow (5YR 6/6) light sandy clay loam, yellowish red (5YR 4/6) when moist; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine pores; few thin clay films; slightly calcareous; mildly alkaline.

The A horizon is brown or pale brown when dry and brown or dark brown when moist. It is sandy loam or loamy sand. It is structureless or has weak structure and is neutral or mildly alkaline.

The B2t horizon is brown, light brown, or pink grading below a depth of 40 inches to yellowish red, light brown, or reddish yellow when dry. It is clay loam, and the upper 20 inches averages about 33 to 35 percent clay. The B2t horizon is mildly or moderately alkaline.

Rk—Rickmore sandy loam (0 to 3 percent slopes). This soil is on uplands in areas of 10 to 200 acres.

Included with this soil in mapping are Dallam soils, which make up about 10 percent of the mapped acreage; Gruver sandy loam, which makes up about 10 percent; and Spurlock loamy sand, which makes up about 2 percent. These soils are in no regular pattern on the landscape.

This soil is used for range, irrigated and nonirrigated crops, and wildlife habitat. Irrigated capability unit IIIe–4, nonirrigated capability unit IIIe–3; Sandy range site.

Rizozo series

The Rizozo series consists of shallow, well drained

soils. These soils are along the Cimarron River. They formed in residuum weathered from sandstone. Slopes are 0 to 9 percent. Elevation is 4,500 to 5,000 feet. Vegetation is mainly blue grama, side-oats grama, small soapweed (yucca), and scattered oneseed juniper. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 49° to 57° F. The length of the frost free season is 160 to 180 days.

In a representative profile the soil is yellowish red loam and red channery silt loam about 10 inches thick over red sandstone. The soil is calcareous and moderately alkaline.

Permeability is moderately rapid above the bedrock. Runoff is medium. Available water capacity is 0.5 to 3 inches. Effective rooting depth is 4 to 15 inches. The hazard of water erosion is severe, and the hazard of soil blowing is moderate.

These soils are used for range and wildlife habitat.

Representative profile of Rizozo loam, from an area of Rizozo-Rock outcrop complex, 150 feet east of the northwest corner of sec. 31, T. 31 N., R. 34 E.:

A1—0 to 5 inches; yellowish red (5YR 4/6) loam, dark red (2.5YR 3/6) when moist; weak fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; common very fine pores; strongly calcareous; moderately alkaline; abrupt smooth boundary. 2 to 5 inches thick.

C—5 to 10 inches; red (2.5YR 4/6) channery silt loam, dark red (2.5YR 3/6) when moist; weak medium and fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; common fine roots; common very fine pores; strongly calcareous; moderately alkaline; abrupt wavy boundary. 2 to 10 inches thick.

R—10 inches; hard red sandstone bedrock.

Depth to bedrock is 4 to 15 inches. The A and C horizons are reddish brown, red, dark red, or yellowish red when moist. They are silt loam, loam, or very fine sandy loam. Sandstone fragments make up 0 to 35 percent of the soil.

Rz—Rizozo-Rock outcrop complex (0 to 9 percent slopes). Rizozo loam, 0 to 9 percent slopes, makes up about 70 percent of this complex, and Rock outcrop makes up 20 percent. Included soils make up the remaining 10 percent. This complex is along the Cimarron River drainage area in areas of 40 to 300 acres.

Rizozo soils are on hills, and Rock outcrop is along breaks and erosion channels. The Rizozo soil has the profile described as representative of the series.

Included with this complex in mapping, and making up about 10 percent of the mapped acreage, are Alicia soils in depressions and broad drainage channels. Also included are small areas of Travessilla soils.

This complex is used for range and wildlife habitat. Nonirrigated capability subclass VIIs; Rizozo loam in Shallow Sandstone range site, Rock outcrop not assigned to range site.

Rock outcrop

Rock outcrop consists of exposures of bare rock in areas that range from nearly level to vertical. Elevation is 4,300 to 8,700 feet. In many areas the only vegetation is lichens, but some areas support brush and trees in fractures. The average annual precipitation, the average annual air temperature, and the length of the frost free season are determined by the soils with which Rock outcrop is mapped.

Where Travessilla or Rizozo soils are near Rock outcrop, the exposures are sandstone in flat areas on the top edges of breaks, on vertical escarpments leading away from these breaks, on side slopes, or on rounded hills or ridges formed by water erosion. Where Apache, Fallsam, La Brier, Raton, or Ustolls soils are nearby, exposures are broad flows of basalt in areas of a few rounded hills formed by volcanic vents. These exposures are mainly on the rounded hills, on the upper edges of escarpments, and in water channels; many basalt squeeze-ups are in areas of Fallsam and La Brier soils. Where Dalcan and Des Moines soils are nearby, exposures are andesite that has been bared by erosion.

Rock outcrop is essentially wasteland but can be used for wildlife habitat and water supply. Runoff is very rapid on Rock outcrop.

In Union County Rock outcrop is mapped only in complex with Apache, Dalcan, Des Moines, Fallsam, La Brier, Raton, Rizozo, Travessilla, and Ustolls soils.

Rubble land

Rubble land consists of piles of stones and boulders or talus dislodged from overlying ridges or escarpments. It is on hillsides and mountainsides. Slopes are 10 to 90 percent. The sparse vegetation is mostly scrub trees and brush. The average annual precipitation is 17 to 19 inches, and the average annual air temperature is 45° to 50° F. The length of the frost free season is 120 to 160 days.

In Union County Rubble land is mapped only in complex with Aridic Haplustolls.

Sherm series

The Sherm series consists of deep, well drained soils on broad upland plains. These soils formed in eolian and alluvial deposits. Slopes are 0 to 3 percent. Elevation is 4,500 to 6,000 feet. Vegetation is mainly blue grama, galleta, western wheatgrass, and three-awn. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 50° to 57° F. The length of the frost free season is 160 to 185 days.

In a representative profile the surface layer is dark grayish brown clay loam about 4 inches thick. The subsoil extends to a depth of 90 inches or more. To a depth of 21 inches, it is dark grayish brown and brown clay. Below this it is brown, very pale brown, and pink clay loam. The soil material is noncalcareous in the upper 15 inches, slightly calcareous in the next 6 inches, and strongly calcareous below. Reaction is neutral in the upper 7 inches, mildly alkaline in the next 14 inches, and moderately alkaline below.

Permeability is very slow. Runoff is medium. Available water capacity is 8.5 to 10 inches. Effective rooting depth is more than 60 inches. The hazards of soil blowing and water erosion are moderate.

These soils are used for range and wildlife habitat.

Representative profile of Sherm clay loam, in the NE¼NW¼ sec. 36, T. 26 N., R. 35 E.:

A1—0 to 4 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate very fine subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many fine and very fine roots; many fine pores; neutral; clear smooth boundary. 2 to 9 inches thick.

B1t—4 to 7 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; strong medium angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; many very fine roots; few very fine pores; many moderately thick clay films on peds; neutral; clear smooth boundary. 3 to 9 inches thick.

B21t—7 to 15 inches; dark grayish brown (10YR 4/2) clay, dark brown (10YR 3/3) when moist; strong medium angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; many very fine roots; few very fine pores; continuous moderately thick clay films on peds; mildly alkaline; clear smooth boundary. 6 to 10 inches thick.

B22t—15 to 21 inches; brown (10YR 4/3) clay, dark grayish brown (10YR 4/2) when moist; strong medium angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; common very fine roots; few very fine pores; many moderately thick clay films on peds; slightly calcareous; mildly alkaline; clear wavy boundary. 5 to 15 inches thick.

B23tca—21 to 48 inches; brown (7.5YR 5/4) heavy clay loam, dark brown (7.5YR 4/4) when moist; weak and moderate medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few very fine roots; common very fine pores; few thin clay films on peds; strongly calcareous; moderately alkaline; abrupt wavy boundary. 10 to 40 inches.

B24tca—48 to 72 inches; very pale brown (10YR 8/3) clay loam, very pale brown (10YR 7/3) when moist; massive; slightly hard when dry, very friable when moist, sticky and plastic when wet; many very fine pores; strongly calcareous; moderately alkaline; gradual smooth boundary. 10 to 36 inches thick.

B25tca—72 to 90 inches; pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; few very fine pores; strongly calcareous; moderately alkaline.

The A1 horizon is brown, dark grayish brown, and grayish brown when dry and dark brown or very dark grayish brown when moist. It is heavy loam or clay loam and neutral to mildly alkaline.

The B1t horizon is heavy clay loam or clay and has the same colors as the A horizon. The upper part of the B2t horizon is dark grayish brown, grayish brown, or brown when dry and brown, dark brown, or dark grayish brown when moist. It is clay, and clay content ranges from 40 to 55 percent. Structure is strong or moderate, medium, angular or subangular blocky. Texture of the lower part of the B2t horizon ranges from clay loam to clay. Some parts of the Bt horizon below a depth of 40 inches have chroma of more than 4.

Sh—Sherm clay loam (0 to 3 percent slopes). This soil is on plane to slightly concave uplands of the High Plains in areas of 40 to 600 acres.

Included with this soil in mapping are La Brier soils, which make up about 10 percent of the mapped acreage, and Gruver and Torreon soils, which make up about 5 percent each. The La Brier soils are along drainage channels, the Gruver soils are in no regular pattern in the landscape, and the Torreon soils are near basalt flows.

This soil is used for range and wildlife habitat. Irrigated capability unit IIIe–8, nonirrigated capability unit IIIe–2; Clayey range site.

Spurlock series

The Spurlock series consists of deep, well drained soils on upland ridges or hills. These soils formed in calcareous sediment weathered from the Ogallala Formation. Slopes are 1 to 9 percent. Elevation is 4,300 to 5,600 feet. Vegetation is mainly blue grama, three-awn, and side-oats grama. The average annual precipitation is 14 to 17 inches, and the average annual air temperature is 50° to 57° F. The length of the frost free season is 150 to 185 days.

In a representative profile the surface layer is brown loam about 6 inches thick. The subsoil is pale brown clay loam about 10 inches thick. The substratum is very strongly calcareous, white and pink clay loam and sandy clay loam to a depth of 60 inches. The soil material is mildly alkaline to a depth of 16 inches. Below this it is moderately alkaline.

Permeability is moderate. Available water capacity is 7.5 to 10 inches. Effective rooting depth is 60 inches. Below a depth of 20 inches, growth of roots is somewhat restricted because of lime concentration.

These soils are used mostly for range and wildlife habitat, but a few areas are used for irrigated crops.

Representative profile of Spurlock loam, 1 to 5 percent slopes, 1,400 feet south and 1,400 feet west of the northeast corner of sec. 28, T. 26 N., R. 36 E.:

A1—0 to 6 inches; brown (10YR 5/3) heavy loam, brown (10YR 4/3) when moist; weak fine subangular blocky structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and very fine roots; common very fine pores; strongly cal-

careous; mildly alkaline; clear smooth boundary. 4 to 14 inches thick.

B2—6 to 16 inches; pale brown (10YR 6/3) clay loam, brown (10YR 4/3) when moist; weak medium subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; few fine and very fine roots; common very fine pores; very strongly calcareous; mildly alkaline; clear wavy boundary. 0 to 14 inches thick.

C1ca—16 to 28 inches; white (10YR 8/2) clay loam, pale brown (10YR 6/3) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine pores; very strongly calcareous; moderately alkaline; clear abrupt boundary. 6 to 20 inches thick.

C2ca—28 to 40 inches; pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; few very fine pores; very strongly calcareous; moderately alkaline; clear wavy boundary. 6 to 24 inches thick.

C3—40 to 60 inches; pink (7.5YR 7/4) sandy clay loam, light brown (7.5YR 6/4) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; many very fine pores; strongly calcareous; moderately alkaline.

The depth to the C1ca horizon is 12 to 20 inches. The A and B2 horizons are brown or pale brown when dry. The A horizon is sand, loamy sand, sandy loam, or loam and 0 to 5 percent rock fragments. The A and B2 horizons are mildly or moderately alkaline.

The Cca horizon is white, pink, or very pale brown when dry and light brown, pale brown, or very pale brown when moist. It is loam to clay loam and 0 to 10 percent coarse fragments. The calcium carbonate equivalent ranges from 40 to 60 percent. The C3 horizon is clay loam or sandy clay loam.

The length of time these soils are moist under natural conditions is slightly less than defined in the range for the series. This difference, however, does not alter the usefulness and behavior of the soils.

SpD—Spurlock loamy sand, 1 to 9 percent slopes. This soil is on uplands. Wind has deposited sand on the surface. Areas are 160 to more than 600 acres in size. The surface layer of this soil is 4 to 20 inches of loamy sand, but the profile is otherwise similar to the one described as representative of the series.

Included with this soil in mapping are areas of Guy, Valent, Vingo, and Plack soils. Guy soils make up about 10 percent of the mapped acreage; Valent soils, about 5 percent; Vingo soils, about 5 percent; and Plack soils, about 1 percent. The Plack soil is on ridges or in blownout areas. The Valent, Vingo, and Guy soils are not in any definite pattern.

Runoff is slow on this soil. The hazard of water erosion is moderate, and the hazard of soil blowing is severe.

This soil is used for range and wildlife habitat. Nonirrigated capability subclass VIe; Deep Sand range site.

SrC—Spurlock loam, 1 to 5 percent slopes. This soil is on uplands in areas of 40 to more than 300 acres. It has the profile described as representative of the series.

Included with this soil in mapping are Dioxice soils, Kim soils near drainage channels, Dallam soils in flatter areas, and Plack soils on ridgetops. Dioxice soils have no definite pattern of occurrence. They make up about 10 percent of the mapped acreage, and Kim, Dallam, and Plack soils each make up about 5 percent. Also included in this unit, and making up only about 1 percent of the mapped acreage, are Travessilla soils.

Runoff is medium on this Spurlock soil. The hazards of water erosion and soil blowing are moderate.

These soils are used mostly for range and wildlife habitat, but a few areas are used for irrigated crops. Irrigated capability unit IIIe–12; nonirrigated capability subclass VIe; Sandy range site.

Su—Spurlock-Plack complex (0 to 9 percent slopes). Spurlock loam, 1 to 5 percent slopes, makes up 60 percent of this complex, and Plack loam, 0 to 9 percent slopes, makes up 20 percent. Included soils make up the other 20 percent. Areas are 40 to more than 300 acres in size.

The Spurlock soil is on the sides of ridges, and the Plack soil is on ridgetops and small escarpments. The Spurlock soil has a profile similar to the one described as representative of its series, and the Plack soil has the profile described as representative of its series.

Included with these soils in mapping, and making up about 10 percent of the mapped acreage, is a soil that is similar to this Plack soil except that the depth to indurated caliche is 20 to 40 inches. This soil is in the same position on the landscape as the Plack soil. Also included, and making up the remaining 10 percent of this complex, are small areas of Dioxice, Guy, and Texline soils. The Texline soils are near drainage channels. Dioxice and Guy soils are in the same position on the landscape as the Spurlock soil.

Runoff is medium in the soils of this complex. The hazards of water erosion and soil blowing are moderate. Nonirrigated capability subclass VIe; Spurlock soil in Sandy range site, Plack soil in Shallow range site.

Texline series

The Texline series consists of deep, well drained soils on valley fill near the bases of escarpments. These soils formed in mixed alluvium. Slopes are 1 to 5 percent. Elevation is 4,500 to 7,300 feet. Vegetation is mainly blue grama, hairy grama, and three-awn. The average annual precipitation is 14 to 18 inches and the average annual air temperature is 50° to 57° F. The length of the frost free season is 140 to 185 days.

In a representative profile the surface layer is dark grayish brown loam about 5 inches thick. The subsoil extends to a depth of 96 inches. It is dark grayish brown clay loam to a depth of 16 inches and pale brown, light brown, and pinkish gray silty clay loam and clay loam below. The profile is noncalcareous to slightly calcareous to a depth of 16 inches and strongly

calcareous below. It is mildly alkaline in the upper 5 inches and moderately alkaline below.

Permeability is moderate. Runoff is medium. Available water capacity is 8 to 10 inches. Effective rooting depth is 60 inches or more. The hazards of water erosion and soil blowing are moderate.

These soils are used for range and wildlife habitat.

Representative profile of Texline loam, 1 to 5 percent slopes, in the SE¼SW¼ sec. 20, T. 29 N., R. 31 E.:

A1—0 to 5 inches; dark grayish brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; weak fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; many fine and very fine roots; few very fine pores; mildly alkaline; clear smooth boundary. 5 to 16 inches thick.

B21t—5 to 16 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few medium and common fine and very fine roots; few fine and common very fine pores; thin patchy clay films on peds; slightly calcareous below a depth of 10 inches; moderately alkaline; gradual smooth boundary. 7 to 15 inches thick.

B22tca—16 to 33 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; moderate medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few medium, fine, and very fine roots; common very fine pores; thin patchy clay films on peds; common white soft masses of lime; strongly calcareous; moderately alkaline; gradual smooth boundary. 8 to 18 inches thick.

B23t—33 to 63 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 4/4) when moist; weak medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few fine and very fine roots; many very fine pores; few white soft masses of lime; moderately calcareous; moderately alkaline; clear smooth boundary. 20 to 40 inches thick.

B24tca—63 to 70 inches; pinkish gray (7.5YR 7/2) silty clay loam, brown (7.5YR 5/4) when moist; weak medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine pores; common white soft masses of lime; strongly calcareous; moderately alkaline; clear smooth boundary. 0 to 15 inches thick.

B25tca—70 to 96 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) when moist; weak medium subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine pores; common white soft masses of lime; strongly calcareous; moderately alkaline.

The solum is more than 60 inches thick. The A horizon is calcareous or noncalcareous. It is brown, dark grayish brown, or grayish brown when dry and dark brown, very dark grayish brown, or very dark brown when moist. It is fine sandy loam, loam, or clay loam.

The B21t horizon has the same colors as the A horizon. The remaining part of the B2t horizon is pale brown, light brown, pinkish gray, or reddish yellow when dry and brown, strong brown, or yellowish red when moist. The part of the B2t horizon below the B21t horizon is loam, sandy clay loam, silty clay loam, or clay loam.

TeC—Texline loam, 1 to 5 percent slopes. This soil is in valley fill along the bases of steep escarpments in long, narrow areas of 40 to 400 acres.

Included with this soil in mapping, and making up 5 percent each of the mapped acreage, are Dallam, Gruver, Kim, and Manzano soils. These included soils are in no definite pattern in the landscape, and changes from one kind of soil to another are gradual.

This mapping unit is used for range and wildlife habitat. Irrigated capability unit IIIe–6, nonirrigated capability unit IVe–1; Loamy range site.

Torreon series

The Torreon series consists of deep, well drained soils on broad, basalt-capped uplands. These soils formed in alluvium weathered from basalt modified by eolian material. Slopes are 0 to 3 percent. Elevation is 5,000 to 7,000 feet. Vegetation is mainly blue grama, western wheatgrass, galleta, fringed sagebrush, and woolly indianweed. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 47° to 53° F. The length of the frost free season is 140 to 175 days.

In a representative profile the surface layer is dark brown silty clay loam about 5 inches thick. The subsoil is 42 inches thick. The upper 20 inches is brown clay, and the lower 22 inches is pale brown silty clay loam. The substratum is very pale brown silty clay loam about 25 inches thick. Basalt bedrock is at a depth of about 72 inches. The soil material is noncalcareous in the upper 15 inches, slightly calcareous in the next 10 inches, and strongly calcareous below. Reaction is neutral in the upper 5 inches, mildly alkaline in the next 10 inches, and moderately alkaline below.

Permeability is slow. Runoff is medium. Available water capacity is 8 to 10 inches. Effective rooting depth is more than 40 inches. The hazards of water erosion and soil blowing are moderate.

These soils are used for range and wildlife habitat.

Representative profile of Torreon silty clay loam, in the SE¼NE¼ sec. 4, T. 26 N., R. 21 E.:

A1—0 to 5 inches; dark brown (10YR 3/3) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate fine and medium subangular blocky struc-

ture; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; common fine roots; few very fine pores; neutral; clear smooth boundary. 2 to 10 inches thick.

B21t—5 to 15 inches; brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; strong medium subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; many fine roots; few very fine pores; thin continuous clay films on peds; mildly alkaline; gradual smooth boundary. 5 to 14 inches thick.

B22t—15 to 25 inches; brown (7.5YR 5/3) clay, brown (10YR 4/3) when moist; strong medium subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; many fine roots; few very fine pores; thin continuous clay films; slightly calcareous; moderately alkaline; clear wavy boundary. 6 to 18 inches thick.

B3tca—25 to 47 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; moderate (grading to weak below a depth of 33 inches) medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many very fine roots; common very fine pores; patchy clay films on peds; strongly calcareous; many thin threads of lime; moderately alkaline; abrupt wavy boundary. 10 to 30 inches thick.

Cca—47 to 72 inches; very pale brown (10YR 7/3) silty clay loam, pale brown (10YR 6/3) when moist; massive; slightly hard when dry, friable when moist, sticky and plastic when wet; few to many very fine pores; strongly calcareous; moderately alkaline. 10 to 40 inches thick.

R—72 inches; basalt bedrock.

The depth to the Cca horizon is 40 to 50 inches. Depth to rock is more than 40 inches. Gravel or cobblestones make up 0 to 5 percent of the soil material.

The A horizon is grayish brown, dark grayish brown, brown, or dark brown when dry, and dark brown, very dark brown, or very dark grayish brown when moist. It is silt loam, loam, silty clay loam, or clay loam.

The upper part of the B2t horizon has the same colors as the A horizon. The lower part is brown or pale brown when dry. The B2t horizon is clay, silty clay, or heavy silty clay loam. The B horizon is noncalcareous to strongly calcareous.

The Cca horizon is very pale brown, light gray, or white when dry. Cobblestones and gravel make up 0 to 50 percent of the Cca horizon.

Tn—Torreon silty clay loam (0 to 3 percent slopes). This soil is in broad, basalt-capped areas of 200 to 600 acres.

Included with this soil in mapping are a few areas of Torreon silty clay loam that has slopes of 3 to 5 percent. Also included are Capulin soils, which make up 10 percent of the mapped acreage; La Brier soils, which make up 5 percent; soils that are similar to this Torreon silty clay loam except that they have rock at a depth of 20 to 40 inches, which make up 5 percent; and Apache and Ayon soils, which make up less than 1 percent. The Capulin, Apache, and Ayon soils and the soils that are moderately deep over bedrock are on small ridges or hills. The La Brier soils are in depressions and along water channels.

This soil is used for range and wildlife habitat. Irrigated capability unit IIIe–8, nonirrigated capability unit IVe–1; Loamy range site.

Travessilla series

The Travessilla series consists of shallow, well drained soils on uplands and canyon sides around the edges of sandstone breaks. They formed in material weathered from sandstone and mixed eolian material. Slopes are 0 to 75 percent. Elevation is 4,300 to 6,700 feet. Vegetation is mainly pinon pine, oneseed juniper, skunkbush sumac, oakbrush, blue grama, side-oats grama, broom snakeweed, and small soapweed (yucca). The average annual precipitation is 14 to 20 inches, and the average annual air temperature is 47° to 57° F. The length of the frost free season is 140 to 185 days.

In a representative profile the surface layer is light brownish gray sandy loam about 4 inches thick. The substratum is pale brown loam underlain by sandstone bedrock at a depth of 8 inches. The soil is mildly or moderately alkaline and slightly calcareous.

Permeability is moderately rapid. Runoff is medium to rapid. Available water capacity is 0.5 to 2 inches. Effective rooting depth is 4 to 20 inches. The hazard of soil blowing is moderate. The hazard of water erosion is moderate to severe.

These soils are used for range, wildlife habitat, and water supply.

