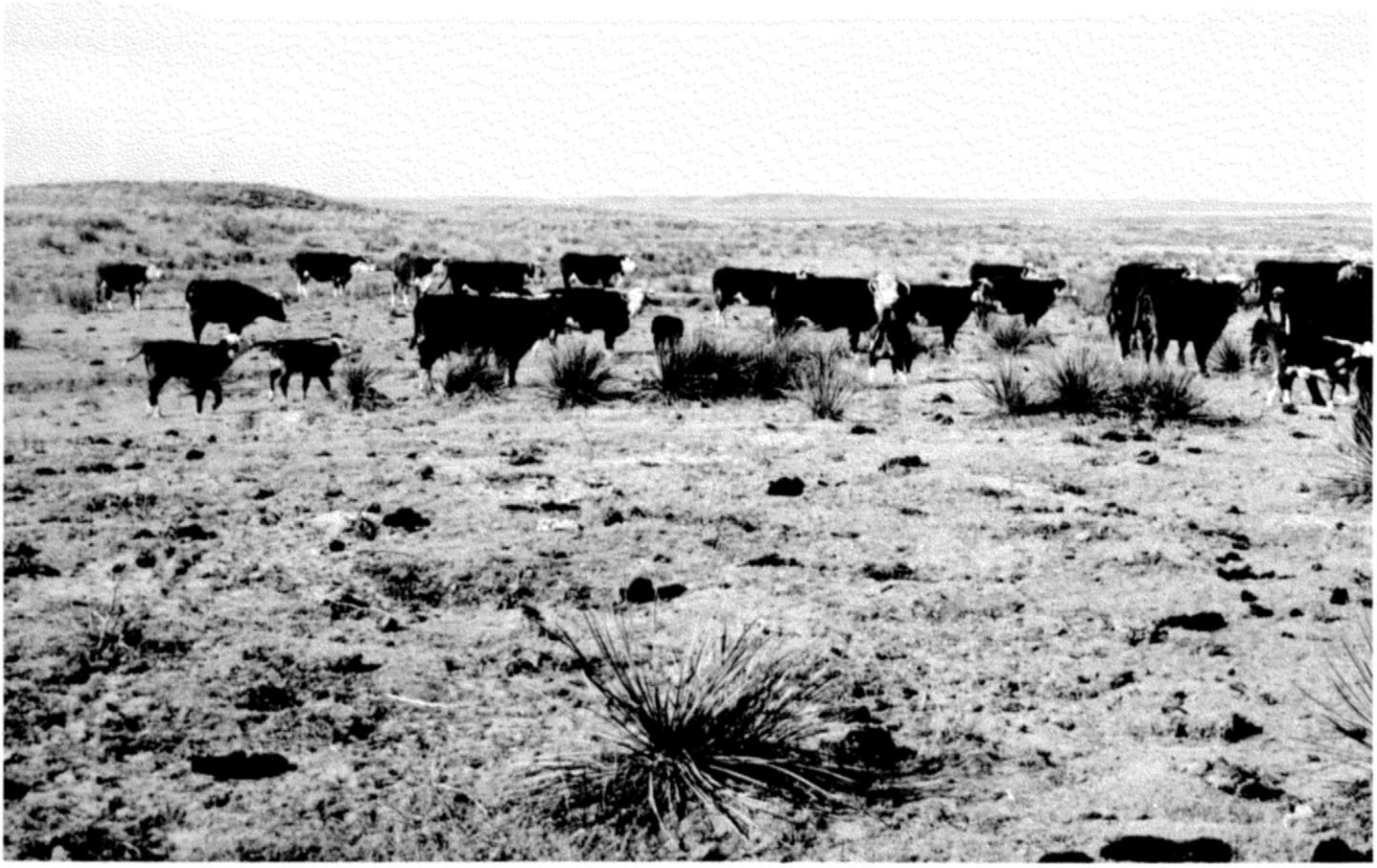
SOIL SURVEY OF

Harding County, New Mexico



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

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Major fieldwork for this soil survey was done in the period 1957-63. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1963. This survey was made cooperatively by the Soil Conservation Service and the New Mexico Agricultural Experiment Station. It is part of the technical assistance furnished to the Mesa, Ute Creek, and Canadian River Soil and Water Conservation Districts.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

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, industry, and recreation.

Locating Soils

All the soils of Harding 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 symbols. 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. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the capability unit and range site in which the soil has been placed.

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 subsection "Management of Cropland."

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Management of Wildlife."

Ranchers and others can find, under "Range Management," 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 "Soils in 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 Harding County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They also may be interested in the information about the county given at the beginning of the publication and in the section "Additional Facts About the County."

Cover: An area of the Mansker-Portales association, gently sloping, in the Sandy range site.

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SOIL SURVEY OF HARDING COUNTY, NEW MEXICO

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN
COOPERATION WITH NEW MEXICO AGRICULTURAL EXPERIMENT STATION

HARDING COUNTY is in the northeastern part of New Mexico (fig. 1). Mosquero, the county seat, has a population of 310. The county has a total area of 1,367,040 acres, or 2,136 square miles.

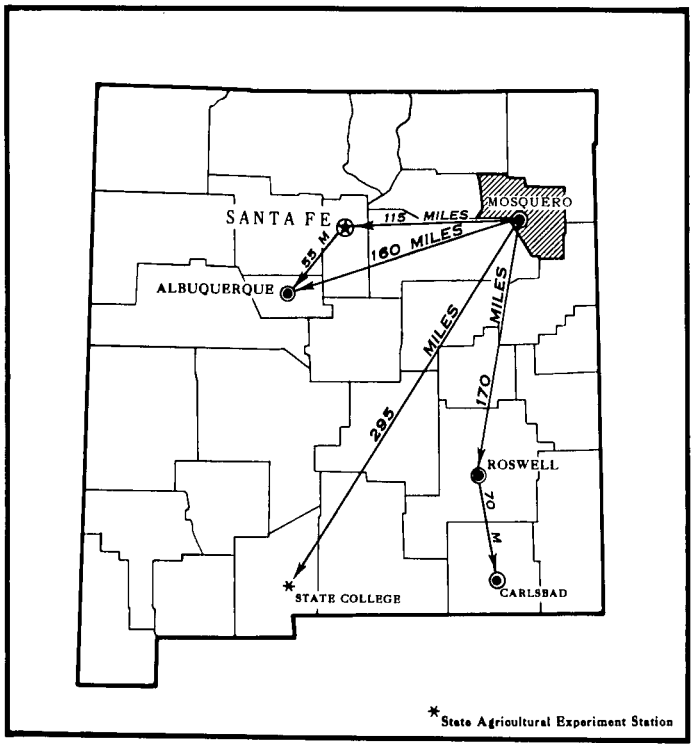


Figure 1.--Location of Harding County in New Mexico.

The county is in the Great Plains province of the Interior Plains. The Canadian River has cut a deep gorge along the western boundary. The western part of the county is a relatively high mesa broken along the edges by numerous canyons and arroyos. Ute Creek has cut a valley that extends in a north-south direction through the center of the county. The eastern part of the county consists of the valley of Ute Creek and undulating to rolling uplands. Elevation of the land ranges from about 3,900 feet in the southeastern corner to about 6,100 feet in the north-central part of the county.

About 95 percent of the county is in rangeland or abandoned cropland that is used for range. Many of the smaller farms are now combined in the larger ranches.

Harding County was organized from parts of Union and Mora Counties in 1921. Its population was 4,421 in 1930, but this began to decrease in the Dust Bowl days of the 1930's. The years of drought in the 50's again caused a large decrease in population. In 1960, population of the county was 1,874. Roy, the largest town, has a population of 633.

In most of the county, adequate water is available for domestic use and for livestock. Important water-bearing sources of water for wells are the underground geologic formations of Ogallala sand and gravel and the Dakota Sandstone. Underground water has not been found in sufficient volume for irrigation.

The county has a semiarid continental climate. Most summers are mild, and the annual rainfall is mainly from thunderstorms in summer. The moisture in these thunderstorms comes in the general circulation of air from the Gulf of Mexico. In winter, rain falls when storms move eastward from the Pacific Ocean. These winter rains are generally light. The average annual rainfall in Harding County is between 13 and 17 inches. Winds are chiefly from the southwest and average about 12 miles per hour.

Harding County is covered by three soil and water conservation districts. These are the Mesa District, the Ute Creek District, and the Canadian River District. The districts were organized so that farmers and ranchers could effectively control water erosion, soil blowing, overgrazing of grassland, and the invasion of brush and noxious weeds. They also recognized the need for increasing the number of watering places for livestock.

For more information about Harding County, refer to the section "Additional Facts About the County" at the back of this survey.

HOW THIS SURVEY WAS MADE

Soil scientists made this survey to learn what kinds of soil are in Harding County, where they are located, and how they can be used. 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 a local survey (8) 1/.

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. Campus and Dean, 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 their 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, Campus loam, 0 to 3 percent slopes, eroded, is one of several phases within the Campus 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 the aerial photographs.

The areas shown on a soil map are called mapping units. 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 have been seen within an area that is dominantly of a recognized soil phase.

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

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 dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Tivoli-Springer 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. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, 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. Campus-Dean association, gently sloping, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Ima and Quay soils is an example.

In most areas surveyed, there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rough broken land is a land type in Harding County.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

1/ Underscored numbers in parentheses refer to Literature Cited, p.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, 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 the way the soils behave under present methods of use and management.

SOIL SURVEY INTENSITIES

Harding County required soil surveys of mixed mapping intensities to meet the expected uses. Most of the dryfarming is in the western two-fifths of the county, which was mapped as a medium-intensity detailed soil survey. The eastern three-fifths of the county mainly consists of large ranches and was mapped as a low-intensity detailed soil survey. The approximate boundary between the medium- and low-intensity detailed soil surveys is shown on the index to map sheets at the back of this survey.

The mapping units shown as soil associations or land types are primarily in the low-intensity soil survey. These mapping units, along with the other mapping units in the low-intensity soil survey, are less homogeneous than the mapping units in the medium-intensity soil survey.

The soils mapped at low intensity are identified by a symbol consisting of two capital letters. The soils mapped at medium intensity are identified by a symbol consisting of a capital letter and a small letter.

The "Guide to Mapping Units" at the back of this soil survey is in two parts. One of these parts is for the medium-intensity soil survey, and the other part is for the low-intensity survey. Campus loam, 0 to 3 percent slopes, for example, is in the medium-intensity soil survey. Campus loam, 0 to 9 percent slopes, is in the low-intensity soil survey. Dumas loam, 0 to 3 percent slopes, occurs in both the medium- and the low-intensity soil surveys.

GENERAL SOIL MAP

The general soil map at the back of this survey shows, in color, the soil associations in Harding County. A soil association is a landscape that has a distinctive proportional pattern of soils. 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. 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 the exact location of 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 in Harding County are discussed in the following pages.

Areas Dominated by Dark-Colored, Loamy Soils Used Mainly for Range and Dryfarming

The soils in this group occur on the mesa at elevations ranging from about 4,800 to 6,100 feet. These soils formed under short grasses, mid grasses, and forbs. They formed in loamy, calcareous old alluvium that has been reworked by wind. The one soil association in this group occurs in the central and northeastern parts of the county.

1. Dumas-Dioxice-La Brier Association

Nearly level to gently sloping soils on the mesa

This association consists of well-drained soils. These soils have a loam surface layer over a clay loam to clay subsoil. They formed in loamy, calcareous old alluvium that has been reworked by wind. Vegetation is short grasses, mid grasses, and forbs. The association occurs in the central and northeastern parts of the county. Slopes range from 0 to 5 percent, and elevations from 4,800 to 6,100 feet. Average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days.

This association covers about 16 percent of the county. About 35 percent of this is Dumas soils, 25 percent is Dioxice soils, and 25 percent is La Brier soils. The remaining 15 percent is Tricon and Manzano soils.

Typically, Dumas soils have a brown loam surface layer, a brown, reddish-brown, and yellowish-red clay loam and silty clay loam subsoil, and a pinkish-white clay loam substratum that is high in lime content. Dioxice soils have a dark grayish-brown loam surface layer, a dark grayish-brown, grayish-brown, and brown clay loam subsoil, and a pinkish-white loam substratum that is high in lime content. La Brier soils have a very dark grayish-brown heavy loam surface layer, a dark grayish-brown and grayish brown clay and light-brown clay loam subsoil,

and a pink silty clay loam substratum that is high in lime content.

These soils are used for range, dryfarmed small grains and pasture, wildlife, and water supply. Ranches and farms normally are small but are medium sized in some places. Carrying capacities and water supplies are moderate. Windmills and stock tanks supply most of the water. Dryfarmed wheat and millet are grown principally on the level and nearly level Dumas loam, Dioxice loam, and La Brier loam. Wildlife is mainly scaled quail, mourning dove, and antelope. The hazard of soil blowing is moderate on dryfarmed fields and on range in poor condition. Soil blowing is minimized by maintaining maximum cover on range and using soil and water conserving practices on dryfarmed cropland. Runoff is largely from the gently sloping soils.

Areas Dominated by Light-Colored to Dark-Colored, Loamy Soils Used Mainly for Range

The soils in this group are on uplands and alluvial fans at elevations of 4,000 to 5,900 feet. These soils formed under short grasses, mid grasses, forbs, and shrubs. They formed in alluvium, windlaid sediments, or material weathered from limestone. The soil associations in this group are in the western and eastern parts of the county along Ute Creek and its tributaries.

2. Litle-Berthoud-Penrose Association

Light-colored, gently sloping to strongly sloping soils on uplands

This association consists of well-drained soils. These soils have a loam, channery loam, or clay loam surface layer that overlies a clay loam to clay subsoil or bedrock. They formed in calcareous alluvium or material weathered from shale or limestone bedrock. The association occupies slopes of 1 to 12 percent in the western part of the county. Vegetation is short grasses, mid grasses, forbs, and shrubs. Elevations range from 5,400 to 5,900 feet. Average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days.

This association makes up about 4 percent of the county. About 35 percent of this is Litle soils, 30 percent is Berthoud soils, and 15 percent is Penrose soils. The remaining 20 percent is Manzano, La Brier, and Vermejo soils (see fig. 2).

Typically, Litle soils have a brown and grayish-brown, calcareous clay loam surface layer, a grayish-brown, calcareous clay and silty clay subsoil, and a light brownish-gray, calcareous, clayey shale substratum. Berthoud soils have a grayish-brown, calcareous loam surface layer, a light brownish-gray, calcareous light clay loam subsoil, and a pale-brown, calcareous sandy clay loam substratum. Penrose soils have a light brownish-gray, calcareous loam, channery loam, or clay loam surface layer that overlies limestone bedrock.

The major soils in this association are used for range, wildlife, and water supply. Cattle are grazed on these soils. Ranches are medium sized. They have moderate carrying capacity and limited water supplies. The water generally is kept in stock tanks and is pumped by windmills or is kept in ranch ponds (earthen dams) and comes from surface runoff. Runoff is largely from the Penrose and Litle soils. Wildlife is mainly antelope, scaled quail, and mourning dove. A few areas of Manzano soils are in dryfarmed wheat that is grown for pasture and grain. The hazard of soil blowing is moderate on dryfarmed cropland and range areas in poor condition. Soil blowing can be minimized by maintaining maximum cover on range and by using practices that conserve soil and water on dryfarmed cropland.

3. Berthoud-Kinkead Association

Light-colored to dark-colored, nearly level to gently sloping soils on alluvial fans

This association consists of well-drained soils. These soils have a clay loam to fine sandy loam surface layer over a clay loam to clay subsoil. They formed in loamy, calcareous alluvium. Vegetation is short and mid grasses and forbs. The association occurs in the eastern part of the county in the valley of Ute Creek. Slopes range from 0 to 9 percent, and elevations from 4,200 to 5,000 feet. Average annual precipitation is 13 to 16 inches, average annual air temperature is 55° to 60° F., and the frost-free season is 160 to 190 days.

This association occupies about 7 percent of the county. About 65 percent of this is Berthoud soils, 30 percent is Kinkead soils, and the remaining 5 percent is Bippus and Guadalupe soils.

Typically, Berthoud soils have a grayish-brown, calcareous loam or fine sandy loam surface layer, a light brownish-gray, calcareous light clay loam subsoil, and a pale-brown, calcareous sandy clay loam substratum. Kinkead soils have a dark grayish-brown clay loam surface layer, a dark grayish-brown and grayish-brown clay subsoil, and a brown, calcareous heavy sandy clay loam substratum.

These soils are used for range, wildlife, and water supply. Cattle and horses are grazed. The ranches are large, carrying capacities moderate, and water supplies limited. Water is supplied mainly by means of stock tanks, windmills, and pipelines. A few springs have been developed at the higher elevations. The wildlife is mainly deer, antelope, scaled quail, and mourning dove. Runoff is largely from the Berthoud soils. The hazard of soil blowing is moderate on range in poor condition. Soil blowing is reduced by maintaining maximum cover on range.

4. Quay-Ima-Tucumcari Association

Light-colored, nearly level to gently undulating soils on alluvial fans

This association consists of well-drained soils. These soils have a loam to fine sandy loam surface

layer over a heavy clay loam to sandy loam subsoil. They formed in alluvial valley fill and mixed wind-laid deposits. The association has slopes of 0 to 5 percent and occurs in the valley of Ute Creek in the eastern part of the county. Vegetation is short grasses, mid grasses, forbs, and shrubs. Elevations range from 4,000 to 4,600 feet. Average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days.

This association makes up about 6 percent of the county. About 25 percent of this is Quay soils, 20 percent is Ima soils, and 20 percent is Tucumcari soils. The remaining 35 percent is Lacita, Guadalupe, Vernon, Latom, and Montoya soils.

Typically, Quay soils have a calcareous, brown loam or reddish-brown fine sandy loam surface layer, a reddish-brown, calcareous loam subsoil, and a pink loam substratum that is high in lime content. Ima soils have a reddish-brown, calcareous fine sandy loam surface layer and a reddish-brown, calcareous sandy loam subsoil and substratum. Tucumcari soils have a reddish-brown loam surface layer, a reddish-brown, calcareous heavy clay loam subsoil, and a light reddish-brown, calcareous clay loam substratum.

The major soils in this association are used for range, wildlife, and water supply. Cattle and horses are grazed. Ranches are large, carrying capacities moderate, and water supplies limited. The water generally is kept in stock tanks and is pumped by windmills or is kept in ranch ponds (earthen dams) and comes from runoff. Wildlife is mainly deer, antelope, scaled quail, and mourning dove. Runoff is largely from Lacita loam and the Vernon-Shale outcrop complex. The hazard of soil blowing is moderate to severe on range in poor condition. Soil blowing can be minimized on range by maintaining maximum cover.

Areas Dominated by Light-Colored to Dark-Colored, Loamy, Calcareous Soils Used Mainly for Range

The soils in this group are on uplands and adjacent to playa lakes at elevations of 4,000 to 6,100 feet. These soils formed under short grasses, mid grasses, forbs, and shrubs. They formed in old calcareous alluvium, wind-laid sands or silts, and caliche beds. The soil associations in this group are on low ridges and slopes and around playa lakes in the central and eastern parts of the county.

5. Church-Karde Association

Light-colored, nearly level to rolling soils adjacent to playa lakes

This association consists of somewhat poorly drained and well-drained soils. These soils have a clay loam to loam surface layer that is underlain by a subsoil of clay loam and clay or by a layer of loam. They formed in calcareous, water-laid or wind-laid sediments around playa lakes. The soils have slopes of 0 to 9 percent and occur in scattered areas of the central and northeastern parts of the county. Vegetation is short grasses, mid grasses, forbs, and scattered shrubs. Elevations range from 4,800 to 5,900 feet. Average annual precipitation is 14 to 17 inches, average annual temperature is 54° to 57° F., and the frost-free season is 150 to 180 days.

This association makes up about 2 percent of the county. About 35 percent of this is Church soils, 35 percent is Karde soils, and the remaining 30 percent is La Brier and Manzano soils, playa lakes, and lakes.

Typically, Church soils have a gray, calcareous clay loam surface layer, a light-gray, calcareous heavy clay loam and clay subsoil, and a light-gray, calcareous clay substratum. Karde soils have a grayish-brown, calcareous loam surface layer over a light brownish-gray, calcareous loam layer, and a light-gray, calcareous heavy loam and light clay loam substratum.

The major soils in this association are used for range, wildlife, and water supply. Cattle are grazed on these soils. Ranches are small, and carrying capacities are moderate to high. Playa lakes that have pit tanks and windmills primarily supply the water. Scaled quail, mourning dove, and antelope are the main wildlife. Migrating flocks of ducks and geese use the playa lakes when they contain water. Chicosa Lake has been developed for fishing. Runoff is largely from the Karde soils. The hazard of soil blowing is moderate on range in poor condition. Soil blowing can be minimized on range by maintaining maximum cover.

6. Campus-Dean Association

Moderately dark colored, nearly level to gently rolling soils underlain by caliche, on uplands

This association consists of well-drained soils. These soils have a loam, gravelly loam, or stony loam surface layer over loam layers or caliche. They formed in old calcareous alluvium and deposits reworked by wind. This association has slopes of 0 to 9 percent and occurs in the central and northeastern parts of Harding County. Vegetation is short grasses, mid grasses, forbs, and shrubs. Elevations range from 4,800 to 6,100 feet. Average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days.

This association makes up about 10 percent of the county. About 70 percent of this is Campus soils, and 25 percent is Dean soils. The remaining 5 percent is Dioxice, Manzano, and Pastura soils.

Typically, Campus soils have a grayish-brown, calcareous loam or gravelly loam surface layer over a light brownish-gray, calcareous loam layer. This layer, in turn, is underlain by a light-gray and pinkish-white loam substratum high in lime content. Dean soils have a grayish-brown, calcareous stony loam, gravelly loam, or loam surface layer over caliche.

The major soils in this association are used for range, wildlife, water supply, and construction material. Cattle and horses are grazed. Ranches are small to medium sized, carrying capacities moderate, and water supplies limited. The water generally is pumped by windmills. Wildlife is mainly antelope, scaled quail, and mourning dove. Runoff is largely from Campus loam, 3 to 9 percent slopes; Campus loam, 0 to 9 percent slopes; and Dean soils, 0 to 9 percent slopes. The hazard of soil blowing is severe on areas of Campus soils where the range is in poor condition. Soil blowing can be minimized on range by maintaining maximum cover. Caliche pits dug for highway construction are in many areas of Dean soils.

7. Mansker-Portales Association

Dark-colored, gently undulating to strongly sloping soils underlain by caliche, on uplands

This association consists of well-drained soils. These soils have a fine sandy loam surface layer over layers of loam. They formed in old calcareous alluvium and mixed wind-laid deposits. This association has slopes of 0 to 9 percent and occurs in the eastern part of Harding County. Vegetation is mid grasses, forbs, and shrubs. Elevations range from 4,000 to 4,800 feet. Average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days.

This association makes up about 3 percent of the county. About 55 percent of this is Mansker soils, 30 percent is Portales soils, and the remaining 15 percent is Potter soils and Wet alluvial land.

Typically, Mansker soils have a brown, calcareous fine sandy loam surface layer over a brown, calcareous loam layer and a pink loam substratum high in lime content. Portales soils have a dark grayish-brown, calcareous fine sandy loam surface layer, a grayish-brown, calcareous loam subsoil, and a white loam substratum high in lime content.

The major soils in this association are used for range, wildlife, water supply, and to a limited extent for irrigated farming. Cattle and horses are grazed. Ranches are large, carrying capacities moderate, and water supplies limited. The water generally is kept in stock tanks and is pumped by windmills or is kept in ranch ponds (earthen dams) and comes from surface runoff. Wildlife is mainly antelope, scaled quail, and mourning dove. Runoff is largely from Mansker fine sandy loam. Irrigated sorghum and permanent pasture are grown principally on the gently sloping Mansker fine sandy loam and Portales fine sandy loam. The hazard of soil blowing is severe on range and on irrigated farmland where crop residues are not used. Soil blowing is minimized on cropland by using practices that conserve soil and water. Indian artifacts occur in scattered places throughout the association.

Areas Dominated by Loamy to Sandy Soils Used Mainly for Range and Wildlife and, to a Limited Extent, for Dryfarming and Irrigated Farming

The soils in this group are on uplands at elevations of 4,000 to 6,000 feet. These soils formed under mid grasses, tall grasses, forbs, and shrubs. They formed in sandy alluvium and wind-worked sands. The soil associations in this group are in the north-central and eastern parts of the county.

8. Otero-Dalhart Association

Loamy to sandy, nearly level to gently sloping soils on mesa uplands

This association consists of well-drained soils. These soils have a fine sandy loam to loamy fine sand surface layer over fine sandy loam to sandy clay loam layers. They formed in old alluvium and wind-worked sands. The association has slopes of 0 to 9 percent and occurs in the north-central part of the county. Vegetation is mid grasses, tall grasses, forbs, and shrubs. Elevations range from 4,700 to 6,000 feet. Average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days.

This association makes up about 3 percent of the county. About 60 percent of this is Otero soils, and 30 percent is Dalhart soils. The remaining 10 percent is Manzano, Tapia, and Campus soils (see fig. 3).

Typically, Otero soils have a brown, calcareous fine sandy loam or grayish-brown loamy fine sand surface layer over a grayish-brown, calcareous fine sandy loam layer, and a pale-brown, calcareous fine sandy loam and loamy sand substratum. Dalhart soils have a dark grayish-brown fine sandy loam surface layer, a brown sandy clay loam and heavy loam subsoil, and a very pale brown loam substratum that is high in lime content.

The major soils in this association are used for range, wildlife, water supply, and to a limited extent for dryfarmed crops. Cattle and horses are grazed. Ranches are mainly large, carrying capacities moderate, and water supplies limited. The water generally is kept in stock tanks and is pumped by windmills or is kept in ranch ponds (earthen dams) and comes from surface runoff. Wildlife is mainly scaled quail, mourning dove, and antelope. Runoff is largely from Dalhart complex, severely eroded, and Otero fine sandy loam. Dryfarmed sorghum and millet are grown for forage, principally on Dalhart fine sandy loam. The hazard of soil blowing is moderate to severe on dryfarmed cropland and range areas in poor condition. Soil blowing is minimized by maintaining maximum cover on range and using practices that conserve soil and water on dryfarmed cropland.

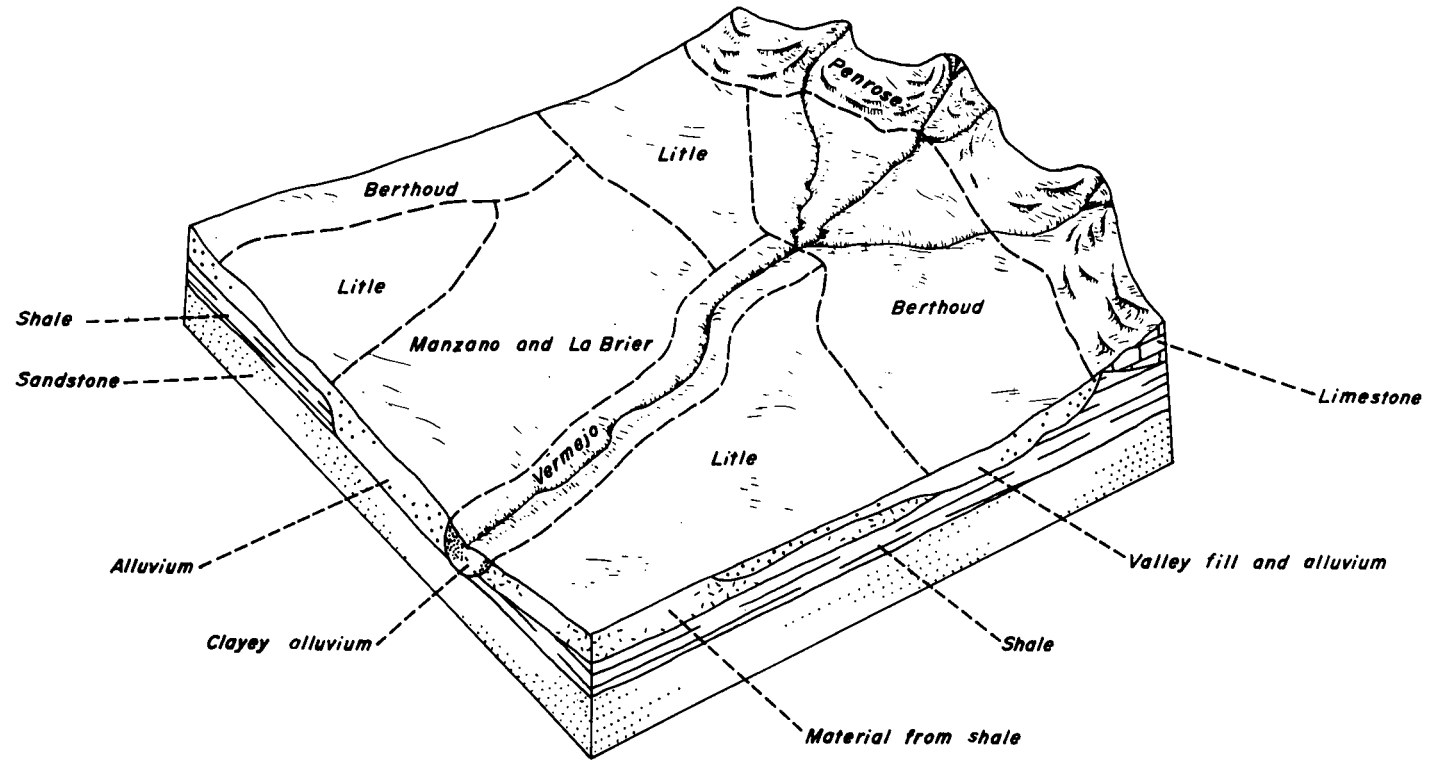


Figure 2.--Typical pattern of soils in association 2 in the northwestern part of the county.

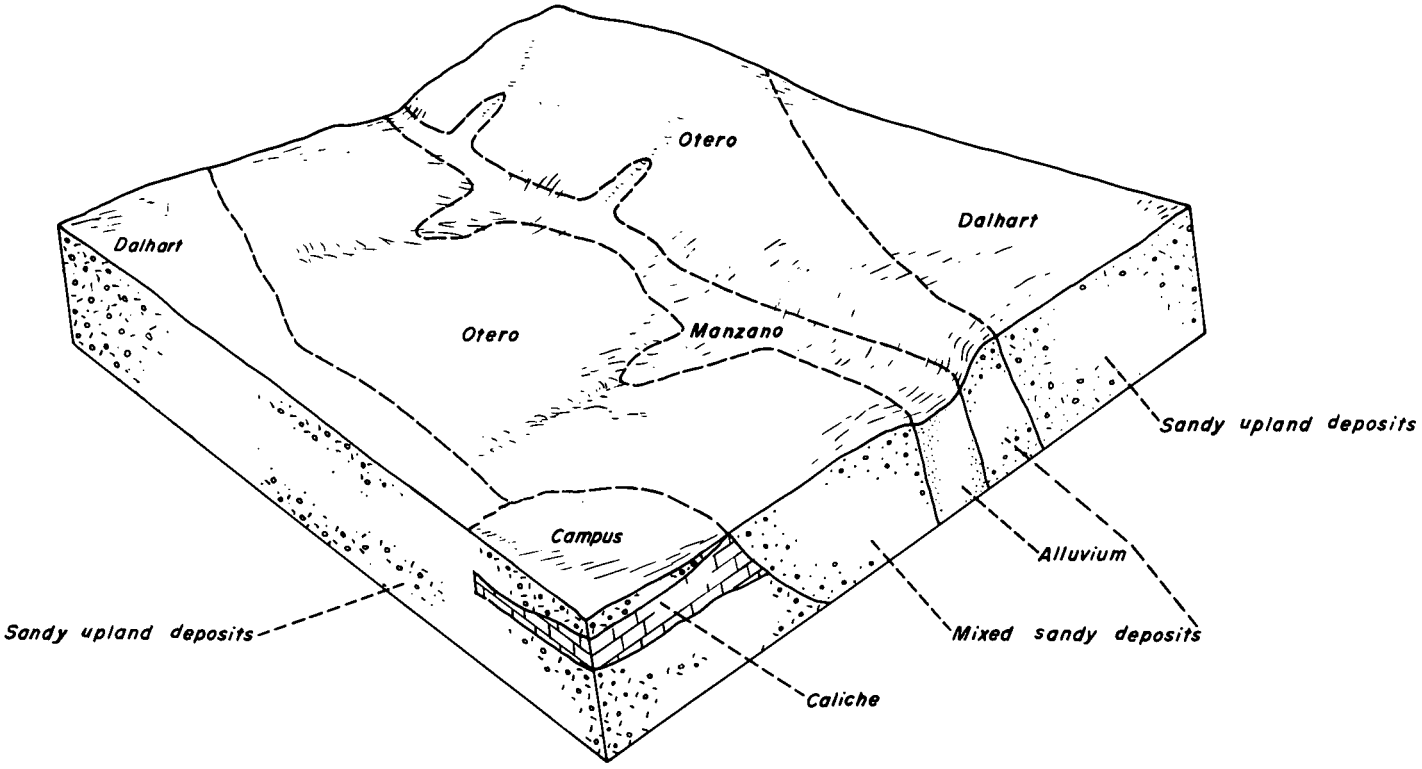


Figure 3.--Typical pattern of soils in association 8 in the north-central part of the county.

9. Amarillo Association

Loamy, nearly level to gently undulating soils on uplands

This association consists of well-drained soils. These soils have a fine sandy loam surface layer over a sandy clay loam subsoil. They formed in old alluvium and sandy wind-laid deposits. The association has slopes of 1 to 3 percent and occurs in the eastern part of the county. Vegetation is mid grasses, forbs, and shrubs. Elevations range from 4,000 to 4,800 feet. Average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days.

This association makes up about 3 percent of the county. About 95 percent of this is Amarillo soils, and the remaining 5 percent is Springer, Mansker, and Portales soils.

Typically, Amarillo soils have a brown fine sandy loam surface layer, a reddish-brown and yellowish-red sandy clay loam subsoil, and a light reddish-brown sandy clay loam substratum that is high in lime content.

The major soils in this association are used for range, wildlife, water supply, and to a limited extent for dryfarming and irrigated farming. Cattle and horses are grazed. Ranches are large, carrying capacities moderate, and water supplies limited. The water generally is kept in stock tanks and is pumped by windmills or is kept in ranch ponds (earthen dams) and comes from surface runoff. Wildlife is mainly antelope, scaled quail, and mourning dove. Runoff is mainly from the gently undulating soils. Dryfarmed sorghum and broomcorn, irrigated sorghum, and permanent pasture are grown. The hazard of soil blowing is moderate to severe on dryfarmed fields and on range in poor condition. Soil blowing is minimized by maintaining maximum cover on range and using practices that conserve soil and water on cropland.

10. Springer-Tivoli-Amarillo Association

Sandy, gently undulating to rolling soils on uplands

This association consists of well-drained to excessively drained soils. These soils have a loamy fine sand to fine sand surface layer over layers of sandy clay loam to fine sand. They formed in sandy alluvium and wind-worked sands. The association has slopes of 1 to 9 percent and occurs in the eastern part of the county. Vegetation is mid grasses, tall grasses, forbs, and shrubs. Elevations range from 4,000 to 4,800 feet. Average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days.

This association makes up about 20 percent of the county. About 45 percent of this is Springer soils, 25 percent is Tivoli soils, and 25 percent is Amarillo soils. The remaining 5 percent is Active dune land and Mansker, Portales, and Potter soils (see fig. 4)

Typically, Springer soils have a brown and reddish-brown loamy fine sand surface layer, a yellowish-red light fine sandy loam subsoil, and brown loamy fine sand substratum. Tivoli soils have a pale-brown fine sand surface layer and a light yellowish-brown fine sand substratum. Amarillo soils have a brown loamy fine sand surface layer, a reddish-brown and yellowish-red sandy clay loam subsoil, and light reddish-brown sandy clay loam substratum that is high in lime content.

These soils are used for range, wildlife, water supply, and to a limited extent for irrigated farming. Cattle and horses are grazed. Ranches are large, carrying capacities moderate, and water supplies limited. The water generally is kept in stock tanks and is pumped by windmills or is kept in ranch ponds (earthen dams) and comes from surface runoff. Wildlife is mainly antelope, scaled quail, and mourning dove. Runoff is largely from the Mansker, Portales, and Potter soils. Irrigated sorghum is grown principally on the gently sloping Amarillo loamy fine sand. The hazard of soil blowing is severe on range in poor condition. Soil blowing is minimized on range by maintaining maximum cover. Indian artifacts occur in scattered places throughout the association.

Areas Dominated by Loamy, Shallow to Moderately Deep Soils Used Mainly for Range and Wildlife

The soils in this group are on uplands at elevations of 4,600 to 6,100 feet. These soils formed under short grasses, mid grasses, forbs, shrubs, and low trees. The soils formed in old alluvium or material weathered from basalt or sandstone. The soil associations in this group are in the northern, central, and western parts of the county.

11. Pastura-Apache-Dioxice Association

Nearly level to rolling soils underlain by caliche or basalt

This association consists of well-drained soils. These soils have a loam or stony loam surface layer over a gravelly loam or a stony loam layer or a clay loam subsoil. They formed in old mixed alluvium, calcareous wind-laid deposits, and material weathered from basalt on uplands. The association has slopes of 0 to 9 percent and occurs in the north-central part of the county. Vegetation is short grasses, mid grasses, forbs, and shrubs. Elevations range from 5,600 to 6,100 feet. Average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days.

This association makes up about 3 percent of the county. About 40 percent of this is Pastura soils, 25 percent is Apache soils, and 15 percent is

Dioxice soils. The remaining 20 percent is Manzano and La Brier soils (see fig. 5).

Typically, Pastura soils have a grayish-brown, calcareous loam surface layer and a grayish-brown gravelly loam layer over indurated caliche at a depth of about 10 inches. Apache soils have a dark grayish-brown, calcareous stony loam surface layer and a grayish-brown, calcareous stony loam subsoil over basalt at a depth of about 12 inches. Dioxice soils have a dark grayish-brown loam surface layer, a dark grayish-brown, grayish-brown, and brown, calcareous clay loam subsoil, and a pinkish-white loam substratum that is high in lime content.

The major soils in this association are used for range, wildlife, and water supply. Cattle, sheep, and horses are grazed. Ranches are medium sized, carrying capacities moderate, and water supplies limited. Most of the water is kept in stock tanks in the drainageways and is pumped by windmills or is kept in ranch ponds (earthen dams) and comes from surface runoff. Wildlife is mainly scaled quail, mourning dove, and antelope. Runoff is largely from the gently sloping Dioxice loam and the rolling Apache stony loam. The hazard of soil blowing is moderate on the Dioxice soils where the range is in poor condition. Soil blowing is minimized on range by maintaining maximum cover.

12. Travessilla-Carnero Association

Nearly level to moderately steep soils underlain by sandstone

This association consists of well-drained soils. These soils have a loam or stony loam surface layer over a clay loam subsoil or sandstone. They formed in material weathered from sandstone and wind-laid, calcareous, loamy material of the uplands. The association occupies slopes of 0 to 15 percent and occurs in the northern, central, and western parts of the county. Vegetation is short grasses, mid grasses, forbs, shrubs, and low trees. Elevations range from 4,600 to 5,700 feet. Average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days.

This association makes up about 10 percent of the county. About 70 percent of this is Travessilla soils, 25 percent is Carnero soils, and the remaining 5 percent is Rough broken and stony land.

Typically, Travessilla soils have a brown stony loam surface layer underlain by sandstone bedrock at a depth of about 6 inches. Carnero soils have a brown loam surface layer, a brown sandy clay loam and light-brown clay loam subsoil, and a light-brown loam substratum that is high in content of lime. Bedrock is sandstone.

The major soils in this association are used for range, wildlife, and water supply. Cattle and horses are grazed. Ranches are large to medium sized, carrying capacities moderate, and water supplies limited. Water is kept in stock tanks and is pumped by windmills or is kept in ranch ponds (earthen dams) in drainageways and comes from surface runoff. Wildlife is mainly deer and Barbary sheep. Runoff is largely from the Travessilla stony loam. The hazard of soil blowing is moderate on range in poor condition. Soil blowing is minimized on range by maintaining maximum cover.

Areas Dominated by Very Gravelly Soils or Stony Land Types Used Mainly for Range and Wildlife

The soils in this group are on terraces and breaks at elevations of 3,900 feet to 5,800 feet. These soils formed under short grasses, mid grasses, forbs, shrubs, and low trees. They formed in old gravelly alluvium and from material weathered from sandstone, basalt, and shale bedrock. The soil associations in this group are in the western, central, and southern parts of the county.

13. Gallegos Association

Very gravelly, undulating to hilly soils on terraces

This association consists of well-drained soils. These soils have a very gravelly sandy loam surface layer over a very gravelly sandy clay loam subsoil. They formed in gravelly alluvium on old dissected stream terraces. The association has slopes of 3 to 35 percent and occurs in the southern part of the county. Vegetation is mid grasses, short grasses, forbs, and shrubs. Elevations range from 3,900 to 4,400 feet. Average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days.

This association makes up about 2 percent of the county. About 95 percent of this is Gallegos soils, and 5 percent is Ima and Quay soils and Rough broken land.

Typically, Gallegos soils have a brown very gravelly sandy loam surface layer, a reddish-brown very gravelly sandy clay loam subsoil, and a substratum of pinkish-white very gravelly light clay loam that is high in lime content and that is over gravelly coarse sand and gravelly sandy loam.

The major soils in this association are used for range, water supply, wildlife, and construction material. Cattle and horses are grazed. Ranches are large, carrying capacities moderately low, and water supplies limited. The water generally is kept in stock ponds and is pumped by windmills or is kept in ponds (earthen dams) in drainageways and comes from runoff. Wildlife is mainly deer, antelope, scaled quail, and mourning dove. Runoff is mainly from the steeper slopes. Gravel pits have been dug to furnish material for highway construction.