Representative profile of Travessilla sandy loam from an area of Travessilla-Rock outcrop complex, 0 to 15 percent slopes, 1,560 feet north and 4,200 feet west of the southeast corner sec. 24, T. 31 N., R 36 E.:

A1—0 to 4 inches; light brownish gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak fine granular structure; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; many fine and medium roots; common fine pores; 15 percent rock fragments; slightly calcareous; mildly alkaline; gradual smooth boundary. 2 to 8 inches thick.

C—4 to 8 inches; pale brown (10YR 6/3) loam, brown (10YR 4/3) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and slightly plastic when wet; common fine and medium roots; few fine and common very fine pores; slightly calcareous; 20 percent rock fragments; moderately alkaline; abrupt smooth boundary. 2 to 12 inches thick.

R—8 inches; noncalcareous sandstone bedrock.

The soil ranges from 4 to 20 inches thick over sand-

stone bedrock. Cobblestones make up 0 to 10 percent of the soil, and gravel makes up 0 to 35 percent. Total rock fragments make up 0 to 35 percent of the soil.

The A1 horizon is light brown, brown, or light brownish gray when dry and brown, dark grayish brown, or grayish brown when moist. It is loamy sand to sandy loam or loam, noncalcareous or slightly calcareous, and mildly alkaline.

The C horizon is sandy loam, loam, or light sandy clay loam; mildly or moderately alkaline; and slightly or moderately calcareous. Thin, discontinuous accumulations of calcium carbonate are immediately above the bedrock, and there are thin coatings on the bedrock in places.

TrE—Travessilla-Rock outcrop complex, 0 to 15 percent slopes. Travessilla sandy loam, 0 to 15 percent slopes, makes up about 70 percent of this complex, and Rock outcrop makes up 20 percent. Included soils make up the remaining 10 percent. Areas are 40 to more than 640 acres in size.

The Travessilla soil borders canyons on uplands. Rock outcrop also borders canyons but is on the edges of steplike terraces or is on eroded hills. The Travessilla soil has the profile described as representative of the series.

Included with this complex in mapping are Carnero and Escabosa soils in depressions. These soils make up about 10 percent of the mapped areas. Also included are minor acreages of Litle, Plack, and Rizozo soils.

This complex is used for range and wildlife habitat. Nonirrigated capability subclass VIIs; Travessilla sandy loam in Shallow Sandstone range site, Rock outcrop not assigned to a range site.

TrF—Travessilla-Rock outcrop complex, 30 to 75 percent slopes. Travessilla stony sandy loam, 30 to 75 percent slopes, makes up about 40 percent of this complex, and Rock outcrop makes up 30 percent. Included soils make up the remaining 30 percent. Areas are 200 to more than 2,000 acres in size.

This complex is on the sandstone breaks or escarpments leading from the uplands down to the river valleys (fig. 16). The Travessilla soil is on the sides of the escarpments, and Rock outcrop is on the upper edges and on the sides. The Travessilla soil has a profile similar to the one described as representative of the series except that cobblestones and stones cover 5 to 40 percent of the surface.

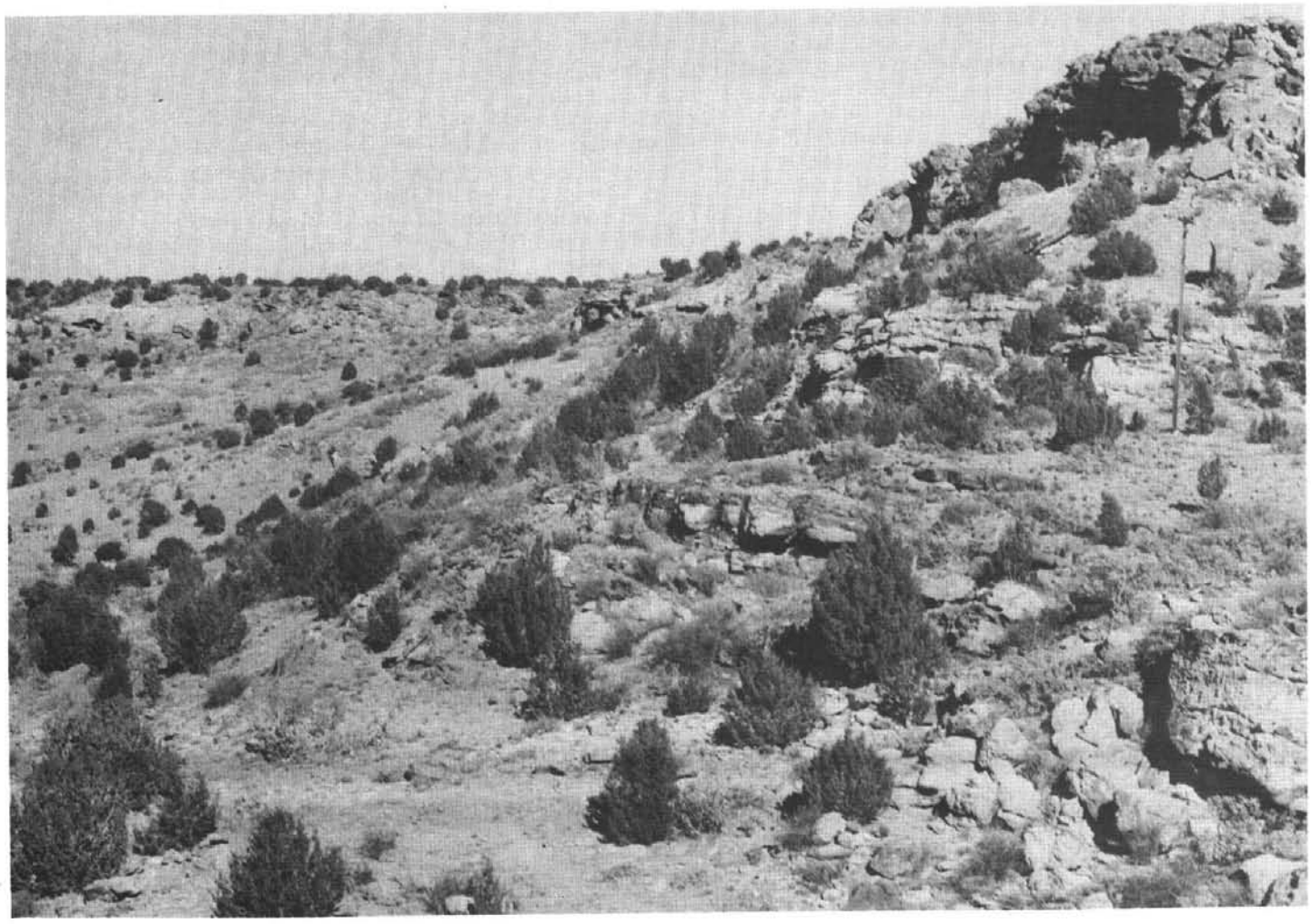

Figure 16.—**Landscape of Travessilla-Rock outcrop complex, 30 to 75 percent slopes.**

Included with this complex in mapping are Rubble land, which makes up 10 percent of the mapped acreage; Aridic Haplustolls, which make up 5 percent; Litle soils, which make up 5 percent; and Alicia, Kim, Manzano, and Texline soils, which make up 5 percent. Rubble land, Aridic Haplustolls, and Litle soils are in the same areas as Travessilla soils. The Alicia, Kim, Manzano, and Texline soils are at the bottoms of escarpments or in narrow valleys between escarpments.

This complex is used for range, wildlife habitat, and water supply. Nonirrigated capability subclass VIIs; Travessilla stony sandy loam in Breaks range site, Rock outcrop not assigned to a range site.

Ustolls

In certain types of terrain, separation of soils at the level of phases of soil series was not feasible. In such areas the soils were mapped and named in a category in the soil classification system broader than the series. Ustolls, for example, is a suborder. See the section "Formation and Classification of the Soils" for a more complete explanation of the system.

Ustolls are shallow to deep, well drained soils. They formed in a variety of material derived from basalt, sandstone, and upland deposits of the Ogallala Formation and in valley fill leading away from vertical basalt escarpments of basalt-capped mesas. Slopes are typically 25 to 75 percent. Elevation is 4,900 to 7,500 feet. Vegetation is mainly oneseed juniper, pinon pine, oakbrush, skunkbrush sumac, mountainmahogany, bluestem, blue grama, and side-oats grama. The average annual precipitation is 15 to 20 inches, and the average annual air temperature is 45° to 57° F. The length of the frost free season is 120 to 180 days.

The surface layer is dark colored gravelly, cobbly, or stony loam or clay loam. The substratum is reddish brown or yellowish red loam, clay loam, silty clay loam, or clay in most places. In places a white layer of lime accumulation is in the substratum. Gravel, cobblestones, or stones make up 20 to 70 percent of the soil material. In a few areas sandstone or shale is at a shallow or moderate depth. The soils are noncalcareous to strongly calcareous and mildly or moderately alkaline.

Permeability is moderately slow to slow. Runoff is rapid. Available water capacity is mostly 6 to 10 inches in deep soils and 0.5 to 2 inches in soils that are shallow over shale or sandstone. Effective rooting depth is 10 to 60 inches. The hazard of water erosion is severe, and the hazard of soil blowing is slight or moderate.

These soils are used for range, wildlife habitat, and water supply.

Ur—Ustolls-Rock outcrop association (25 to 75 percent slopes). Ustolls make up 75 percent of this association, and Rock outcrop makes up 15 percent. Included soils and land types make up the remaining 10 percent. Areas are long and narrow and 100 to several hundred acres in size. Ustolls are on the sides of escarpments in basalt-capped mesas; Rock outcrop is on the top edges of the escarpments.

Included with this association in mapping, and making up 5 percent each of the mapped acreage, are Travessilla soils and Rubble land. Travessilla soils are in sandstone areas over which basalt flowed. Rubble land is immediately below the Rock outcrop.

This association is used for range, wildlife habitat, and water supply. Ustolls in nonirrigated capability subclass VIIs. Rock outcrop in nonirrigated capability subclass VIIIs; Ustolls in Breaks range site, Rock outcrop not assigned to a range site.

Valent series

The Valent series consists of deep, excessively drained soils on sand dunes and hummocky upland plains. These soils formed in eolian sand. Slopes are 3 to 9 percent. Elevation is 4,300 to 6,200 feet. Vegetation is mainly blue grama, hairy grama, side-oats grama, bluestem, sand dropseed, skunkbush sumac, sand sagebrush, and small soapweed (yucca). The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 50° to 57° F. The length of the frost free season is 160 to 185 days.

In a representative profile the surface layer is brown loamy sand about 5 inches thick. The substratum is brown and pink sand to a depth of 94 inches or more. The soil material is noncalcareous throughout. Reaction is neutral to a depth of 50 inches and mildly alkaline below.

Permeability is very rapid. Runoff is slow. Available water capacity is 3 to 6 inches. Effective rooting depth is 60 inches or more. The hazard of soil blowing is severe, and the hazard of water erosion is slight.

These soils are used for range and wildlife habitat.

Representative profile of Valent loamy sand, 3 to 9 percent slopes, 900 feet south of the north quarter corner of sec. 7, T. 23 N., R. 36 E.:

A1—0 to 5 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) when moist; weak fine granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; many fine roots; many fine interstitial pores; neutral; clear smooth boundary. 4 to 9 inches thick.

C1—5 to 50 inches; brown (7.5YR 5/4) sand, dark brown (7.5YR 4/4) when moist; single grained; loose when dry or moist, nonsticky and nonplastic when wet; few fine roots and many coarse roots; many fine interstitial pores; neutral; clear smooth boundary. 24 to 60 inches.

C2—50 to 94 inches; pink (7.5YR 7/4) sand, brown (7.5YR 5/4) when moist; single grained; loose when dry or moist, nonsticky and nonplastic when wet; many fine interstitial pores; mildly alkaline.

The soil is 60 inches thick or more. It is noncalcareous or slightly calcareous and neutral or mildly alkaline.

The A1 horizon is brown, pale brown, light brown, or grayish brown when dry and brown, dark brown, or dark grayish brown when moist. It is loamy sand or sand.

The C horizon is pale brown, very pale brown, yellowish brown, light brown, brown, or pink when dry

and brown, pale brown, dark brown, or light brown when moist.

VaD—Valent loamy sand, 3 to 9 percent slopes. This soil is in narrow areas of dunes. Areas are 20 to 200 acres in size.

Included with this soil in mapping, and making up 15 percent of the mapped acreage, are Vingo soils in nearly level areas of the landscape or in depressions.

This soil is used for range and wildlife habitat. Nonirrigated capability subclass VIe; Deep Sand range site.

Vermejo series

The Vermejo series consists of deep, moderately well drained soils in drainageways and depressions. These soils formed in fine textured alluvium derived from mixed sources. Slopes are 0 to 3 percent. Elevation is 5,400 to 7,000 feet. Vegetation is mainly blue grama, ring muhly, sleepygrass, western wheatgrass, and broom snakeweed. The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 46° to 57° F. The length of the frost free season is 140 to 170 days.

In a representative profile the surface layer is grayish brown silty clay loam about 10 inches thick. The substratum is grayish brown, light brownish gray, and light yellowish brown clay and silty clay to a depth of 66 inches or more. The soil material is strongly calcareous throughout. Reaction is moderately alkaline in the upper 31 inches and strongly alkaline below.

Permeability is very slow. Runoff is medium. Available water capacity is 6 to 10 inches. Effective rooting depth is 40 inches or more. The hazard of water erosion is moderate or severe, and the hazard of soil blowing is slight.

These soils are used for range and wildlife habitat.

Representative profile of Vermejo silty clay loam, 2,300 feet north of the southwest corner of sec. 23, T. 33 N., R. 29 E.:

A1—0 to 10 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak fine subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; common fine roots; few very fine pores; strongly calcareous; moderately alkaline; clear smooth boundary. 6 to 14 inches thick.

C1—10 to 31 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (10YR 4/2) when moist; weak fine and medium subangular blocky and angular blocky structure; very hard when dry, firm when moist, very sticky and plastic when wet; few roots in peds, many between peds; few very fine pores; strongly calcareous; moderately alkaline; clear smooth boundary. 10 to 24 inches thick.

C2—31 to 46 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) when moist; massive; hard when dry, firm when moist, very sticky and plastic when wet; few very fine pores; strongly calcareous; strongly alkaline; gradual wavy boundary. 8 to 22 inches thick.

C3—46 to 66 inches; light yellowish brown (2.5Y 6/4) silty clay, light olive brown (2.5Y 5/4) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; few very fine pores; strongly calcareous; strongly alkaline.

Shale is below a depth of 40 inches. The soil is moderately or strongly calcareous and moderately or strongly alkaline.

The A1 horizon is light brownish gray, grayish brown, brown, or pale brown when dry and dark grayish brown or brown when moist. It is clay loam or silty clay loam.

The C horizon is light gray, light brownish gray, very pale brown, grayish brown, or light yellowish brown when dry and grayish brown, dark grayish brown, light olive brown, or yellowish brown when moist. It is heavy silty clay loam, clay, or silty clay.

Ve—Vermejo silty clay loam (0 to 3 percent slopes). This soil is along drainage channels and in depressions in areas of 40 to 200 acres. Slopes are 0 to 3 percent.

Included with this soil in mapping are Litle soils adjacent to playa lakes and La Brier soils in depressions and along drainageways. Also included on playa lake bottoms in areas too small to be shown on the soil map is a soil that is similar to this Vermejo soil except that it is poorly drained. The La Brier soils and the soil that is similar to this Vermejo soil each make up 5 percent of the mapped acreage.

This soil is used for range and wildlife habitat. Irrigated capability unit IVs–9, nonirrigated capability subclass VIs; Clayey range site.

Vingo series

The Vingo series consists of deep, well drained soils on hummocky uplands. These soils formed in sandy eolian material. Slopes are 1 to 5 percent. Elevation is 4,300 to 6,200 feet. Vegetation is mainly blue grama, hairy grama, side-oats grama, bluestem, sand sagebrush, and small soapweed (yucca). The average annual precipitation is 14 to 18 inches, and the average annual air temperature is 50° to 57° F. The length of the frost free season is 160 to 185 days.

In a representative profile the surface layer is brown loamy sand about 11 inches thick. The subsoil extends to a depth of 80 inches or more. It is brown and yellowish red sandy loam. It is noncalcareous and neutral to a depth of 62 inches and slightly calcareous and mildly alkaline below.

Permeability is moderately rapid. Runoff is very slow. Available water capacity is 7 to 8.5 inches. Effective rooting depth is 60 inches or more. The hazard of soil blowing is severe, and the hazard of water erosion is slight.

These soils are used for range and wildlife habitat.

Representative profile of Vingo loamy sand, in an area of Vingo-Dallam complex, 1,600 feet south and 500 feet west of the north quarter corner sec. 28, T. 22 N., R. 36 E.:

A1—0 to 11 inches; brown (7.5YR 5/4) loamy sand, dark brown (10YR 4/3) when

moist; very weak medium subangular blocky structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; many fine roots; many fine interstitial pores; neutral; clear smooth boundary. 6 to 14 inches thick.

B21t—11 to 21 inches; brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/4) when moist; weak coarse subangular blocky structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; few fine pores; few patchy clay films on peds; common clay bridges on sand grains; neutral; gradual smooth boundary. 8 to 20 inches thick.

B22t—21 to 62 inches; yellowish red (5YR 5/6) sandy loam, yellowish red (5YR 4/6) when moist; weak coarse subangular blocky structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; few fine roots; few fine pores; few patchy clay films and common clay bridges between sand grains; neutral; diffuse smooth boundary. 6 to 45 inches thick.

B23tca—62 to 80 inches; yellowish red (5YR 5/6) sandy loam, yellowish red (5YR 5/6) when moist; weak fine subangular blocky structure; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; few lime nodules; slightly calcareous; mildly alkaline.

The A horizon is mostly noncalcareous but in a few areas it is slightly calcareous. Reaction is neutral or mildly alkaline to a depth of 40 inches.

The A1 horizon is brown, yellowish brown, pale brown, or strong brown when dry and dark brown, strong brown, or brown when moist. Texture is sand or loamy sand.

The Bt horizon is brown, strong brown, yellowish red, or reddish yellow when dry and dark brown, brown, strong brown, reddish yellow, or yellowish brown when moist. Above a depth of 40 inches it is fine sandy loam to sandy loam and averages sandy loam. It is sandy loam or sandy clay loam below a depth of 40 inches. The Btca horizon is pink, light brown, strong brown, or yellowish red when moist and dry. It is sandy clay loam, sandy loam, or loamy sand.

Vn—Vingo-Dallam complex (0 to 5 percent slopes). Vingo loamy sand, 1 to 5 percent slopes, makes up about 70 percent of this complex, and Dallam loamy sand, 0 to 3 percent slopes, makes up 20 percent. Included soils make up the remaining 10 percent. This complex is mapped in areas of 160 acres or larger.

The Vingo soil is on hummocks and dune sides, and the Dallam soil is in depressions. The Vingo soil has the profile described as representative of its series. The Dallam soil has a profile that is similar to the one described as representative of its series except that the surface layer is loamy sand.

Included with these soils in mapping are Valent soils in areas of dunes and Spurlock loamy sand in intermingled areas of dunes that adjoin landscapes dominated by the Ogallala Formation. These soils each make up about 5 percent of the mapped acreage.

These soils are used for range and wildlife habitat. Irrigated capability unit IVe–10, nonirrigated capability subclass VIe; Deep Sand range site.

Use and Management of the Soils

The use and management of soils for irrigated and nonirrigated cropland, range, wildlife habitat, and engineering are presented in this section. Explanations of range sites and capability classifications of soils are given, management of irrigated and nonirrigated soils by capability units are discussed, and estimated yields of crops under a high level of management are given for crops grown in irrigated and nonirrigated areas. Tables in this section present information significant to engineering (tables 6, 7, and 8) and the establishment of wildlife habitat (table 5).

To find the names of the soils in any given capability unit or range site, refer to the "Guide to Mapping Units" at the back of this soil survey.

Range [3]

Ninety-five percent of all the land in Union County is used for range. The ranching enterprises are cow and calf yearling operations (*5, 7*). The size of these livestock operations ranges from a few hundred acres to several thousand acres.

The area is climatically suited to year-round grazing. Most ranchers use supplemental feed in the winter months. In years of below normal precipitation, they use supplemental feed in other months as well.

Range Sites and Condition Classes

A range site is a distinctive kind of range that differs from other kinds in its potential to produce a characteristic natural plant community. It is the product of all environmental factors responsible for its development—soil, climate, and vegetation. Soils that have the capacity to produce the same kinds, amounts, and proportions of range plants are grouped together in the same range site.

The potential or climax vegetation of a range site is the native plant community best adapted to the particular set of environmental factors at the site. These plant communities are relatively stable and are dynamically balanced with the environment.

Abnormal disturbances, such as overuse by livestock and excessive burning or plowing, result in changes in the climax plant community. If the disturbance is drastic enough, the community may be completely destroyed. If the range site is not deteriorated significantly under such disturbances as water erosion or soil blowing, secondary plant succession progresses in the direction of the natural potential, or climax plant community, for the site. Range conservationists and soil scientists together have determined the natural potential plant communities for individual soils of Union County and have grouped these soils into range sites.

[3] HENRY E. WALL, JR., range conservationist, Soil Conservation Service, assisted in preparation of this section.

Range condition is the present state of the vegetation or plant community on a range site as related to the climax plant community for the site. The primary purpose in determining range condition is to provide an index of changes that have taken place in the plant cover. When the potential plant community for a site is known, the present range condition can be determined. As a result, a basis is provided for predicting the nature and direction of plant community changes to be expected under a specified program of management.

When changes that occur in the climax plant community are caused by particular kinds of use by livestock or by other disturbance, plants of certain species increase, while plants of other species decrease. Reaction of the plants to grazing depends on the kind of animal grazed, the season of use, and the extent of plant tissue removal. By comparing the composition of the present plant community to that of the climax plant community, it is possible to see how certain species increase and other species decrease. Plants not in the climax community that show up in the present plant community are known as "invaders."

The composition of plant communities, both climax and present, together with other range site information, provides the interpretative basis for selecting management objectives, designing grazing systems, managing for wildlife habitat, determining recreation potentials, and evaluating hydrologic conditions.

Management objectives for range generally require an increase in desirable plants and restoration of range to as near climax conditions as is reasonably feasible. At times the management objectives are to create or maintain plant communities somewhat removed from the climax to fit specific needs in the grazing program and to provide for wildlife habitat or other benefits. Any management objective must be compatible with conservation objectives, which provide for plant communities that protect and improve soil and water resources while meeting the desires and needs of the operator.

Descriptions of Range Sites

In the following pages the range sites of Union County are described, the climax plants and principal invaders on the sites are named, and an estimate is given of the potential annual yield of air-dry vegetation for each site when the site is in excellent condition. Unless otherwise noted the soil textures given in each range site description are for the surface layer. The soil series represented is named in the description of each range site. This does not mean, however, that in a given series all the soils are in the same site. To find the range site for any given soil, refer to the "Guide to Mapping Units" at the back of this soil survey.

Rock outcrop and Rubble land are not included in the range sites, because they are not suited to use as range.

BREAKS RANGE SITE

This range site consists of well drained soils that are 5 to 70 percent cobblestones and stones. These soils have a surface layer of sandy loam, clay loam, loam, or clay. Slopes range from 1 to 75 percent but are predominantly more than 25 percent.

Permeability is moderately rapid to very slow in soils of this site. Runoff is rapid.

About 80 percent of the vegetation on this site is grasses, 5 percent is shrubs, and 15 percent is pinon pine and juniper trees. Forbs are present, but they are sparsely scattered.

The composition, by weight, of the climax vegetation, or potential plant community, is about 20 percent little bluestem, 20 percent side-oats grama, 20 percent blue and hairy grama, 10 percent western wheatgrass, 10 percent pinon pine, 5 percent galleta, 5 percent needleandthread, 5 percent skunkbush sumac, and 5 percent oneseed juniper. Associated species are black grama, big bluestem, oak brush, mountainmahogany, three-awn, and fringed sagebrush. Where this site is heavily and continually grazed by cattle, little bluestem, side-oats grama, and western wheatgrass are replaced by blue and hairy grama, oak brush, pinon pine, and oneseed juniper. Yellow sweetclover and perennial forbs invade this site in places.

Livestock seek areas of this site to protect themselves against winter storms. Trails and access roads are commonly needed to provide better distribution of livestock.

If this site is in excellent condition, the total annual yield of all vegetation ranges from 1,500 pounds in favorable years to 600 pounds in unfavorable years. Approximately 75 percent of this yield is from plants that furnish forage for cattle.

CINDER RANGE SITE

This range site (fig. 17) consists of somewhat excessively drained soils that are underlain by a continuous layer of cinders at a depth of 12 to 26 inches. The soils of this range site have a surface layer of gravelly silt loam. Slopes range from 0 to 25 percent.

Permeability is moderate, and runoff is slow.

About 80 percent of the vegetation on this site is grasses, 5 percent is shrubs, and 15 percent is pinon pine and juniper trees. Forbs are present, but they are sparsely scattered.

The composition, by weight, of the climax vegetation, or potential plant community, is about 25 percent little bluestem, 25 percent side-oats grama, 20 percent blue grama, 10 percent pinon pine, 5 percent big bluestem, 5 percent junegrass, 5 percent oneseed juniper, and 5 percent oak brush. Associated species are galleta, wolftail, yucca, Apacheplume, mountainmahogany, and skunkbush sumac. Where this site is heavily and continually grazed by cattle, little bluestem, side-oats grama, big bluestem, and junegrass are replaced by blue grama, oneseed juniper, pinon pine, oak brush, skunkbush sumac, and mountainmahogany. Ring muhly and sleepgrass invade this site in places.

The soils in this site are suited to range seeding and brush management where improvement of range conditions is needed. Care, however, should be taken to protect the soil against water erosion.

If this site is in excellent condition, the total annual yield of all vegetation is as much as 1,300 pounds, air-dry weight, per acre in favorable years and as little as 700 pounds in unfavorable years. Approximately 80 percent of this yield is from plants that furnish forage for cattle.

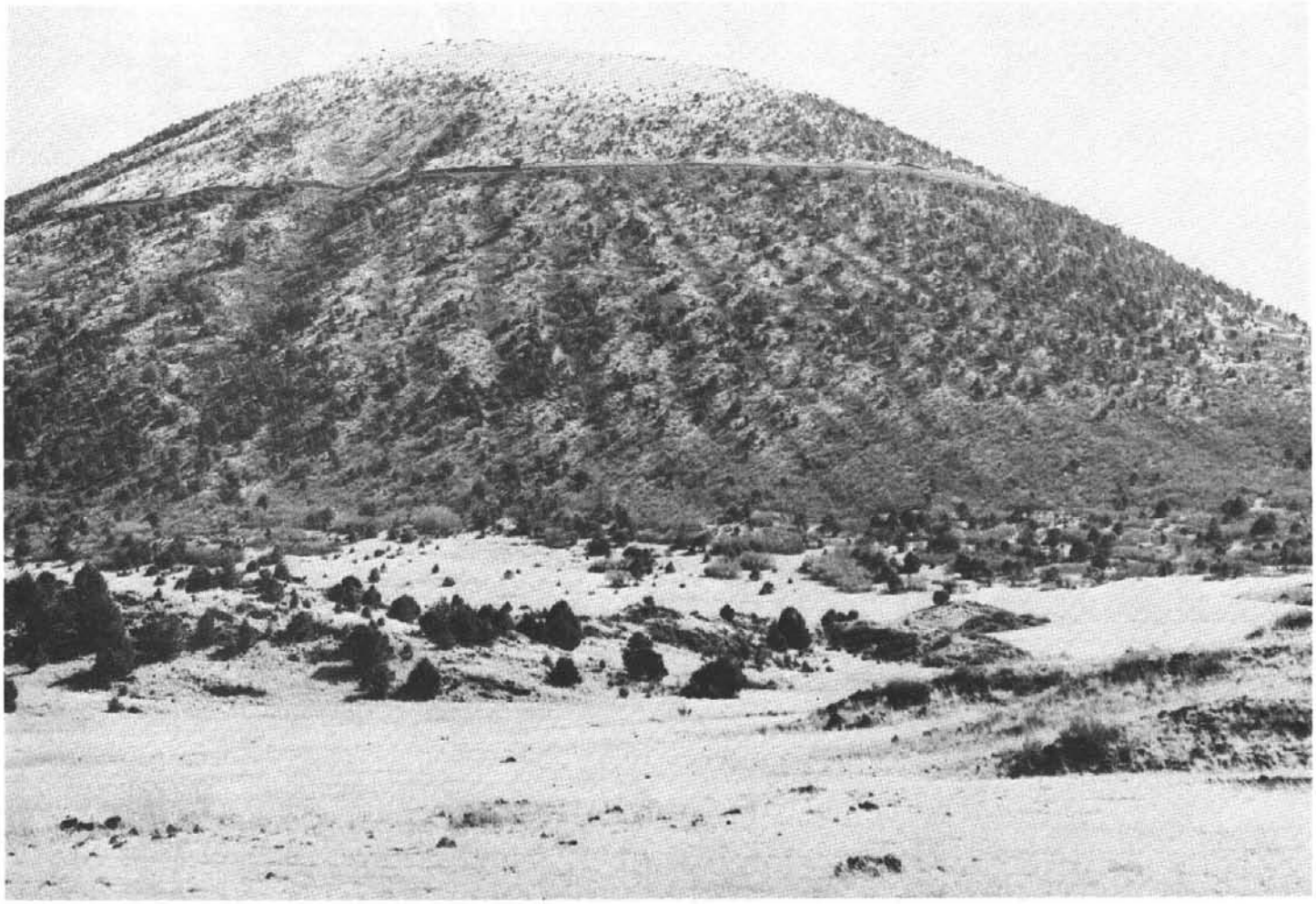

Figure 17.—An area of Cinder range site on Capulin Mountain National Monument. The soil is in the Bandera association. The steeper soil near the upper part of the mountain is not in a range site, but it is suited to wildlife use.

CLAYEY RANGE SITE

This range site (fig. 18) consists of moderately well drained or well drained soils that have a surface layer of clay loam or silty clay loam. Slopes range from 0 to 9 percent.

Permeability is moderately slow to very slow in soils of this site. Runoff is slow to rapid.

About 90 to 95 percent of the vegetation on this site is mid and short grasses, and 5 percent is shrubs. Few or no forbs are present.

The composition, by weight, of the climax vegetation, or potential plant community, is about 25 percent blue grama, 20 percent western wheatgrass, 15 percent galleta, 10 percent vine mesquite, 10 percent side-oats grama, 5 percent buffalograss, 5 percent mat muhly, 5 percent three-awn, and 5 percent four-wing saltbush. Associated species are cactus, ring muhly, and broom snakeweed. Where this site is heavily and continually grazed by cattle, western wheatgrass, vine mesquite, and side-oats grama, are replaced by blue grama, galleta, buffalograss, cactus, and four-wing saltbush. Gumweed, western ragweed, and tumblegrass invade this site in places.

The soils in this site are suited to range seeding, brush management, contour furrowing, and pitting where improvement of range condition is needed.

If this site is in excellent condition, the total yield of all vegetation ranges from 1,200 pounds per acre in favorable years to 400 pounds in unfavorable years. Approximately 95 percent of this yield is from plants that furnish forage for cattle.

DEEP SAND RANGE SITE

This range site consists of excessively drained or well drained soils that have a surface layer of loamy sand. Slopes range from 0 to 9 percent.

Permeability is moderate to very rapid in soils of this range site. Runoff is slow or very slow.

About 90 percent of the vegetation on this site is grass and 10 percent is yucca. Only a few forbs are present.

The composition, by weight, of the climax vegetation, or potential community, is about 30 percent little bluestem, 15 percent blue and hairy grama, 15 percent sand bluestem, 10 percent side-oats grama, 10 percent sand dropseed, 5 percent New Mexico feathergrass, 5 percent sand sagebrush, 5 percent silver bluestem, and 5 percent small soapweed (yucca). Asso-

Figure 18.—An area of Clayey range site. The soil is Sherm clay loam, and the vegetation is mostly galleta and blue grama.

ciated species are black grama, needleandthread, and tumblegrass. Where this site is heavily and continually grazed by cattle, little bluestem, sand bluestem, side-oats grama, and New Mexico feathergrass are replaced by blue and hairy grama, sand dropseed, sand sagebrush, silver bluestem, and small soapweed (yucca).

The soils in this site are suitable for range seeding and brush management where improvement of range condition is needed. Special consideration, however, must be made to control soil blowing during revegetation.

If this site is in excellent condition, the total yield of all vegetation ranges from 1,900 pounds per acre in favorable years to 1,000 pounds in unfavorable years. Approximately 90 percent of this yield is from plants that furnish forage for cattle.

LOAMY RANGE SITE

This range site consists of well drained soils that have a surface layer of loam and silty clay loam. Slopes range from 0 to 9 percent.

Permeability is moderate to slow in soils of this site. Runoff is medium.

Vegetation on this range site is almost entirely pure grass. Only a few forbs or woody species are present.

The composition, by weight, of the climax vegetation, or plant community, is about 40 percent blue grama, 15 percent western wheatgrass, 10 percent side-oats grama, 5 percent vine mesquite, 5 percent sand dropseed, 10 percent buffalograss, 10 percent galleta, and 5 percent three-awn. Associated species are fringed sagebrush, wolftail, gumweed, small soapweed (yucca), broom snakeweed, and ring muhly. Where this site is heavily and continually grazed by cattle, side-oats grama, vine-mesquite, and western wheatgrass are replaced by blue grama, buffalograss, galleta, and ring muhly. Cactus and annuals invade this site in places.

The soils in this site are suited to range seeding, brush management, contour furrowing, and pitting where improvement of range condition is needed. If this site is in excellent condition, the total yield of all vegetation ranges from 1,300 pounds per acre in favorable years to 600 pounds in unfavorable years. Approximately 95 percent of this yield is from plants that furnish forage for cattle.

MALPAIS RANGE SITE

This range site (fig. 19) consists of well drained, cobbly soils that have a surface layer of loam, silt loam, or clay loam. Slopes range from 1 to 15 percent.

Permeability in the soils of this site is moderate to slow. Runoff is medium to rapid.

Vegetation on this range site is almost entirely pure grass. Only a few forbs or woody species are present.

The composition, by weight, of the climax vegetation, or potential plant community, is about 25 percent side-oats grama, 20 percent little bluestem, 20 percent western wheatgrass, 20 percent blue and hairy grama, 10 percent galleta, and 5 percent indiangrass. Associated species are fringed sagebrush and wolftail and ring muhly. Where this site is heavily and continually grazed by cattle, side-oats grama, little bluestem, western wheatgrass, and indiangrass are replaced by blue grama, three-awn, and galleta. Small soapweed (yucca), broom snakeweed, cholla, pricklypear, or oneseed juniper invade this site in places.

The soils in this site are suited to range seeding and brush management where improvement of range condition is needed.

If this site is in excellent condition, the total of all vegetation ranges from 1,200 pounds per acre in favorable years to 500 pounds per acre in unfavorable years. About 90 percent of this yield is from plants that furnish forage for cattle.

MOUNTAIN GRASSLAND RANGE SITE

This range site consists of well drained soils that have a surface layer of cobbly silt loam. Slopes range from 9 to 70 percent.

Permeability is slow in soils of this site. Runoff is rapid.

The vegetation is predominantly grasses, but oak brush, pinon, and ponderosa pine are sparsely scattered on this site.

The composition, by weight, of the climax vegetation, or potential plant community, is about 15 percent little bluestem, 15 percent mountain muhly, 15 percent blue grama, 10 percent side-oats grama, 10 per-

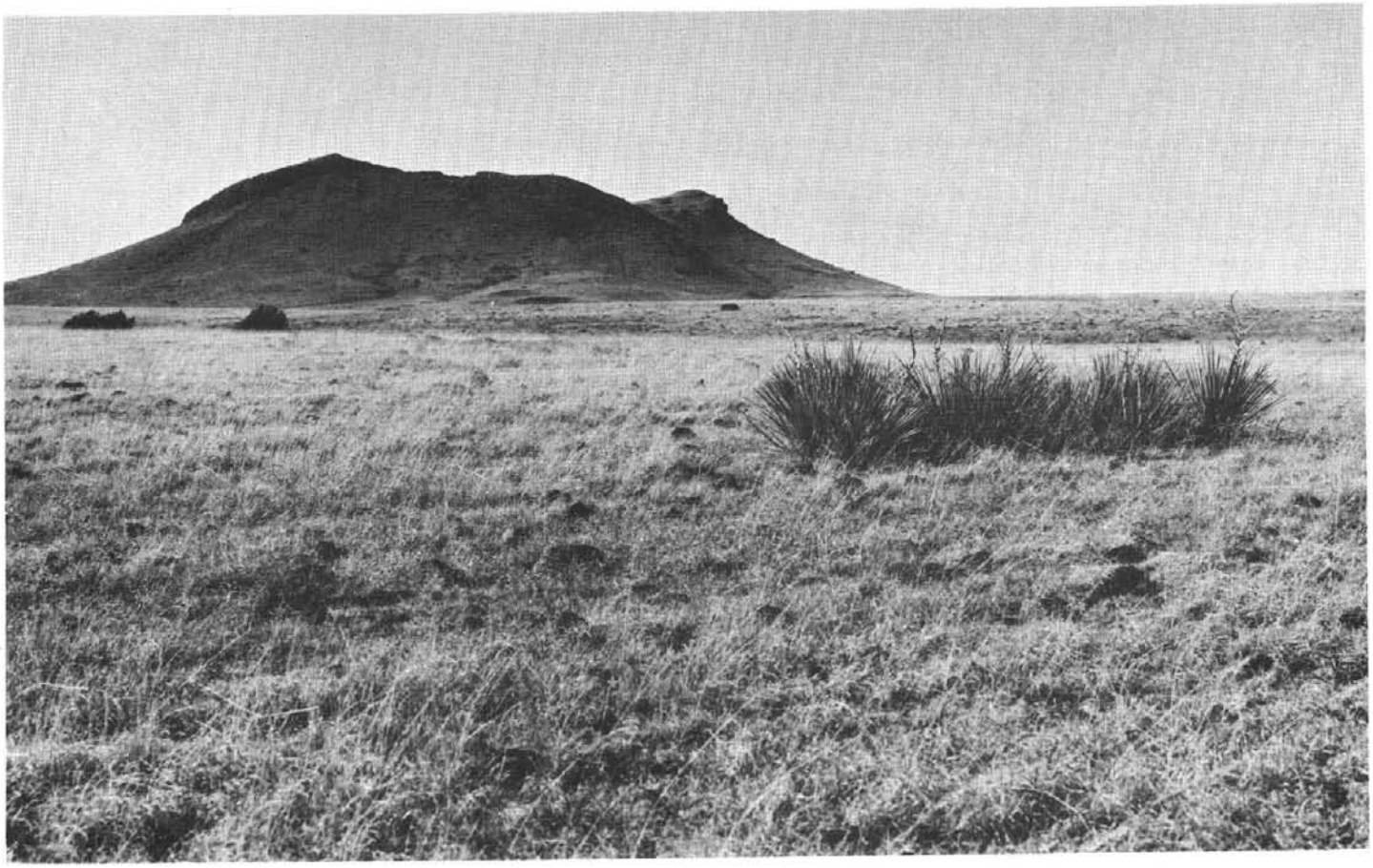

Figure 19.—An area of Malpais range site. The soils are in the Ayon-Apache association and the Apache-Rock outcrop complex.

cent western wheatgrass, 5 percent junegrass, 5 percent mountain brome, 5 percent muttongrass, 5 percent pine dropseed, 5 percent oak brush, 5 percent ponderosa pine, and 5 percent pinon pine. Associated species are side-oats grama, Arizona fescue, mountain-mahogany, sedges, oneseed juniper, and oatgrass. Where this site is heavily and continually grazed by cattle, little bluestem, junegrass, mountain brome, mountain muhly, muttongrass, oatgrass, and pine dropseed are replaced by blue grama, oak brush, oneseed juniper, pinon pine, and ponderosa pine. Kentucky bluegrass, timothy, and redtop invade this site in places.

Designed trails and access roads are commonly needed to provide distribution of livestock.

If this site is in excellent condition, the total annual yield of all vegetation ranges from 1,500 pounds in favorable years to 700 pounds in unfavorable years. About 85 percent of this yield is from plants that furnish forage for cattle.

SANDY RANGE SITE

This range site consists of well drained soils that have a surface layer of fine sandy loam, sandy loam, or loam. Slopes range mostly from 0 to 5 percent, but in a few areas they range up to 9 percent.

Permeability is moderate or moderately slow in soils of this site. Runoff is slow or medium.

The vegetation on this site is predominantly a mixture of grasses. Only a few forbs and scattered small soapweed (yucca) are present.

The composition, by weight, of the climax vegetation, or potential plant community, is about 35 percent side-oats grama, 25 percent blue and hairy grama, 15 percent little bluestem, 10 percent New Mexico feathergrass, 5 percent sand dropseed, 5 percent three-awn, and 5 percent small soapweed (yucca). Associated species are galleta, sand bluestem, sand sagebrush, winterfat, and needleandthread. Where this site is heavily and continually grazed by cattle, side-oats grama, little bluestem, and needlegrasses are replaced by blue grama, hairy grama, three-awn, and small soapweed (yucca). Pricklypear and cholla invade this site in places.

The soils in this site are suited to range seeding and brush management where improvement of the range condition is needed. Special consideration, however, must be made to control soil blowing during revegetation.

If this site is in excellent condition, the total annual yield of all vegetation ranges from 1,300 pounds per acre in favorable years to 800 pounds in unfavorable years. About 90 percent of the yield is from plants that furnish forage for cattle.

SHALLOW RANGE SITE

This range site consists of well drained soils that have a surface layer of gravelly loam or loam. The

soils are shallow over indurated caliche or are moderately deep or deep over bedrock. Slopes range from 0 to 9 percent.

Permeability is moderately rapid or moderate in soils of this site. Runoff is medium.

The vegetation on this site is mostly grasses. A few forbs and woody plants are present.

The composition, by weight, of the climax vegetation, or potential plant community, is about 30 percent blue and hairy grama, 25 percent side-oats grama, 25 percent little bluestem, 5 percent needleandthread, 5 percent New Mexico feathergrass, 5 percent three-awn, and 5 percent wolftail. Associated species are skunkbush sumac, big bluestem, broom snakeweed, western wheatgrass, and small soapweed (yucca). Where this site is heavily and continually grazed by cattle, little bluestem, needlegrasses, and side-oats grama are replaced by blue grama, hairy grama, three-awn, and small soapweed (yucca).

The moderately deep and deep soils in this range site are suited to brush control and range seeding.

If this site is in excellent condition, the total annual yield of all vegetation ranges from 900 pounds per acre in favorable years to 200 pounds per acre in unfavorable years. About 90 percent of this yield is from plants that furnish forage for cattle.

SHALLOW SANDSTONE RANGE SITE

The range site consists of well drained, shallow soils that have a surface layer of loam or sandy loam. Bedrock is at a depth of 4 to 20 inches. Slopes range from 0 to 15 percent.

Permeability is moderately rapid in soils of this site. Runoff is medium.

The vegetation on this site is mostly grass. Some skunkbush sumac, open stands of juniper, and pinon pine are also present.

The composition, by weight, of the climax vegetation, or potential plant community, is about 30 percent side-oats grama, 25 percent little bluestem, 20 percent blue and hairy grama, 10 percent oneseed juniper, 5 percent New Mexico feathergrass, 5 percent pinon pine, and 5 percent skunkbush sumac. Associated species are silver bluestem, big bluestem, mountainmahogany, oak brush, and fringed sagebrush. Where this site is heavily and continually grazed by cattle, the little bluestem, side-oats grama, and New Mexico feathergrass are replaced by blue grama, hairy grama, oneseed juniper, pinon pine, and skunkbush sumac. Cactus, broom snakeweed, and small soapweed (yucca) invade this site in places.

If this site is in excellent condition, the total annual yield of all vegetation ranges from 1,200 pounds per acre in favorable years to 600 pounds in unfavorable years. Approximately 80 percent of this yield is from plants that furnish forage for cattle.

Plant Glossary

The following is a list of plant names, other than those of domestic grain, that are used in this survey. Most of these plants are mentioned in the section that follows—"Descriptions of Range Sites."

Common name	*Scientific name*
alkali sacaton	*sporobolus airoides*
Apacheplume	*fallugia paradoxa*
Arizona fescue	*festuca arizonica*
big bluestem	*andropogon gerardi*
black grama	*bouteloua eriopoda*
blue grama	*bouteloua gracilis*
broom snakeweed	*gutierrezia sarothrae*
buffalograss	*buchloe dactyloides*
cactus	*opuntia spp.*
cholla	*opuntia spp.*
cocklebur	*xanthium spp.*
fourwing saltbush	*atriplex canescens*
fringed sagebrush	*artemisia frigida*
galleta	*hilaria jamesii*
gumweed	*grindelia squarrosa*
hairy grama	*bouteloua hirsuta*
indiangrass	*sorghastrum nutans*
junegrass	*koeleria cristata*
Kentucky bluegrass	*poa pratensis*
little bluestem	*andropogon scoparius*
littleleaf sumac	*rhus microphylla*
mat muhly	*muhlenbergia richardsonis*
mountain brome	*bromus carinatus*
mountain muhly	*muhlenbergia montana*
mountainmahogany	*cercocarpus spp.*
muttongrass	*poa fendleriana*
needleandthread	*stipa comata*
New Mexico feathergrass	*stipa neomexicana*
oak brush	*quercus spp.*
oatgrass	*danthonia spp.*
oneseed juniper	*juniperus monosperma*
pine dropseed	*blepharoneuron tricholepis*
pinon pine	*pinus edulis*
ponderosa pine	*pinus ponderosa*
pricklypear	*opuntia spp.*
redtop	*agrostis alba*
ring muhly	*muhlenbergia torreyi*
sand bluestem	*andropogon hallii*
sand dropseed	*sporobolus cryptandrus*
sand sagebrush	*artemisia filifolia*
sedges	*carex spp.*
side-oats grama	*bouteloua curtipendula*
silver bluestem	*andropogon saccharoides*
skunkbush sumac	*rhus trilobata*
sleepygrass	*stipa robusta*
small soapweed (yucca)	*yucca glauca*
three-awn	*aristida spp.*
timothy	*phleum pratense*
tumblegrass	*schedonnardus paniculatus*
vine-mesquite	*panicum obtusum*
western ragweed	*ambrosia psilostachya*
western wheatgrass	*agropyron smithii*
winterfat	*eurotia lanata*
wolftail	*lycurus phleoides*
wooly indianheat	*plantago psyllium (purshii)*
yellow sweetclover	*melilotus officinalis*

Use of the Soils for Crops

The capability grouping of soils, the use and management by irrigated capability units, estimated yields of irrigated soils, the use and management by nonirrigated capability units, and estimated yields of nonirrigated soils are discussed in this section.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of farming. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slopes, depth, or other characteristics of the soils; does not

take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of the soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, windbreaks, or engineering.