14. Rough Broken and Stony Land Association

Stony, steep to very steep land types on breaks

This association consists of stony very shallow soils over sandstone, shale, or basalt. These soils

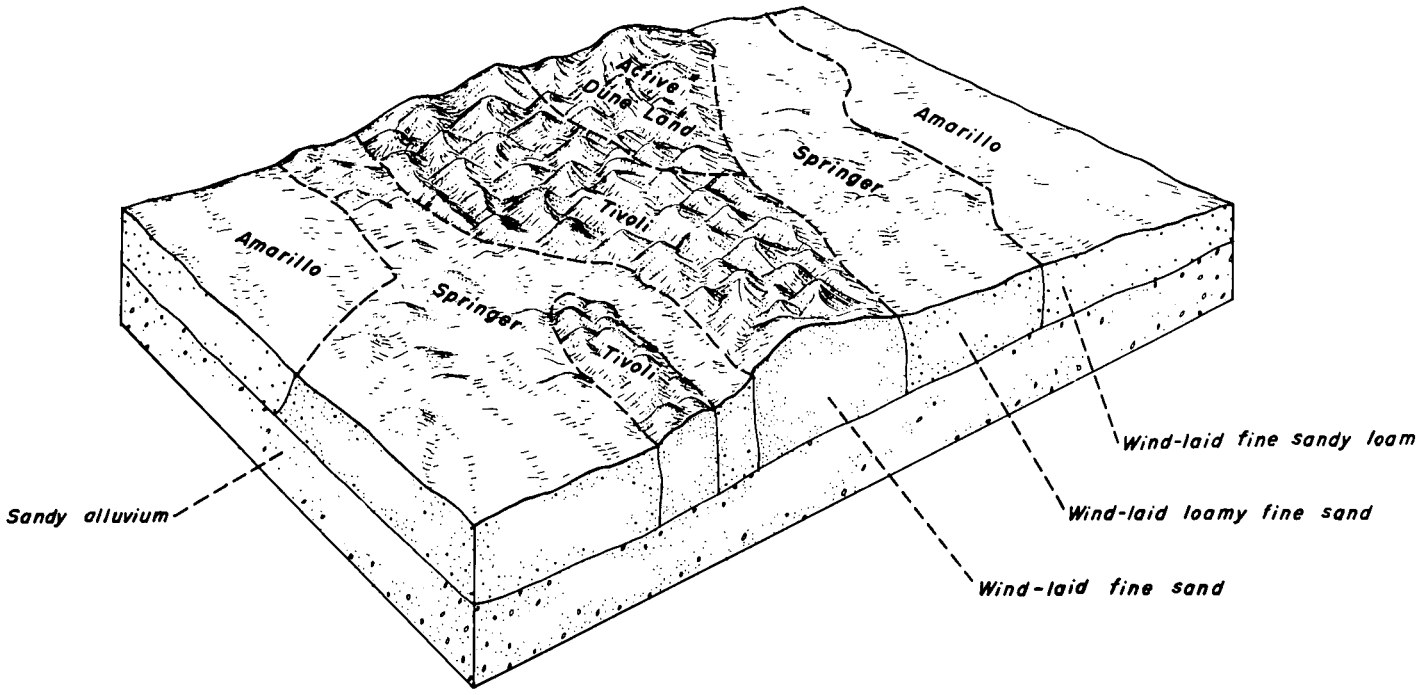


Figure 4.--Typical pattern of soils in association 10 in the eastern part of the county.

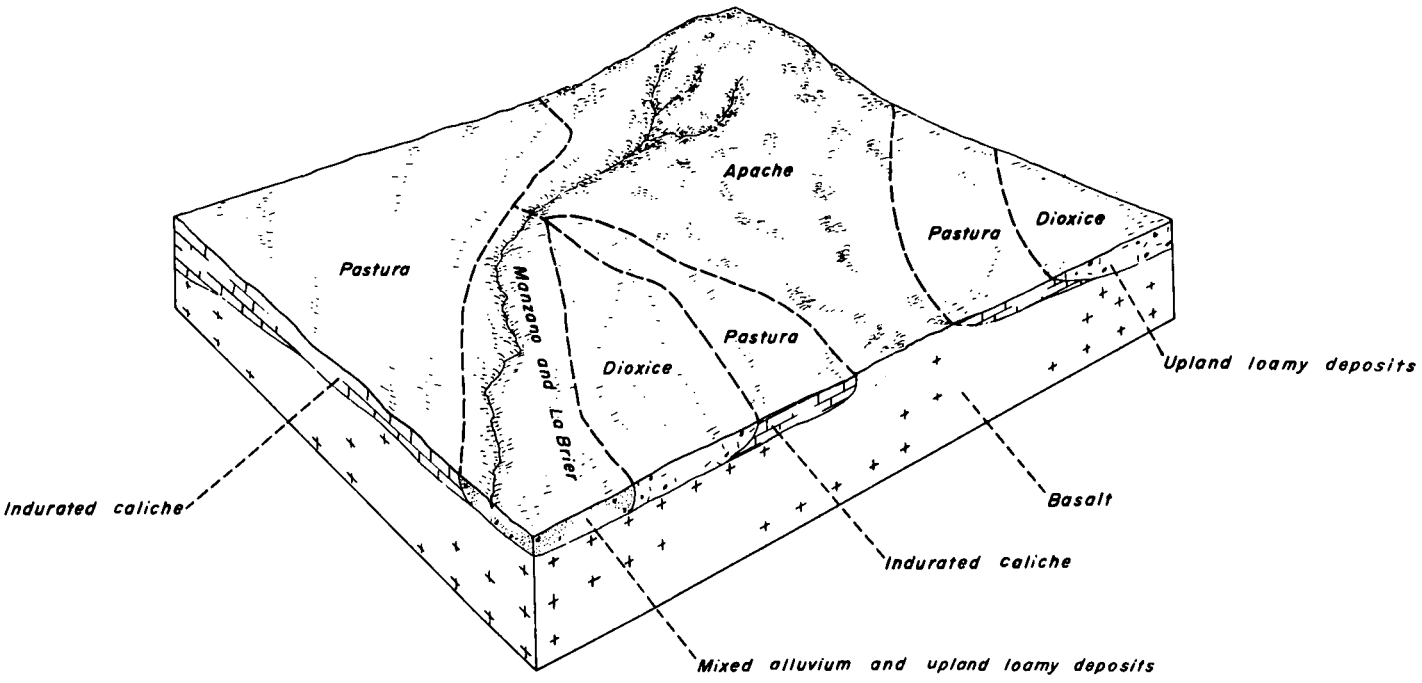


Figure 5.--Typical pattern of soils in association 11 in the north-central part of the county.

formed in a mixture of weathered bedrock and colluvial-alluvial deposits on the breaks. The association has slopes of 25 to 80 percent and occurs in the western, north-central, and southwestern parts of the county. Vegetation is short grasses, mid grasses, shrubs, and low trees. Elevations range from 3,900 to 5,800 feet. Average annual precipitation is 13 to 17 inches, average annual air temperature is 54° to 60° F., and the frost-free season is 150 to 190 days.

This association makes up about 11 percent of the county. About 90 percent of this is Rough broken and stony land, and about 10 percent is Rough broken land and Riverwash.

These land types are used for range, wildlife, water supply, and recreation. Cattle and horses are grazed. Ranches are large, carrying capacities low, and water supplies limited. Water generally is kept in stock tanks in small canyons. Developed springs are a primary source of water. Wildlife is mainly deer and Barbary sheep. Runoff is from the steep and very steep slopes. The water erosion hazard is severe on range in poor condition. Water erosion is minimized on range by maintaining maximum cover and by constructing stock trails on the more nearly level slopes. Indian ruins and artifacts are scattered throughout the association.

DESCRIPTIONS OF THE SOILS

In this section the soil series and mapping units of Harding County are described. The approximate acreage and proportionate extent of each mapping unit are given in table 1.

The series descriptions are in alphabetic order. Following each series description is a fairly detailed description of one mapping unit of the series. This detailed description is followed by brief descriptions of the rest of the mapping units. Miscellaneous land types, such as Active dune land, are described in alphabetic order along with other mapping units.

In each series description is a short narrative description of a profile representative of the series. In the first mapping unit description is a more detailed description of the same profile, which can be used by scientists, engineers, and others in making highly technical interpretations. The descriptions of the rest of the mapping units tell mainly how these units differ from the one described in detail. In those instances where a soil of a particular series is not mapped separately in this county, the Potter and Quay series, for example, the technical description is shown in the series description.

TABLE 1.--APPROXIMATE ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

[The total acreage in Harding County is 1,367,040 acres. Of this total, 53 percent is in the low-intensity survey and 47 percent is in the medium-intensity survey]

Mapping unit	Low intensity	Medium intensity	Extent
	Acres	Acres	Percent
Active dune land	4,905	-----	0.4
Amarillo fine sandy loam	43,079	-----	3.2
Apache stony loam, 1 to 9 percent slopes	-----	12,523	.9
Berthoud loam	-----	18,583	1.4
Berthoud fine sandy loam, 1 to 9 percent slopes	17,253	-----	1.3
Berthoud loam, 1 to 5 percent slopes	41,018	-----	3.0
Bippus loam	2,650	-----	.2
Campus fine sandy loam	-----	5,930	.4
Campus loam, 0 to 3 percent slopes	-----	17,457	1.3
Campus loam, 0 to 3 percent slopes, eroded	-----	4,111	.3
Campus loam, 0 to 9 percent slopes	25,055	-----	1.8
Campus loam, 0 to 9 percent slopes, eroded	2,293	-----	.2
Campus loam, 3 to 9 percent slopes	-----	16,678	1.2
Campus loam, 3 to 9 percent slopes, eroded	-----	1,192	.1
Campus gravelly loam, 1 to 25 percent slopes	-----	2,418	.2
Campus-Dean association, gently sloping	33,386	-----	2.4
Carnero loam	-----	15,245	1.1
Carnero loam, eroded	-----	1,188	.1
Carnero complex	-----	22,714	1.7
Carnero complex, eroded	-----	1,446	.1
Church clay loam	-----	7,923	.6
Dalhart fine sandy loam	-----	12,153	.9
Dalhart complex, severely eroded	-----	2,041	.1
Dean soils, 0 to 9 percent slopes	6,428	22,211	2.1
Dioxice loam, 0 to 3 percent slopes	-----	48,035	3.5
Dioxice loam, 0 to 3 percent slopes, eroded	-----	10,970	.8
Dioxice loam, 3 to 5 percent slopes	-----	3,315	.2
Dumas loam, 0 to 3 percent slopes	22,086	32,658	4.0
Dumas loam, 3 to 5 percent slopes	-----	1,226	.1
Dumas loam, thin solum, 0 to 3 percent slopes	-----	5,297	.4
Dumas complex, 0 to 3 percent slopes, eroded	1,933	9,323	.8
Gallegos very gravelly sandy loam, 3 to 35 percent slopes	17,899	-----	1.3
Guadalupe fine sandy loam	8,272	-----	.6
Ima and Quay soils	27,365	-----	2.0
Karde loam, 1 to 9 percent slopes	-----	7,535	.5
Kinkead clay loam	25,195	-----	1.8
Kinkead clay loam, alkali	4,116	-----	.3

TABLE 1.--APPROXIMATE ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Mapping unit	Low intensity	Medium intensity	Extent
	Acres	Acres	Percent
La Brier loam	3,873	32,832	2.7
La Brier loam, eroded	-----	13,557	1.0
La Brier clay loam	-----	6,520	.5
Lacita loam, 1 to 9 percent slopes	8,760	-----	.6
Latom fine sandy loam	5,007	-----	.4
Litle clay loam	-----	19,486	1.4
Mansker-Portales association, gently sloping	28,013	-----	2.0
Mansker-Potter association, gently sloping	10,480	-----	.8
Manzano sandy loam	-----	2,211	.2
Manzano loam	-----	10,091	.7
Manzano and La Brier soils	-----	17,911	1.3
Manzano loam, wet variant	-----	424	(1/)
Montoya clay	2,450	-----	.2
Otero loamy fine sand, 1 to 9 percent slopes	-----	11,766	.9
Otero fine sandy loam	3,747	10,133	1.0
Pastura fine sandy loam	648	-----	(1/)
Pastura loam	-----	17,620	1.3
Penrose soils, 0 to 12 percent slopes	-----	8,638	.6
Riverwash	7,938	-----	.6
Rough broken land	10,094	-----	.7
Rough broken and stony land	14,059	118,517	9.7
Springer loamy fine sand, 1 to 9 percent slopes	52,929	-----	3.9
Springer-Amarillo association	137,680	-----	10.1
Springer-Amarillo association, severely eroded	3,776	-----	.3
Tapia complex	-----	2,080	.2
Tivoli fine sand	58,946	-----	4.3
Tivoli-Springer complex	14,320	-----	1.0
Travessilla stony loam, 0 to 9 percent slopes	44,253	55,589	7.3
Tricon loam	-----	13,560	1.0
Tricon complex	-----	7,388	.5
Tricon soils, eroded	-----	1,395	.1
Tucumcari-Quay association	26,882	-----	2.0
Vermejo clay	-----	6,367	.5
Vernon-Shale outcrop complex, 1 to 9 percent slopes	5,363	-----	.4
Wet alluvial land	3,022	-----	.2
Gravel pits	-----	38	(1/)
Intermittent lakes	-----	3,466	.3
Lakes	-----	106	(1/)
Total	725,173	641,867	100.0

1/ Less than 0.1 percent.

Unless otherwise specified, all terms used to describe color and consistence are for the soil when dry. Reaction (pH) given in the soil descriptions generally was determined with field indicators, using a soil-water ratio of about 1:5. For the Kinkead, La Brier, Litle, and Tucumcari soils, however, pH was determined by the glass electrode, using a saturated paste. In the detailed descriptions of profiles, a range in thickness is shown at the end of each horizon. This is the range in thickness of that horizon in Harding County.

The term runoff, used throughout the descriptions, refers to an estimate of the total annual surface runoff. The runoff (inches) plus the water-supplying capacity (inches) roughly equals the average annual precipitation.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. At the end of the description of each mapping unit are listed the capability unit and the range site in which the mapping unit has been placed. The pages where these interpretative groups are described can be readily learned by referring to the "Guide to Mapping Units" at the back of this survey.

In Harding County the soils were mapped at two intensities--medium intensity and low intensity. The composition of the low-intensity mapping units is more variable than that of the medium-intensity units but has been controlled well enough to allow interpretations for the expected uses of the soils. Soils mapped at each intensity are given in this "Guide to Mapping Units".

Active Dune Land

Active dune land (AC) occurs in rolling areas, mainly in the southeastern part of the county. Slopes range from 5 to 9 percent.

This land type consists of blowout spots and wind-sifted sand dunes. The surface is bare or nearly bare of all vegetation, and when winds are high, loose sand shifts, small blowouts are enlarged rapidly, and there is an accumulation of windblown material that forms dunes. Runoff is slow, and the hazard of soil blowing is severe. Included with this land type in mapping are small areas of Tivoli, Springer, Mansker, and Portales soils.

This land type should not be grazed until a good vegetative cover has been established. Fencing areas to prevent grazing is a good practice. Although reseeding is difficult, it is essential in stabilizing areas where soil blowing is active. To a limited extent, this land is used by wildlife and for locating Indian artifacts. (Dryland capability unit VIIIe-1; range site not assigned)

Amarillo Series

The Amarillo series consists of nearly level to gently undulating, well-drained soils that have a sandy clay loam subsoil. These soils formed in old alluvium and mixed, sandy, wind-laid deposits on uplands. Slopes range from 0 to 3 percent. The main vegetation is mid and tall grasses, forbs, and shrubs. Elevations range from 4,000 to 4,800 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Springer and Tivoli series.

Typically, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is reddish-brown and yellowish-red sandy clay loam about 43 inches thick. The substratum is light reddish-brown sandy clay loam that has a high content of lime. In places the surface layer is loamy fine sand about 8 inches thick. The soil is noncalcareous to a depth of 34 to 64 inches.

Amarillo soils are used for range, wildlife, water supply, and to a limited extent, for dryfarmed and irrigated crops. Some areas contain Indian artifacts.

Amarillo fine sandy loam (1 to 3 percent slopes) (AM).--This nearly level to gently undulating soil occurs in the eastern part of the county. Included with this soil in mapping are areas of Springer, Mansker, and Portales soils, and Amarillo loamy fine sand.

This soil is moderately permeable. Runoff is slow, and the hazard of soil blowing is moderate. Roots can penetrate to a depth of 60 inches or more. The water-supplying capacity is 10 to 12 inches during the growing season. Runoff is 2 to 3 inches. Fertility is moderate.

Representative profile, 0.5 mile south of Bueyeros, 0.15 mile west of State Route 102, 25 feet north of fence in the SE1/4 SE1/4 sec. 12, T. 20 W., R. 30 E.:

A1--0 to 5 inches, brown (7.5YR 5/2) fine sandy loam, dark brown (7.5YR 3/2) when moist; weak, medium, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; many fine roots; noncalcareous, mildly alkaline (pH 7.4); clear boundary; horizon 4 to 6 inches thick.

B1--5 to 14 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; weak, coarse, prismatic structure and weak, medium, subangular blocky; hard, very friable when moist, slightly sticky and slightly plastic when wet; common fine roots; many insect casts; noncalcareous, moderately alkaline (pH 7.9); gradual boundary; horizon 0 to 10 inches thick.

B21t--14 to 25 inches, reddish-brown (5YR 5/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; weak, coarse, prismatic structure that parts to weak, medium, subangular blocky; hard, friable when moist, sticky and plastic when wet; common fine roots; many insect casts; thin, patchy clay films; noncalcareous, moderately alkaline (pH 8.1); gradual boundary; horizon 8 to 14 inches thick.

B22t--25 to 48 inches, yellowish-red (5YR 5/6 and 5YR 4/6, moist) sandy clay loam; moderate, coarse, prismatic structure that parts to weak, medium, subangular blocky; very hard, very friable when moist, slightly sticky and slightly plastic when wet; few fine roots; thin, patchy clay films; noncalcareous, moderately alkaline (pH 8.1); gradual boundary; horizon 22 to 34 inches thick.

Cca--48 to 65 inches, light reddish-brown (5YR 6/4) sandy clay loam, reddish brown (5YR 5/4) when moist; massive; hard, very friable when moist, slightly sticky and slightly plastic when wet; very few fine roots; common (about 20 percent of horizon) threads and soft masses of calcium carbonate; strongly calcareous, strongly alkaline (pH 8.5).

The A horizon has a value of 4 and 5 when dry and 3 and 4 when moist; chromas are 2 to 4. The B2t horizons have a hue of 7.5YR or 5YR, values of 5 and 6 when dry and 3 to 5 when moist. Variegated colors are common in the B2t horizons. The B2t horizons range from light sandy clay loam to heavy sandy clay loam. Their structure ranges from weak, coarse, prismatic to moderate, coarse, prismatic that parts to weak or moderate, medium, subangular blocky.

The lower part of the B2t horizon ranges from noncalcareous to moderately calcareous. The Cca horizon has a hue of 7.5YR or 5YR, values of 6 to 8 when the horizon is dry and 5 to 7 when it is moist; chromas are 2 to 4. Strata of loamy fine sand are common below a depth of 25 inches. Buried soils of clay loam texture are common below a depth of 34 inches.

This soil is used for range, wildlife, and water supply. Small tracts are planted to dryfarmed wheat, millet, and sorghum, and to irrigated wheat, alfalfa, and sorghum. (Dryland capability unit IVe-1; Sandy range site)

Apache Series

The Apache series consists of well-drained soils that have a loam subsoil. These soils formed partly in wind-laid or water-deposited material and partly in material weathered from basalt. Slopes are 1 to 9 percent. The vegetation is mainly short grasses and mid grasses, but there are some tall grasses, forbs, and shrubs. Elevations range from 5,600 to 6,100 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Pastura, Dioxice, and Manzano series.

Typically, the surface layer is dark grayish-brown, moderately calcareous stony loam about 5 inches thick. The subsoil is grayish-brown, strongly calcareous heavy loam about 7 inches thick. The subsoil abruptly overlies caliche-coated basalt.

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

Apache stony loam, 1 to 9 percent slopes (Ap).--This gently sloping to rolling soil occurs around old volcanic cinder cones and the shallow lava flows leading away from volcanic centers. It is in the north-central part of the county. Included with this soil in mapping are areas of Pastura and Dioxice soils.

This soil is moderately permeable. Runoff is medium, and the erosion hazard is slight. Effective rooting depth to bedrock is 8 to 19 inches. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. Fertility is high.

Representative profile, 25 feet west of fence and 0.5 mile south of the NE. corner of the NW1/4 sec. 1, T. 22 N., R. 28 E.:

A1--0 to 5 inches, dark grayish-brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) when moist; weak, very fine, granular structure; hard, friable when moist, nonsticky and nonplastic when wet; many fine roots; 10 to 25 percent of the surface is covered with basalt fragments, up to 12 inches in size, and scoria and caliche fragments; moderately calcareous, moderately alkaline (pH 8.0); clear boundary; horizon 4 to 10 inches thick.

B2ca--5 to 12 inches, grayish-brown (10YR 5/2) heavy loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; very hard, friable when moist, slightly sticky and nonplastic when wet; many fine roots, common threads of lime, common lime nodules, and 20 percent basalt fragments and stones; strongly calcareous, moderately alkaline (pH 8.1); abrupt boundary; horizon 4 to 9 inches thick.

R--12 inches, caliche-coated basalt that is fractured in the upper 5 inches.

The A horizon is loam or stony loam and is noncalcareous in a few places. A high percentage of basalt and scoria stones, along with indurated caliche, are scattered on the surface and throughout the soil in many places. Depth to basalt ranges from 8 to 19 inches. The upper 5 inches of the basalt is fractured into fragments that can be removed with a spade. A few inches of indurated caliche over the basalt is common. Outcroppings of basalt are common.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIs-6; Malpais range site)

Berthoud Series

The Berthoud series consists of well-drained soils that have a light clay loam subsoil. These soils formed in calcareous alluvium and valley fill along the margins of the mesa. Slopes are 1 to 9 percent. The vegetation is principally short and mid grasses. Elevations range from 4,600 to 5,900 feet. The average annual precipitation is 13 to 17 inches, average annual air temperature is 55° to 58°

F., and the frost-free season is 150 to 180 days. The associated soils are in the Litle, Penrose, and Kinkead series.

Typically, the surface layer is grayish-brown, moderately calcareous loam about 12 inches thick. The subsoil is light brownish-gray, strongly calcareous light clay loam about 16 inches thick. The substratum is pale-brown, strongly calcareous sandy clay loam. In places the surface layer is fine sandy loam about 6 inches thick.

Berthoud soils are used for range, wildlife, and water supply.

Berthoud loam, 1 to 5 percent slopes (BH).--This gently sloping soil is in the low-intensity survey. It occurs on foot slopes and alluvial fans on the margin of the mesa in the east-central and northeastern parts of the county.

This soil contains more inclusions than the Berthoud loam mapped in the medium-intensity survey. Included in mapping are Travessilla and Kinkead soils. Also, there are minor areas of eroded Berthoud soils.

This soil is moderately permeable. Runoff is medium, and the erosion hazard is moderate. Roots can penetrate to a depth of 60 inches or more. The water-supplying capacity during the growing season is 8 to 10 inches. Runoff is 5 to 6 inches. Fertility is moderate.

Representative profile, SW. corner of the NE1/4 sec. 14, T. 19 N., R. 32 E.:

A1--0 to 12 inches, grayish-brown (10YR 5/2) loam, brown (10YR 4/3) when moist; weak, fine, granular structure; slightly hard, very friable when moist, slightly sticky and nonplastic when wet; many fine roots; moderately calcareous, moderately alkaline (pH 8.1); gradual boundary; horizon 5 to 19 inches thick.

B2--12 to 28 inches, light brownish-gray (10YR 6/2) light clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; hard, friable when moist, slightly sticky and nonplastic when wet; common fine roots; few worm casts; few threads of lime; strongly calcareous, moderately alkaline (pH 8.4); clear boundary; horizon 8 to 24 inches thick.

Cca--28 to 60 inches, pale-brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) when moist; weak, medium, prismatic structure; hard, friable when moist, slightly sticky and nonplastic when wet; common fine roots; common worm casts; few pebbles; about 5 percent lime nodules; strongly calcareous, strongly alkaline (pH 8.5).

The A horizon is noncalcareous in a few places. This horizon is light clay loam in small areas. The B2 horizon ranges from heavy loam or light clay loam to sandy clay loam. The Cca horizon ranges from sandy clay loam or loam to clay loam. Lime nodules, limestone, basalt, and sandstone pebbles are commonly scattered on the surface and throughout the profile. Gravel content ranges from 0 to 15 percent throughout the profile.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-1; Loamy 1 range site)

Berthoud loam (1 to 5 percent slopes) (Bd).--This gently sloping soil is in the medium-intensity survey. It occurs on old alluvial fans along the margins of the mesa in the western part of the county. Included with this soil in mapping are areas of Campus and Penrose soils.

This soil is similar to Berthoud loam, 1 to 5 percent slopes, mapped in the low-intensity survey, except that it is slightly more silty throughout and typically has a thinner B2 horizon, about 10 inches thick. The water-supplying capacity during the growing season is 9 to 11 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-1; Loamy 1 range site)

Berthoud fine sandy loam, 1 to 9 percent slopes (BE).--This gently sloping to strongly sloping soil occurs on alluvial fans on the margin of the mesa, in the northeastern and central parts of the county.

This soil is similar to Berthoud loam, 1 to 5 percent slopes, except that it is gently sloping to strongly sloping and has a surface layer of fine sandy loam about 6 inches thick.

Included with this soil in mapping are areas of Berthoud loam and of Quay and Latom soils. Also included are small areas northeast of Bueyeros that have a sandy shale substratum at a depth below 24 inches. The inclusions that have the sandy shale substratum occur on gently sloping knolls and ridges. These inclusions comprise about 15 percent of the mapping unit.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-2; Sandy range site)

Bippus Series

The Bippus series consists of well-drained soils that have a clay loam to loam subsoil. These soils formed in alluvium along drainageways, valley floors, and stream terraces. Slopes are 0 to 3 percent. The vegetation is mainly short and mid grasses. Elevations range from 4,000 to 4,600 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 160 to 180 days. The associated soils are in the Kinkead and Guadalupe series.

Typically, the surface layer is dark grayish-brown loam and clay loam about 18 inches thick. The subsoil is grayish-brown, moderately calcareous light clay loam about 10 inches thick. The substratum is grayish-brown and light brownish-gray, moderately calcareous light clay loam and clay loam.

Bippus soils are used for range, wildlife, and, to a limited extent, dryfarmed crops and supplemental pasture.

Bippus loam (0 to 3 percent slopes) (BP).--This level and nearly level soil occurs along streams. The streams have cut 10 to 20 feet deep, so that the soil is no longer subject to flooding. It occurs in the central part of the county. Included in mapping are areas of Kinkead and Guadalupe soils.

This soil is moderately permeable. Runoff is slow, and the hazard of soil blowing is moderate. Small tracts have gullies headcutting from the streams. Roots can penetrate to a depth of 60 inches or more. The water-supplying capacity during the growing season is 10 to 13 inches. Runoff is 3 to 4 inches. Fertility is moderate.

Representative profile, 104 feet south of gate, 156 feet east of fence, north of Ute Creek in the SW1/4 NW1/4 sec. 12, T. 20 N., R. 31 E.:

A11--0 to 7 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; hard, very friable when moist, nonsticky and nonplastic when wet; many fine roots; noncalcareous, mildly alkaline (pH 7.8); abrupt boundary; horizon 6 to 10 inches thick.

A12--7 to 18 inches, dark grayish-brown (10YR 4/2) clay loam, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure parting to weak, fine, granular; hard, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; moderately calcareous, moderately alkaline (pH 8.0); clear boundary; horizon 8 to 12 inches thick.

B2--18 to 28 inches, grayish-brown (10YR 5/2) light clay loam, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure; hard, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; few threads of lime; moderately calcareous, moderately alkaline (pH 8.3); clear boundary; horizon 8 to 14 inches thick.

C1--28 to 45 inches, grayish-brown (10YR 5/2) light clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure; hard, firm when moist, slightly sticky and slightly plastic when wet; few fine roots; few threads of lime; moderately calcareous, moderately alkaline (pH 8.4); clear boundary; horizon 15 to 20 inches thick.

C2--45 to 60 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; massive; hard, firm when moist, sticky and plastic when wet; few fine roots; moderately calcareous, moderately alkaline (pH 8.4).

The A horizon has a hue of 7.5YR or 10YR, and a value of 4 or 5 when dry and 2 or 3 when moist. The A horizon may be noncalcareous to a depth of 14 inches. The B2 horizon has a hue of 7.5YR or 10YR and a value of 4 or 5 when dry. The B2 horizon ranges from loam to clay loam. The C horizon has a hue of 7.5YR or 10YR, a value of 4 or 5 when moist, and a chroma of 2 or 3. The C2 horizon ranges from clay loam to fine sandy loam. Commonly, the C2 horizon is stratified.

This soil is used for range and wildlife. A few small tracts are used for dryfarmed sorghums and supplemental pasture. (Dryland capability unit IVec-1; Loamy 2 range site)

Campus Series

The Campus series consists of well-drained soils that are loam to clay loam between depths of 10 and 40 inches. These soils formed in old calcareous alluvium and wind-reworked deposits on uplands. Slopes are 0 to 25 percent but are mainly 0 to 9 percent. The vegetation is principally short and mid grasses and forbs. Elevations range from 4,800 to 6,000 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Dean, Dioxice, and Dumas series.

Typically, the surface layer is grayish-brown, moderately calcareous loam about 9 inches thick. The next layer is light brownish-gray, moderately calcareous loam about 9 inches thick. The substratum is light-gray to pinkish-white loam that has a high lime content (see pl. I, top left). In some places the surface layer is fine sandy loam or gravelly loam.

Campus soils are used for range, wildlife, and water supply. Small tracts are used for dryfarmed crops where they are included in larger fields of Dioxice, Dumas, and La Brier soils.

Campus loam, 0 to 3 percent slopes (Cb).--This soil is level and nearly level. It occurs in scattered areas in the central part of the county.

Included in mapping are areas of Dioxice, Karde, and Dean soils and Campus loam, 0 to 3 percent slopes, eroded.

This soil is moderately permeable. Runoff is slow. The hazard of soil blowing is moderate. Rooting depth to the strong lime zone is 18 to 30 inches. The water-supplying capacity during the growing season is 12 to 14 inches. Runoff is 2 to 3 inches. Fertility is moderate.

Representative profile, 45 feet south and 0.55 mile west of the SE. corner of sec. 4, T. 21 N., R. 26 E.:

A11--0 to 4 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; moderately calcareous, moderately alkaline (pH 7.9); abrupt boundary; horizon 2 to 6 inches thick.

A12--4 to 9 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; hard, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; few fine concretions of lime; moderately calcareous, moderately alkaline (pH 8.0); clear boundary; horizon 4 to 6 inches thick.

AC--9 to 18 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; hard, friable when moist, slightly sticky and slightly plastic when wet; common fine and very fine roots; few fine concretions of lime; moderately calcareous, moderately alkaline (pH 8.1); gradual boundary; horizon 5 to 13 inches thick.

C1ca--18 to 28 inches, light-gray (10YR 7/2) loam, pale brown (10YR 6/3) when moist; weak, medium, subangular blocky structure; hard, friable when moist, slightly sticky and slightly plastic when wet; few fine and very fine roots; many fine and medium threads and soft masses of lime; strongly calcareous, moderately alkaline (pH 8.1); gradual boundary; horizon 7 to 13 inches thick.

C2ca--28 to 60 inches, pinkish-white (7.5YR 8/2) loam, pink (7.5YR 7/4) when moist; massive; hard, firm when moist, nonsticky and nonplastic when wet; no roots; segregated lime throughout mass, decreasing below a depth of 48 inches; strongly calcareous, strongly alkaline (pH 8.5).

The A horizon has a hue of 7.5YR to 10YR, value of 4 or 5 when dry, and chroma of 2 and 3. The A horizon ranges from clay loam to loam. The AC horizon has a hue of 7.5YR to 10YR, values of 5 or 6 when dry and 3 or 4 when moist, and chroma of 2 or 3. The AC horizon ranges from loam to clay loam and has a clay content ranging from 22 to 32 percent. The Cca horizon ranges in hue from 7.5YR to 10YR and in value from 6 to 8 when dry and 5 to 7 when moist. The segregated lime in the Cca horizon ranges from common threads and soft concretions to many threads and soft or hard nodules; it has a calcium carbonate equivalent of more than 25 percent. Scattered caliche pebbles are common in the solum.

This soil is used for range, wildlife, and water supply. Small tracts are used for dryfarmed crops where they are included in large tracts of Dioxice, Dumas, and La Brier soils. (Dryland capability unit VIe-4; Loamy 1 range site)

Campus loam, 0 to 3 percent slopes, eroded (Cc).--This soil is level and nearly level. It occurs in old formerly cultivated fields in the central part of the county. Included with this soil in mapping are areas of Dean soils and of Dioxice loam, 0 to 3 percent slopes, eroded.

This soil is similar to Campus loam, 0 to 3 percent slopes, except that it has been severely blown by wind and also eroded by water. During cultivation the original surface layer was mixed with the next layer, and commonly about 8 to 12 inches of the upper part of the profile was removed by erosion. The strong lime zone is within 1 foot of the surface. Many caliche nodules generally are scattered on the surface. Runoff is medium. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. Fertility is low.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-4; Loamy 1 range site)

Campus loam, 3 to 9 percent slopes (Cf).--This soil is gently sloping to strongly sloping. It occurs in the central part of the county. Included in mapping are areas of Dean and Dioxice soils.

This soil is similar to Campus loam, 0 to 3 percent slopes, except that it is more sloping and has medium runoff. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-4; Loamy 1 range site)

Campus loam, 3 to 9 percent slopes, eroded (Cg).--This soil is gently sloping to strongly sloping. It occurs in old formerly cultivated fields in the central part of the county. Included are areas of Dean and Dioxice soils.

This soil is similar to Campus loam, 0 to 3 percent slopes, except that it has had severe soil blowing and moderate water erosion. About 10 to 14 inches of the original surface layer and next layer have been removed by wind and water. The strong lime zone is commonly at or near the present surface layer. Many caliche nodules are generally scattered on the surface. Runoff is medium, and the erosion hazard is moderate. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. Fertility is low.

This soil is used for range, water supply, and wildlife. (Dryland capability unit VIe-4; Loamy 1 range site)

Campus loam, 0 to 9 percent slopes (CD).--This soil is nearly level to strongly sloping. It occurs in the northeastern part of the county. Included in mapping are areas of Dioxice, Dean, Karde, and Dumas soils.

The soil is similar to Campus loam, 0 to 3 percent slopes, but it is more sloping and has medium runoff. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-4; Loamy 1 range site)

Campus loam, 0 to 9 percent slopes, eroded (CE).--This soil is nearly level to strongly sloping. It occurs in old formerly cultivated fields in the northeastern part of the county. Included in this mapping unit are areas of Dean and Dioxice soils. Also included are small tracts of Mansker fine sandy loam, eroded.

This soil is similar to Campus loam, 0 to 3 percent slopes, but it has had severe wind and moderate water erosion. About 10 to 14 inches of the

original surface layer and next layer have been removed by erosion. The strong lime zone is at or within 10 inches of the present surface layer. Runoff is medium. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. Fertility is low.

This soil is used for range, water supply, and wildlife. (Dryland capability unit VIe-4; Loamy 1 range site)

Campus fine sandy loam (0 to 5 percent slopes) (Ca).--This soil is nearly level to gently sloping. It occurs in the north-central part of the county. Included with this soil in mapping are areas of Otero and Dalhart soils and a Campus fine sandy loam that is eroded.

This soil is similar to Campus loam, 0 to 3 percent slopes, except that it has a fine sandy loam surface layer about 7 inches thick. Also, this soil has more mid grasses and shrubs.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-4; Sandy range site)

Campus gravelly loam, 1 to 25 percent slopes (Cm).--This undulating to hilly soil occurs on ridges and edges of the mesa in the north-central and northwestern parts of the county. Included with this soil in mapping are areas of Dean and Dioxice soils, and Campus loam, 3 to 9 percent slopes.

This soil is similar to Campus loam, 0 to 3 percent slopes, but it contains 15 to 35 percent gravel throughout the soil and occurs on more rolling and hilly topography. Runoff is rapid. The hazard of water erosion is severe. The water-supplying capacity during the growing season is 7 to 9 inches. Runoff is 7 to 8 inches. Fertility is low.

This soil is used for range, water supply, and wildlife. It is a potential source of gravel. (Dryland capability unit VIe-7; Shallow 1 range site)

Campus-Dean association, gently sloping (0 to 9 percent slopes) (CN).--This association consists of about 60 percent Campus loam, 0 to 5 percent slopes, and 35 percent Dean loam, 1 to 9 percent slopes. It occurs in the central and northeastern parts of the county. The Campus soil is along the tops of ridges and on slopes between low ridges. The Campus soil is similar to Campus loam, 0 to 3 percent slopes, but it is gently sloping and has medium runoff. The Dean soil is on low ridges having gentle to strong slopes. The Dean soil is similar to Dean soils, 0 to 9 percent slopes, except that the surface layer is generally loam about 8 inches thick. The water-supplying capacity during the growing season is 9 to 11 inches and runoff is 5 to 6 inches.

About 5 percent of this mapping unit is small areas of Dioxice and Dumas soils.

The soils in this association are used for range, wildlife, and water supply. Caliche pits for construction purposes occur in many areas of the Dean soil. (Campus part, dryland capability unit VIe-4, Loamy 1 range site; Dean part, dryland capability unit VIe-4, Shallow 1 range site)

Carnero Series

The Carnero series consists of well-drained soils that have a clay loam to heavy loam subsoil. These soils formed in material weathered from noncalcareous sandstone and wind-laid loamy material on mesas. Slopes are 0 to 5 percent. The vegetation is mainly short and mid grasses, forbs, and shrubs. Elevations range from 4,900 to 5,700 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Travessilla series.

Typically, the surface layer is brown loam about 6 inches thick. The subsoil is about 26 inches thick. It is brown sandy clay loam in the upper part and is brown and light-brown clay loam in the lower part. The substratum is light-brown loam that has a high lime content. The soil is noncalcareous to depths of 8 to 20 inches. The soil is 20 to 40 inches deep over sandstone bedrock.

Carnero soils are used for range, wildlife, and water supply. A few small tracts are used for dryland crops. Some areas contain Indian artifacts.

Carnero loam (0 to 5 percent slopes) (Co).--This level to gently sloping soil occurs on uplands in the central and western parts of the county. Included with this soil in mapping are areas of Travessilla and La Brier soils and Carnero complex.

This soil is moderately permeable. Runoff is medium, and the erosion hazard is moderate. Effective rooting depth to bedrock is 20 to 40 inches. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. Fertility is moderate.

Representative profile, 135 feet north and 480 feet east of the SW. corner of sec. 5, T. 19 N., R. 26 E.:

A1--0 to 6 inches, brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) when moist; moderate, very fine, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; many very fine and fine roots; a few sandstone fragments on the surface of the soil; noncalcareous, neutral (pH 7.2); clear boundary; horizon 4 to 7 inches thick.

B1--6 to 13 inches, brown (7.5YR 4/3) sandy clay loam, dark brown (7.5YR 3/3) when moist; moderate, medium, subangular blocky structure; hard, very friable when moist, slightly sticky and slightly plastic when wet; many very fine and fine roots; thin patchy clay films, principally on the vertical faces of the soil aggregates; noncalcareous, neutral (pH 7.3); clear boundary; horizon 3 to 8 inches thick.

B21t--13 to 18 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/3) when moist; moderate,

medium, prismatic structure parting to strong, medium, subangular blocky; very hard, friable when moist, sticky and plastic when wet; common very fine and few fine roots; thin continuous clay films on the surfaces of the soil aggregates; noncalcareous, mildly alkaline (pH 7.7); clear boundary; horizon 4 to 6 inches thick.

B22t--18 to 24 inches, brown (7.5YR 5/3) clay loam, dark brown (7.5YR 3/3) when moist; moderate, medium, prismatic structure parting to moderate and strong, medium, subangular blocky; very hard, friable when moist, sticky and plastic when wet; common very fine and few fine roots; thin nearly continuous clay films on the surfaces of the soil aggregates; few lime nodules; moderately calcareous, moderately alkaline (pH 8.2); clear boundary; horizon 4 to 7 inches thick.

B3ca--24 to 32 inches, light-brown (7.5YR 6/3) light clay loam, brown (7.5YR 4/3) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; very hard, friable when moist, slightly sticky and nonplastic when wet; common very fine and few fine roots; thin patchy clay films; few threads of lime and lime nodules; strongly calcareous, moderately alkaline (pH 8.3); gradual boundary; horizon 5 to 9 inches thick.

Cca--32 to 36 inches, light-brown (7.5YR 6/3) loam, brown (7.5YR 5/3) when moist; massive; hard, very friable when moist, slightly sticky and nonplastic when wet; few very fine roots; few sandstone fragments; common threads of lime and lime nodules; strongly calcareous, moderately alkaline (pH 8.4); abrupt boundary; horizon 0 to 5 inches thick.

Rca--36 inches, lime-coated sandstone bedrock.

The hue of the A horizon is 7.5YR to 10YR. The A horizon ranges from fine sandy loam to loam or light sandy clay loam. The B horizon has a hue of 5YR to 10YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 to 4. The B2t horizon ranges from heavy loam to clay loam and silty clay loam and has a clay content of 23 to 35 percent. More than 15 percent of this horizon is coarser than very fine sand. The hue of the C horizon is 7.5YR to 10YR. The Cca horizon contains less than 15 percent calcium carbonate. A few strata of shale occur at depths below 30 inches. Depth to sandstone bedrock ranges from 20 to 40 inches.

This soil is used for range, wildlife, and water supply. Where this soil is about 40 inches deep in tracts of sufficient size, it is suitable for growing dryland feed crops. A few fields are used for dryfarmed crops. (Dryland capability unit VIs-3; Loamy 1 range site)

Carnero loam, eroded (0 to 5 percent slopes) (Cr).--This soil is level and nearly level. It occurs in old formerly cultivated fields in the central and western parts of the county. Included are areas of Travessilla and La Brier soils and Carnero complex, eroded.

This soil is similar to Carnero loam, except that the surface layer and a part of the subsoil have been removed by soil blowing. Some patches of the original surface layer may remain, and in adjacent areas accumulation of a few inches to 1 foot or more may occur. The surface layer varies from clay loam where the subsoil is exposed to fine sandy loam in areas of accumulation. Sandstone fragments 1/2 inch to 10 inches in diameter are commonly scattered on the surface. Rill erosion and small gullies are common. The erosion hazard is moderate. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is about 5 to 6 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIs-3; Loamy 1 range site)

Carnero complex (0 to 5 percent slopes) (Cs).--This complex consists of about 80 percent Carnero loam (0 to 5 percent slopes) and 15 percent Carnero clay loam, alkali (0 to 3 percent slopes). Included in mapping are small areas of Travessilla soils, which make up about 5 percent of the total acreage.

Carnero loam is level to gently sloping and occurs along the edge of mesas near sandstone escarpments. Carnero clay loam, alkali, occurs in oblong, slightly depressional spots 10 to 100 feet in diameter. The Carnero loam in this complex is similar to the Carnero loam described in the representative profile, but sandstone bedrock typically occurs at a depth of about 26 inches. The erosion hazard is moderate, and effective rooting depth is 20 to 30 inches. Carnero clay loam, alkali, is similar to Carnero loam, except that commonly the original surface layer has been removed by erosion so that the clay loam subsoil is exposed. It is alkali affected, dispersed, and very slowly permeable. Areas of this soil are commonly called slick spots. Runoff is slow in these depressional areas. The hazard of soil blowing is moderate. Effective rooting depth is 20 to 30 inches. Fertility is low.