In the capability system the kinds of soils are grouped at three levels: the capability class, subclass, and unit.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use. (None of the soils in this county are in Class I.)

Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode, but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat. (None of the soils in this county are in Class V.)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In Class I, there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in Class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreational areas.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol; for example, IIs–1 or IIIe–6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In Union County the capability units are set up and numbered within a system of capability classification that is used throughout the land resource areas that occur in the County (*3*). Not all the capability units in this system are applicable, and for this reason the numbering of the capability units is not consecutive in all cases.

In the following pages the capability units in Union County are described and suggestions for the use and management of the soils are given. For classes VI, VII, and VIII, the soils are only given a class and subclass classification.

In each description the soil series represented in the capability unit are mentioned, but this does not necessarily mean that all the soils of the series are in the same capability unit. To determine the capability unit in which a soil has been placed, refer to that soil in the section "Descriptions of the Soils" or to the "Guide to Mapping Units" at the back of this survey.

Irrigated Capability Units[4]

In this section capability units are described for soils of the county that are irrigated or have suitable sources of water for irrigation systems. Underground sources of water are generally available for irrigation on soils in the capability units described in this section. The Ogallala Formation (*4*) is the major geologic source for this water. Little recharge of the water supply occurs, and as a result water levels are receding. Most irrigation wells are in the eastern part of the county (*8*). A limited amount of surface water is used for irrigation in areas along the Cimarron River. (*9*).

The following management practices apply to all of the soils that are suitable for crops, pasture, or hay:

Base the use of fertilizers on recent soil tests and results of field trials. (The soils in Union County commonly respond to nitrogen and phosphorus for all crops.)

Apply and manage irrigation water so that an even distribution of water throughout the root zone is achieved without waste.

Control weeds, insects, and plant diseases.

Select varieties of plants that are adapted to local conditions.

[4] J. V. MCDONALD, JR., conservation agronomist, Soil Conservation Service, assisted in the preparation of this section.

The following management practices apply specifically to irrigated cropland:

Leave crop residues on or near the surface. When adequate residues are not available, leave fields rough or cloddy or plant close-growing crops to control soil blowing. (The critical period for soil blowing is about February 1 to July 15.)

Maintain the organic matter content by incorporating crop residues, mulches, or manure into the soil or by including grass and legumes in the cropping system. Return at least 3,000 pounds of crop residue per acre per year. Do not exceed 10 tons of manure per acre per year.

Limit tillage operations to those necessary for seedbed preparation, planting, cultivation, and harvest. Do not till the soils when they are wet.

The following management practices apply to all soils used for irrigated hayland or pasture:

Let the growth characteristics of the plants used (*14*) be the guide when determining the minimum height of the plants for grazing or the proper height for cutting. Manage hay crops so that at least 1½ tons of litter and stubble per acre per year are returned to the soil.

Keep cattle and other traffic off of pasture and hayland when the soils are wet enough for compaction to occur.

Rotate the grazing of pastures so that each pasture has a definite rest period between grazing periods.

In Union County a common cropping sequence is continuous grain sorghum or two years of grain sorghum followed by two years of wheat. An alternate cropping system that would help maintain soil organic matter content and furnish protection from erosion is alfalfa for 3 to 5 years in rotation with 2 years of grain sorghum, wheat, or silage.

The irrigated capability units for soils in Union County are described in the paragraphs that follow. A brief description of the kinds of soils in each classification and their use and management is presented in these paragraphs. The names of the soils in each unit can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey.

IRRIGATED CAPABILITY UNIT IIe–6

The soils of this capability unit are well drained. The surface layer is loam, and the subsoil is silty clay loam or clay. Slopes of the soils in this unit are 0 to 5 percent. The average annual precipitation is 14 to 18 inches, and the length of the frost free season is 140 to 180 days.

Permeability is moderate to moderately slow in these soils. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is 6 to 10 inches. Effective rooting depth is 40 to more than 60 inches.

All crops adapted to the climate of Union County can be grown in the soils of this unit. Crops are mainly grain sorghum, alfalfa, corn, and wheat. The soils of this unit are generally irrigated by sprinklers. Land leveling is required to get uniform irrigation in a surface system.

High residue or soil improving crops need to be grown in a cropping sequence with other crops and shifted from field to field in such a way that all of the cropland will be covered at least one-third of the time. High residue or soil improving crops will also help to reduce the hazard of erosion.

IRRIGATED CAPABILITY UNIT IIe–1

La Brier silty clay loam is the only soil in this capability unit. It is well drained. The surface layer is silty clay loam or clay loam, and the subsoil is silty clay loam and clay. Slopes of the soils in this unit are mainly 0 to 1 percent but range to 3 percent. The average annual precipitation is 14 to 18 inches, and the length of the frost free season is 140 to 180 days.

Permeability is very slow in this soil. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is 8.5 to 10 inches. Effective rooting depth is more than 60 inches.

The soils in this unit are better suited to surface irrigation systems than to other types. If the soils are tilled excessively, the soil aggregates break down to sand sized particles that are easily moved by wind. Tillage operations need to be timed according to the amount of moisture in the soil. Thus, excessive compaction or an excessive amount of clods will be avoided.

High residue or soil improving crops need to be grown in a cropping sequence with other crops and shifted from field to field in such a way that all of the cropland will be covered one-third of the time. High residue or soil improving crops will also help to maintain soil structure and water intake rate.

IRRIGATED CAPABILITY UNIT IIIe–4

The soils of this capability unit are well drained. The surface layer is fine sandy loam or sandy loam, and the subsoil is sandy clay loam or clay loam. Slopes of soils in this unit are 0 to 5 percent. The average annual precipitation is 14 to 17 inches, and the length of the frost free season is 165 to 185 days.

Permeability is moderate or moderately slow in soils of this unit. Runoff is medium or slow. The hazard of soil blowing is moderate. Available water capacity is 7.5 to 10 inches. Effective rooting depth is 60 inches or more.

All crops adapted to the climate of Union County can be grown in soils of this unit. Crops are mainly grain sorghum, alfalfa, corn, and wheat. These soils are generally irrigated with sprinklers. Land leveling is required to obtain uniform irrigation with a surface system.

High residue or soil improving crops need to be grown in cropping sequence with other crops and shifted from field to field in such a way that all of the cropland will be covered at least one-half of the time. In order to leave the surface of this soil rough or cloddy, it is necessary to plow deep enough into the subsoil to bring part of the subsoil material to the surface. High residue or soil improving crops will help to reduce the hazard of soil blowing.

IRRIGATED CAPABILITY UNIT IIIe–6

The soils of this capability unit are well drained. The surface layer is loam, and the subsoil is silty clay loam, or clay loam. Slopes of soils in this unit are 0 to 5 percent. The average annual precipitation is 14

to 18 inches, and the length of the frost free season is 140 to 185 days.

Permeability is moderate in soils of this unit. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is 5 to 10 inches. Effective rooting depth is 40 inches or more.

Crops are mainly corn, grain sorghum, and wheat. This soil is better suited to a sprinkler system than to a surface irrigation system, because land leveling is required for uniform water distribution when using a surface system. If land leveling is used, care should be taken not to expose the lime or caliche layers.

High residue or soil improving crops need to be grown in a cropping sequence with other crops and shifted from field to field in such a way that all of the cropland will be covered one-half of the time. High residue or soil improving crops will also help reduce the hazard of soil blowing and will make more nutrients available to plants.

IRRIGATED CAPABILITY UNIT IIIe-8

The soils in this capability unit are well drained. The surface layer is silty clay loam, clay loam, or loam and the subsoil is clay, silty clay loam, clay loam, or sandy clay loam. The slopes of this soil are 0 to 3 percent. The average annual precipitation is 14 to 18 inches, and the length of the frost free season is 140 to 185 days.

Permeability is moderately slow, slow, or very slow in soils in this unit. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is 8 to 10 inches. Effective rooting depth is more than 40 inches.

Crops are mainly grain sorghum, alfalfa, corn, and wheat. This soil is better suited to a surface system of irrigation than to other types, because the surface system permits long runs, requires small streams of water, and generally is efficient when combined with a tail water recovery system. If this soil is tilled excessively, the natural soil aggregates break down to sand sized particles that are easily moved by wind. Tillage operations should be timed according to the amount of moisture in the soil to prevent excessive compaction or an excessive amount of clods.

High residue or soil improving crops need to be grown in cropping sequence with other crops and shifted from field to field in such a way that all of the cropland will be covered one-half of the time. High residue or soil improving crops help to reduce the hazard of erosion and improve the water intake rate.

IRRIGATED CAPABILITY UNIT IIIe-9

This capability unit consists of well drained soils that have a surface layer of loam or silty clay loam and a subsoil of heavy clay loam or clay. Bedrock is at a depth of 20 to 40 inches in most areas, but in some areas it is more than 40 inches. The slopes of these soils are 0 to 5 percent. The average annual precipitation is 14 to 18 inches, and the length of the frost free season is 140 to 180 days.

Permeability is moderately slow or slow in these soils. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is mainly 3.5 to 5 inches, but in some of the deeper soils it is as much as 9 inches. Effective rooting depth is 20 to 40 inches in most areas, but in some it is 40 inches or more.

These soils are not cultivated. Crops need to be limited to permanent pasture or hay. Because of slow permeability, excessive slopes, and location of steep escarpments next to this unit, these soils require a carefully designed irrigation system for the safe application of water. These soils need protective cover, high residue crops, or soil improving crops at all times.

IRRIGATED CAPABILITY UNIT IIIe-10

Dallam loamy sand, 0 to 5 percent slopes, is the only soil in this capability unit. It is well drained. The surface layer is loamy sand, and the subsoil is sandy clay loam. The average annual precipitation is 14 to 17 inches, and the length of the frost free season is 165 to 185 days.

Permeability is moderate in this soil. Runoff is slow. The hazard of water erosion is slight, and the hazard of soil blowing is severe. Available water capacity is 7.5 to 10 inches. Effective rooting depth is more than 60 inches.

This soil is better suited to sprinkler systems than to surface irrigation systems. (Land leveling and extensive maintenance are required for surface systems.)

High residue or soil improving crops need to be grown in cropping sequence with other crops and shifted from field to field in such a way that all of the cropland will be covered at least one-half of the time. In order to leave the surface of this soil rough or cloddy, it is necessary to plow deep enough into the subsoil to bring part of it up to the surface. High residue or soil improving crops help to reduce the hazard of soil blowing.

IRRIGATED CAPABILITY UNIT IIIe-12

Spurlock loam, 1 to 5 percent slopes, is the only soil in this capability unit. It is well drained. The surface layer is loam, and the subsoil is clay loam. Below this, to a depth of 60 inches or more, is clay loam and sandy clay loam. The average annual precipitation is 14 to 17 inches, and the length of the frost free season is 150 to 185 days.

Permeability is moderate in this soil. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is 7.5 to 10 inches. Effective rooting depth is 60 inches or more, but roots are somewhat restricted below a depth of 20 inches because of the heavy concentration of lime.

This soil is used for range and wildlife habitat but is not used for crops. It is suited to permanent pasture, hay, or similar crops. In the event that this soil is used for crops, high residue or soil improving crops will be needed at least two-thirds of the time.

Either a sprinkler or a surface irrigation system can be used, but land leveling is needed for an effective surface system. The content of lime is high between depths of 12 to 20 inches in this soil, and care needs to be taken not to expose the lime in land leveling. Also, the plants selected need to be ones that are not susceptible to chlorosis. High residue or soil improving crops help reduce the hazard of erosion and make plant nutrients more available.

IRRIGATED CAPABILITY UNIT IVe–6

This capability unit consists of well drained soils that have a surface layer of loam or silty clay loam and an underlying layer of silty clay loam or clay loam. Slopes are dominantly 3 to 5 percent, but they range from 0 to 9 percent. The average annual precipitation is 14 to 18 inches, and the frost free season is 140 to 185 days.

Permeability is moderate or moderately slow in these soils. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is 6 to 10 inches. Effective rooting depth is 40 to 60 inches or more.

All crops adapted to the climate of Union County can be grown in these soils. The main crops grown are grain sorghum, alfalfa, corn, and wheat. Areas of such crops are generally irrigated by sprinklers. A surface irrigation system requires extensive reshaping of the soil. Also, the size of the stream used as a water source needs to be very closely controlled.

High residue or soil improving crops need to be grown in cropping sequence with other crops and shifted from field to field in such a way that all of the areas will be covered two-thirds of the time. High residue or soil improving crops help to reduce the hazards of erosion.

IRRIGATED CAPABILITY UNIT IVe–10

The soils of this capability unit are well drained. The surface layer is loamy sand, and the subsoil is sandy clay loam or sandy loam. Slopes are 0 to 5 percent. The average annual precipitation on soils of this unit is 14 to 18 inches, and the length of the frost free season is 160 to 185 days.

Permeability is moderate or moderately rapid in the soils of this unit. Runoff is slow or very slow. The hazard of water erosion is slight, and the hazard of soil blowing is severe. Available water capacity is 7 to 10 inches. Effective rooting depth is more than 60 inches.

Principal crops grown in the soils of this unit are grain sorghum and wheat. The soils, however, are better suited to permanent pasture or hay than to other uses, and they need to be carefully protected to prevent erosion. The soils of this unit are better suited to irrigation by sprinklers than to other types of irrigation.

To prevent soil blowing these soils should be kept in permanent vegetation or protected with crop residues. Further prevention by means of a rough surface, even with deep plowing, is difficult. If used for crops, high residue or soil improving crops should cover all of the areas at least three-fourths of the time.

IRRIGATED CAPABILITY UNIT IVe–9

Vermejo silty clay loam is the only soil in this capability unit. It is moderately well drained. The surface layer is silty clay loam, and the underlying material is silty clay or clay. Slopes are 0 to 3 percent. The average annual precipitation on the soil is 14 to 18 inches, and the length of the frost free season is 140 to 170 days.

Permeability is very slow in this soil. Runoff is medium. The hazard of water erosion is moderate or severe, and the hazard of soil blowing is slight. Available water capacity is 6 to 10 inches. Effective rooting depth is 40 inches or more.

This soil is used mostly for range and wildlife habitat and is not used for crops. It is suited to pasture and to alfalfa or corn. This soil is better suited to surface irrigation than to other types of irrigation. Drainage is difficult because of the clay, underlying shale, very slow permeability, and low position of the soil in the landscape. It is important to plow this soil at the proper moisture content. Thus, soil compaction or formation of large clods will be avoided.

High residue or soil improving crops should be included in cropping systems. Not only does returning crop residue to the soil help maintain the organic matter content and a favorable soil structure, it reduces the hazard of erosion and improves the water intake rate.

Estimated Yields of Irrigated Crops

The estimates of yields given in table 2 are averages that can be expected over a period of years. These estimates are based on results of research and on information obtained from interviews with farmers and other knowledgeable persons. The yields of soils that are presently used only for range are estimated by referring to similar soils. Although wheat is listed in many capability units as a crop, yields are not given because most wheat is used for fall and spring pasture and accurate yield data are not available.

The yields given are based on a high level of management. In determining yields, the following assumptions were made:

Conservation cropping systems include crops that produce a large amount of residue and crops that improve the soil.

Suitable crop varieties are selected, and seed is planted at the proper time and at the correct rates.

The correct fertilizer is applied in proper amounts and at the proper time.

The soils are tilled carefully at the proper time with the proper implements so that crop residue is used and excessive compaction is avoided.

Insect pests, weeds, and plant diseases are controlled.

Length and slope of irrigation runs are suitable, and both surface and sprinkler irrigation systems are properly designed.

Irrigation water is applied at the proper times and according to crop needs.

Crops are harvested at the proper times and harvesting equipment is properly operated.

Yields may change in the future as a result of the development of new crop varieties that will tolerate the diseases and insect pests common in the county. Yields higher than the estimates given are not uncommon in small fields or in experimental plots.

Nonirrigated Capability Units

In this section capability units are described for the nonirrigated soils of the county. Many of the soils in the county that could be cropped are not cropped at present. Nevertheless, these soils were considered

TABLE 2.—*Estimated average yields per acre of principal irrigated crops under a high level of management*

[Only the soils used to a significant extent for any of the specified crops are listed. Absence of figure indicates crop is not suited to that soil or is not commonly grown in it]

Soils	Corn silage	Grain sorghum	Alfalfa hay	Corn	Pasture[1]
	Tons	*Lb*	*Tons*	*Bu*	*AUM*[2]
Alicia loam, 3 to 9 percent slopes	[3] 18	5,500	5.5	100	11
Capulin loam, 0 to 5 percent slopes	20	7,000	6.5	120	13
Carnero-Partri complex	----------	4,500	5.0	90	10
Colmor silty clay loam, 0 to 5 percent slopes	18	5,700	6.0	120	12
Dallam loamy sand, 0 to 5 percent slopes	[3] 18	5,500	6.0	105	12
Dallam fine sandy loam, 0 to 5 percent slopes	20	6,700	6.5	120	13
Dioxice loam, 0 to 5 percent slopes	[3] 17	4,500	5.5	95	11
Gruver loam	22	7,500	6.0	130	12
Kim loam (Kim-Manzano association)	[3] 18	5,500	5.5	100	11
La Brier silty clay loam, (0 to 3 percent slopes)	21	7,000	5.5	125	11
Manzano loam	22	7,500	7.0	130	14
Rickmore sandy loam	22	7,000	7.0	130	14
Sherm clay loam	21	7,000	5.5	125	11
Spurlock loam, 1 to 5 percent slopes	[3] 17	4,500	5.5	95	11
Texline loam, 1 to 5 percent slopes	19	6,500	6.5	120	13
Torreon silty clay loam	19	7,000	5.0	120	11
Vermejo silty clay loam	----------	4,500	4.5	85	9
Vingo-Dallam complex	----------	5,000	6.0	90	12

[1] Very few acres of irrigated pasture are present. Estimated yields are mostly projected from other crop yields.
[2] AUM means animal-unit month—the number of animal units per acre multiplied by the months the pasture can be grazed during a single grazing season without injury to the sod. An acre of pasture that provides 7 months of grazing for 2 cows has a carrying capacity of 14 animal-unit-months.
[3] Yields are for corn silage grown only in areas where slope is at lower part of slope range for the particular soil.

along with those that are cropped. Also, those soils in capability classes VI, VII, and VIII that are suited to uses other than nonirrigated crops were assigned to subclasses of these classes. (See "Guide to Mapping Units" at the back of this soil survey for identification of the soils in nonirrigated capability units or in nonirrigated subclasses.)

Most of the precipitation in the county falls during the growing season; however, profitable nonirrigated crop yields can be expected only during those years when precipitation is average or above average.

The following are several management practices that apply to all of the soils suitable for nonirrigated crops or hay:

Base the use of fertilizers on recent soil tests and results of field trials. (The soils in Union County commonly respond to nitrogen and phosphorus for all crops in years of average or above average moisture.)

Control weeds, insects, and plant diseases.

Use plant varieties adapted to local conditions.

The following management practices apply to cropland:

Leave crop residues on or near the surface to reduce soil blowing hazard. If adequate amounts of crop residue are not available, leave the surface rough or cloddy or plant a close growing cover. The critical period for this protection from soil blowing is about February 1 to July 15.

Improve or maintain the content of organic matter and physical condition of the soil by incorporating crop residues, mulches, or manure into the soil material or by including pasture in a cropping sequence.

Limit tillage operations to those necessary for seedbed preparation, planting, cultivation, and harvest. Do not till the soil when it is wet. Perform all tillage operations in such a way that the surface layer will be disturbed as little as possible, except when the purpose of the tillage is to roughen the surface to reduce soil blowing.

The nonirrigated capability units and characteristics of soils in subclasses of classes VI, VII, and VIII are described in paragraphs that follow. A more complete description of the use and management of soils in classes VI, VII, and VIII is given in the sections "Range" and "Suitability of the Soils for Wildlife Habitat."

Subclass VIe. Soils that are generally unsuited to cultivation or are severely limited, chiefly because of risk of erosion, if protective cover is not maintained.

Subclass VIs. Soils that are generally unsuited to cultivation and are restricted to other uses because of limited water capacity, gravel, or fine texture.

Subclass VIw. Soils that are generally unsuited to cultivation or are severely limited, chiefly because of risk of flooding.

Subclass VIIs. Soils that are unsuited to cultivation or are very severely limited, chiefly because of shallowness, stones, or other soil features.

Subclass VIIIs. Land types that consist mainly of rock or other material that has little potential for plant use.

NONIRRIGATED CAPABILITY UNIT IIIe-2

The soils in this capability unit are well drained. The surface layer is loam or clay loam, and the subsoil is sandy clay loam, clay, silty clay loam, or clay loam. The slopes of these soils are 0 to 3 percent. The average annual precipitation is 14 to 18 inches, and the frost free season is 140 to 185 days.

Permeability is moderately slow in these soils. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is 7.5 to 10 inches. Effective rooting depth is 60 inches or more.

The principal crop is grain sorghum. These soils are well suited to permanent pasture.

High residue or soil improving crops need to be grown in a cropping sequence with other crops and shifted from field to field in such a way that all of the cropland will be covered at least two-thirds of the time. High residue or soil improving crops also help to reduce the hazard of soil blowing. Plowing needs to be at a right angle to the slope to prevent erosion. All established waterways need a permanent cover of grass. Terraces are needed to reduce the hazard of water erosion on slopes of more than 1 percent.

NONIRRIGATED CAPABILITY UNIT IIIe-3

Rickmore sandy loam is the only soil in this capability unit. It is well drained. The surface layer is sandy loam, and the subsoil is sandy clay loam or clay loam. The slopes are 0 to 3 percent. The average annual precipitation is 14 to 17 inches, and the length of the frost free season is 160 to 185 days.

Permeability is moderately slow. Runoff is slow. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Available water capacity is 7.5 to 9.5 inches. Effective rooting depth is 60 inches or more.

The principal crop is grain sorghum. This soil is well suited to permanent pasture.

High residue or soil improving crops need to be grown in a cropping sequence with other crops and shifted from field to field in such a way that all of the cropland will be covered at least two-thirds of the time. To protect against soil blowing, it is necessary to leave clods on the surface. This can be done by plowing deep enough to bring fragments of the subsoil to the surface. High residue or soil improving crops help to reduce the hazard of soil blowing.

NONIRRIGATED CAPABILITY UNIT IVe-1

The soils in this capability unit are well drained. The surface layer is fine sandy loam, loam or silty clay loam, and the subsoil is silty clay loam, sandy clay loam, clay loam, or clay. Slopes are 0 to 5 percent.

The average annual precipitation is 14 to 18 inches, and the frost free season is 140 to 185 days. Permeability is moderate, slow, or very slow in these soils. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is 5 to 10 inches. Effective rooting depth is 40 to 60 inches or more.

The principal crop is grain sorghum. These soils are better suited to permanent pasture than to crops, and they are used for crops only occasionally. Most of these soils are used for range.

High residue or soil improving crops need to be grown in a cropping sequence with other crops and shifted from field to field in such a way that all of the cropland will be covered at least three-fourths of the time. High residue or soil improving crops help to reduce the hazard of soil blowing. Plowing needs to be at right angles to the slope, and all waterways need a cover of permanent grass to prevent erosion. Terraces to reduce the hazard of water erosion are needed where slopes are more than 1 percent. To protect against soil blowing, it is necessary to leave clods on the surface. This can be done by plowing deep enough to bring fragments of the subsoil to the surface. Plant residues need to be used to protect cultivated fields.

NONIRRIGATED CAPABILITY UNIT IVe-2

The soils in this capability unit are well drained. The surface layer is silty clay loam or loam, and the subsoil or underlying material is clay loam or silty clay loam. Slopes are 0 to 5 percent. The average annual precipitation is 14 to 18 inches, and the frost free season is 140 to 185 days.