This complex is used for range, wildlife, and water supply. (Dryland capability unit VIs-3; Loamy 1 range site)

Carnero complex, eroded (0 to 3 percent slopes) (Ct).--This complex is level and nearly level. It occurs in old formerly cultivated fields in the central and western parts of the county. Included in mapping are areas of Travessilla soils that make up about 5 percent of the total acreage.

This complex is similar to Carnero complex except that in many areas the surface layer and part of the subsoil have been removed by erosion. The depth to sandstone bedrock is about 20 inches.

This complex is used for range, wildlife, and water supply. (Dryland capability unit VIs-3; Loamy 1 range site)

Church Series

The Church series consists of somewhat poorly drained soils that have a clay to heavy clay loam subsoil. These soils formed in clayey, calcareous, moderately alkaline, water-laid sediments on low benches surrounding large enclosed basins or playas. Slopes are 0 to 2 percent. The vegetation is mainly short and mid grasses and forbs. Elevations range from 4,800 to 5,800 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Karde and La Brier series.

Typically, the surface layer is gray, calcareous clay loam about 7 inches thick. The upper part of the subsoil is light-gray, calcareous heavy clay loam about 4 inches thick. The lower part of the subsoil is light-gray, calcareous clay, about 12 inches thick, that contains mottles of brownish yellow. The substratum is light-gray clay with mottles of brownish yellow and olive yellow. This layer is high in lime content.

Church soils are used for range, wildlife, and, to a limited extent, water supply. Some areas contain Indian artifacts.

Church clay loam (0 to 2 percent slopes) (Cu).--This nearly level soil occurs in the northeastern and central parts of the county. Included with this soil in mapping are areas of La Brier, Manzano, and Karde soils.

This soil is very slowly permeable. Runoff is very slow. Commonly, this soil receives runoff from the adjacent slopes. The hazard of soil blowing is moderate. Roots can penetrate to a depth of 60 inches or more. The water-supplying capacity during the growing season is 20 to 30 inches from precipitation and from additional runoff from the adjacent slopes. Runoff is 1 to 2 inches. Fertility is moderate.

Representative profile, 50 feet north and 1,600 feet west of the SE. corner of sec. 25, T. 19 N., R. 28 E.:

A1--0 to 7 inches, gray (10YR 5/1) clay loam, dark gray (10YR 4/1) when moist; topmost 1 1/2 inches is grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable when moist, slightly sticky and slightly plastic when wet; fine roots; moderately calcareous, moderately alkaline (pH 8.0), slightly saline; clear, smooth boundary; horizon 5 to 10 inches thick.

B1--7 to 11 inches, light-gray (2.5Y 7/1) heavy clay loam, gray (2.5Y 5/1) when moist; moderate, medium, subangular blocky structure parting to moderate, medium, granular; hard, friable when moist, sticky and plastic when wet; common fine roots; considerable tonguing and mixing from the A1 horizon; few, fine, faint threads of lime; strongly calcareous, moderately alkaline (pH 8.2), moderately saline; abrupt, wavy boundary; horizon 3 to 7 inches thick.

B2--11 to 23 inches, light-gray (5Y 7/1) clay, gray (5Y 6/1) when moist; few, fine, prominent mottles of brownish yellow (10YR 6/6), yellowish brown (10YR 5/6) when moist; surfaces of peds and root channels are coated with dark-gray (10YR 4/1) moist soil from horizons above; moderate, medium, prismatic structure parting to moderate, subangular and angular blocky; very hard, very firm when moist, sticky and plastic when wet; few fine roots; strongly calcareous, strongly alkaline (pH 8.5), moderately saline; gradual boundary; horizon 10 to 26 inches thick.

Cg--23 to 60 inches, light-gray (5Y 7.5/1) clay, light olive gray (5Y 6/2) when moist; common, fine, prominent mottles of brownish yellow (10YR 6/6), yellowish brown (10YR 5/6) when moist, and olive yellow (2.5Y 6/7), light olive brown (2.5Y 5/7) when moist; massive in place, but parts to weak, medium, subangular and angular blocky structure; very hard, very firm when moist, sticky and plastic when wet; very few fine roots; strongly calcareous, strongly alkaline (pH 8.7), moderately saline.

The A horizon has a hue of 10YR to 2.5Y, chromas of 1 and 2, and values of 5 and 6 when dry and 3 to 5 when moist. The A horizon ranges from clay loam to clay. In places this horizon contains layers of dark-colored deposition as much as 4 inches thick. The B horizon has chromas of 1 to 2, and values of 5 to 7 when dry and 4 to 6 when moist. The B horizon is dominantly clay but is heavy clay loam to silty clay in some places. The clay content of this horizon ranges from 38 to 52 percent. Lime accumulation ranges from none to a few threads or concretions. The C horizon has a hue of 2.5Y to 5Y, and values of 6 to 8 when dry and 4 to 6 when moist. The B and C horizons are moderately to strongly alkaline and slightly to moderately saline. Ponding in the adjacent playas may cause the water table to rise into the C horizon during some years.

This soil is used for range and wildlife, but it has limited use for water supply. Indian artifacts occur in some tracts. (Dryland capability unit VIw-2; Salt Flats range site)

Dalhart Series

The Dalhart series consists of well-drained soils that have a sandy clay loam to light clay loam subsoil. These soils formed in old alluvium and mixed, sandy, wind-laid deposits on the mesa. Slopes are 0 to 5 percent. The vegetation is mainly mid grasses, forbs, and shrubs. Elevations range from 4,800 to 6,000 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54°

to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Otero and Dumas series.

Typically, the surface layer is dark grayish-brown fine sandy loam about 6 inches thick. The subsoil is brown sandy clay loam and heavy loam about 27 inches thick. The substratum is very pale brown heavy loam that is high in lime content.

Dalhart soils are used for range, wildlife, water supply, and, to a limited extent, dryfarmed crops.

Dalhart fine sandy loam (0 to 3 percent slopes) (Da).--This nearly level to gently undulating soil occurs in the northeastern and north-central parts of the county. Included are small areas of Otero soils, Dalhart loamy fine sand, and Dalhart complex, severely eroded.

This soil is moderately permeable. Runoff is slow. The hazard of soil blowing is moderate. Roots can penetrate to a depth of about 60 inches or more. The water-supplying capacity during the growing season is 12 to 14 inches. Runoff is 2 to 3 inches. Fertility is moderate.

Representative profile, 0.4 mile east and 0.1 mile north of the SW. corner of sec. 19, T. 21 N., R. 28 E.:

A1--0 to 6 inches, dark grayish-brown (10YR 4/2) fine sandy loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; slightly hard, very friable when moist, nonsticky and nonplastic when wet; many fine roots; noncalcareous, mildly alkaline (pH 7.6); gradual boundary; horizon 5 to 13 inches thick.

B21t--6 to 18 inches, brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, very friable when moist, slightly sticky and slightly plastic when wet; common fine roots; many worm casts; noncalcareous, mildly alkaline (pH 7.8); clear boundary; horizon 8 to 15 inches thick.

B22t--18 to 25 inches, brown (10YR 5/3) sandy clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, subangular blocky structure; very hard, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many worm casts, thin patchy clay films; few faint threads of lime; moderately calcareous, moderately alkaline (pH 8.0); clear, wavy boundary; horizon 5 to 10 inches thick.

B3ca--25 to 33 inches, brown (10YR 5/3) heavy loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, subangular blocky structure; very hard, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many fine, prominent lime nodules (approximately 10 to 25 percent); strongly calcareous, moderately alkaline (pH 8.3); gradual boundary; horizon 5 to 15 inches thick.

Cca--33 to 60 inches, very pale brown (10YR 7/3) heavy loam, brown (10YR 5/3) when moist; massive; very hard, friable when moist, slightly sticky and nonplastic when wet; few fine roots; strongly calcareous, strongly alkaline (pH 8.6).

The A horizon is mainly fine sandy loam but ranges to loamy fine sand. The B horizon has a hue of 7.5YR or 10YR, and chroma of 2 to 4. The B horizon ranges from loam or sandy clay loam to light clay loam. The Cca horizon has values of 6 to 8 when dry and 5 to 7 when moist, and chroma of 2 to 4.

This soil is used for range, wildlife, water supply, and dryfarmed crops. (Dryland capability unit IVe-1; Sandy range site)

Dalhart complex, severely eroded (0 to 3 percent slopes) (Db).--The soils in this complex are nearly level to gently undulating. They occur in old formerly cultivated fields in the north-central part of the county. Included with this complex in mapping are areas of Otero and Campus soils that occupy about 10 percent of the total acreage.

This complex consists of about 45 percent Dalhart sandy clay loam, 25 percent Dalhart fine sandy loam, and 20 percent Dalhart loamy fine sand. The sandy clay loam in this complex is similar to Dalhart fine sandy loam, except that all of the surface layer has been removed by soil blowing. Runoff is medium. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. The fine sandy loam in this complex is similar to Dalhart fine sandy loam, except that part of the surface layer has been removed by soil blowing. The loamy fine sand is similar to Dalhart fine sandy loam, except that the surface layer is loamy fine sand. It occurs in low hummocks where sand has accumulated. The erosion hazard is severe.

This complex is used for range, wildlife, and water supply. (Dryland capability unit VIe-2; Sandy range site)

Dean Series

The Dean series consists of well-drained soils that are 5 to 14 inches deep over strongly cemented caliche. These soils formed in mixed calcareous sediments on low ridges and slopes on the upland mesa. Slopes are 0 to 9 percent. The vegetation is principally mid grasses, forbs, and shrubs. Elevations range from 4,800 to 6,100 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Campus and Dioxice series.

The surface layer of a representative profile is grayish-brown, calcareous stony loam about 6 inches thick, but areas mapped contain significant-sized areas where this layer is gravelly loam, loam, or fine sandy loam. Abruptly under the surface layer is white, strongly cemented, gravelly caliche (see pl. I, top right).

Dean soils are used for range, wildlife, and water supply. Caliche pits for construction purposes are commonly located within areas of Dean soils.

Dean soils, 0 to 9 percent slopes (Dd) (DE).-- The soils in this undifferentiated group are nearly level to gently rolling and occupy low ridges and knolls. They occur in the central part of the county in the medium-intensity survey and in the northeastern part of the county in the low-intensity survey. Included with these soils in mapping are areas of Campus and Penrose soils. The low-intensity survey contains more caliche outcroppings than the medium-intensity survey. The low-intensity survey contains a higher percentage of Campus and Penrose soils than does the medium-intensity survey.

Dean soils are slowly permeable. Runoff is medium, and the erosion hazard is moderate. Effective rooting depth to caliche is 5 to 14 inches. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. Fertility is low.

Representative profile, about 1,750 feet south and 350 feet east of the NW. corner of sec. 32, T. 21 N., R. 26 E.:

A1--0 to 6 inches, grayish-brown (10YR 5/2) stony loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; many hard caliche nodules and stones are present; strongly calcareous, strongly alkaline (pH 8.5); abrupt boundary; horizon 5 to 14 inches thick.

Ccam--6 inches, white (10YR 8/1), gravelly caliche, strongly cemented in the upper part, becoming less hard with depth.

The A horizon has a hue of 7.5YR to 10YR, values of 5 and 6 when dry and 3 and 4 when moist, and chroma of 2 and 3. The A horizon ranges from stony loam or gravelly loam to loam or fine sandy loam. Depth to caliche is 5 to 14 inches. Commonly, the surface is scattered with caliche fragments. Beds of caliche crop out in many places.

This undifferentiated group is used for range, wildlife, and water supply. Caliche pits, which are used for construction, occur in many areas of Dean soils. (Dryland capability unit VIe-4; Shallow 1 range site)

Dioxice Series

The Dioxice series consists of well-drained soils that have a clay loam to heavy loam subsoil. These soils formed in old alluvium on the mesa. Slopes are 0 to 5 percent. The vegetation is mainly short and mid grasses. Elevations range from 5,400 to 6,100 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Dumas and Campus series.

Typically, the surface layer is dark grayish-brown loam about 8 inches thick. The subsoil is dark grayish-brown, grayish-brown, and brown, calcareous clay loam about 27 inches thick. The substratum is pinkish-white loam that has a high lime content.

Dioxice soils are used for range, wildlife, dry-farmed crops, and water supply.

Dioxice loam, 0 to 3 percent slopes (Df).- This soil is nearly level and level. It occurs in the west-central part of the county. Included with this soil in mapping are areas of Campus, Dumas, and Dean soils, and Dioxice loam, 3 to 5 percent slopes.

This soil has moderately slow permeability. Runoff is slow. The hazard of soil blowing is moderate. Rooting depth to the strong lime zone is 21 to 40 inches. The water-supplying capacity during the growing season is 12 to 14 inches. Runoff is 2 to 3 inches. Fertility is moderate.

Representative profile, 45 feet north and 240 feet west of SE. corner of sec. 8, T. 20 N., R. 26 E.:

A11--0 to 4 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable when moist, nonsticky and nonplastic when wet; many very fine and common fine roots; noncalcareous, mildly alkaline (pH 7.7); clear boundary; horizon 3 to 5 inches thick.

A12--4 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard, friable when moist, slightly sticky and slightly plastic when wet; many very fine and common fine roots; moderately calcareous, moderately alkaline (pH 7.9); clear boundary; horizon 3 to 7 inches thick.

B21--8 to 18 inches, dark grayish-brown (10YR 4/2) clay loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, friable when moist, sticky and plastic when wet; many very fine and few fine roots; few medium lime nodules; moderately calcareous, moderately alkaline (pH 7.9); gradual boundary; horizon 5 to 12 inches thick.

B22--18 to 28 inches, grayish-brown (10YR 5/2) clay loam, brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; very hard, friable when moist, sticky and plastic when wet; common very fine roots; few threads and nodules of lime; moderately calcareous, moderately alkaline (pH 8.1); gradual boundary; horizon 5 to 13 inches thick.

B3ca--28 to 35 inches, brown (10YR 5/3) clay loam, dark yellowish brown (10YR 3/4) when moist; moderate, medium, subangular blocky structure; very hard, friable when moist, sticky and plastic when wet; few very fine roots; common, medium, soft masses and concretions of lime; strongly calcareous, moderately alkaline (pH 8.1); gradual boundary; horizon 5 to 16 inches thick.

Cca--35 to 60 inches, pinkish-white (7.5YR 8/2) loam, pink (7.5YR 7/4) when moist; massive; some fragments of strongly cemented or indurated caliche; strongly calcareous, strongly alkaline (pH 8.6).

The A horizon has a hue of 7.5YR to 10YR, values of 3 to 5 when dry and 2 or 3 when moist, and a chroma of 2 or 3. The A horizon ranges from clay loam to loam. The B2 horizon has a hue of 7.5YR to 10YR. The B3 horizon has a hue of 7.5YR to 10YR and values of 5 or 6 when dry and 3 to 5 when moist. The B horizon is dominantly clay loam but ranges to heavy loam or sandy clay loam. The Cca horizon has a hue of 7.5YR to 10YR and values of 7 or 8 when dry and 5 to 7 when moist. The segregated lime in the Cca horizon ranges from common threads and soft concretions to many threads and hard concretions or strongly cemented caliche.

This soil is used for range, dryfarmed crops, wildlife, and water supply. (Dryland capability unit IVec-2; Loamy 1 range site)

Dioxice loam, 0 to 3 percent slopes, eroded (Dg).--This soil is level and nearly level. It occurs in old formerly cultivated fields in the west-central part of the county. Included in mapping are areas of Campus, La Brier, and Dumas soils.

This soil is similar to Dioxice loam, 0 to 3 percent slopes, but the surface layer and a part of the subsoil have been removed by wind. Some patches of the original surface layer may remain, and in adjacent areas an accumulation of a few inches to 1 foot or more may occur. Scattered caliche nodules on the surface are common. The soil is calcareous to the surface. The hazard of soil blowing is severe. Runoff is medium. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-1; Loamy 1 range site)

Dioxice loam, 3 to 5 percent slopes (Dh).--This soil is gently sloping. It occurs in the central part of the county. Included with this soil in mapping are areas of Campus, Dumas, and La Brier soils.

This soil is similar to Dioxice loam, 0 to 3 percent slopes, but it is more sloping. Runoff is medium. The erosion hazard is moderate. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-1; Loamy 1 range site)

Dumas Series

The Dumas series consists of well-drained soils that have a clay loam to light silty clay loam subsoil. These soils formed in old alluvium and thin deposits of loamy wind-laid materials on the mesa. Slopes are 0 to 5 percent. The vegetation is mainly short and mid grasses. Elevations range from 4,800 to 6,100 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Dioxice, La Brier, and Campus series.

Typically, the surface layer is brown loam about 7 inches thick. The subsoil is about 29 inches thick. It is brown and reddish-brown clay loam in the upper part and yellowish-red, calcareous silty clay loam in the lower part. The substratum is pinkish-white clay loam that has a high lime content. The soil is noncalcareous to a depth of 15 to 39 inches.

Dumas soils are used for range, dryfarmed crops, wildlife, and water supply.

Dumas loam, 0 to 3 percent slopes (Dm) (DN).--This soil is nearly level and level in the medium-intensity survey and nearly level to gently sloping in the low-intensity survey. It occurs in the central part of the county in the medium-intensity survey and in the northeastern part of the county in the low-intensity survey.

Included in mapping in the medium-intensity survey are areas of La Brier, Dioxice, and Campus soils, which make up about 10 percent of the acreage mapped as this soil. Included in the low-intensity survey are areas of Dioxice and Campus soils, which occupy 12 percent, and of La Brier soils, which occupy 3 percent of the total acreage.

This soil has moderately slow permeability. Runoff is slow. Soil blowing is a moderate hazard. Rooting depth to the strong lime zone is 32 to 54 inches. Water-supplying capacity during the growing season is 12 to 14 inches. Runoff is 2 to 3 inches. Fertility is moderate to high.

Representative profile, about 750 feet east and 0.2 mile north of the SW. corner of the SW1/4 sec. 22, T. 21 N., R. 27 E.:

A1--0 to 7 inches, brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) when moist; weak, medium, granular structure; slightly hard, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; noncalcareous, mildly alkaline (pH 7.5); clear boundary; horizon 6 to 11 inches thick.

B21t--7 to 10 inches, brown (7.5YR 4/3) clay loam, dark brown (7.5YR 3/3) when moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, very firm when moist, sticky and plastic when wet; many fine roots; few thin clay films; noncalcareous, mildly alkaline (pH 7.7); clear boundary; horizon 3 to 8 inches thick.

B22t--10 to 20 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, extremely firm when moist, sticky and plastic when wet; common fine roots; common thin clay films on peds; noncalcareous in upper part, slightly calcareous in lower part,

mildly alkaline (pH 7.7); gradual boundary; horizon 6 to 20 inches thick.

B3ca--20 to 36 inches, yellowish-red (5YR 5/6, 5YR 4/6 moist) silty clay loam; weak, coarse, prismatic structure; very hard, firm when moist, slightly sticky and plastic when wet; common fine roots; few distinct threads of lime and lime nodules; moderately calcareous, mildly alkaline (pH 7.8); abrupt, wavy boundary; horizon 5 to 17 inches thick.

Cca--36 to 60 inches, pinkish-white (7.5YR 8/2) clay loam, pink (7.5YR 7/4) when moist; massive; very few fine roots; strongly calcareous, strongly alkaline (pH 8.6).

The A horizon has a value of 4 or 5 when dry and a chroma of 2 or 3. The B2t horizons have hues of 5YR to 10YR and values of 4 or 5 when dry and 3 or 4 when moist. The B2t horizons range from clay loam to light silty clay loam and have a clay content of 28 to 35 percent. The B22t horizon ranges from noncalcareous to moderately calcareous. The B3 horizon has hue of 5YR to 7.5YR, values of 5 or 6 when dry and 4 or 5 when moist, and chroma of 4 or 6. The B3 horizon is clay loam, sandy clay loam, or silty clay loam. The Cca horizon has a hue of 7.5YR or 10YR and values of 7 or 8 when dry and 6 or 7 when moist. The Cca horizon ranges from loam or sandy clay loam to clay loam.

This soil is used for range, dryfarmed crops, wildlife, and water supply. (Dryland capability unit IVec-1; Loamy 1 range site)

Dumas loam, 3 to 5 percent slopes (Do).--This soil is gently sloping. It occurs in the central part of the county. Included in mapping are areas of Dioxice, Campus, and Dean soils.

This soil is similar to Dumas loam, 0 to 3 percent slopes, but it is more sloping. Runoff is medium, and the erosion hazard is moderate. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-1; Loamy 1 range site)

Dumas loam, thin solum, 0 to 3 percent slopes (Dr).--This soil is level and nearly level. It occurs in the central part of the county. Included in mapping are areas of Dioxice and Campus soils.

This soil is similar to Dumas loam, 0 to 3 percent slopes, but it typically has a thinner subsoil, which is about 20 inches thick. Rooting depth to the strong lime zone is 20 to 32 inches. Fertility is moderate.

This soil is used for range, dryfarmed crops, wildlife, and water supply. (Dryland capability unit IVec-2; Loamy 1 range site)

Dumas complex, 0 to 3 percent slopes, eroded (Du) (DV).--This complex is level and nearly level in the medium- and low-intensity surveys. It occurs in old formerly cultivated fields in the central part of the county in the medium-intensity survey and in the northeastern part of the county in the low-intensity survey.