Permeability is moderate or moderately slow in these soils. Runoff is medium. The hazards of water erosion and soil blowing are moderate. Available water capacity is 6 to 10 inches. Effective rooting depth is more than 40 inches and for the most part is more than 60 inches.

These soils are not dry-farmed, but in the past they were used for grain sorghum, broomcorn, and pinto beans. They are better suited to permanent pasture crops and other crops that furnish continual cover than to other cropland uses.

If these soils are plowed or mechanically disturbed, the resultant plow line needs to be at right angles to the dominant slope to prevent the formation of gullies. Tillage practices need to be kept to a minimum, because if soils of this unit are tilled too frequently, the natural soil aggregates break down to sand sized particles that are easily moved by wind.

High residue or soil improving crops need to be grown in a cropping sequence with other crops and shifted from field to field in such a way that all the cropland will be covered at least two-thirds of the time. These soils do not make stable clods during emergency tillage. High residue or soil improving crops help to reduce the hazard of soil blowing. Terraces to help reduce the hazard of water erosion are needed where slopes are more than 1 percent.

NONIRRIGATED CAPABILITY UNIT IVe-3

Dallam loamy sand, 0 to 5 percent slopes, is the only soil in this capability unit. It is well drained. The surface layer is loamy sand, and the subsoil is sandy clay loam. The annual average precipitation is 14 to 17 inches, and the frost free season is 165 to 185 days. Permeability is moderate in these soils. Runoff is slow. The hazard of water erosion is slight, and the hazard of soil blowing is severe. Available water capacity is 7.5 to 10 inches.

The only nonirrigated crop grown in this soil is grain sorghum. This soil is, however, well suited to permanent pasture.

High residue or soil improving crops need to be grown in a cropping sequence with other crops and

shifted from field to field in a way that all of the cropland will be covered at least three-fourths of the time. To protect against soil blowing, it is necessary to leave clods on the surface by plowing deep enough to bring fragments of the subsoil to the surface. High residue or soil improving crops are needed to reduce the hazard of soil blowing.

Estimated Yields of Nonirrigated Crops

The estimates of yields given in table 3 are averages that can be expected over a period of years. These estimates are based on results of research and on information obtained from interviews with land users and other knowledgeable persons. Soils suited to use as range only are not listed in the table.

The yields in table 3 are given for a high level of management, and it was assumed that the following conditions exist:

- Soil blowing is controlled by proper use of crop residue and, if necessary, by emergency tillage.
- Precipitation is conserved and water erosion is limited by controlling runoff by means of terraces, diversions, and contour tillage.
- The soil is tilled when the moisture content is such that clods form but excessive compaction does not result.
- Suitable varieties are selected and seed is planted at the proper time and at correct rates in properly prepared seedbeds.
- Insect pests, weeds, and plant diseases are controlled.
- The right kind of fertilizer is applied in proper amounts and at the proper time.
- Crops are harvested at the proper time and with equipment that is properly operated.

Yields may change in the future as a result of the development of new crop varieties that will withstand low moisture and that will tolerate the diseases and insect pests common in the county. Yields higher than the estimates given are not uncommon where outstanding producers are applying exceptional management.

TABLE 3.—*Estimated average yields per acre of nonirrigated sorghum under a high level of management*

Soils	Pounds per acre
Capulin loam, 0 to 5 percent slopes	1,500
Colmor silty clay loam, 0 to 5 percent slopes	1,500
Dallam loamy sand, 0 to 5 percent slopes	1,600
Dallam fine sandy loam, 0 to 5 percent slopes	1,700
Dioxice loam, 0 to 5 percent slopes	1,600
Gruver loam	1,500
Kim loam (part of Kim-Manzano association)	1,500
La Brier silty clay loam	1,400
Manzano loam (alone or as part of Kim-Manzano association)	1,900
Rickmore sandy loam	1,700
Sherm clay loam	1,400
Texline loam, 1 to 5 percent slopes	1,500
Torreon silty clay loam	1,400

Windbreaks [5]

This section provides information on establishing windbreaks in the soils of Union County.

Windbreaks return substantial benefits to landowners. They reduce the cost of heating homes by diverting cold winds, control the drifting of snow, protect livestock, provide summer shade, enhance the beauty of the home and its surroundings, and provide food and cover for wildlife. (*12,13*)

Evergreens are the most desirable trees for windbreaks—they have a long life, and they resist damage from wind, snow, and disease. They are especially beneficial in this county because of their protection against spring winds, which occur before the deciduous trees leaf out. Evergreens grow much more slowly the first few years than deciduous trees and shrubs do. As a result, evergreens need to be planted in single rows, apart from the faster growing and shorter lived broadleaf trees.

Windbreak groups are included in this section of the survey. Each group is made up of soil series that affect tree growth similarly because of the characteristics of the soils within the series. In table 4, growth rate, vigor, and survival rate of certain preferred species of trees are presented by windbreak groups.

The native vegetation of Union County is mostly grass and a few patches of pinon pine and oneseed juniper on the rough areas above drainage channels and on sides of mountains. Use the following procedures to grow an effective windbreak:

- Fence new plantings to protect them against animals.
- Provide supplemental water during the period of establishment.

WINDBREAK GROUP 1

Soil series in this group are Alicia, Capulin, Colmor, Dallam, Dioxice, Gruver, Kim, Manzano, Partri, Rickmore, Spurlock, and Texline. The soils are deep and well drained. Below the surface layer the material is clay, clay loam, silty clay loam, or sandy clay loam. The soils have no layers that restrict root growth above a depth of 40 inches. Permeability is moderate or moderately slow.

Where the soils of this group have a surface layer of sandy loam or loamy sand, young plants require protection from blowing sand.

WINDBREAK GROUP 2

Soil series in this group are La Brier, Sherm, Torreon, and Vermejo. The soils are deep and well drained or moderately well drained. Below the surface layer the material is clay, silty clay, or silty clay loam. Permeability is slow or very slow.

Supplemental water needs to be managed very carefully on these soils, because saturation for long periods restricts the oxygen supply required for growth of trees.

WINDBREAK GROUP 3

Soil series in this group are Bankard, Guy, Valent, and Vingo. The soils are deep and well drained or excessively drained. Below the surface layer the ma-

[5] CARY HULL, woodland specialist, Soil Conservation Service, assisted in the preparation of this section.

TABLE 4.—*Ratings of soils*

Mapping unit and group	Oriental arborvitae			Rocky Mountain juniper		
	Height	Survival	Vigor	Height	Survival	Vigor
	Ft	*Pct*		*Ft*	*Pct*	
Group 1: AcD, CaC, Ch (Capulin part), Cp (Partri part), CrC, DhC, DmC, DxC, Gr, Gt (Texline part), KaD, Km, Mn, Rk, SpD, SrC, Su (Spurlock part), TeC, Vn (Dallam part).	12–14	90	Good	14	80	Good
Group 2: Fr (Fallsam part), La, Lr (La Brier part), Sh, Tn, Ve.	12	90	Good	12	100	Good
Group 3: Bk, Gt (Guy part), VaD, Vn (Vingo part).	10–12	80	Good	12	90	Fair
Group 4: CnC, Cp (Carnero part), EsC, LtD.	8–12	70	Fair	8–12	70	Good

terial is sand, loamy sand, gravelly loamy sand, gravelly sandy loam, or sandy loam. Permeability is moderately rapid to very rapid.

Young plants need to be protected from wind and blowing sand. They also need to be watered often enough to keep the material below the surface layer moist.

WINDBREAK GROUP 4

Soil series in this group are Carnero, Escabosa, and Litle. The soils are moderately deep and well drained. Below the surface layer the material is loam, silty clay loam, or clay loam. The soils in this group have a restrictive layer of hard sandstone or soft shale at a depth of 20 to 40 inches. Permeability is slow to moderate.

Plants selected for use in these soils need to have root systems that are adapted to moderately deep soils.

WINDBREAK GROUP 5

Soil series in this group are Apache, Aridic Haplustolls, Ayon, Bandera, Dalcan, Des Moines, Fallsam, Plack, Raton, Rizozo, Travessilla, and Ustolls. Characteristics of the soils in this group vary, but for the most part the soils are unsuited to the planting of windbreaks. (Native trees and bushes grow well, but it is difficult to establish windbreak plantings.) Soils are mostly shallow and steep, and they commonly are more than 15 percent coarse fragments. Ratings for soils of this group 5 are not included in table 4.

Suitability of the Soils for Wildlife Habitat [6]

Wildlife of many species find desirable habitat in Union County. Among them are mule deer, pronghorn antelopes, quail, pheasants, turkeys, mourning doves, ducks, and geese. Jackrabbits, cottontail rabbits, skunks, prairie dogs, ravens, roadrunners, curlews, raccoons, coyotes, bobcats, foxes, and badgers also live in the county. In addition to this, many resident and migratory songbirds, as well as hawks and eagles, have made their homes in the county. Also, snakes, lizards, salamanders, toads, and tortoises are commonly found in suitable habitats.

A limited number of aquatic habitats are in Union County. The Cimarron River, one of the main means of drainage, flows year around only in upstream reaches. This river supports a small fishery near Folsom Falls. Tramperos Creek and a number of constructed ponds provide fish habitats and resting areas for migratory waterfowl. The flow of Ute Creek is short lived; thus, it does not support aquatic habitats of any appreciable significance. The New Mexico Department of Game and Fish owns Clayton Lake and manages it for public fishing and as a waterfowl refuge. Also, a small number of private ponds are managed for fishing. The Forest Service manages parts of the Kiowa National Grassland with particular attention to quail habitat. As a result, brush shelters, wildlife watering facilities, and livestock exclosures have been constructed.

In the sense that management and use of the soils strongly influence its production, wildlife is an important "crop" in Union County. By the same token, it is a natural resource that is strongly influenced by past and present uses of the soils and by characteristics of the soils that effect the growth of suitable plants for habitat. A fairly stable trend in use of the soils in recent years has had a stabilizing effect on this natural resource and "crop" of the county.

The distribution of wildlife species within the county parallels the distribution of soils that lend themselves to certain uses and the production of specific vegetation. In table 5 the soils of Union County have been rated according to their suitability for the improvement, maintenance, or development of specific wildlife habitat elements. These ratings reflect conditions without the use of supplemental irrigation. They were made for the wildlife habitat elements defined as follows:

[6] Prepared by EDWIN A. SWENSON and DAVID E. CHALK, biologists, Soil Conservation Service.

for species suitability

Ponderosa pine			Russian-olive			Siberian elm		
Height	Survival	Vigor	Height	Survival	Vigor	Height	Survival	Vigor
Ft	*Pct*		*Ft*	*Pct*		*Ft*	*Pct*	
16–18	70	Fair	16–20	60	Fair	20–25	80	Fair.
18	90	Good	12	85	Fair	36	100	Good.
20–22	80	Good	15–20	75	Good	22–26	85	Good.
12–16	50	Fair	12	70	Fair	18	80	Fair.

Grain and seed crops.—Domestic grain or other seed producing annuals that are planted to produce wildlife food. Examples are corn, sorghum, wheat, barley, millet, and sunflowers.

Grasses and legumes.—Perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescues, wheatgrasses, brome, orchardgrass, clovers, alfalfa, and sweetclover.

Wild herbaceous plants.—Native or established range grasses and forbs that provide food and cover for wildlife. Examples are grama grasses, wheatgrasses, bluestems, galleta, penstemons, vetches, wild clovers, globemallows, and sunflowers.

Shrubs.—Native or established woody shrubs that produce browse or mast for wildlife food or provide cover for wildlife. Examples are mountainmahogany, skunkbush sumac, oak brush, rabbitbrush, sand sagebrush, fourwing saltbush, currant, and American plum.

Wetland plants.—Annual and perennial wild herbaceous plants in moist to wet sites, exclusive of submerged or floating aquatics, that produce food or cover for wetland wildlife. Examples are smartweed, wild millet, rushes, sedges, and cattail.

Shallow water developments.—Natural or constructed areas of shallow water that has an average depth of less than five feet. Examples are marshes, flooded cropland, wildlife watering developments, and wildlife ponds.

The bases for rating soils for these wildlife habitat elements are thickness of the soil, texture, available water capacity, drainage class, surface stoniness, frequency of flooding, slopes, salinity or alkalinity, and moisture regime. The ratings are expressed as good, fair, poor, or very poor.

An additional rating was made for suitability of the soil for producing all the essential habitat elements required for three general types of wildlife—open land, wetland, and range. A method of assigning a weighted factor to selected habitat elements was used to arrive at a suitability rating. Definitions of the general types of wildlife rated are:

Open land wildlife.—Birds and mammals that generally frequent cropland, pastures, meadows, and other farm associated areas. Examples are bobwhite quail, ring-necked pheasant, mourning dove, cottontail rabbit, skunk, and housefinch. The habitat elements considered for open land wildlife were grain and seed crops, domestic grasses and legumes, wild herbaceous plants, and shrubs.

Wetland wildlife.—Birds and mammals that generally frequent swamp, marsh, riparian, and open water areas. Examples are kingfisher; marsh wren; varieties of ducks, geese, and shore birds; and muskrat and beaver. Wetland plants and shallow water areas were the elements of wildlife habitat considered in determining this rating.

Range wildlife.—Birds and mammals that generally frequent natural grasslands, shrublands, and pinon and juniper areas. Examples are scaled quail, burrowing owl, marsh hawk, meadowlark, jackrabbit, mule deer, pronghorn antelope, and prairie dog. Wild herbaceous plants and shrubs were the elements of wildlife habitat considered in determining this rating.

The significance of each of the suitability ratings is as follows:

Good.—Habitats are easily improved, maintained, or created. Few or no soil limitations in habitat management exist, and satisfactory results can be expected.

Fair.—Habitats can be improved, maintained, or created on the soils. Moderate soil limitations, however, affect habitat management or development. In places moderate intensity of management and fairly frequent attention may be required to insure satisfactory results.

Poor.—Habitats can be improved, maintained, or created on the soils, but the soil limitations are severe. Management is difficult and expensive and requires intensive effort. Results of management are of questionable value.

Very poor.—Under the prevailing soil conditions, attempting to improve, maintain, or create habitats is impractical. Unsatisfactory results of management are probable.

TABLE 5.—*Suitability of the soils*

Soil mapping units and symbols	Elements of wildlife habitat		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants
Alicia loam, 3 to 9 percent slopes: AcD	Fair	Good	Fair
Apache-Rock outcrop complex: Ap	Very poor	Very poor	Poor
Aridic Haplustolls-Rubble land complex: Ar	Very poor	Very poor	Fair
Ayon-Apache association: Ay			
Ayon cobbly clay loam	Poor	Fair	Fair
Apache cobbly loam	Poor	Poor	Fair
Bandera association: Bd			
Bandera gravelly silt loam	Poor	Fair	Fair
Cinder land	Very poor	Very poor	Very poor
Bankard loamy sand: Bk	Poor	Fair	Fair
Capulin loam, 0 to 5 percent slopes: CaC	Fair	Good	Fair
Capulin-Apache complex: Ch	Poor	Poor	Fair
Carnero loam, 0 to 5 percent slopes: CnC	Poor	Fair	Fair
Carnero-Partri complex: Cp	Poor	Fair	Fair
Colmor silty clay loam, 0 to 5 percent slopes: CrC	Fair	Good	Fair
Dalcan-Rock outcrop complex: Da	Very poor	Very poor	Fair
Dallam loamy sand, 0 to 5 percent slopes: DhC	Fair	Good	Fair
Dallam fine sandy loam, 0 to 5 percent slopes: DmC	Fair	Good	Fair
Des Moines-Rock outcrop complex: Dr	Very poor	Very poor	Fair
Dioxice loam, 0 to 5 percent slopes: DxC	Fair	Good	Fair
Escabosa loam, 3 to 5 percent slopes: EsC	Poor	Fair	Fair
Fallsam-Rock outcrop complex: Fr	Very poor	Very poor	Fair
Gruver loam: Gr	Fair	Good	Fair
Guy-Texline complex: Gt	Poor	Fair	Fair
Kim sandy loam, 1 to 9 percent slopes: KaD	Fair	Good	Fair
Kim-Manzano association: Km	Fair	Good	Fair
La Brier silty clay loam: La	Poor	Poor	Fair
La Brier-Rock outcrop complex: Lr	Poor	Poor	Fair
Litle clay loam, 1 to 9 percent slopes: LtD	Poor	Fair	Fair
Manzano loam: Mn	Fair	Good	Fair
Plack loam, 0 to 9 percent slopes: PkD	Very poor	Very poor	Poor
Raton-Rock outcrop complex: Ra	Very poor	Very poor	Poor
Rickmore sandy loam: Rk	Fair	Good	Fair
Rizozo-Rock outcrop complex: Rz	Very poor	Very poor	Poor
Sherm clay loam: Sh	Poor	Poor	Fair
Spurlock loamy sand, 1 to 9 percent slopes: SpD	Poor	Fair	Fair
Spurlock loam, 1 to 5 percent slopes: SrC	Poor	Fair	Fair
Spurlock-Plack complex: Su	Poor	Fair	Fair
Texline loam, 1 to 5 percent slopes: TeC	Fair	Good	Fair
Torreon silty clay loam: Tn	Poor	Poor	Fair
Travessilla-Rock outcrop complex, 0 to 15 percent slopes: TrE	Very poor	Very poor	Poor
Travessilla-Rock outcrop complex, 30 to 75 percent slopes: TrF	Very poor	Very poor	Poor
Ustolls-Rock outcrop association: Ur			
Ustolls	Very poor	Very poor	Fair
Rock outcrop	Very poor	Very poor	Very poor
Valent loamy sand, 3 to 9 percent slopes: VaD	Poor	Fair	Fair
Vermejo silty clay loam: Ve	Poor	Fair	Fair
Vingo-Dallam complex: Vn	Poor	Fair	Fair

Ratings for the suitability of each soil for wildlife habitat elements, as well as for the three general types of wildlife habitats, are based on the potential of the soil and not on its present use.

In table 5 the suitability of each of the soils in Union County is rated for the elements of wildlife habitat and the three general types of wildlife.

Engineering [7]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. In various degrees and combinations these properties affect construction and maintenance of roads, airports, pipelines, foundations

[7] CHARLES M. CARUSO, engineer, Soil Conservation Service, assisted in preparation of this section.

for wildlife habitat

Elements of wildlife habitat—Continued			Kinds of wildlife		
Shrubs	Wetland plants	Shallow water developments	Open land	Wetland	Range
Poor	Poor	Very poor	Fair	Very poor	Poor.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Fair	Poor	Very poor	Fair	Very poor	Fair.
Fair	Poor	Very poor	Poor	Very poor	Fair.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Poor	Very poor	Very poor	Very poor	Very poor	Very poor.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Poor	Poor	Very poor	Fair	Very poor	Fair.
Fair	Poor	Very poor	Poor	Very poor	Fair.
Poor	Poor	Very poor	Fair	Very poor	Poor.
Poor	Poor	Very poor	Fair	Very poor	Poor.
Poor	Poor	Poor	Fair	Poor	Fair.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Fair	Poor	Very poor	Fair	Very poor	Fair.
Fair	Poor	Very poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Poor	Poor	Very poor	Fair	Very poor	Poor.
Fair	Poor	Very poor	Fair	Very poor	Fair.
Fair	Poor	Very poor	Fair	Very poor	Fair.
Poor	Poor	Very poor	Fair	Very poor	Poor.
Poor	Poor	Very poor	Fair	Very poor	Poor.
Poor	Poor	Poor	Poor	Poor	Poor.
Fair	Poor	Very poor	Poor	Very poor	Fair.
Poor	Poor	Very poor	Fair	Very poor	Fair.
Poor	Poor	Very poor	Fair	Very poor	Poor.
Poor	Very poor	Very poor	Poor	Very poor	Poor.
Fair	Very poor	Very poor	Poor	Very poor	Fair.
Fair	Poor	Very poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Very poor	Very poor	Fair.
Poor	Poor	Poor	Poor	Poor	Poor.
Fair	Poor	Very poor	Fair	Very poor	Fair.
Poor	Poor	Very poor	Fair	Very poor	Poor.
Poor	Very poor	Very poor	Fair	Very poor	Poor.
Poor	Poor	Very poor	Fair	Very poor	Poor.
Poor	Poor	Poor	Poor	Poor	Poor.
Fair	Very poor	Very poor	Very poor	Very poor	Fair.
Fair	Very poor	Very poor	Very poor	Very poor	Fair.
Fair	Very poor	Very poor	Very poor	Very poor	Fair.
Very poor	Very poor	Very poor	Very poor	Very poor	Very poor.
Fair	Very poor	Very poor	Fair	Very poor	Fair.
Poor	Poor	Poor	Poor	Poor	Fair.
Fair	Poor	Very poor	Fair	Very poor	Fair.

for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built to predict performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6, 7, and 8. These tables show, respectively, several estimated soil properties significant to engi-

TABLE 6.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. fully the instructions for referring to other series that appear in the first column of this table. Absence

Soil series and map symbols	Depth to indurated caliche or bedrock	Depth from surface	Dominant USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
	In	*In*				
Alicia: AcD	>60	0–73	Silty clay loam	CL	A–6	0
*Apache: Ap	4–20	0–16	Cobbly clay loam	CL	A–6	15–40
Rock outcrop part too variable to rate.		16	Basalt bedrock.			
*Aridic Haplustolls: Ar. Too variable to rate.						
*Ayon: Ay	40–60	0–11	Cobbly clay loam	ML	A–7	0–40
For Apache part, see Apache series.		11–42	Very cobbly loam	GM	A–2 or A–7	30–60
Bandera: Bd	>60	0–19	Gravelly silt loam	ML	A–4	0
		19–120	Cinders	GP	A–1	0
Bankard: Bk	>60	0–77	Sand or loamy sand	SM, SP–SM, SP	A–2 or A–3	0–10
*Capulin: CaC, Ch	>40	0–41	Loam or clay loam	CL	A–6 or A–7	0–25
For Apache part in Ch, see Apache series.		41–66	Cobbly loam	CL	A–6 or A–7	15–60
*Carnero: CnC, Cp	20–40	0–9	Loam or clay loam	CL	A–6	0–5
For Partri part in Cp, see Partri series.		9–28	Heavy clay loam or clay	CL	A–6 or A–7	0–5
		28	Sandstone bedrock.			
Colmor: CrC	>40	0–44	Silty clay loam and clay loam.	CL	A–6 or A–7	0
		44	Sandstone.			
*Dalcan: Da	20–40	0–31	Very cobbly silty clay loam and very cobbly clay.	CH, CL, SC or GC	A–6 or A–7	50–90
Rock outcrop part too variable to rate.		31	Andesite bedrock.			
Dallam:						
DhC		0–11	Loamy sand	SM	A–2	0
DmC		0–11	Fine sandy loam	SM	A–2 or A–4	0
DhC, DmC	>80	11–72	Sandy clay loam	SC or CL	A–6	0
*Des Moines: Dr	>40	0–18	Very cobbly silty clay loam.	CL	A–6	30–75
Rock outcrop part too variable to rate.		18–48	Very stony silty clay	CL, CH, GC	A–7	50–90
Dioxice: DxC	>40	0–24	Silty clay loam and clay loam.	CL	A–6 or A–7	0
		24–46	Loam	CL	A–6	0–15
		46	Indurated caliche.			
Escabosa: EsC	20–40	0–36	Loam or clay loam	CL or CL–ML	A–6 or A–4	2–20
		36	Sandstone bedrock.			
*Fallsam: Fr	>40	0–9	Cobbly silty clay loam	CL	A–6	50–80
Rock outcrop part too variable to rate.		9–46	Very cobbly clay	CL or CH	A–7	50–90
Gruver: Gr	>60	0–80	Clay loam or sandy clay loam.	CL	A–7 or A–6	0

significant to engineering

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-
of an entry in a column indicates that properties are not estimated. < = less than; > = more than]