Included in the medium-intensity survey are areas of Campus and Dioxice soils. Included in the low-intensity survey are areas of Dioxice soils, which make up 10 percent of the total acreage, and areas of Campus and Dean soils, which make up 5 percent.

The soils in this complex are similar to Dumas loam, 0 to 3 percent slopes, except that the surface layer and part of the subsoil have been removed by wind. Some rill and gully erosion is common. Patches of the original surface layer remain in some places, and in adjacent areas there is an accumulation of a few inches to 1 foot or more of soil material. The texture of the surface layer in the medium-intensity survey ranges from loam to clay loam. The surface layer in the low-intensity survey ranges from loam or fine sandy loam to clay loam or sandy clay loam. Locally, the soil is calcareous to the surface. Numerous Ogallala pebbles and caliche nodules are generally scattered on the surface. Rooting depth to the strong lime zone is 25 to 40 inches. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. The hazard of soil blowing is severe.

This complex is used for range, wildlife, and water supply. (Dryland capability unit VIe-1; Loamy 1 range site)

Gallegos Series

The Gallegos series consists of well-drained soils that have a very gravelly sandy clay loam to very gravelly clay loam subsoil. These soils formed in gravelly alluvium on old dissected stream terraces. Slopes are 3 to 35 percent. The vegetation is mainly mid and short grasses, forbs, and shrubs. Elevations range from 3,900 to 4,400 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Quay, Ima, and Tucumcari series.

Typically, the surface layer is brown very gravelly sandy loam about 3 inches thick (see pl. I, bottom left). The subsoil is reddish-brown very gravelly sandy clay loam about 12 inches thick. The substratum is pinkish-white very gravelly light clay loam and gravelly sandy loam, which are high in lime content, and reddish-yellow gravelly coarse sand. The soil is noncalcareous to depths of 8 to 26 inches.

Gallegos soils are used for range, water supply, and wildlife. Gravel pits commonly are located within areas of Gallegos soils.

Gallegos very gravelly sandy loam, 3 to 35 percent slopes (GA).--This soil is undulating to hilly. It occurs in the southern part of the county. Included in areas mapped as this soil are areas of Ima, Quay, and Lacita soils and Rough broken land.

This soil is moderately rapidly permeable. Runoff is rapid, and the hazard of water erosion is moderate to severe. Rooting depth to the strong lime

zone is 8 to 26 inches. Water-supplying capacity during the growing season is 6 to 8 inches. Runoff is 7 to 8 inches. Fertility is low.

Representative profile, north bank of roadcut about 720 feet north and 380 feet east of the SW. corner of sec. 29, T. 14 N., R. 32 E.:

A1--0 to 3 inches, brown (7.5YR 5/4) very gravelly sandy loam, dark brown (7.5YR 4/4) when moist; weak, very fine, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; about 60 percent by volume consists of waterworn gravel; many fine roots; noncalcareous, moderately alkaline (pH 8.0); clear boundary; horizon 2 to 9 inches thick.

B2--3 to 15 inches, reddish-brown (5YR 4/4) very gravelly sandy clay loam; dark reddish brown (5YR 3/4) when moist; moderate, fine, granular structure; slightly hard, very friable when moist, slightly sticky and slightly plastic when wet; about 75 percent by volume consists of waterworn gravel; common fine roots; noncalcareous, moderately alkaline (pH 8.2); abrupt boundary; horizon 6 to 17 inches thick.

C1ca--15 to 21 inches, pinkish-white (7.5YR 8/2) very gravelly light clay loam, light brown (7.5YR 6/4) when moist; moderate, fine, granular structure; slightly hard, friable when moist, slightly sticky and slightly plastic when wet; about 65 percent by volume consists of waterworn gravel; undersides of gravel are lime coated; very few fine roots; strongly calcareous, moderately alkaline (pH 8.4); clear boundary; horizon 6 to 15 inches thick.

IIC2--21 to 34 inches, reddish-yellow (5YR 6/6) gravelly coarse sand, yellowish red (5YR 5/6) when moist; single grain; loose (dry and moist), nonsticky and nonplastic when wet; no roots; strongly calcareous, moderately alkaline (pH 8.3); abrupt boundary; horizon 0 to 15 inches thick.

IIIC3ca--34 to 60 inches, pinkish-white (7.5YR 8/2) gravelly sandy loam, light brown (7.5YR 6/4) when moist; consisting of weakly cemented calcium carbonate and waterworn pebbles and cobblestones; no roots.

The A1 horizon ranges from very gravelly sandy loam to gravelly loam. The content of gravel in the A1 horizon ranges from 35 to 75 percent by volume. The A1 horizon has a hue of 5YR to 7.5YR, values of 5 or 6 when dry and 4 or 5 when moist, and chroma from 3 to 5. The B horizon is very gravelly sandy clay loam to very gravelly clay loam. The content of gravel in the B horizon ranges from 40 to 80 percent by volume. The B horizon has a hue of 5YR to 7.5YR, values of 4 or 5 when dry and 3 to 5 when moist, and chroma of 4 or 5. The B horizon is thickest on the lower slopes and is thinner on the steeper slopes. Typically, the B horizon is noncalcareous, but locally it is weakly calcareous. The content of gravel in the C horizon ranges from 35 to 75 percent by volume.

This soil is used for range, wildlife, and water supply. It also is used as a source of gravel. (Dryland capability unit VIe-7; Shallow 2 range site)

Guadalupe Series

The Guadalupe series consists of well-drained soils that have a fine sandy loam and loam subsoil. These soils formed in alluvium deposited by flood waters along Ute Creek and its tributaries. Slopes are 0 to 3 percent. The vegetation is mainly mid grasses and forbs. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Bippus series.

Typically, the surface layer is brown fine sandy loam about 9 inches thick. The subsoil is about 41 inches thick. It is brown fine sandy loam in the upper part and brown loam in the lower part. The substratum is brown and reddish-brown fine sandy loam. The soil is calcareous throughout.

Guadalupe soils are used for range and wildlife.

Guadalupe fine sandy loam (0 to 3 percent slopes) (GU).--This soil is level to gently undulating. It occurs on the alluvial flood plains along Ute Creek and its tributaries. Included in mapping are areas of Kinkead soils and of soils consisting of stratified loamy fine sand.

This soil has moderately rapid permeability. Runoff is slow. The hazard of soil blowing is moderate. Roots can penetrate to a depth of about 60 inches or more. The water-supplying capacity during the growing season is 11 to 13 inches. Some areas of this soil are subject to overflow during periods of flooding from streams. Runoff is 2 to 3 inches. Fertility is moderate.

Representative profile, about 690 feet east of where State Highway 39 bridge crosses Mosquero Creek, on north streambank, NW1/4 sec. 27, T. 17 N., R. 30 E.:

A1--0 to 9 inches, brown (7.5YR 5/4; 7.5YR 4/4, moist) fine sandy loam; weak, medium, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; many fine roots; moderately calcareous, moderately alkaline (pH 8.0); clear boundary; horizon 7 to 12 inches thick.

B1--9 to 30 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable when moist, nonsticky and nonplastic when wet; many fine roots; moderately calcareous, strongly alkaline (pH 8.5); abrupt boundary; horizon 15 to 25 inches thick.

IIB2--30 to 50 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable when

moist, slightly sticky and slightly plastic when wet; few fine roots; few threads of lime; moderately calcareous, strongly alkaline (pH 8.5); gradual boundary; horizon 0 to 24 inches thick.

IIIC1--50 to 70 inches, brown (7.5YR 5/4; 10YR 4/4, moist) fine sandy loam; massive; slightly hard, friable when moist, nonsticky and nonplastic when wet; few fine roots; few threads of lime; moderately calcareous, strongly alkaline (pH 8.6); clear boundary; horizon 10 to 25 inches thick.

IIIC2--70 to 80 inches, reddish-brown (5YR 5/3; 5YR 4/3, moist) fine sandy loam; massive; soft, very friable when moist, nonsticky and nonplastic when wet; no roots; stratified sand and gravel; moderately calcareous, strongly alkaline (pH 8.6).

The soil has hues throughout of 5YR to 10YR, values of 5 or 6 when dry and 4 or 5 when moist, and a chroma of 3 or 4. The A horizon is predominantly fine sandy loam but ranges to loamy fine sand. Stratification that has lenses of loam, loamy fine sand, or gravel is common.

This soil is used for range and wildlife. (Dryland capability unit VIe-2; Sandy range site)

Ima Series

The Ima series consists of well-drained soils that have a sandy loam to fine sandy loam subsoil. These soils formed in old alluvium and mixed, sandy, wind-laid deposits on old alluvial fans. Slopes are 2 to 5 percent. The vegetation is mainly mid grasses, forbs, and shrubs. Elevations range from 4,000 to 4,600 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Quay and Gallegos series.

Typically, the surface layer is reddish-brown, calcareous fine sandy loam about 7 inches thick. The subsoil is reddish-brown, calcareous sandy loam about 6 inches thick. The substratum is reddish-brown, calcareous sandy loam and fine sandy loam over weak-red silty clay.

Ima soils are used for range, wildlife, and water supply.

Ima and Quay soils (1 to 5 percent slopes) (IM).--The soils in this undifferentiated group are gently undulating or gently sloping. They occur in the southern part of the county, mainly west of Ute Creek. Included with these soils in mapping are areas of Lacita, Latom, and Berthoud soils.

This undifferentiated group consists of about 60 percent Ima fine sandy loam, 2 to 5 percent slopes, and 30 percent Quay fine sandy loam, 1 to 4 percent slopes. The Ima soil is gently undulating. Permeability of the Ima soil is moderately rapid. Runoff is medium, and the erosion hazard is moderate. Roots can penetrate to depth of 40 to 60 inches. Water-supplying capacity during the growing season is 8 to 10 inches. Runoff is 5 to 6 inches. Fertility is moderate. The Quay soil is gently sloping. It is similar to the Quay loam described under the Quay series, except that it has a fine sandy loam surface layer about 7 inches thick. Permeability of the Quay soil is moderate. Runoff is medium, and the erosion hazard is moderate. Roots can penetrate to a depth of 14 to 24 inches. The water-supplying capacity during the growing season is 8 to 10 inches. Runoff is 5 to 6 inches. Fertility is moderate.

Representative profile of Ima fine sandy loam, 0.12 mile east along fence from road and 0.12 mile north of fence, SE. corner of SW1/4 NW1/4 sec. 6, T. 14 N., R. 31 E.:

A1--0 to 7 inches, reddish-brown (5YR 5/4; 5YR 4/4 moist) fine sandy loam; weak, fine and medium, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; many fine roots; moderately calcareous, moderately alkaline (pH 8.2); clear boundary; horizon 5 to 8 inches thick.

B2--7 to 13 inches, reddish-brown (5YR 5/4; 5YR 4/4 when moist) sandy loam; weak, coarse, prismatic structure parting to weak, fine, granular; slightly hard, very friable when moist, nonsticky and nonplastic when wet; many fine roots; few, fine, faint threads of lime; strongly calcareous, strongly alkaline (pH 8.5); clear boundary; horizon 6 to 13 inches thick.

C1--13 to 25 inches, reddish-brown (5YR 5/4; 5YR 4/4 when moist) sandy loam; weak, medium, subangular blocky structure parting to weak, medium, granular; slightly hard, very friable when moist, nonsticky and nonplastic when wet; common fine roots; common distinct threads of lime; strongly calcareous, strongly alkaline (pH 8.5); clear boundary; horizon 10 to 21 inches thick.

C2--25 to 47 inches, reddish-brown (5YR 5/3; 5YR 4/3 when moist) fine sandy loam; weak, fine, subangular blocky structure parting to moderate, fine, granular; slightly hard, very friable when moist, nonsticky and nonplastic when wet; few fine roots; few faint threads of lime increasing with depth; strongly calcareous, strongly alkaline (pH 8.6); abrupt boundary; horizon 14 to 27 inches thick.

IIC3--47 to 60 inches, weak-red (10R 5/4; 10R 4/4 when moist) silty clay; red-bed shale, stratified with light-gray (5Y 7/2) shale, light olive gray (5Y 6/2) when moist; very hard, very firm when moist, sticky and plastic when wet; no roots; strongly calcareous, strongly alkaline (pH 8.8).

The A horizon has hues of 7.5YR to 5YR, a value of 4 or 5, and a chroma of 3 or 4 when dry. The B2 horizon has hues of 2.5YR and 5YR, a value of 4 or 6, and a chroma of 3 or 4 when dry. The B2 horizon is sandy loam to fine sandy loam. Buried soils are common. The silty clay red-bed shale is discontinuous.

The soils in this undifferentiated group are used for range, wildlife, and water supply. (Dryland capability unit VIe-6; Sandy range site)

Karde Series

The Karde series consists of well-drained soils that are light clay loam to loam between depths of 10 and 40 inches. These soils formed in calcareous, loamy, wind-laid deposits on the leeward side of dry or intermittant lakes or playas. Slopes are 1 to 9 percent. The vegetation is mainly short and mid grasses, forbs, and shrubs. Elevations range from 4,800 to 5,900 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Church and Dioxice series.

Typically, the surface layer is grayish-brown, calcareous loam about 4 inches thick. The next layer is light brownish-gray, calcareous loam about 7 inches thick. The substratum is light-gray, calcareous heavy loam and light clay loam.

Karde soils are used for range, wildlife, and water supply.

Karde loam, 1 to 9 percent slopes (Ka).--This soil is gently sloping to rolling. It occurs in scattered areas in the central and northeastern parts of the county. Included with this soil in mapping are areas of Church, Dioxice, and Campus soils.

This soil has moderately slow permeability. Runoff is medium, and the erosion hazard is moderate. Roots can penetrate to a depth of 60 inches or more. Water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. Fertility is low.

Representative profile, 135 yards south and 270 yards east of the NW. corner of sec. 29, T. 19 N., R. 29 E.:

A1--0 to 4 inches, grayish-brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; weak, fine, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; many very fine roots; calcareous, lime disseminated throughout, moderately alkaline (pH 8.0); clear boundary; horizon 3 to 10 inches thick.

AC--4 to 11 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; very weak, coarse, prismatic structure to massive; soft, very friable when moist, nonsticky and nonplastic when wet; common very fine roots; calcareous, lime disseminated throughout; moderately alkaline (pH 8.1); clear boundary; horizon 5 to 10 inches thick.

C1--11 to 17 inches, light-gray (2.5Y 7/2) heavy loam, grayish brown (2.5Y 5/2) when moist; massive, but a few, weak, vertical cleavage planes; soft, friable when moist, slightly sticky and nonplastic when wet; few very fine roots; calcareous, lime disseminated throughout, moderately alkaline (pH 8.1); gradual boundary; horizon 4 to 8 inches thick.

C2--17 to 60 inches, light-gray (5Y 7/2) light clay loam, light olive gray (5Y 6/2) when moist; massive, but a few, weak, vertical cleavage planes; slightly hard, friable when moist, slightly sticky and nonplastic when wet; very few very fine roots in upper part; calcareous, lime disseminated throughout, moderately alkaline (pH 8.4).

The A and AC horizons have hues of 10YR to 2.5Y, values of 5 to 7 when dry and 4 to 6 when moist, and chromas of 2 to 4. The A and AC horizons range from very fine sandy loam to loam and to silt loam. The C horizon has a hue of 10YR to 5Y, values from 6 to 8 when dry and 5 to 7 when moist, and chromas from 1 to 3.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-4; Sandy range site)

Kinkead Series

The Kinkead series consists of well-drained soils that have a clay subsoil. These soils formed in loamy calcareous deposits on old alluvial fans below the margin of the mesa. Slopes are 0 to 3 percent. The vegetation is mainly short grasses and forbs. Elevations range from 4,200 to 4,800 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Berthoud and Quay series.

Typically, the surface layer is dark grayish-brown clay loam about 7 inches thick. The subsoil is dark grayish-brown and grayish-brown clay about 35 inches thick. The substratum is brown, calcareous heavy sandy clay loam. The soil is noncalcareous to a depth of 10 to 22 inches.

Kinkead soils are used for range, wildlife, and water supply.

Kinkead clay loam (0 to 3 percent slopes) (KC).--This soil is level and nearly level. It occurs in the eastern part of the county, along Ute Creek and its tributaries. Included with this soil in mapping are areas of Berthoud and Tucumcari soils.

This soil is slowly permeable. Runoff is slow, and the erosion hazard is moderate. Roots can penetrate to a depth of about 60 inches or more. The water-supplying capacity during the growing season is 11 to 13 inches. Runoff is 2 to 3 inches. Locally, this soil receives some runoff from the adjacent slopes. Fertility is moderate.

Representative profile, 30 feet west of old trail, 400 feet north and 1,100 feet east of the SW. corner of sec. 33, T. 18 N., R. 30 E.:

A1--0 to 7 inches, dark grayish-brown (10YR 4/2) clay loam, dark brown (10YR 3/3) when moist;

moderate, medium, granular structure; hard, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; noncalcareous, neutral (pH 7.0); clear boundary; horizon 3 to 8 inches thick.

B21t--7 to 15 inches, dark grayish-brown (10YR 4/2) clay, dark brown (10YR 3/3) when moist; moderate, coarse, prismatic and moderate, medium, angular blocky structure; very hard, extremely firm when moist, sticky and plastic when wet; many very fine roots; thin patchy clay films; common pressure faces on peds; noncalcareous, mildly alkaline (pH 7.4); clear boundary; horizon 7 to 14 inches thick.

B22t--15 to 24 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; moderate, coarse, prismatic and moderate, medium, angular blocky structure; very hard, extremely firm when moist, sticky and plastic when wet; common very fine roots; thin patchy clay films; common pressure faces on peds; slightly calcareous, mildly alkaline (pH 7.8); gradual boundary; horizon 9 to 12 inches thick.

B3ca--24 to 42 inches, grayish-brown (10YR 5/2) light clay, dark grayish brown (10YR 4/2) when moist; weak, medium, angular blocky structure; very hard, extremely firm when moist, sticky and plastic when wet; few very fine roots; common pressure faces on peds; few threads of lime and lime nodules; strongly calcareous mildly alkaline (pH 7.8); gradual boundary; horizon 7 to 16 inches thick.

Cca--42 to 60 inches, brown (7.5YR 5/3) heavy sandy clay loam, dark brown (7.5YR 4/4) when moist, massive; hard, very friable when moist, slightly sticky and slightly plastic when wet; no roots; common distinct threads of lime; strongly calcareous, mildly alkaline (pH 7.8).

The A horizon has a hue of 7.5YR to 10YR and values from 4 or 5 when dry and 2 or 3 when moist. The A horizon ranges from heavy loam to clay loam. Locally, this horizon is calcareous. The B2t horizon has a hue of 7.5YR or 10YR and chromas of 2 to 4. The B2t horizon is clay in texture and has a clay content of 40 to 50 percent. The C horizon has a hue of 5YR to 10YR. Lime accumulations in the lower part of the B and upper part of the C horizons range from few to common.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIs-1; Loamy 2 range site)

Kinkead clay loam, alkali (0 to 3 percent slopes) (KK).--This soil is level and nearly level. It occurs west of Ute and Tequesquite Creeks.

This soil is very slowly permeable. Runoff is slow. The erosion hazard is moderate. Fertility is low. Water-supplying capacity during the growing season is 16 to 23 inches from precipitation and from additional runoff from adjacent slopes.

This soil is similar to Kinkead clay loam, but it is moderately to severely affected by salts and alkali, and the substratum, below a depth of 40 inches, is heavy clay loam. Many slick spots occur and occupy 25 percent of the area. Only the more salt-tolerant grasses, including inland saltgrass, and alkali sacaton grow on these slick spots.

On 35 percent of the acreage, the surface layer has been so eroded that the clay subsoil is exposed. Some of the surface layer remains around clumps of alkali sacaton, and this causes the surface to have rough microrelief. A thin crust of white salt is common on the surface. The subsoil and substratum contain many, fine, prominent threads of salt and gypsum crystals.

Thirty percent of this mapping unit consists of Kinkead clay loam that is slightly to moderately salt and alkali affected. These areas occur in a complex pattern. The surface layer ranges from loam to clay loam.

Ten percent of this unit consists of soils that have an overburden ranging in thickness from 2 to 12 inches. The overburden ranges from loam or fine sandy loam to sandy clay loam. It occurs in areas of 1/2 acre to 2 acres.

This soil is used for range and wildlife. (Dryland capability unit VIs-7; Salt Flats range site)

La Brier Series

The La Brier series consists of well-drained soils that have a clay to heavy clay loam subsoil. These soils formed in moderately fine textured alluvium and silty wind-laid deposits on the uplands. Slopes are 0 to 3 percent. The vegetation is mainly short grasses and forbs. Elevations range from 5,000 to 5,900 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Dumas, Dioxice, and Manzano series.

Typically, the surface layer is mainly very dark grayish-brown heavy loam and is about 8 inches thick. The upper part of the subsoil is dark grayish-brown and grayish-brown clay about 23 inches thick. The lower part is light-brown clay loam about 29 inches thick. The substratum is pink silty clay loam that is high in lime content. The soil is noncalcareous to a depth of 11 to 24 inches. In places the surface layer is grayish-brown clay loam about 6 inches thick.

La Brier soils are used for range, dryfarmed crops, supplemental pasture, wildlife, and water supply.

La Brier loam (0 to 3 percent slopes) (La) (LB).--This soil is level and nearly level in both the medium- and low-intensity surveys. It occurs in the west-central part of the county in the medium-intensity survey and in the northeastern part of the county in the low-intensity survey. Included in mapping in the medium-intensity survey are areas of Dumas and Dioxice soils and La Brier loam, eroded. Included in the low-intensity survey are areas of Dumas and Campus soils that occupy about 15 percent of the acreage.