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						In/hr	*In/in*	*pH*			
95–100	95–100	90–100	75–90	25–40	10–15	0.2–0.6	0.14–0.17	7.9–8.4 (0–32″) 8.5–9.0 (32–73″)	Moderate	Moderate	Low.
80–100	75–95	65–90	50–75	30–40	10–20	0.6–2.0	0.11–0.16	7.9–8.4	Low	Moderate	Low.
70–100	70–100	70–100	65–95	40–50	10–20	0.6–2.0	0.10–0.17	7.4–7.8	Moderate	Moderate	Low.
35–60	30–55	25–50	15–40	40–50	10–20	0.6–2.0	0.06–0.10	7.9–8.4	Low or moderate.	Moderate	Low.
70–80	65–75	55–70	50–60	20–30	0–5	0.6–2.0	0.10–0.16	6.6–8.4	Low	Moderate	Low.
15–35	10–30	5–15	0–5	----------	[1] NP	6.0–20.0	----------	----------	Low	Low	Low.
80–100	70–100	50–80	0–15	----------	NP	6.0–20.0	0.05–0.10	6.6–7.8	Low	Low	Low.
80–100	80–100	75–100	50–90	35–50	15–25	0.6–2.0	0.12–0.16	7.4–8.4	Moderate	Moderate	Low.
75–100	70–95	70–90	50–80	30–45	15–20	0.6–2.0	0.08–0.14	7.9–8.4	Low	Moderate	Low.
95–100	95–100	90–100	50–80	20–35	10–20	0.2–0.6	0.13–0.17	6.6–7.3	Moderate	Moderate	Low.
85–100	80–100	80–100	60–90	35–50	20–30	0.06–0.2	0.13–0.17	6.6–7.3	High	Moderate	Low.
100	100	90–100	75–90	30–45	10–20	0.2–0.6	0.15–0.19	7.9–8.4	Moderate	Moderate	Low.
60–95	55–90	50–85	45–80	30–55	10–30	0.06–0.2	0.05–0.10	6.6–7.3	Moderate	Moderate	Low.
100	100	70–95	15–35	----------	NP	6.0–20.0	0.05–0.10	7.4–7.8	Low	Low	Low.
100	100	80–95	30–50	15–25	NP	2.0–6.0	0.06–0.14	7.4–7.8	Low	Low	Low.
100	95–100	80–95	35–55	25–40	10–25	0.6–2.0	0.14–0.18	7.4–8.4	Low or moderate.	Moderate	Low.
60–95	55–85	50–80	50–75	30–40	10–15	0.06–2.0	0.06–0.11	6.6–7.3	Moderate	Moderate	Low.
60–95	55–95	50–90	45–80	40–60	15–35	0.06–0.2	0.05–0.11	6.6–7.8	Moderate	Moderate	Low.
95–100	90–100	85–100	65–85	35–45	15–20	0.6–2.0	0.15–0.19	7.4–8.4	Moderate	High	Low.
85–100	80–95	75–90	50–75	30–40	10–20	0.6–2.0	0.12–0.16	7.9–8.4	Low	High	Low.
85–100	60–95	55–90	50–80	25–35	5–15	0.6–2.0	0.11–0.18	7.9–8.4	Low or moderate.	High	Low.
65–100	60–95	55–85	50–80	30–40	15–25	0.2–0.6	0.07–0.12	6.6–7.3	Moderate	Moderate	Low.
65–100	60–95	55–90	50–85	40–60	25–40	0.06–0.2	0.03–0.10	6.6–7.3	Moderate	High	Low.
100	100	85–100	50–80	25–50	10–30	0.2–0.6	0.13–0.19	6.6–8.4	Moderate	Moderate	Low.

TABLE 6.—*Estimated soil properties*

Soil series and map symbols	Depth to indurated caliche or bedrock	Depth from surface	Dominant USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
	In	*In*				
*Guy: Gt For Texline part in Gt, see Texline series.	>60	0–60	Gravelly sandy loam	SM or SC–SM	A–2	0–20
*Kim: KaD, Km For Manzano part of Km, see Manzano series.	>60	0–60	Loam, clay loam or sandy clay loam.	CL or CL–ML	A–6 or A–4	0–5
*La Brier: La, Lr For Fallsam part of Lr, see Fallsam series. Rock outcrop part of Lr too variable to rate.	>60	0–77	Silty clay loam or clay	CL or CH	A–7	0
Litle: LtD	20–30	0–22 22–40	Heavy silty clay loam Soft shale.	CL or CH	A–6 or A–7	0
Manzano: Mn	>60	0–63	Loam, clay loam and silty clay loam.	CL	A–6	0–5
Partri Mapped only in complex with Carnero.	>40	0–48 48	Clay Sandstone.	CL	A–7 or A–6	0–10
Plack: PkD	4–20	0–12 12	Loam Indurated caliche.	CL–ML or CL	A–4 or A–6	0
*Raton: Ra Rock outcrop part too variable to rate.	8–20	0–9 9–18 18	Cobbly silt loam Very cobbly clay Basalt bedrock.	CL, CL–ML CL or CH	A–4 or A–6 A–7	15–85 50–70
Rickmore: Rk	>80	0–13 13–93	Sandy loam or loamy sand. Clay loam and sandy clay loam.	SM CL	A–2 or A–4 A–6 or A–7	0 0
*Rizozo: Rz Rock outcrop part too variable to rate.	4–15	0–10 10	Loam or silt loam Sandstone bedrock.	CL–ML or ML	A–4	5–20
Rock outcrop. Mapped only in complex with other soils. Too variable to rate.						
Rubble land. Mapped in complex with Aridic Haplustolls. Too variable to rate.						
Sherm: Sh	>80	0–21 21–90	Clay Clay loam	CH or CL CL	A–7 A–6 or A–7	0 0
Spurlock:						
SpD		0–16	Loamy sand	SM	A–2	0
SrC, Su		0–16	Loam or clay loam	CL, CL–ML	A–4 or A–6	0
SpD, SrC, Su	>60	16–60	Clay loam	CL	A–6	0
Texline: TeC	>60	0–96	Clay loam	CL	A–6	0
Torreon: Tn	>40	0–25 25–72	Clay Silty clay loam	CL or CH CL	A–7 A–6 or A–7	0–5 0–5
*Travessilla: TrE, TrF Rock outcrop part too variable to rate.	4–20	0–8 8	Sandy loam Sandstone bedrock.	SM	A–4 or A–2	0–15

significant to engineering—Continued

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						In/hr	*In/in*	*pH*			
65–90	55–85	40–70	20–35	20–35	5–10	2.0–6.0	0.05–0.10	7.9–8.4	Low	High	Low.
90–100	90–100	85–100	50–80	25–40	5–15	0.6–2.0	0.15–0.17	7.4–8.4	Moderate	Moderate	Low.
100	100	95–100	85–100	40–55	20–30	<0.06	0.14–0.18	7.9–8.4	High	High	Low.
100	100	90–100	85–100	30–55	10–30	0.06–0.2	0.15–0.18	7.9–8.4	High	High	Moderate.
95–100	95–100	85–100	60–80	25–40	10–20	0.2–0.6	0.13–0.19	6.6–8.4	Moderate	Moderate	Low.
90–100	90–100	90–100	65–95	35–50	20–30	0.2–0.6	0.13–0.18	6.6–8.4	High	High	Low.
90–100	90–100	80–95	50–70	20–30	5–15	0.6–2.0	0.10–0.17	7.9–8.4	Moderate	Moderate	Low.
90–100	85–90	80–90	65–80	25–35	5–15	0.2–0.6	0.06–0.10	6.6–7.3	Moderate	Low	Low.
80–95	75–90	70–90	65–85	45–55	20–30	0.06–0.2	0.06–0.08	6.6–7.3	Moderate	High	Low.
100	100	90–95	20–50	----------	NP	2.0–6.0	0.06–0.12	7.4–7.8	Low	Low	Low.
100	100	90–95	50–80	30–50	15–30	0.2–0.6	0.13–0.18	7.4–8.4	Moderate	Moderate	Low.
70–95	60–90	55–85	50–80	20–35	5–10	2.0–6.0	0.13–0.16	7.9–8.4	Moderate	Moderate	Low.
100	95–100	95–100	80–95	40–55	20–35	<0.06	0.14–0.16	6.6–7.8	High	High	Low.
95–100	95–100	95–100	75–90	35–50	20–30	0.06–0.2	0.13–0.17	7.9–8.4	Moderate	High	Low.
100	100	70–95	15–35	----------	NP	6.0–20.0	0.05–0.10	7.4–7.8	Low	Moderate	Low.
95–100	90–100	85–95	50–70	20–35	5–15	0.6–2.0	0.12–0.18	7.4–7.8	Low	Moderate	Low.
95–100	85–100	85–95	50–70	25–35	10–20	0.6–2.0	0.12–0.18	7.9–8.4	Moderate	Moderate	Low.
100	100	90–100	50–80	25–35	10–20	0.6–2.0	0.13–0.18	7.4–8.4	Moderate	Moderate	Low.
95–100	90–100	85–95	75–95	40–55	15–30	0.06–0.2	0.15–0.16	6.6–8.4	High	High	Low.
95–100	95–100	85–95	70–90	30–50	10–30	0.2–0.6	0.12–0.17	7.9–8.4	Moderate	High	Low.
65–100	55–100	40–65	20–40	20–30	NP–5	2.0–6.0	0.10–0.16	7.4–8.4	Low	Moderate	Low.

TABLE 6.—*Estimated soil properties*

Soil series and map symbols	Depth to indurated caliche or bedrock	Depth from surface	Dominant USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
	In	*In*				
*Ustolls: Ur Rock outcrop part too variable to rate.						
Valent: VaD	>60	0–94	Sand or loamy sand	SM, SP or SP–SM	A–2 or A–3	0
Vermejo: Ve	>40	0–66	Clay or silty clay	CH or CL	A–7	0
*Vingo: Vn For Dallam part in Vn, see Dallam series.	>80	0–11 11–80	Loamy sand Sandy loam	SM SM	A–2 A–2 or A–4	0 0

[1] NP = Nonplastic.

neering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 6 and 7, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meanings to soil scientists not known to all engineers. The Glossary defines many of these terms commonly used in soil science.

Engineering Soil Classification Systems

The two systems most commonly used in classifying samples of soils for engineering (*11*) are the Unified soil classification system (*2*) used by SCS engineers, Department of Defense, and others, and the AASHTO system adopted by the American Association of State Highway and Transportation Officials (*1*).

In the Unified system soils are classified according to particle size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes; eight classes of coarse grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL–ML.

The AASHTO (*1*) system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 8; the estimated classification, without group index numbers, is given in table 6 for all soils mapped in the survey area.

Soil Properties Significant to Engineering

Several estimated soil properties significant in engineering are given in table 6. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Explanations of some of the columns in table 6 are given in the following paragraphs.

Depth to indurated caliche or bedrock is the distance from the surface of the soil to the upper surface of the rock layer.

Soil texture is described in table 6 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt,

significant to engineering—Continued

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						In/hr	*In/in*	*pH*			
100	100	90–100	0–30	----------	NP	>20.0	0.05–0.10	6.6–7.8	Low ------	Low ------	Low.
100	100	95–100	80–95	45–55	20–30	<0.06	0.13–0.16	7.9–9.0	High ------	High ------	Moderate.
100	100	70–100	15–25	----------	NP	6.0–20.0	0.06–0.10	6.6–7.8	Low ------	Low ------	Low.
100	100	80–95	25–45	20–30	NP–5	2.0–6.0	0.10–0.15	6.6–7.8	Low ------	Low ------	Low.

and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

The Unified and AASHTO columns are explained in the next section, "Engineering soil classification systems."

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 6, but in table 8 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure, porosity, and texture. The estimates in table 6 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink swell potential is the relative change in volume to be expected of soil material with changes in moisture content; that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of the shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Corrosivity, as used in table 6, pertains to potential soil induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means there is a low probability of soil induced corrosion damage. A rating of *high* means there is a high probability of damage, and therefore protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering Interpretations

The interpretations in table 7 are based on the estimated engineering properties of soils shown in table 6, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Union County. In table 7 ratings are used to summarize limitation or suitability of the soils for all listed purposes except ponds, reservoir areas, levees and other embankments, and terraces and diversions. For these particular uses, table 7 lists those soil features not to be overlooked in planning, installation, and maintenance.

TABLE 7.—*Interpretations of engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. See fully the instructions for referring to other series that appear in the first column of this table.

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill
Alicia: AcD	Severe: moderately slow permeability.	Moderate where slopes are 3 to 7 percent; severe where slopes are 7 to 9 percent.	Slight	Moderate: moderate shrink swell potential.	Moderate: silty clay loam soil.
*Apache: Ap Rock outcrop part too variable to rate. (See Rock outcrop.)	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.
*Aridic Haplustolls: Ar. Too variable to rate. Severe limitations or poor suitability for most uses.					
*Ayon: Ay For Apache part, see Apache series.	Severe: bedrock at a depth of less than 48 inches.	Moderate where slopes are 1 to 7 percent, excess coarse fragments; severe where slopes are 7 to 9 percent.	Severe: very gravelly or very cobbly.	Moderate: moderate shrink swell potential.	Severe: very gravelly or very cobbly.
Bandera: Bd	Slight where slopes are 0 to 8 percent; moderate where slopes are 8 to 15 percent; severe where slopes are 15 to 25 percent.	Severe: rapid permeability.	Severe: sidewall instability.	Slight where slopes are 0 to 8 percent; moderate where slopes are 8 to 15 percent; severe where slopes are 15 to 25 percent.	Severe: rapid permeability.
Bankard: Bk	Severe: flood hazard.	Severe: flood hazard; rapid permeability.	Severe: flood hazard; sand or loamy sand.	Severe: flood hazard.	Severe: flood hazard; rapid permeability.
*Capulin: CaC, Ch For Apache part in Ch, see Apache series.	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: stones or cobbles below a depth of 40 inches.	Moderate: moderate shrink swell potential.	Moderate: cobbles or stones below a depth of 40 inches.
*Carnero: CnC, Cp For Partri part in Cp, see Partri series.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: high shrink swell potential.	Severe: bedrock at a depth of 20 to 40 inches.

properties of the soils

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-
text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils]

Degree and kind of limitation for—Cont.	Suitability as a source of—			Soil features affecting—			Hydrologic soil group
Local roads and streets	Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Terraces and diversions	
Moderate: moderate shrink swell potential; CL material.	Fair: moderate shrink swell potential; CL material.	Unsuited: no sand or gravel.	Fair: silty clay loam soil.	Slopes of 3 to 9 percent; moderately slow permeability.	Low shear strength; medium compressibility; fair to good compaction characteristics.	Slopes of 3 to 9 percent; moderately slow permeability.	B
Severe: bedrock at a depth of less than 20 inches.	Poor: shallow to bedrock.	Unsuited: no sand; excess fines.	Poor: stony; shallow to rock.	Bedrock at a depth of 20 inches or less.	Bedrock at a depth of 20 inches or less.	Bedrock at a depth of 20 inches or less.	D
Moderate: moderate shrink swell potential; stony and very cobbly.	Fair: moderate shrink swell potential.	Unsuited: no sand; excess fines.	Poor: more than 15 percent coarse fragments.	More than 35 percent coarse fragments; slopes of 1 to 9 percent; stones in the underlying layer.	Medium shear strength; low to medium compressibility.	More than 35 percent coarse fragments; moderate permeability.	B
Slight where slopes are 0 to 8 percent; moderate where slopes are 8 to 15 percent; severe where slopes are 15 to 25 percent.	Good where slopes are 0 to 15 percent; fair where slopes are 15 to 25 percent.	Unsuited for conventional sand or gravel; good for cinder gravel.	Poor: more than 15 percent gravel.	Slopes of 0 to 25 percent; rapid permeability.	High compacted permeability.	Slopes of 0 to 25 percent; cinders at a depth of 12 to 26 inches.	B
Severe: flood hazard.	Good ----------	Fair: excess fines.	Poor: sand or loamy sand.	Rapid permeability.	High compacted permeability; high piping potential.	Not applicable.	A
Severe: high plasticity index.	Poor: high plasticity index.	Unsuited: excess fines.	Fair: clay loam.	Bedrock, cobbles, stones, or caliche below a depth of 40 inches.	Medium compressibility; medium to low shear strength.	0 to 5 percent slopes; moderately permeable.	B
Severe: high shrink swell potential.	Poor: high shrink swell potential.	Unsuited: excess fines.	Poor: thin surface; clay subsoil.	Bedrock at a depth of 20 to 40 inches.	Medium to low shear strength.	Bedrock at a depth of 20 to 40 inches.	C

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill
Colmor: CrC	Severe: moderately slow permeability.	Moderate where slopes are 2 to 5 percent and bedrock is at a depth of 40 to 60 inches; slight where bedrock is at a depth of more than 60 inches and slopes are 0 to 2 percent.	Slight: moderate if bedrock is at a depth of 40 to 60 inches.	Moderate: moderate shrink swell potential.	Moderate: silty clay loam.
*Dalcan: Da Rock outcrop part too variable to rate. (See Rock outcrop.)	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate where slopes are 9 to 15 percent, moderate shrink swell potential; severe where slopes are 15 to 45 percent.	Severe: bedrock at a depth of 20 to 40 inches.
Dallam: DhC, DmC	Slight	Moderate: moderate permeability.	Slight	Moderate: moderate shrink swell potential.	Slight
*Des Moines: Dr Rock outcrop part too variable to rate. (See Rock outcrop.)	Severe: slopes of 15 to 70 percent.	Severe: slopes of 15 to 70 percent.	Severe: slopes of 15 to 70 percent.	Severe: slopes of 15 to 70 percent.	Severe where slopes are 25 to 70 percent.
Dioxice: DxC	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: clay loam; caliche below a depth of 40 inches.	Moderate: moderate shrink swell potential.	Moderate: clay loam; caliche below a depth of 40 inches.
Escabosa: EsC	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.
*Fallsam: Fr Rock outcrop part too variable to rate. (See Rock outcrop.)	Severe: slow permeability.	Severe: very cobbly.	Severe: very cobbly.	Moderate: moderate shrink swell potential.	Severe: bedrock at a depth of less 72 inches.

properties of the soils—Continued

Degree and kind of limitation for—Cont.	Suitability as a source of—			Soil features affecting—			Hydrologic soil group
Local roads and streets	Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Terraces and diversions	
Moderate: moderate shrink swell potential.	Fair: moderate shrink swell potential.	Unsuited: excess fines.	Fair: silty clay loam.	Bedrock below a depth of 40 inches.	Medium compressibility; low shear strength.	Moderately slow permeability.	B
Moderate where slopes are 9 to 15 percent, moderate shrink swell potential; severe where slopes are 15 to 45 percent.	Moderate where slopes are 9 to 25 percent, moderate shrink swell potential; severe where slopes are 25 to 45 percent.	Unsuited: excess fines.	Poor: more than 15 percent coarse fragments.	Slopes of 9 to 45 percent; bedrock at a depth of 20 to 40 inches.	Medium shear strength; thin layer.	Slopes of 9 to 45 percent; bedrock at a depth of 20 to 40 inches.	C
Moderate: CL soil.	Fair: CL soil.	Unsuited: excess fines.	Fair where surface layer is fine sandy loam; poor where surface layer is loamy sand.	Conditions favorable.	Medium to low shear strength.	Moderate or severe soil blowing hazard; moderate permeability.	B
Severe: slopes of 15 to 70 percent.	Poor where slopes are 25 to 70 percent; fair where slopes are 15 to 25 percent.	Unsuited: excess fines.	Poor: slopes of 15 to 70 percent.	Slopes of 15 to 70 percent.	Poor compaction characteristics; low strength.	Slopes of 15 to 70 percent.	C
Moderate: moderate shrink swell potential; CL soil.	Fair: moderate shrink swell potential; CL soil.	Unsuited: excess fines.	Fair: clay loam.	Conditions favorable.	Medium compressibility; medium or low shear strength; medium piping potential.	Caliche below a depth of 40 inches; moderate permeability.	B
Moderate: bedrock at a depth of 20 to 40 inches; CL soil.	Fair: moderate shrink swell potential; CL soil.	Unsuited: excess fines.	Fair: limited material.	Bedrock at a depth of 20 to 40 inches.	Medium to low shear strength; medium piping potential; thin layer.	Bedrock at a depth of 20 to 40 inches; moderate permeability.	C
Severe: high plasticity index.	Poor: high plasticity index.	Unsuited: excess fines.	Poor: cobbly.	Bedrock below a depth of 40 inches; 50 to 90 percent cobbles.	Low shear strength; medium compressibility.	50 to 90 percent cobbles.	C

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill
Gruver: Gr	Severe: moderately slow permeability.	Slight where slopes are 0 to 2 percent; moderate where slopes are 2 to 3 percent.	Moderate: clay loam.	Moderate: moderate shrink swell potential.	Moderate: clay loam.
*Guy: Gt For Texline part, see Texline series.	Slight	Severe: moderately rapid permeability.	Moderate: gravelly.	Slight	Severe: moderately rapid permeability.
*Kim: KaD, Km For Manzano part in Km, see Manzano series.	Slight	Moderate where slopes are 3 to 7 percent; moderate permeability; severe where slopes are 7 to 9 percent.	Moderate: clay loam.	Moderate: moderate shrink swell potential.	Moderate: clay loam.
*La Brier: La, Lr For Fallsam part in Lr, see Fallsam series. Rock outcrop part of Lr too variable to rate. (See Rock outcrop.)	Severe: very slow permeability.	Slight	Severe: clay subsoil.	Severe: high shrink swell potential.	Severe: clay subsoil.
Litle: LtD	Severe: shale at a depth of 20 to 30 inches.	Severe: shale at a depth of 20 to 30 inches.	Severe: shale at a depth of 20 to 30 inches.	Severe: high shrink swell potential.	Severe: shale at a depth of 20 to 30 inches.
Manzano: Mn	Severe: moderately slow permeability.	Severe: rare flood hazard.	Moderate: clay loam.	Severe: rare flood hazard.	Moderate: rare flood hazard.
Partri Mapped only in complex with Carnero.	Severe: moderately slow permeability.	Moderate: bedrock at a depth of 40 to 60 inches.	Moderate: bedrock at a depth of 40 to 60 inches.	Severe: high shrink swell potential.	Severe: bedrock at a depth of 40 to 60 inches.
Plack: PkD	Severe: indurated caliche at a depth of less than 20 inches.	Severe: indurated caliche at a depth of less than 20 inches.	Severe: indurated caliche at a depth of less than 20 inches.	Severe: indurated caliche at a depth of less than 20 inches.	Severe: indurated caliche at a depth of less than 20 inches.
*Raton: Ra Rock outcrop part too variable to rate. (See Rock outcrop.)	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.