This soil is slowly permeable. Runoff is slow. The hazard of soil blowing is moderate. Roots can penetrate to a depth of 60 inches or more. The water-supplying capacity during the growing season is 12 to 14 inches. Runoff is 2 to 3 inches. Fertility is moderate.

Representative profile, 625 yards south of the NE. corner of sec. 16, T. 19 N., R. 28 E.:

A11--0 to 2 inches, grayish-brown (10YR 5/2) silt loam, overburden from nearby field, dark brown (10YR 3/3) when moist; weak, thin, platy structure; soft, friable when moist, slightly sticky and nonplastic when wet; many fine roots; noncalcareous, neutral (pH 7.2); abrupt boundary; horizon 0 to 2 inches thick.

A12--2 to 8 inches, very dark grayish-brown (10YR 3/1.5) heavy loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; noncalcareous, neutral (pH 7.2); gradual boundary; horizon 4 to 7 inches thick.

B1--8 to 11 inches, dark grayish-brown (10YR 4/2) light clay, very dark grayish brown (10YR 3/2) when moist; strong, fine and medium, subangular blocky structure; hard, firm when moist, sticky and plastic when wet; common fine roots; very fine sand and coarse silt on the ped surfaces; noncalcareous, neutral (pH 7.0); clear boundary; horizon 2 to 4 inches thick.

B21t--11 to 20 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate to strong, coarse, angular blocky and weak, medium, prismatic structure; very hard, firm to very firm when moist, sticky and plastic when wet; common very fine roots; vertical cleavage slightly dominant; discontinuous clay film along vertical planes; shiny faces or pressure marks on surfaces of peds; noncalcareous, neutral (pH 7.2); gradual boundary; horizon 5 to 11 inches thick.

B22t--20 to 31 inches, grayish-brown (10YR 5/2) clay, dark brown (10YR 3/3) when moist; strong, medium, angular blocky structure; very hard, firm when moist, sticky and plastic when wet; few fine roots; slight coatings and moderately distinct, continuous, shiny clay films on ped surfaces; moderately calcareous, mildly alkaline (pH 7.8); gradual boundary; horizon 7 to 12 inches thick.

B3ca--31 to 60 inches, light-brown (7.5YR 6/3) clay loam, brown (7.5YR 5/3) when moist; weak to moderate, medium to coarse, subangular blocky structure; hard, friable when moist, sticky and plastic when wet; no roots; white lime nodules 1/2 inch in diameter; strongly calcareous, moderately alkaline (pH 8.1); diffuse boundary; horizon 15 to 30 inches thick.

Cca--60 to 72 inches, pink (7.5YR 8/3; 7.5YR 7/3 when moist) silty clay loam; massive; hard, friable when moist, slightly sticky and slightly plastic when wet; no roots; numerous friable concretions of segregated calcium carbonate; strongly calcareous, strongly alkaline (pH 8.5).

The A horizon has chroma of 1 to 3. The texture of the A horizon is heavy loam to silt loam. The B2t horizon has a value of 4 or 5 when dry and a chroma of 2 or 3. The B1 and B2 horizons range from heavy clay loam or heavy silty clay loam to clay or silty clay. The B3ca horizon has a hue of 7.5YR or 10YR, values of 5 or 6 when dry and 4 or 5 when moist, and a chroma of 2 or 3. The B3ca horizon is clay loam to silty clay loam.

This soil is used for range, dryfarmed crops, supplemental pasture, wildlife, and water supply in the medium-intensity survey, and for range, wildlife, and water supply in the low-intensity survey. (Dryland capability unit IVs-1; Loamy 1 range site)

La Brier loam, eroded (0 to 3 percent slopes) (Lc).--This soil is level and nearly level. It occurs in old formerly cultivated fields in the west-central part of the county. Included in mapping are areas of Tricon, Dumas, and Dioxice soils.

This soil is similar to La Brier loam, but the surface layer and part of the subsoil commonly have been removed by soil blowing. Adjacent areas may have soil accumulations of several inches. Some patches of the original surface layer remain. A few scattered caliche nodules are on the surface in some places. Runoff is medium. The hazard of soil blowing is moderate. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIs-1; Loamy 1 range site)

La Brier clay loam (0 to 2 percent slopes) (Ld).--This soil is level and nearly level. It occurs in the central part of the county. This soil is similar to La Brier loam, but it has a grayish-brown clay loam surface layer about 6 inches thick. Also, the substratum of this soil has a lower lime content than that of La Brier loam. Included with this soil in mapping are areas of Manzano and Dioxice soils.

This soil is slowly permeable. Runoff is slow. The hazard of soil blowing is moderate. Roots can penetrate to a depth of 60 inches or more. The water-supplying capacity during the growing season is 12 to 14 inches. Runoff is 2 to 3 inches. Fertility is moderate.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIs-1; Loamy 1 range site)

Lacita Series

The Lacita series consists of well-drained soils that are loam or silt loam in texture. These soils formed in alluvium derived from red, fine-grained

sandstone and shale. Slopes are 1 to 9 percent. The vegetation is mainly mid grasses, forbs, and shrubs. Elevations range from 4,000 to 4,800 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Ima and Quay series.

Typically, the surface layer is reddish-brown, calcareous loam about 13 inches thick. The next layer is reddish-brown, calcareous loam or silt loam about 14 inches thick. The substratum is reddish-brown, calcareous loam or silt loam.

Lacita soils are used for range, wildlife, and water supply.

Lacita loam, 1 to 9 percent slopes (LE).--This soil is gently sloping to strongly sloping. It occurs in the eastern part of the county, mainly west of Ute Creek (see pl. I, bottom, right). Included in mapping are areas of Ima, Quay, and Montoya soils.

This soil has moderately slow permeability. Runoff is medium to rapid, and the hazard of water erosion is moderate to severe. Roots can penetrate to a depth of 60 inches or more. The water-supplying capacity during the growing season is 7 to 8 inches. Runoff is 6 to 8 inches. Fertility is low.

Representative profile, 1 mile southwest of Gallegos, 0.3 mile west of graded road, 100 yards south of east-west fence, SW. corner of NE1/4 sec. 23, T. 16 N., R. 30 E.:

A1--0 to 13 inches, reddish-brown (5YR 5/4; 5YR 4/4 when moist) loam; weak, fine, granular structure; soft, friable when moist, nonsticky and nonplastic when wet; many fine roots; common threads and few fine lime nodules; moderately calcareous, moderately alkaline (pH 8.0); gradual boundary; horizon 6 to 15 inches thick.

ACca--13 to 27 inches, reddish-brown (5YR 5/4) loam or silt loam, yellowish red (5YR 4/6) when moist; weak, very coarse, prismatic structure; slightly hard, friable when moist, slightly sticky and nonplastic when wet; common fine roots; common faint threads of lime; strongly calcareous, strongly alkaline (pH 8.5); gradual boundary; horizon 12 to 22 inches thick.

C--27 to 70 inches, reddish-brown (5YR 5/5) loam or silt loam, yellowish red (5YR 4/6) when moist; massive; soft, friable when moist, slightly sticky and nonplastic when wet; few fine roots in upper part; few pebbles; strongly calcareous, strongly alkaline (pH 8.5).

This soil has a hue of 2.5YR or 5YR, values of 4 or 5 when dry and 3 or 4 when moist, and chromas of 4 to 6 throughout. The A horizon ranges from loam and silt loam to fine sandy loam. The AC and C horizons range from loam and silt loam to heavy very fine sandy loam. These horizons have a clay content of 18 to 26 percent and less than 15 percent coarser material than very fine sand. Strata of gravel and sandy or clayey material are common below a depth of 3 feet. Sandstone gravel is commonly scattered on the surface.

This soil is used for range, wildlife, and water supply. It is a source of silt sedimentation. (Dryland capability unit VIe-3; Loamy 2 range site)

Latom Series

The Latom series consists of well-drained soils that are fine sandy loam and loam overlying bedrock at a depth of less than 20 inches. These soils formed in material weathered from sandstone. Slopes are 1 to 5 percent. The vegetation is mainly mid grasses, forbs, and shrubs. Elevations range from 4,200 to 4,800 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Ima, Quay, and Gallegos soils.

Typically, the surface layer is reddish-brown, calcareous fine sandy loam about 6 inches thick. The next layer is reddish-brown, calcareous loam about 10 inches thick. Lime-coated sandstone occurs at a depth of 16 inches.

Latom soils are used for range, wildlife, and water supply.

Latom fine sandy loam (1 to 5 percent slopes) (LF).--This soil is nearly level to gently sloping. It occurs in the southern part of the county. Included in mapping are areas of Ima, Quay, Gallegos, and Tucumcari soils. Depth to sandstone bedrock ranges from 0, where sandstone crops out, to 24 inches within a short horizontal distance.

This soil has moderate permeability. Runoff is medium, and the erosion hazard is moderate. The effective rooting depth is 14 to 20 inches to bedrock. The water-supplying capacity during the growing season is 8 to 10 inches. Runoff is 5 to 6 inches. Fertility is low.

Representative profile, south roadbank, 340 feet west of turnoff to ranch, NW1/4 NE1/4 sec. 21, T. 14 N., R. 31 E.:

A1--0 to 6 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak, medium, granular structure; hard, very friable when moist, nonsticky and nonplastic when wet; many fine roots; moderately calcareous, moderately alkaline (pH 8.2); clear boundary; horizon 5 to 9 inches thick.

ACca--6 to 16 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/4) when moist; weak, medium, granular structure; hard, friable when moist, nonsticky and nonplastic when wet; common fine roots; common distinct threads of lime; moderately calcareous, moderately alkaline (pH 8.4); abrupt boundary; horizon 9 to 11 inches thick.

R--16 inches, weak-red (2.5YR 5/2) sandstone, dark reddish brown (2.5YR 3/3) when moist; thin coat of calcium carbonate on top surface of sandstone; strongly calcareous.

The A and AC horizons have hues of 2.5YR to 7.5YR and values of 4 or 5 when dry and 3 or 4 when moist. The A horizon is fine sandy loam, sandy loam, or stony sandy loam. The AC horizon ranges from fine sandy loam to loam. A thin mantle of waterworn pebbles is common on the ridges.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-8; Sandy range site)

Litle Series

The Litle series consists of well-drained soils that have a clay subsoil. These soils formed in calcareous, moderately saline, gypsiferous, clayey material weathered from shale. Slopes are 1 to 9 percent. The vegetation is mainly short and mid grasses, forbs, and shrubs. Elevations range from 5,400 to 5,900 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Berthoud, Manzano, and Penrose series.

Typically, the surface layer is brown and grayish-brown, calcareous clay loam about 10 inches thick. The subsoil is grayish-brown, calcareous clay and silty clay about 14 inches thick. The substratum is light brownish-gray, calcareous clayey shale.

Litle soils are used for range, wildlife, and water supply.

Litle clay loam (1 to 9 percent slopes) (Lt).--This soil is gently sloping to strongly sloping. It occurs in the western part of the county. Included in mapping are areas of Berthoud, Manzano, Penrose, and Vermejo soils.

This soil is slowly permeable. Runoff is medium to rapid, and the hazard of water erosion is moderate to severe. Effective rooting depth is 20 to 40 inches to shale. The water-supplying capacity during the growing season is 8 to 9 inches. Runoff is 6 to 8 inches. Fertility is low.

Representative profile, about 0.25 mile west and 0.40 mile north of the SE. corner of sec. 27; about 25 feet west of fence in the NE. corner of NW1/4 SE1/4 sec. 27, T. 21 N., R. 25 E.:

A11--0 to 3 inches, brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; moderately calcareous, mildly alkaline (pH 7.8); clear boundary; horizon 3 to 5 inches thick.

A12--3 to 10 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, fine and very fine, granular structure; hard, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; strongly calcareous, moderately alkaline (pH 7.9); gradual boundary; horizon 0 to 7 inches thick.

B2--10 to 16 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; moderate, fine, subangular blocky structure; hard, friable when moist, sticky and plastic when wet; common fine roots; strongly calcareous, moderately alkaline (pH 8.0); gradual boundary; horizon 5 to 14 inches thick.

B3--16 to 24 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate, very fine, angular blocky structure; very hard, friable when moist, sticky and plastic when wet; few fine roots; few shale fragments; strongly calcareous, moderately alkaline (pH 8.1); clear boundary; horizon 8 to 14 inches thick.

C--24 inches, light brownish-gray (2.5Y 6/2) clayey shale, dark grayish brown (2.5Y 4/2) when moist; no roots; few threads of lime between the plates of shale; strongly calcareous, moderately alkaline (pH 8.4).

The A horizon has a value of 4 to 6 when dry and 3 to 5 when moist. The A horizon ranges from clay loam to clay. The B and C horizons have a hue of 10YR to 2.5Y, values of 4 to 6 when dry and 3 to 5 when moist, and a chroma of 2 to 4. Segregation of calcium sulfate in the B and C horizons ranges from about 2 to 12 percent, by volume, and varies from threads to concretions. Depth to shale ranges from 20 to 40 inches. Scattered limestone pebbles are common on the surface, but there are few in the profile.

This soil is used for range, wildlife, and water supply. It is a source of silt sedimentation. (Dryland capability unit VIe-9; Clayey 1 range site)

Mansker Series

The Mansker series consists of well-drained soils that are loam to heavy sandy loam between depths of 10 and 40 inches. These soils formed in old calcareous alluvium on uplands. Slopes are 0 to 9 percent. The vegetation is mainly mid grasses, forbs, and shrubs. Elevations range from 4,000 to 4,800 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Portales and Potter series.

Typically, the surface layer is brown, calcareous fine sandy loam about 5 inches thick. The next layer is brown, calcareous loam about 9 inches thick. The substratum is pink loam that has a high lime content.

Mansker soils are used for range, wildlife, water supply, and, to a limited extent, irrigated farming. Some areas contain Indian artifacts.

Mansker-Portales association, gently sloping (0 to 9 percent slopes) (MA).--This association is gently undulating to strongly sloping. It occurs in the southeastern part of the county.

This association consists of about 55 percent Mansker fine sandy loam, 1 to 9 percent slopes, and 40 percent Portales fine sandy loam, 0 to 5 percent slopes. The remaining 5 percent is Amarillo and Springer soils (see pl. II, top).

The Mansker soil is gently undulating to strongly sloping. Permeability of the Mansker soil is moderate. Runoff is medium, and the erosion hazard is moderate. Rooting depth to the strong lime zone is 15 to 30 inches. The water-supplying capacity during the growing season is 8 to 10 inches. Runoff is 5 to 6 inches. Fertility is low.

The Portales soil is nearly level to gently undulating. It is similar to the Portales fine sandy loam described under the Portales series. Permeability of the Portales soils is moderate. Runoff is medium. The hazard of soil blowing is moderate. Rooting depth to the strong lime zone is 20 to 40 inches. Water-supplying capacity during the growing season is 8 to 10 inches. Runoff is 5 to 6 inches. Fertility is moderate.

Representative profile of Mansker fine sandy loam, 100 feet north and 0.2 mile east of fence corner; NE. corner of SE1/4 sec. 3, T. 16 N., R. 33 E.:

A1--0 to 5 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, medium, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; many fine roots; moderately calcareous, moderately alkaline (pH 8.0); gradual boundary; horizon 4 to 9 inches thick.

AC--5 to 14 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; moderate, medium, granular structure; soft, friable when moist, nonsticky and nonplastic when wet; many fine roots; strongly calcareous, moderately alkaline (pH 8.3); gradual boundary; horizon 6 to 11 inches thick.

Cca--14 to 60 inches, pink (7.5YR 8/4) loam, pink (7.5YR 7/4) when moist; massive; slightly hard, friable when moist, nonsticky and nonplastic when wet; few fine roots in upper part; many threads and masses of lime; strongly calcareous, strongly alkaline (pH 8.5).

The A horizon has a value of 4 or 5 when dry and a chroma of 2 or 3. The AC horizon has a hue of 7.5YR or 10YR, values of 4 or 5 when dry and 3 to 5 when moist, and a chroma of 2 to 4. The Cca horizon ranges from loam to heavy sandy loam.

The soils in this association are used mainly for range, wildlife, and water supply. Small tracts are in use for irrigated crops. (Dryland capability unit VIe-4; Sandy range site)

Mansker-Potter association, gently sloping (1 to 9 percent slopes) (MK).--This association is gently sloping to strongly sloping. It occurs in the eastern part of the county.

This association consists of about 60 percent Mansker fine sandy loam, 1 to 9 percent slopes, and 35 percent Potter fine sandy loam, 1 to 9 percent slopes. The remaining 5 percent is Amarillo soils.

The Mansker soil is gently undulating to strongly sloping. It is similar to the Mansker fine sandy loam that is mapped in the Mansker-Portales association. The Potter soil occurs on the low ridges and knolls and is gently to strongly sloping. It is similar to the Potter fine sandy loam described under the Potter series.

The Potter soil is moderately permeable. Runoff is medium to rapid, and the hazard of water erosion is moderate. Effective rooting depth is 5 to 13 inches to platy caliche. The water-supplying capacity during the growing season is 7 to 8 inches. Runoff is 6 to 8 inches. Fertility is low.

The soils in this association are used for range, wildlife, and water supply. (Mansker part, dryland capability unit VIe-4, Sandy range site; Potter part, dryland capability unit VIIs-1, Shallow 2 range site)

Manzano Series

The Manzano series consist of well-drained soils that have a clay loam or loam subsoil. These soils formed in alluvium along drainageways and the lower parts of alluvial fans. Slopes are 0 to 3 percent. The vegetation is mainly short grasses, mid grasses, and forbs. Elevations range from 4,900 to 6,000 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the La Brier and Berthoud series.

Typically, the surface layer is about 19 inches thick. It is brown loam in the upper part and dark grayish-brown clay loam in the lower part. The subsoil is grayish-brown and brown, calcareous clay loam about 26 inches thick. The substratum is pinkish-gray, calcareous clay loam. The profile is noncalcareous to a depth of 12 to 22 inches.

Manzano soils are used for range, wildlife, water supply, and dryfarmed crops.

Manzano loam (0 to 3 percent slopes) (Mn).--This soil is level and nearly level. It occurs in long, narrow areas in the central part of the county. Included with this soil in mapping are areas of La Brier and Dioxice soils and Manzano clay loam.

This soil has moderately slow permeability. Runoff is slow, and the erosion hazard is moderate. This soil receives water in runoff from adjoining soils, and it is subject to flooding for short periods. Roots can penetrate to a depth of 60 inches or more. The water-supplying capacity during the growing season is 20 to 30 inches. The water comes from precipitation and flooding. Runoff is 2 to 3 inches. Fertility is moderate to high.

Representative profile, 900 feet east and 450 feet south of the NW. corner of section 16 (NW1/4 NW1/4 sec. 16, T. 19 N., R. 27 E.):

A11--0 to 10 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; moderate, fine and medium, granular structure; hard, very

friable when moist, slightly sticky and slightly plastic when wet; many fine roots; noncalcareous, mildly alkaline (pH 7.7); clear boundary; horizon 6 to 12 inches thick.

A12--10 to 19 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, granular structure; hard, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; noncalcareous, moderately alkaline (pH 7.9); clear boundary; horizon 6 to 10 inches thick.

B2--19 to 38 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard, friable when moist, sticky and plastic when wet; common fine roots; slightly calcareous, moderately alkaline (pH 8.0); gradual boundary; horizon 10 to 20 inches thick.

B3ca--38 to 45 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; few threads of lime; moderately calcareous, moderately alkaline (pH 8.2); gradual boundary; horizon 6 to 12 inches thick.

Cca--45 to 60 inches, pinkish-gray (7.5YR 6/2) clay loam, brown (7.5YR 4/2) when moist; weak, medium, subangular blocky structure; no roots; common threads of lime; strongly calcareous, moderately alkaline (pH 8.4).

The A and B2 horizons are 7.5YR or 10YR in hue and, in value, are 3 to 5 when dry and 2 or 3 when moist. Locally, the A horizon is calcareous. The lower part of the A horizon and the B2 horizon range from loam to clay loam. The B3ca and Cca horizons are 7.5YR or 10YR in hue and 3 to 5 in value when moist; chromas are 2 to 4. The B3ca and Cca horizons range from loam to clay loam.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIw-1; Bottomland range site)

Manzano sandy loam (0 to 3 percent slopes) (Mm).--This soil is nearly level to gently undulating. It occurs in the north-central part of the county along Carrizo Creek. Included with this soil in mapping are areas of Otero and Dalhart soils.

This soil is similar to Manzano loam except that it has a sandy loam surface layer that typically is about 16 inches thick. The subsoil is loam, and the substratum is loam that grades to fine sandy loam.

This soil has moderately slow permeability. Runoff is slow. The hazard of soil blowing is moderate. The water-supplying capacity is 20 to 30 inches during the growing season. Water comes from precipitation and flooding. Runoff is 2 to 3 inches. Fertility is moderate.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIw-1; Bottomland range site)

Manzano and La Brier soils (0 to 3 percent slopes) (Mo).--The soils in this undifferentiated group are level and nearly level. They occur along the margins of the uplands in the northwestern and north-central parts of the county.

This mapping unit consists of about 70 percent Manzano clay loam, 0 to 3 percent slopes, and 25 percent La Brier clay loam, 0 to 3 percent slopes. The rest is included soils. The Manzano soil occurs alone, or it is intermingled with the La Brier soil. The Manzano soil is on the lower parts of alluvial fans and adjacent to drainageways. The La Brier soil occurs on the higher parts of alluvial fans. The Manzano soil is similar to Manzano loam, except that it is not subject to flooding and it has a clay loam surface layer that typically is about 13 inches thick. The water-supplying capacity is 12 to 14 inches during the growing season. The La Brier soil is similar to La Brier loam, except that it has a clay loam surface layer about 10 inches thick.