properties of the soils—Continued

Degree and kind of limitation for—Cont.	Suitability as a source of—			Soil features affecting—			Hydrologic soil group
Local roads and streets	Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Terraces and diversions	
Severe: high plasticity index.	Poor: high plasticity index.	Unsuited: excess fines.	Fair: upper 16 inches is clay loam.	Moderately slow permeability; 0 to 3 percent slopes.	Low shear strength; high compressibility.	Slopes of 0 to 3 percent; moderately slow permeability.	C
Moderate: excess plastic fines.	Fair: excess plastic fines.	Poor: excess fines.	Poor: 15 to 35 percent gravel.	Moderately rapid permeability; slopes of 1 to 9 percent.	Medium shear strength; high piping potential.	Moderately rapid permeability; slopes of 1 to 9 percent.	B
Moderate: compressibility; CL soil.	Fair: moderate shrink swell potential; CL soil.	Unsuited: excess fines.	Fair: clay loam.	Slopes of 1 to 9 percent; moderate permeability.	Medium to low shear strength; high to medium piping potential.	Short slopes of 1 to 9 percent; moderate permeability.	B
Severe: high shrink swell potential; high plasticity index.	Poor: high shrink swell potential; high plasticity index.	Unsuited: excess fines.	Fair: silty clay loam surface layer.	Conditions favorable.	Low shear strength; fair to poor compaction characteristics; high compressibility.	Long uniform 0 to 3 percent slopes; clay subsoil.	C
Severe: high shrink swell potential.	Poor: high shrink swell potential; high plasticity index.	Unsuited: excess fines.	Fair: clay loam or silty clay loam.	1 to 9 percent slopes; shale at a depth of 20 to 30 inches.	Low shear strength; limited material.	Short 1 to 9 percent slopes; slow permeability.	C
Moderate: moderate shrink swell potential; CL soil.	Fair: moderate shrink swell potential; CL soil.	Unsuited: excess fines.	Fair: clay loam.	Conditions favorable.	Medium to low shear strength.	Long 0 to 3 percent slopes; moderately slow permeability.	C
Severe: high shrink swell potential; high plasticity index.	Poor: high shrink swell potential; high plasticity index.	Unsuited: excess fines.	Fair: silty clay loam or clay loam.	Bedrock at a depth of 40 to 60 inches.	Low shear strength; high compressibility.	Bedrock below a depth of 40 inches; 0 to 3 percent slopes.	C
Severe: indurated caliche at a depth of less than 20 inches.	Poor: thin layer (good source for caliche).	Unsuited: excess fines (good source for caliche).	Poor: limited material.	Indurated caliche at a depth of less than 20 inches; 0 to 9 percent slopes.	Limited material; high in lime.	Slopes of 0 to 9 percent; indurated caliche at a depth of less than 20 inches.	D
Severe: bedrock at a depth of less than 20 inches.	Poor: limited material.	Unsuited: limited material.	Poor: limited material.	Bedrock at a depth of 8 to 20 inches; 50 to 90 percent coarse fragments.	Limited material; bedrock at a depth of less than 20 inches.	Bedrock at a depth of 8 to 20 inches; slopes of 3 to 15 percent.	D

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill
Rickmore: Rk	Severe: moderately slow permeability.	Slight where slopes are 0 to 2 percent; moderate where slopes are 2 to 3 percent.	Moderate: clay loam.	Moderate: moderate shrink swell potential.	Moderate: clay loam.
*Rizozo: Rz Rock outcrop part too variable to rate. (See Rock outcrop.)	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.
Rock outcrop: Mapped only in complex with other soils. Too variable to rate, and severe limitations or poor suitability for most uses.					
Rubble land: Mapped only in complex with Aridic Haplustolls. Too variable to rate, and severe limitations or poor suitability for most uses.					
Sherm: Sh	Severe: very slow permeability.	Slight where slopes are 0 to 2 percent; moderate where slopes are 2 to 3 percent.	Severe: clay	Severe: high shrink swell potential.	Severe: clay
Spurlock: SpD, SrC, Su For Plack part of Su, see Plack series.	Slight	Moderate where slopes are 1 to 7 percent; moderate permeability; severe where slopes are 7 to 9 percent.	Moderate: clay loam.	Moderate: low strength.	Moderate: clay loam.
Texline: TeC	Slight	Moderate: moderate permeability.	Moderate: clay loam.	Moderate: moderate shrink swell potential.	Moderate: clay loam.
Torreon: Tn	Severe: slow permeability.	Slight where slopes are 0 to 2 percent; moderate where slopes are 2 to 3 percent.	Severe: clay	Severe: high shrink swell potential.	Severe: clay
*Travessilla: TrE, TrF Rock outcrop part of TrE too variable to rate. (See Rock outcrop.)	Severe: bedrock at a depth of less than 20 inches	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches.

properties of the soils—Continued

Degree and kind of limitation for—Cont.	Suitability as a source of—			Soil features affecting—			Hydrologic soil group
Local roads and streets	Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Terraces and diversions	
Severe: high plasticity index.	Poor: high plasticity index.	Unsuited: excess fines.	Fair: soil when mixed is sandy clay loam.	Conditions favorable.	Low shear strength; high compressibility.	Moderately slow permeability; 0 to 3 percent slopes.	C
Severe: bedrock at a depth of less than 20 inches.	Poor: limited material.	Unsuited: limited material.	Poor: limited material.	Bedrock at a depth of less than 20 inches.	Limited material; bedrock at a depth of less than 20 inches.	Bedrock at a depth of less than 20 inches.	D
Severe: high shrink swell potential.	Poor: high shrink swell potential.	Unsuited: excess fines.	Poor: clay	Conditions favorable.	Low shear strength; fair to poor compaction characteristics; high compressibility.	Long, uniform 0 to 3 percent slopes; clay.	D
Moderate: moderate plasticity index.	Fair: moderate plasticity index.	Unsuited: excess fines.	Fair: clay loam.	Moderate permeability; 1 to 9 percent slopes.	Medium to low shear strength; medium piping potential.	Moderate permeability; slopes of 1 to 9 percent.	B
Severe: medium or high plasticity index.	Poor: medium or high plasticity index.	Unsuited: excess fines.	Fair: clay loam.	1 to 5 percent slopes.	Medium to low shear strength; medium or low piping hazard.	Moderate permeability; slopes of 1 to 5 percent.	B
Severe: high shrink swell potential.	Poor: high shrink swell potential.	Unsuited: excess fines.	Poor: clay	0 to 3 percent slopes.	Low shear strength; medium or low piping potential.	0 to 3 percent slopes; slow permeability.	C
Severe: bedrock at a depth of less than 20 inches.	Poor: limited material.	Unsuited: limited material.	Poor: limited material.	Bedrock at a depth of less than 20 inches.	Limited material; bedrock at a depth of less than 20 inches.	Bedrock at a depth of less than 20 inches.	D

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill
*Ustolls: Ur. Too variable to rate, and severe limitations or poor suitability for most uses.					
Valent: VaD	Slight	Severe: very rapid permeability.	Severe: sand.	Slight	Severe: sand; very rapid permeability.
Vermejo: Ve	Severe: very slow permeability.	Slight where slopes are 0 to 2 percent; moderate where slopes are 2 to 3 percent.	Severe: clay	Severe: high shrink swell potential.	Severe: clay
*Vingo: Vn. For Dallam part in Vn, see Dallam series.	Slight	Severe: moderately rapid permeability.	Slight	Slight	Slight

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties are generally favorable for the rated use and have limitations that are minor and easily overcome. *Moderate* means that some soil properties are unfavorable, but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation, special designs, or intensive maintenance is required.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

In the following paragraphs are explanations of some of the columns in table 7.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor, and sides, or embankments, that are compacted to medium density so the area surrounding the pond will be protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter, and slope. If the floor needs to be leveled, depth to bedrock is an important consideration. The soil properties that affect the embankment are the engineering properties of the embankment material, as interpreted from the Unified soil classification system, and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewer lines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or large stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 7, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to ease of excavation and to capacity to support load and resist settlement under load. Soil properties that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks. Properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink swell potential.

Sanitary landfill is refuse disposed in dug trenches.

properties of the soils—Continued

Degree and kind of limitation for—Cont.	Suitability as a source of—			Soil features affecting—			Hydrologic soil group
Local roads and streets	Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Terraces and diversions	
Slight	Good	Good to poor: sand; unsuited for gravel.	Poor: sand	Very rapid permeability.	Medium shear strength; high piping potential; erodes easily.	Severe soil blowing hazard; very rapid permeability.	A
Severe: high shrink swell potential.	Poor: high shrink swell potential.	Unsuited: excess fines.	Poor: clay	Conditions favorable.	Low shear strength; high compressibility.	Clay; very slow permeability.	D
Slight	Good	Poor: excess fines.	Poor: loamy sand.	Moderately rapid permeability.	Medium shear strength; high piping potential.	Severe soil blowing hazard; moderately rapid permeability.	B

The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 7 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are dug much deeper than that. For some soils, however, reliable predictions can be made to a depth of 10 or 15 feet. Nevertheless, every site should be investigated before it is selected.

Local roads and streets, as rated in table 7, have an all weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material, and also the shrink swell potential, indicate traffic supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance about where to look for probable sources of these materials. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as when preparing a seedbed; natural fertility of the material or the response of plants when fertilizer is applied to it; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability, but also considered in the ratings is damage that will result to the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability

TABLE 8.—*Engineering*

[Tests performed by New Mexico State Highway Department and Albuquerque Testing Laboratory in accordance with

Soil name and location	New Mexico report no.	Depth from surface	Mechanical analysis[1]	
			Percentage passing sieve—	
			1 inch	⅜ inch
		Inches		
Bankard loamy sand: SE¼ sec. 19, T. 27 N., R. 27 E.	71–0095	16–47		
Carnero loam: Center sec. 14, T. 23 N., R. 31 E.	7	0–3		
	8	13–22		100
Dallam loamy sand: 65 ft W., 0.35 mi S. of NE. corner, sec. 25, T. 24 N., R. 36 E.	5	0–9		
	1	19–41		
	3	41–55		
Guy gravelly loam: 200 ft S. of E. quarter corner, sec. 32, T. 28 N., R. 34 E.	71–0096	0–6	100	83
	71–0097	14–25		
Sherm clay loam: 0.6 mi W., 0.1 mi S., NE. corner, sec. 36, T. 26 N., R. 35 E.	6	7–14		
	4	28–48		100
Spurlock loam: 1,400 ft S., 1,400 ft W., of NE. corner, sec. 28, T. 26 N., R. 35 E.	71–0064	0–6		
	71–0065	6–16		
	71–0066	16–40		
Valent sand: SW¼SE¼ sec. 35, T. 24 N., R. 36 E.	71–0090	7–60		
Vingo loamy sand: 1,600 ft S., 500 ft W. of N. quarter corner, sec. 28, T. 22 N., R. 36 E.	71–0086	0–11		
	71–0087	21–42		

[1] Mechanical analyses according to AASHTO Designation T 88 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service. In the AASHTO procedure the fine material is analyzed by the hydrometer method, and the various grain sized fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by

and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material resistant to seepage and piping and of favorable stability, shrink swell potential, shear strength, and compactibility. Presence of stones and presence of organic material in the soil are among the unfavorable factors.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Hydrologic soil groups are groupings of the soils that indicate their runoff potential. In table 7 the soils are classified into four hydrologic soil groups. The groupings are based on the intake of water at the end of storms of long duration, after prior wetting and swelling, and when the soil is not protected by plant cover. Group A consists of soils that soak up the most rainfall and lose the least through runoff. Group B consists of soils that absorb more than an average amount of rainfall. Group C consists of soils that absorb less than an average amount of rainfall. Group D consists of soils that soak up the least amount of rainfall and lose the most through runoff.

Soil Test Data

Table 8 contains engineering test data for some of the major soil series in Union County. These tests were made to help evaluate the soils for engineering uses. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material, as has been explained for table 8.

Formation and Classification of the Soils

The major factors of soil formation and their relationship to the soils of Union County are described

test data

standard procedures of the American Association of State Highway and Transportation Officials (AASHTO) (*1*)]

Mechanical analysis [1]—Continued				Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued							
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.047 mm)			AASHTO [2]	Unified
				Percent			
----------	100	56	3	Sandy	[3] NP	A-3(0)	SP
100	99	97	51	23	9	A-4(1)	CL
97	96	95	64	37	25	A-6(12)	CL
----------	100	89	13	Sandy	NP	A-2-4(0)	SM
----------	100	92	27	30	20	A-2-6(1)	SC
100	99	91	38	34	23	A-6(4)	SC
74	68	50	26	27	8	A-2-4(0)	SC
----------	100	65	32	27	7	A-2-4(0)	SC-SM
100	99	98	87	52	35	A-7-6(31)	CH
99	98	97	84	44	29	A-7-6(23)	CL
----------	100	90	62	31	11	A-6(4)	CL
----------	100	88	58	36	15	A-6(6)	CL
----------	100	90	69	32	11	A-6(7)	CL
----------	100	94	8	Sandy	NP	A-3(0)	SP-SM
----------	100	96	18	Sandy	NP	A-2-4(0)	SM
----------	100	95	27	Sandy	NP	A-2-4(0)	SM

the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain sized fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

[2] Based on AASHTO Designation M 145-49.

[3] NP—Nonplastic.

in this section. The system of classification of soils into categories broader than the series is also explained.

Factors of Soil Formation

The characteristics of the soil at any given point are determined by the physical and mineral composition of the parent material; the climate under which the soil material accumulated and has existed since accumulation; the relief, or lay of the land; the plant and animal life on and in the soil; and the length of time these forces have been active.

Climate and vegetation act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. Relief conditions the effects of climate and vegetation. The parent material also affects the kind of profile that is formed and in extreme cases determines it almost entirely. Finally, time is needed for distinct horizons to form.

The factors of soil formation are so closely interrelated that few generalizations can be made regarding the effect of any one factor because the effect of each is modified by the other four.

Parent Material

The soils of Union County formed in material derived from basalt, sandstone, shale, wind-deposited sand, old lake and stream sediment, and upland deposits of limy material.

Valent soils are the youngest soils in the survey area. They formed in sand dunes mostly vegetated and stabilized during recent time. Bankard soils formed at about the same time in sand and fine gravel deposited by water along the channels of ephemeral streams. Other recent soils are Kim and Alicia soils, which formed in loamy alluvium on fans leading from sandstone breaks to river channels, and Manzano soils, which formed in loamy, flood-deposited sediment along stream channels. Many of the characteristics of these recent or young soils are similar to the characteristics of the parent material in which they formed.

Ayon and Apache soils formed on basalt-capped mesas, terraces, and uplands. They have only moderate horizon differentiation because of the durability of the parent rock and the nearly level to strong slopes. Capulin and Torreon soils formed in less sloping areas where the basalt parent rock has received deposits of alluvial, colluvial, and eolian material. The strongly

differentiated profiles in these soils are evident because clay and carbonates have accumulated below the surface.

Soils in the eastern part of the county formed mainly in sediment derived from the Ogallala Formation of the Tertiary geologic system. This Formation consists of sandy deposits in which Dallam and Vingo soils formed; calcareous sediment in which Guy, Plack, and Spurlock soils formed; and clayey deposits in which Gruver, La Brier, Rickmore, and Sherm soils formed. These soils, especially in the layers beneath the surface layer, commonly reflect the texture and color of the parent material. The color of the surface layer commonly reflects the amount of organic matter in the soil. For example, Sherm and La Brier soils are dark grayish brown or very dark grayish brown and have more organic matter than the brown Dallam and Vingo soils.

The Cretaceous period left two main formations in Union County. The Graneros Shale is the younger, and the Dakota Formation is the older. Litle soils formed in residuum weathered from the Graneros Shale; Colmer soils, in eolian material derived from it. Both of these soils are high in silt and clay, low in sand, and have the brown, yellow, and olive colors characteristic of the Graneros Shale. Travessilla, Carnero, Escabosa, and Partri soils formed in the dominantly hard sandstone of the Dakota Formation.

Red sandstone and interbedded shale formations of the Jurassic and Triassic periods are exposed in eroded areas near the Cimarron River. Rizozo soils, which formed in residuum, and Alicia soils, which formed in alluvium, have retained the reddish color of the sandstone from these geologic formations.

Climate

Union County has the semiarid continental climate typical of drier parts of the Southern High Plains and most parts of the Pecos-Canadian Plains and Valleys major land resource areas (*3*). The climate is characterized by abundant sunshine; by wide seasonal variations in precipitation (most precipitation falls late in spring, in summer, and in early autumn); by wide daily and seasonal variations in temperature; and by seasonally high winds.

The high wind velocity in this county created hummocks, or dunes, of eolian sediment in which Dallam and Vingo soils formed. The wind sorts the soil, carrying away clay and silt and leaving only sand-sized particles. Valent soils formed in eolian sand.

The colder areas of the county, such as the Sierra Grande, have soils with a surface layer of very dark grayish brown, dark gray, or dark grayish brown about 18 inches thick. The soil retains more precipitation for use by plants and accumulates more organic matter because of cooler temperature and less evaporation. Des Moines and Dalcan soils are on the Sierra Grande.

Relief

Relief commonly modifies the effects of climate or vegetation. In steep areas of the landscape, much of the precipitation runs off; in level areas, it soaks in.

Most of the soils in Union County absorb much of the precipitation that they receive. The parent material is consequently deeply weathered, and the soils are deep. Torreon and Capulin soils have not only allowed water to soak in but have also received additional eolian sediment and alluvium; as a result, these level to gently sloping soils are deep and have distinct horizons. La Brier and Manzano soils are level to nearly level. They absorb most of the precipitation that falls directly on them and receive additional moisture in the form of runoff from surrounding areas. Because of this, the dark surface layer that is about 10 inches thick in nearby soils is more than 20 inches thick in La Brier and Manzano soils.

Travessilla and Apache soils are in steeper areas and near the edges of breaks. The slope and the shallow depth to bedrock cause them to shed much of the water that falls on them. Because soil is lost by water erosion and gravity at nearly the same rate as new soil is formed, Travessilla and Apache soils are likely to remain shallow to bedrock.

Plant and Animal Life

All forms of life—micro-organisms, plants, and animals, including man—have a part in the formation of soil.

The soils in Union County are mostly under grass, but some steep soils at higher elevations are under trees and brush. Decomposing roots of all kinds have furnished the organic matter that makes the surface layer dark. In some soils grass roots also have influenced the structure of the surface layer.

In a few areas buffalo wallows are still visible and are mapped as included soils in areas of Carnero and Capulin soils. Prairie dogs and other burrowing animals commonly mix the soil because their tunnels extend through more than one soil horizon in most places.

Man has had a definite influence in this area. In much of Union County, homesteaders removed the natural plant cover from the soil as they plowed the fields for their crops. This left the soil more susceptible to erosion, reduced the content of organic matter, and changed the physical condition of the surface layer.

Time

The degree of profile differentiation depends on the intensity of the soil forming factors, including the length of time they have been active. Apache and Raton soils are in the same position on the landscape, but the Raton soil is thought to be older even though most of the other factors of soil formation are essentially the same. The clay accumulation and leaching of lime in the Raton soil indicates that it has been forming for a long time, although this difference may be tempered somewhat by the accumulation of eolian sediment.

A soil is young, or immature, if the soil forming factors have not been active long enough for the soil to have the characteristics imposed by these factors. A soil is mature if it has been in place long enough for the soil forming factors to have altered the parent material and for other changes and transformations to have taken place.

Bankard, Kim, and Valent soils are young and have been altered very little from the original parent material. Alicia and Manzano soils have been altered slightly and are thought to be somewhat older.

Torreon and Fallsam soils have horizons of clay

TABLE 9.—*Classification of soil series by higher categories*

Series	Family	Subgroup	Order
Alicia	Fine-silty, mixed mesic	Ustollic Camborthids	Aridisols.
Apache	Loamy, mixed, mesic	Lithic Haplustolls	Mollisols.
Ayon	Loamy-skeletal, mixed, mesic	Aridic Calciustolls	Mollisols.
Bandera	Cindery	Torriorthentic Haploborolls	Mollisols.
Bankard	Sandy, mixed, mesic	Ustic Torrifluvents	Entisols.
Capulin	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
Carnero	Fine, mixed, mesic	Aridic Argiustolls	Mollisols.
Colmor	Fine-silty, mixed, mesic	Aridic Calciustolls	Mollisols.
Dalcan	Clayey-skeletal, montmorillonitic	Pachic Argiborolls	Mollisols.
Dallam	Fine-loamy, mixed, mesic	Aridic Paleustalfs	Alfisols.
Des Moines	Clayey-skeletal, montmorillonitic	Pachic Argiborolls	Mollisols.
Dioxice	Fine-loamy, mixed, mesic	Aridic Calciustolls	Mollisols.
Escabosa	Fine-loamy, mixed, mesic	Aridic Calciustolls	Mollisols.
Fallsam	Clayey-skeletal, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Gruver	Fine, mixed, mesic	Aridic Paleustolls	Mollisols.
Guy	Coarse-loamy, mixed, mesic	Aridic Calciustolls	Mollisols.
Kim	Fine-loamy, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
La Brier	Fine, mixed, mesic	Torrertic Argiustolls	Mollisols.
Litle	Fine, mixed, mesic	Ustollic Camborthids	Aridisols.
Manzano	Fine-loamy, mixed, mesic	Cumulic Haplustolls	Mollisols.
Partri	Fine, mixed, mesic	Aridic Argiustolls	Mollisols.
Plack	Loamy, mixed, mesic, shallow	Petrocalcic Calciustolls	Mollisols.
Raton	Clayey-skeletal, mixed	Lithic Argiborolls	Mollisols.
Rickmore	Fine, mixed, mesic	Aridic Paleustalfs	Alfisols.
Rizozo	Loamy, mixed (calcareous), mesic	Lithic Ustic Torriorthents	Entisols.
Sherm	Fine, mixed, mesic	Torrertic Paleustolls	Mollisols.
Spurlock[1]	Coarse-loamy, carbonatic, mesic	Ustollic Calciorthids	Aridisols.
Texline	Fine-loamy, mixed, mesic	Calciorthidic Paleustolls	Mollisols.
Torreon	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols.
Travessilla	Loamy, mixed (calcareous), mesic	Lithic Ustic Torriorthents	Entisols.
Valent	Mixed, mesic	Ustic Torripsamments	Entisols.
Vermejo	Fine, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Vingo	Coarse-loamy, mixed, mesic	Aridic Paleustalfs	Alfisols.

[1] These soils are taxadjuncts to the Spurlock series. (They lack an argillic horizon and they are drier than is defined in the range for the Spurlock series.)

accumulation and have been in place long enough for the downward movement of water to remove nearly all soluble salts and lime from the surface layer and subsoil. Dallam and Rickmore soils are thought to be very old. Evidence of this age is a reddish color in the subsoil and thick horizons of clay accumulation. These horizons do not decrease appreciably in clay content with depth.

Classification

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationships to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to management. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison of large areas.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available.[8]

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the differentiae used as a basis for classification are soil properties observed in the field, soil properties inferred from other soil properties observed in the field, or soil properties inferred from the combined data of soil science and other disciplines. The properties that affect classification into higher categories are the result of soil genesis, or they affect soil genesis. In Table 9 the soil series of Union County are placed in categories of the current system. The categories of this system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differentiae for the orders are based on the kind and degree of the dominant sets of soil forming processes that have taken place.

SUBORDER. Each order is subdivided into suborders that are based primarily on properties that influence soil genesis and that are important to plant growth, or they reflect what seemed to be the most important variables within the orders.

GREAT GROUP. Soil suborders are separated into

[8] See the unpublished working document "Selected Chapters from the Unedited Text of the Soil Taxonomy" available in the SCS State Office, Albuquerque, New Mexico.

great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons, soil moisture and temperature regimes, and in base status.

SUBGROUP. Great groups are subdivided into three kinds of subgroups: the central (typic) concept of the great groups (not necessarily the most extensive subgroup) ; the intergrades, or transitional forms to other orders, suborders, or great groups; and extragrade subgroups, which have some properties that are representative of the great groups but that do not indicate transitions to any other known kind of soil.

FAMILY. Soil families are groups within a subgroup. Families have similar enough physical and chemical properties that responses to management are nearly the same for comparable phases. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineralogy, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, slope, and permanent cracks.

SERIES. The series consists of a group of soils that formed from a particular kind of parent material and that have horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

The classification of some of the soils in adjoining counties is different from the classification of soils that they join in Union County because some soil characteristics such as soil temperature and soil moisture regime change gradually over a distance of many miles. The exact point on the landscape that the characteristic changes enough to warrant a change in classification is hard to locate; therefore, arbitrary boundaries are established in some places.

The soils in Quay County and part of Harding County to the south are in a warmer temperature regime. Because of this, they have different names and different classifications. For example, soils that are similar to Amarillo soils in Quay and Harding Counties are called Dallam soils in Union County. The only difference between the two is that Amarillo soils have a thermic temperature regime, and Dallam soils, a mesic temperature regime.

Some of the soils to the east of Union County are moist for a longer time below the surface layer than are the soils in Union County. The increase in precipitation of about 1 inch for every 30 miles from west to east in Union County changes the soil classification and soil series name even though all other characteristics are the same. For example, Corlena and Valentine soils in Dallam County, Texas are similar to Bankard and Valent soils, respectively, in Union County except that they are more moist. Perico soils as mapped in Dallam County differ from Dallam soils as mapped in Union County in that they are calcareous in the surface layer and in the upper part of the subsoil. Perico soils are mapped as an unnamed included soil with Dallam soils in Union County. Dumas soils, mapped separately in adjoining areas, is mapped in Union County only as an included soil with Gruver loam. Dumas soils have about 5 percent less clay in the subsoil than Gruver soils and have fine-loamy particle size instead of the fine particle size characteristic of Gruver soils.

Some of the soils joining Union County from Cimarron County, Oklahoma, to the east have different names because they were mapped and classified according to the concept of the series as it was more than 15 years ago. Because new knowledge has been acquired since that time, definitions of some series have been revised, some have been dropped, and some have been added. As old mapping is revised according to new standards, names across county and state lines will gradually become the same for similar kinds of soil. In the interim, however, soil interpretations as given in this and other publications are based on soil characteristics and will always be current with the state of knowledge regardless of the names given to soils.

The northern boundary of Union County is the New Mexico-Colorado State line. The soils have been mapped and classified in only a small part of the adjoining area of Colorado in Baca County. The soils are the same on both sides of the line except for very small areas of soils that extend near but not across the line.

General Nature of the County

In this section, the agricultural development, land use, and climate of Union County are presented.

Agricultural Development and Land Use

Union County is the extreme northeastern county in New Mexico. The eastern third of the county is on the plains, and the rest is on the rolling foothills between the Rocky Mountains and the plains. The average land gradient is about a 30-foot drop per mile to the southeast. Elevation ranges from 4,300 feet near the southeastern corner of the county to 7,500 feet near the northwestern corner. Rabbit Ear Mountain and Mount Dora, directly north of Clayton, are typical of the volcanic vents throughout the basalt areas of the county. Sierra Grande, the highest peak, rises to an elevation of 8,732 feet. It is in the western part of of the county near Des Moines.

Most of the water for domestic and livestock use comes from artesian flows in sand and sandstone strata 100 to 200 feet below the surface (*10*).

Clayton is the county seat and principal trading center. It has a population of about 3,500. The Colorado and Southern, a wholly owned subsidiary of Burlington Northern, is the only railroad. It traverses the county from a point near the northwestern corner through Mount Dora, Grenville, Des Moines, Folsom, and Clayton to a point near the center along the eastern boundary.

Union County has long been a farming and ranching area. It was first settled in the latter part of the nineteenth century by a few Spanish-Americans who moved in along the creeks and by a few cattle and sheep ranchers. The first range fence was built along the New Mexico-Texas State line in 1882. The use of land for cultivated crops was extremely limited; what small acreage was cultivated was chiefly incidental to livestock production on large ranches.

TABLE 10.—*Temperature and precipitation*

[All data from Clayton. Period of record, 1931–60]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average	One year in 10 will have—		Average number of days with precipitation of—	
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—	0.10 inch or more	0.25 inch or more
	°F	°F	°F	°F	*Inches*	*Inches*	*Inches*		
January	46	20	65	3	0.4	(1)	0.8	1	(2)
February	49	23	68	6	.4	(1)	.7	1	(2)
March	55	27	75	11	.6	(1)	1.6	2	1
April	65	37	82	24	1.2	0.2	2.9	3	1
May	73	46	88	35	2.7	.5	5.6	5	3
June	84	56	95	47	1.5	.4	3.3	3	2
July	88	61	97	54	2.3	.7	5.0	5	3
August	87	60	95	53	2.1	.8	3.4	4	2
September	80	53	91	40	1.6	.2	3.8	3	2
October	69	41	83	27	1.0	.1	3.0	2	1
November	55	28	74	14	.3	(1)	1.0	1	(2)
December	49	23	68	9	.4	(1)	.7	1	(2)
Year	67	40	[3] 99	[4] −3	14.5	8.3	19.3	31	15

[1] Less than 0.05 inch.
[2] Less than one-half day.
[3] Average annual highest temperature.
[4] Average annual lowest temperature.

The transportation facilities provided by the railroad built in the 1880's also contributed much to the early settlement of Union County. Clayton became an important shipping and trade center for the area when the railroad was completed. For a number of years following this period, cattle were driven to Clayton from as far south as Lincoln and Chaves Counties for shipment to markets.

A large percentage of land in Union County is used for grazing of livestock. Ranching therefore remains one of the more important agricultural enterprises, and in 1971 there were approximately 97,000 cattle on the farms and ranches in this county (*7*).

Dryfarming has been practiced extensively in the county. Most of the pioneer farm development took place after 1900, when farmers took up homesteads and began to cultivate the land. Although these early attempts at growing crops were sporadic and often discouraging because of periods of drought, many of the homestead areas remained under cultivation until the 1930's, when this area suffered an extreme drought. At Clayton an average of 8.09 inches of rain was received annually for the period 1932–36. Average annual precipitation, however, was 15.7 inches during the period of 1910–72. Following this severe drought in the 1930's, much of the nonirrigated cropland was abandoned or returned to range use. Now only about 90,000 acres of dry cropland remain under cultivation. Profitable dryland crop yields can be expected only in years of average or above-average precipitation. In addition to the dry cropland, the State Conservation Needs Committee estimated that about 28,200 acres were irrigated in 1966. Although small areas are irrigated by water diverted from the Cimarron River and a few other streams, most of the irrigated land receives its water supply from underground water sources. Irrigation wells are 200 to 500 feet deep in most places. Grain and forage sorghum, corn, small grains, alfalfa, and other hay crops are the most extensively grown crops.

Climate [9]

Average annual precipitation in Union County ranges from about 14 inches in the southeast to 15 inches in other parts of the east and to 19 inches in the higher elevations along the northern border. In general this distribution is the result of moist air from the Gulf of Mexico flowing up onto the mountains. This results in increased condensation and precipitation. In table 10 the monthly and annual distribution of precipitation at Clayton is shown, and the pattern at Clayton is representative of other county locations.

More than three-fourths of the annual average precipitation falls during the months of May through October. May, July, and August are the rainiest months. (Most rain falls in brief but heavy thunderstorms.) More precipitation falls in winter than in spring or

[9] By FRANK E. HOUGHTON, climatologist for New Mexico, National Weather Service, U.S. Department of Agriculture.

fall because moist air from the Pacific Ocean occasionally reaches the area. Although its moisture is greatly decreased by condensation as it passes over the western mountains, it augments the moisture circulating inland from the Gulf of Mexico. The recorded extremes at Clayton—37.65 inches in 1941 and 5.54 inches in 1936—indicate the year-to-year variations in precipitation. A similar variation in monthly total precipitation is apparent if the September 1941 total of 8.69 inches is compared with the complete lack of measurable precipitation in September 1956. This variation is characteristic of semiarid continental climate.

Average annual temperature in Union County is highest in the southeast. It ranges from about 56° F at Amistad to about 46° in the higher elevations of the northwest. Extreme temperatures follow the same general pattern, ranging from highs of 108° F and lows of −20° in the southeast to highs of about 100° and lows of about −30° in the northwest. Table 10 also shows the general pattern of monthly and annual temperatures at Clayton and is representative of the county.

The average number of days per year with a high temperature of 90° F or greater ranges from 78 days in the southeast to 5 days in the northwest; temperatures of 32° or lower occur on an average of 127 days per year in the southeast and 197 days per year in the northwest. Figure 20 shows the probability of occurrence of various temperature thresholds in the spring and fall at Clayton. The average date is the date of 50 percent probability. The average length of the growing season, the period between the last freeze in the spring and the first in the fall, is 166 days.

Few days in any year have a maximum temperature of 100° or more or a minimum temperature below zero. Rapid cooling after sunset results in generally cool nights and relatively large diurnal temperature change. The range between the highest and lowest daily temperatures averages about 28°. The coldest weather occurs when arctic air pushes southward over the Great Plains into northeastern New Mexico, but these incursions of cold air seldom last more than a few days. Temperature may drop rapidly as the cold air arrives. Brief blizzard conditions may occur, but snow is not very deep except where it has drifted. The average number of days with 1 inch or more of snow on the ground for the three seasons 1962–65 was 14 at Clayton airport and 31 at Des Moines.

Average annual total snowfall ranges from about 16 to 25 inches in the southern and central parts of the county but is as much as 42 inches at Des Moines and probably is higher in the mountain areas. Most snows occur during the period November through April. Measurable snow seldom remains on the ground at Clayton for more than a few days. With a heavy snowfall and persistent cold temperatures, the snow may occasionally persist for a week or so.

Occasional heavy showers bring large 24 hour totals of precipitation. Some of these maximum 24 hour amounts are 6.20 inches at Clayton on April 30, 1914; 6.00 inches at the station near Pennington on October 13, 1928; 6.00 inches at Sedan on May 27, 1946; 5.16 inches at Ione on August 21, 1923; and 5.18 inches at Greenville on September 22, 1941. During the 68-year period of record in Union County up to 1966, approximately 64 additional occurrences of 24 hour point rainfall amounts of 3.00 inches or greater have been noted.

Although no records of evaporation have been maintained in Union County, a study of evaporation measurements from stations in surrounding areas shows that annual Class A pan evaporation averages of 90 inches in the southeast to 74 inches in the northwest may be expected in Union County. Approximately two-thirds of the annual evaporation occurs during the six month period of May through October.

The sun shines about three-fourths of the possible time, or about 3,200 hours annually. Nearly half of the days in an average year are clear (less than four-tenths of the sky covered by clouds), and about one-fourth are classified as cloudy (more than seven-tenths of the sky covered by clouds). The percentage of possible sunshine and cloudiness is fairly equally distributed throughout the year.

Records at Clayton for a two year period indicate an average hourly windspeed of 15 miles per hour. Winds exceed 24 miles per hour about 10 percent of the hours throughout the year. Winds are stronger in the spring; April is usually the windiest month. The stronger winds usually blow from the west or southwest except in the winter and spring when they are more commonly from the north. Winds blow from the southwest quadrant nearly 50 percent of the time.

Relative humidity for the year averages about 70 percent in the early morning and about 40 percent in the early afternoon. Seasonally, the relative humidity is lowest in the spring, averaging about 50 percent, and highest in the winter, averaging about 60 percent. Heavy fog that reduces visibility to one-fourth mile or less occurs on an average of once a month at Clayton airport. Such fog is most likely in March and least likely in August.

Union County is near the secondary maximum area of thunderstorms in the United States. There is an average of 54 thunderstorms annually, 35 during the summer. The main season extends from May through September, and thunderstorms occur infrequently from late fall through early spring. Hail sometimes accompanies the thunderstorms. The yearly number of days with hail at Clayton during the period 1947–62 ranged from none to 12, with an average of 6. Hail falls on an average of 2 days each in May and June and on an average of 1 day each in April and July. Hail is rare in late fall and winter. In June 1950, a record 6 days with hail were reported. Large hail (¾ inch in diameter or more) has been reported nine times in Union County during the 14 years of record ending in 1965.

During the period 1916–65, 12 tornadoes were reported in Union County, but most caused little damage. The most damaging were the two of June 5, 1931. One of these caused $10,000 damage, and the second, $19,000 damage and the death of one child, but they may have been two appearances of the same tornado.

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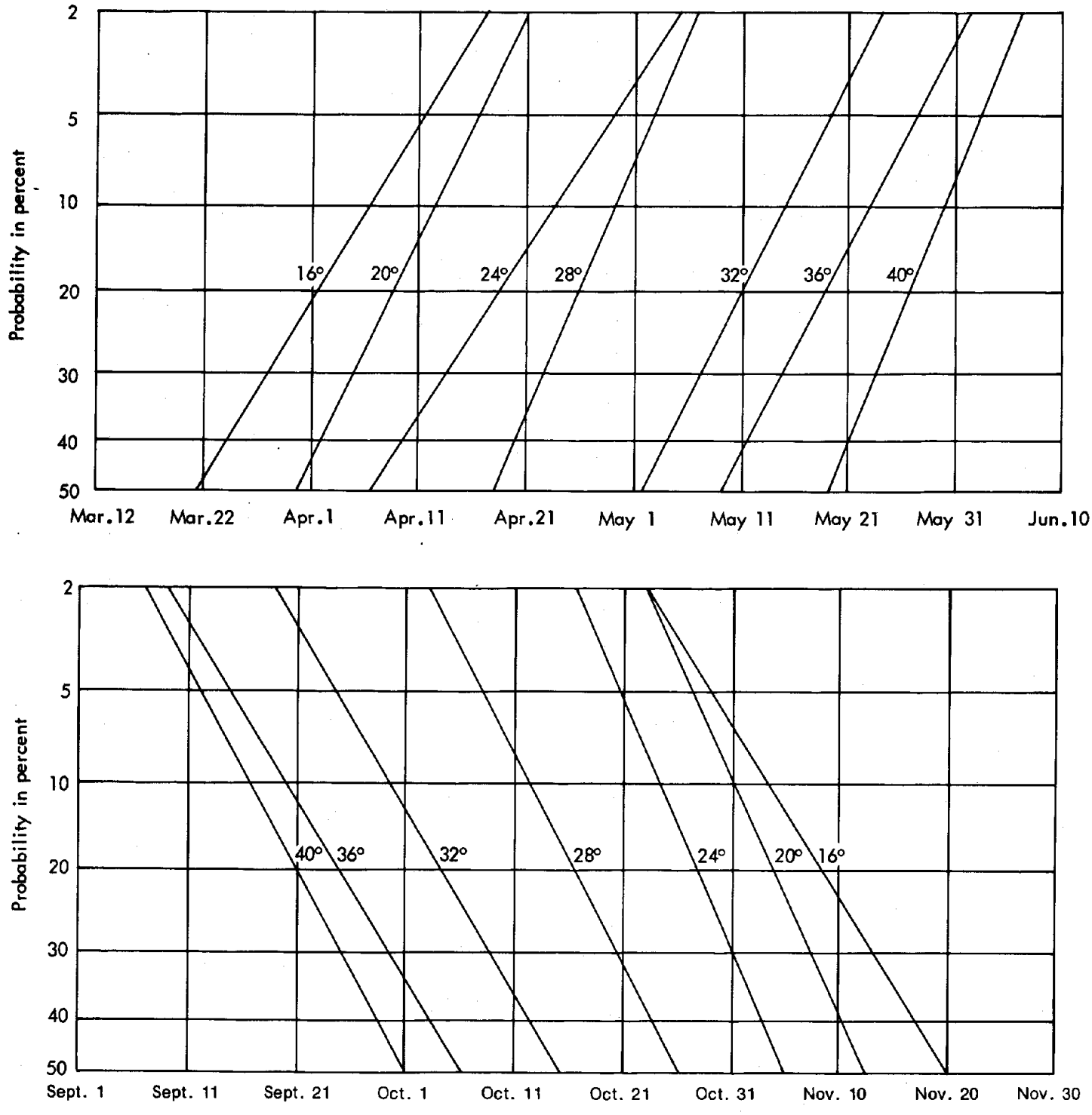

Figure 20.—**Probability of occurrence of selected low temperatures at various dates in spring and in fall.**

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Channery soil. A soil, that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.
Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Depth, soil. Depth to bedrock or to indurated caliche. Such material restricts root development of common plants. In this survey, terms used to describe depth are: shallow, 4 to 20 inches; moderately deep, 20 to 40 inches; and deep, 40 inches or more.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is

high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Ephemeral stream. A stream or portion of a stream that flows only in direct response to precipitation.

Forb. Any herbaceous plant not a grass or a sedge.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Indurated soil. Soil material cemented into a hard mass that will not soften on wetting.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Playa. A shallow basin on a plain. Water collects in playas after rain and is later evaporated.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.5 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		pH
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Residum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by the horizontal distance multiplied by 100. Thus a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey, slope classes and their percentages are:

Percentage	*Single slope*	*Complex slope*
0–1	Level	Level
1–3	Nearly level	Gently undulating
3–5	Gently sloping	Undulating
5–9	Moderately sloping	Gently rolling
9–15	Strongly sloping	Rolling
15–30	Moderately steep	Hilly
30–50	Steep	Steep
50–80	Very steep	Very steep

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Squeeze ups (Geology). Small, domelike extrusions of basalt common in the vicinity of Capulin Mountain.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series of which it is a part. When referring to a capability unit, a range site, or a windbreak group, read the section it is in for general information about its management.

Map symbol	Mapping Unit	Page	Irrigated capability unit	Dryland capability unit or subclass	Range site	Windbreak group
			Symbol	Symbol	Name	Number
AcD	Alicia loam, 3 to 9 percent slopes---------	9	IVe-6	VIe	Loamy	1
Ap	Apache-Rock outcrop complex----------	10	------	VIIs	------	-
	Apache cobbly loam----------	--	------	------	Malpais	5
	Rock outcrop----------	--	------	------	------	-
Ar	Aridic Haplustolls-Rubble land complex-----	11	------	VIIs	------	-
	Aridic Haplustolls----------	--	------	------	Breaks	5
	Rubble land----------	--	------	------	------	-
Ay	Ayon-Apache association----------	11	------	VIIs	Malpais	5
Bd	Bandera association----------	12	------	------	------	-
	Bandera gravelly silt loam----------	--	------	VIe	Cinder	5
	Cinder land----------	--	------	VIIIs	------	-
Bk	Bankard loamy sand----------	13	------	VIe	Deep Sand	3
CaC	Capulin loam, 0 to 5 percent slopes--------	14	IIe-6	IVe-2	Loamy	1
Ch	Capulin-Apache complex----------	14	------	VIs	------	-
	Capulin loam----------	--	------	------	Loamy	1
	Apache cobbly loam----------	--	------	------	Malpais	5
	Ayon cobbly clay loam----------	--	------	------	Malpais	5
CnC	Carnero loam, 0 to 5 percent slopes--------	15	IIIe-9	VIe	Loamy	4
Cp	Carnero-Partri complex----------	15	IIIe-9	VIe	Loamy	-
	Carnero loam----------	--	------	------	------	4
	Partri silty clay loam----------	--	------	------	------	1
CrC	Colmor silty clay loam, 0 to 5 percent slopes----------	16	IVe-6	IVe-2	Clayey	1
Da	Dalcan-Rock outcrop complex----------	17	------	VIIs	------	-
	Dalcan cobbly silt loam----------	--	------	------	Mountain Grassland	5
	Rock outcrop----------	--	------	------	------	-
DhC	Dallam loamy sand, 0 to 5 percent slopes---	18	IIIe-10	IVe-3	Deep Sand	1
DmC	Dallam fine sandy loam, 0 to 5 percent slopes----------	18	IIIe-4	IVe-1	Sandy	1
Dr	Des Moines-Rock outcrop complex----------	19	------	VIIs	------	-
	Des Moines cobbly silt loam----------	--	------	------	Mountain Grassland	5
	Rock outcrop----------	--	------	------	------	-
DxC	Dioxice loam, 0 to 5 percent slopes--------	20	IIIe-6	IVe-1	Loamy	1
EsC	Escabosa loam, 3 to 5 percent slopes-------	21	------	VIe	Shallow	4
Fr	Fallsam-Rock outcrop complex----------	22	------	VIIs	------	-
	Fallsam cobbly silt loam----------	--	------	------	Malpais	5
	Rock outcrop----------	--	------	------	------	-
Gr	Gruver loam----------	23	IIIe-8	IIIe-2	Loamy	1
Gt	Guy-Texline complex----------	25	------	VIe	------	-
	Guy gravelly loam----------	--	------	------	Shallow	3
	Texline loam----------	--	------	------	Loamy	1
KaD	Kim sandy loam, 1 to 9 percent slopes------	26	------	VIe	Sandy	1
Km	Kim-Manzano association----------	26	------	------	Loamy	1
	Kim loam----------	--	IVe-6	IVe-2	------	-
	Manzano loam----------	--	IIe-6	IVe-2	------	-
La	LaBrier silty clay loam----------	27	IIs-1	IVe-1	Clayey	2
Lr	La Brier-Rock outcrop complex----------	27	------	VIs	------	-
	La Brier silty clay loam----------	--	------	------	Clayey	2
	Rock outcrop----------	--	------	------	------	-

Map symbol	Mapping unit	Page	Irrigated capability unit	Dryland capability unit or subclass	Range site	Windbreak group
			Symbol	Symbol	Name	Number
LtD	Litle clay loam, 1 to 9 percent slopes	29	------	VIe	Clayey	4
Mn	Manzano loam	29	IIe-6	IVe-2	Loamy	1
PkD	Plack loam, 0 to 9 percent slopes	30	------	VIIs	Shallow	5
Ra	Raton-Rock outcrop complex	31	------	VIIs	------	-
	Raton cobbly silty loam	--	------	------	Malpais	5
	Rock outcrop	--	------	------	------	-
Rk	Rickmore sandy loam	32	IIIe-4	IIIe-3	Sandy	1
Rz	Rizozo-Rock outcrop complex	33	------	VIIs	------	-
	Rizozo loam	--	------	------	Shallow Sandstone	5
	Rock outcrop	--	------	------	------	-
Sh	Sherm clay loam	34	IIIe-8	IIIe-2	Clayey	2
SpD	Spurlock loamy sand, 1 to 9 percent slopes	35	------	VIe	Deep Sand	1
SrC	Spurlock loam, 1 to 5 percent slopes	35	IIIe-12	VIe	Sandy	1
Su	Spurlock-Plack complex	35	------	VIe	------	-
	Spurlock loam	--	------	------	Sandy	1
	Plack loam	--	------	------	Shallow	5
TeC	Texline loam, 1 to 5 percent slopes	36	IIIe-6	IVe-1	Loamy	1
Tn	Torreon silty clay loam	37	IIIe-8	IVe-1	Loamy	2
TrE	Travessilla-Rock outcrop complex, 0 to 15 percent slopes	38	------	VIIs	------	-
	Travessilla sandy loam	--	------	------	Shallow Sandstone	5
	Rock outcrop	--	------	------	-------	-
TrF	Travessilla-Rock outcrop complex, 30 to 75 percent slopes	38	------	VIIs	------	-
	Travessilla stony sandy loam	--	------	------	Breaks	5
	Rock outcrop	--	------	------	-------	-
Ur	Ustolls-Rock outcrop association	39	------	------	------	-
	Ustolls	--	------	VIIs	Breaks	5
	Rock outcrop	--	------	VIIIs	------	-
VaD	Valent loamy sand, 3 to 9 percent slopes	40	------	VIe	Deep Sand	3
Ve	Vermejo silty clay loam	40	IVs-9	VIs	Clayey	2
Vn	Vingo-Dallam complex	41	IVe-10	VIe	Deep Sand	-
	Vingo loamy sand	--	------	------	------	3
	Dallam loamy sand	--	------	------	------	1

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