Included with these soils in mapping are areas of Dioxice and Berthoud soils.

The soils in this undifferentiated group are used for range, wildlife, water supply, and, to a limited extent, dryfarmed crops. (Manzano part, dryland capability unit IVec-1; La Brier part, dryland capability unit VIs-1; both soils, Loamy 1 range site)

Manzano Series, Wet Variant

The Manzano series, wet variant, consists of somewhat poorly drained soils that have a silty clay loam to clay loam subsoil. These soils formed in alluvium along drainageways. Slopes are 0 to 5 percent. The vegetation is mainly mid grasses, tall grasses, and forbs. Elevations range from 5,400 to 5,800 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Otero, Campus, and Manzano series.

Typically, the surface layer, about 15 inches thick, is very dark gray loam in the upper part and gray silty clay loam in the lower part. The subsoil is gray silty clay loam about 33 inches thick. The substratum is light-gray clay loam that is mottled with brownish yellow and yellowish brown.

Manzano soils, wet variant, are used for range, native hay, wildlife, and water supply.

Manzano loam, wet variant (0 to 5 percent slopes) (Mr).--This soil is nearly level to gently sloping. It occurs in the north-central part of the county along Carrizo Creek. Included with this soil in mapping are areas of Otero and Campus soils and Manzano sandy loam.

This soil is moderately slowly permeable. Runoff is slow to medium, and the erosion hazard is slight. This soil receives extra water in runoff from adjoining soils and from the water table. The soil is slightly saline and has a water table that fluctuates between 1 and 4 feet from the surface. The

water table is perched because there is an impermeable horizontal layer of shale in the substratum. Roots can penetrate to a depth of 60 inches or more. The water-supplying capacity is 30 inches during the growing season. Runoff is 5 to 6 inches. Fertility is moderate.

Representative profile, 0.2 mile west of the gate from State Route 120, 350 feet east of Carrizo Creek in NW1/4 NW1/4 sec. 17, T. 21 N., R. 28 E.:

A1--0 to 5 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; moderate, fine, granular structure; soft, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; moderately calcareous; moderately alkaline (pH 8.0); clear, wavy boundary; horizon 4 to 10 inches thick.

A3--5 to 15 inches, gray (2.5Y 5/1) silty clay loam, very dark gray (2.5Y 3/1) when moist; moderate, fine, granular structure; hard, very friable when moist, sticky and plastic when wet; many fine roots; strongly calcareous, moderately alkaline (pH 8.4); clear boundary; horizon 8 to 12 inches thick.

B2g--15 to 23 inches, gray (2.5Y 5/1) silty clay loam, very dark gray (2.5Y 3/1) when moist; weak, fine and medium, granular structure; hard, very friable when moist, sticky and plastic when wet; common fine roots; iron staining in old root channels; strongly calcareous, moderately alkaline (pH 8.2); gradual boundary; horizon 6 to 12 inches thick.

B3g--23 to 48 inches, gray (5Y 5/1) silty clay loam, dark olive gray (5Y 3/2) when moist; massive; hard, very friable when moist, sticky and plastic when wet; few fine roots; iron staining in old root channels; strongly calcareous, moderately alkaline (pH 8.3); clear boundary; horizon 15 to 28 inches thick.

C1g--48 to 65 inches, light-gray (5Y 6/1) clay loam, olive gray (5Y 4/2) when moist; common, medium, distinct mottles of brownish yellow (10YR 6/6) and yellowish brown (10YR 5/8) when moist; massive; hard, friable when moist, sticky and plastic when wet; few fine roots; strongly calcareous, moderately alkaline (pH 8.3); clear boundary; horizon 12 to 25 inches thick.

C2g--65 to 72 inches, light-gray (5Y 7/1) clay loam, olive gray (5Y 5/2) when moist; common, medium, distinct mottles of brownish yellow (10YR 6/6) and yellowish brown (10YR 5/8) when moist; massive; hard, friable when moist, sticky and plastic when wet; no roots; strongly calcareous, moderately alkaline (pH 8.2).

When dry, the A horizon ranges from 3 to 5 in value; chroma is 1 or 2. The A1 horizon ranges from silt loam to fine sandy loam. The A3 horizon ranges from silty clay loam to clay loam. The B horizon is 4 or 5 in value when dry and 2 or 3 when moist. The B horizon ranges from silty clay loam to clay loam and is 28 to 34 percent clay and more than 15 percent coarser material than very fine sand.

This soil is used for range, native hay, wildlife, and water supply. (Dryland capability unit VIw-3; Meadow range site)

Montoya Series

The Montoya series consists of well-drained soils that have a clay to silty clay subsoil. These soils formed in clay alluvium derived from red-bed shale. Slopes are 0 to 2 percent. The vegetation is mainly short and mid grasses and forbs. Elevation ranges from 4,000 to 4,600 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Tucumcari, Quay, and Lacita series.

Typically, the surface layer is reddish-brown, calcareous silty clay loam grading to clay. This layer is about 7 inches thick. The subsoil is reddish-brown, calcareous clay about 16 inches thick. The substratum is reddish-brown, calcareous clay.

Montoya soils are used for range, wildlife, and water supply.

Montoya clay (0 to 2 percent slopes) (MT).--This soil is level and nearly level. It occurs in the southern part of the county and west of Ute Creek. Included with this soil in mapping are areas of Vernon, Lacita, Tucumcari, and Quay soils.

This soil is very slowly permeable. Runoff is medium, and the erosion hazard is moderate. Roots can penetrate to a depth of 60 inches. The water-supplying capacity during the growing season is 25 to 30 inches from natural precipitation and additional runoff received from surrounding soils. Runoff is 5 to 6 inches. Fertility is moderate.

Representative profile, 115 feet west of trail and 0.2 mile south of gate in the NE. corner of sec. 7, T. 15 N., R. 31 E.:

A1--0 to 7 inches, reddish-brown (5YR 4/3) silty clay loam becoming clay at a depth of 2 inches, dark reddish brown (5YR 3/3) when moist; moderate, thin, platy structure in the upper 2 inches becoming weak, medium, angular blocky; hard, friable when moist, sticky and plastic when wet; many very fine roots; moderately calcareous, moderately alkaline (pH 8.4); gradual boundary; horizon 4 to 8 inches thick.

B2--7 to 23 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; weak, medium, angular blocky structure; very hard, very firm when moist, very sticky and very plastic when wet; common to few, very fine roots; common intersecting slickensides; strongly calcareous, moderately alkaline (pH 8.4); gradual boundary; horizon 12 to 20 inches thick.

C1--23 to 60 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; massive; very hard, very firm when moist, very sticky and plastic when wet; no roots; few threads of lime; strongly calcareous, strongly alkaline (pH 8.5).

The A horizon has a hue of 5YR or 7.5YR. This horizon ranges from silty clay loam or clay loam to

clay. The B2 and C horizons have a hue of 2.5YR or 5YR and values of 4 or 5 when dry and 3 or 4 when moist. These horizons are silty clay to clay. Commonly, there are many cracks 1/2 to 1 inch wide extending to a depth of 2 feet or more when the soil is dry. Stratified layers of sand and gravel are common at a depth below 50 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIew-1; Salty Bottomland range site)

Otero Series

The Otero series consists of well-drained soils that are mainly fine sandy loam. These soils formed in old alluvium and sandy wind-laid deposits on the margins of the mesa uplands. Slopes are 1 to 9 percent. The vegetation is mainly mid and tall grasses, forbs, and shrubs. Elevations range from 4,700 to 5,900 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Dalhart and Campus series.

Typically, the surface layer is grayish-brown, calcareous loamy fine sand about 6 inches thick. The next layer is grayish-brown, calcareous fine sandy loam about 8 inches thick. The substratum is pale-brown, calcareous fine sandy loam and loamy sand. In places the surface layer is brown fine sandy loam about 9 inches thick.

Otero soils are used for range, wildlife, and water supply.

Otero loamy fine sand, 1 to 9 percent slopes (Or).--This soil is gently undulating to gently rolling. It occurs in the north-central part of the county. Included in mapping are areas of Manzano and Dean soils and Otero fine sandy loam. Buried horizons of indurated caliche at a depth below 20 inches occur on the edges of some ridges.

This soil has moderately rapid permeability. Runoff is slow. The hazard of soil blowing is severe. Roots can penetrate to a depth of about 60 inches or more. The water-supplying capacity during the growing season is 12 to 14 inches. Runoff is 2 to 3 inches. Fertility is moderate.

Representative profile, 150 feet west of trail at the SW. corner of NW1/4 NW1/4 sec. 8, T. 21 N., R. 28 E.:

A1--0 to 6 inches, grayish-brown (10YR 5/2) loamy fine sand, dark brown (10YR 3/3) when moist; weak, very fine, granular structure; slightly hard, very friable when moist, nonsticky and nonplastic when wet; many fine roots; moderately calcareous, moderately alkaline (pH 8.0); clear boundary; horizon 5 to 10 inches thick.

AC--6 to 14 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; hard, very friable when moist, nonsticky and nonplastic when wet; common fine roots; strongly calcareous, moderately alkaline (pH 8.2); gradual boundary; horizon 8 to 15 inches thick.

C1ca--14 to 28 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; moderate, fine and medium, granular structure; hard, very friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many, fine, distinct lime nodules; strongly calcareous, moderately alkaline (pH 8.4); gradual boundary; horizon 9 to 16 inches thick.

C2--28 to 65 inches, pale-brown (10YR 6/3) loamy sand, brown (10YR 5/3) when moist; massive; soft, very friable when moist, nonsticky and nonplastic when wet; few fine roots; few threads and nodules of lime; strongly calcareous, moderately alkaline (pH 8.4).

The A horizon has a hue of 7.5YR or 10YR, values of 4 or 5 when dry and 3 or 4 when moist, and chromas of 2 to 4. The AC horizon has hues of 7.5YR and 10YR, values of 5 or 6 when dry and 4 or 5 when moist, and chromas of 2 to 4. The C horizon has hues of 7.5YR and 10YR, values of 6 or 7 when dry and 5 or 6 when moist, and chromas of 3 to 6. Buried loam or clay loam soils are common at a depth below 40 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-5; Deep Sand range site)

Otero fine sandy loam (1 to 5 percent slopes) (Os) (OT).--This soil is nearly level to gently sloping or gently undulating in the medium-intensity survey and is gently undulating to gently sloping in the low-intensity survey. It occurs in the north-central part of the county in the medium-intensity survey and in the northeastern part of the county in the low-intensity survey. Included in the medium-intensity survey are areas of Dalhart and Campus soils and Otero loamy fine sand, which make up about 10 percent of the acreage mapped as this Otero soil. Included in the low-intensity survey are areas of Mansker, Portales, and Dalhart soils, which make up about 15 percent of the acreage.

This soil is similar to Otero loamy fine sand, 1 to 9 percent slopes, but it has a brown fine sandy loam surface layer typically about 9 inches thick. Runoff is medium. The hazard of soil blowing is moderate. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIe-2; Sandy range site)

Pastura Series

The Pastura series consists of well-drained soils that are 6 to 19 inches thick over indurated caliche. These soils formed in mixed alluvium and calcareous,

loamy, wind-laid deposits. Slopes are 0 to 5 percent. The vegetation is mainly short and mid grasses and forbs. Elevations range from 4,800 to 6,000 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Apache and Dioxice series.

Typically, the surface layer is grayish-brown, calcareous loam about 7 inches thick. The next layer is grayish-brown, calcareous gravelly loam about 3 inches thick. The substratum is white, indurated caliche. In places the surface layer is brown fine sandy loam about 7 inches thick.

Pastura soils are used for range, wildlife, and water supply.

Pastura loam (1 to 5 percent slopes) (Pc).--This soil is nearly level to gently sloping. It occurs in the north-central part of the county. Included with this soil in mapping are areas of Apache and Dioxice soils and of slick spots that are alkali affected, dispersed, and very slowly permeable.

This soil is moderately permeable. Runoff is medium, and the hazard of water erosion is moderate. The effective rooting depth to indurated caliche is 6 to 19 inches. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches. Fertility is moderate.

Representative profile, 25 feet west of trail, 0.4 mile southeast of windmill, in NW1/4 NW1/4 sec. 36, T. 22 N., R. 28 E.:

A1--0 to 7 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, very fine, granular structure; slightly hard, very friable when moist, nonsticky and nonplastic when wet; many fine roots; 5 to 10 percent of surface covered with caliche fragments; slightly calcareous, moderately alkaline (pH 7.9); clear boundary; horizon 3 to 8 inches thick.

C1--7 to 10 inches, grayish-brown (10YR 5/2) gravelly loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; hard, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; 30 percent of volume consists of caliche fragments; moderately calcareous, moderately alkaline (pH 8.3); abrupt boundary; horizon 3 to 11 inches thick.

C2cam--10 inches, white (10YR 8/2), indurated caliche, very pale brown (10YR 7/3) when moist; the hardness of the caliche gradually decreases with depth, and the caliche is weakly cemented about 2 feet below the surface of this horizon.

The A horizon has a value of 4 or 5 when dry and a chroma of 2 or 3. The C1 horizon has values of 5 to 7 when dry and 3 to 5 when moist and a chroma of 2 or 3. The C1 horizon is loam to gravelly loam. The content of indurated caliche gravel in the C1 horizon ranges from 10 to 35 percent. The depth to indurated caliche ranges from 6 to 19 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIIs-1; Shallow 1 range site)

Pastura fine sandy loam (0 to 9 percent slopes) (PA).--This soil is nearly level to gently sloping. It occurs in the northeastern part of the county. Included in mapping are areas of Campus and Dean soils.

This soil is similar to Pastura loam, except that it has a brown fine sandy loam surface layer typically about 7 inches thick.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIIs-1; Shallow 1 range site)

Penrose Series

The Penrose series consists of well-drained soils that are 4 to 20 inches thick over bedrock. These soils formed in material weathered from limestone bedrock and interbedded shale below the mesa. Slopes are 0 to 12 percent. Vegetation is mainly short and mid grasses and forbs. Elevations range from 5,400 to 5,900 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Litle and Berthoud series.

The surface layer of the profile described is light brownish-gray, calcareous clay loam about 6 inches thick, but areas mapped contain areas of significant size where this layer is loam or channery loam. The surface layer is abruptly on light-gray limestone bedrock.

Penrose soils are used for range, wildlife, and water supply.

Penrose soils, 0 to 12 percent slopes (Pe).--The soils in this undifferentiated group are gently sloping to strongly sloping. They occur in the western part of the county. Included with these soils in mapping are areas of Dean, Berthoud, and Litle soils and limestone outcrops.

The soils in this undifferentiated group are moderately permeable. Runoff is rapid, and the hazard of water erosion is moderate. The effective rooting depth to bedrock is 4 to 20 inches. The water-supplying capacity during the growing season is 7 to 9 inches. Runoff is 7 to 8 inches. Fertility is low.

Representative profile, 600 feet north and 1,150 feet west of the SE. corner of sec. 14, T. 21 N., R. 25 E.:

A11--0 to 3 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; weak, very fine, granular structure; soft, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; 10 percent limestone fragments; moderately calcareous, moderately alkaline (pH 8.1); clear boundary; horizon 2 to 10 inches thick.

A12--3 to 6 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; slightly hard, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; 10 percent limestone fragments; few threads of lime; strongly calcareous, strongly alkaline (pH 8.5); abrupt boundary; horizon 2 to 10 inches thick.

R--6 inches, light-gray (10YR 6/1) limestone bedrock, grayish brown (10YR 5/2) when moist; horizon several feet thick; some interbedded shale.

The A horizon has a hue of 10YR or 2.5Y, values of 5 or 6 when dry and 4 or 5 when moist, and a chroma of 2 or 3. The A horizon is clay loam, loam, or channery loam. The percentage of channery fragments in the A horizon ranges from 5 to 30 percent. The limestone is interbedded with shale. Depth to limestone bedrock is 4 to 20 inches.

This undifferentiated group is used for range, wildlife, and water supply. (Dryland capability unit VIIs-1; Shallow 1 range site)

Portales Series

The Portales series consists of well-drained soils that have a loam to clay loam subsoil. These soils formed in old calcareous alluvium and mixed wind-laid deposits on uplands. Slopes are 0 to 5 percent. Vegetation is mainly mid grasses, forbs, and shrubs. Elevations range from 4,000 to 4,800 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Mansker and Amarillo series. Portales soils were not mapped separately in this county. They were mapped only in an association with Mansker soils.

Typically, the surface layer is dark grayish-brown, calcareous fine sandy loam about 10 inches thick. The subsoil is grayish-brown, calcareous loam about 11 inches thick. The substratum is white loam that has a high lime content.

Representative profile of a Portales fine sandy loam, 150 feet southeast of gate on the east-west windmill road in the SW1/4 sec. 3, T. 18 N., R. 32 E.:

A1--0 to 10 inches, dark grayish-brown (10YR 4/2) fine sandy loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure parting to weak, fine, granular; soft, very friable when moist, nonsticky and nonplastic when wet; many fine roots; moderately calcareous, moderately alkaline (pH 8.0); clear boundary; horizon 7 to 12 inches thick.

B2--10 to 21 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; soft, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; common distinct threads of lime; strongly calcareous, moderately alkaline (pH 8.4); gradual boundary; horizon 11 to 22 inches thick.

Cca--21 to 60 inches, white (10YR 8/2) loam, grayish brown (10YR 5/2) when moist; massive; soft, friable when moist, slightly sticky and nonplastic when wet; no roots; many lime nodules; strongly calcareous, strongly alkaline (pH 8.5).

The A horizon has a hue of 7.5YR or 10YR, a value of 4 or 5 when dry, and a chroma of 2 or 3. The B2 horizon has a hue of 7.5YR or 10YR, values of 5 or 6 when dry and 4 or 5 when moist, and a chroma of 2 or 3. The B horizon ranges from loam to clay loam. The C horizon has a hue of 7.5YR or 10YR, values of 7 or 8 when dry and 5 to 7 when moist, and a chroma of 2 or 3.

Portales soils are used for range, wildlife, water supply, and, to a limited extent, irrigated farming. Some areas contain Indian artifacts.

Potter Series

The Potter series consists of well-drained fine sandy loams that are 5 to 13 inches thick over caliche. These soils formed in material weathered from beds of caliche on uplands. Slopes are 1 to 9 percent. Vegetation is mainly short and mid grasses, forbs, and shrubs. Elevations range from 4,200 to 4,800 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Mansker and Amarillo series. Potter soils were not mapped separately in this county. They were mapped only in an association with Mansker soils.

Typically, the surface layer is grayish-brown and brown, calcareous fine sandy loam about 8 inches thick. Underlying the surface layer is a substratum of fractured, platy caliche.

Representative profile of a Potter fine sandy loam, 0.7 mile south and 0.5 mile west of the NE. corner of sec. 36, T. 17 N., R. 33 E.:

A11--0 to 4 inches, grayish-brown (10YR 5/2) fine sandy loam, brown (10YR 4/3) when moist; weak, fine, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; many fine roots; common medium caliche gravel; moderately calcareous, moderately alkaline (pH 8.2); clear boundary; horizon 2 to 6 inches thick.

A12--4 to 8 inches, brown (10YR 5/3) heavy fine sandy loam, dark yellowish brown (10YR 3/4) when moist; weak, fine, granular structure; slightly hard, friable when moist, nonsticky and nonplastic when wet; many fine roots; common medium caliche gravel; strongly calcareous, moderately alkaline (pH 8.4); abrupt boundary; horizon 3 to 7 inches thick.

Cca--8 inches, white (10YR 8/2) fractured, platy, strongly cemented caliche, decreasing in

hardness below depth of about 2.5 feet; few roots between fractures; strongly calcareous, strongly alkaline (pH 8.5).

The A horizon has a hue of 7.5YR or 10YR and a value of 5 or 6 when dry. Content of caliche gravel ranges from 10 to 25 percent in the A horizon. The Cca horizon ranges from weakly cemented caliche to fractured, platy, strongly cemented caliche. Depth to caliche is 5 to 13 inches.

Potter soils are used for range, wildlife, and water supply.

Quay Series

The Quay series consists of well-drained soils that have a loam to clay loam subsoil. These soils formed in calcareous alluvium on old alluvial fans. Slopes are 1 to 4 percent. The vegetation is principally short and mid grasses, forbs, and shrubs. Elevation ranges from 4,000 to 4,600 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Ima and Tucumcari series. Quay soils were not mapped separately in this county. They were mapped in an undifferentiated group with Ima soils and in an association with Tucumcari soils.

Typically, the surface layer is brown, calcareous loam about 7 inches thick. The subsoil is reddish-brown, calcareous heavy loam about 11 inches thick. The substratum is pink loam that is high in content of lime. In some places the surface layer is reddish-brown fine sandy loam.

Representative profile of a Quay loam, 30 feet south of trail and 0.2 mile west of first terrace edge west of Ute Creek, SE1/4 NW1/4 sec. 22, T. 14 N., R. 32 E.:

A1--0 to 7 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) when moist; moderate, fine, granular structure; slightly hard, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; moderately calcareous, moderately alkaline (pH 8.0); clear boundary; horizon 6 to 12 inches thick.

B2--7 to 18 inches, reddish-brown (5YR 5/4) heavy loam, reddish brown (5YR 4/4) when moist; moderate, fine, subangular blocky structure; very hard, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; common distinct threads of lime in old root channels; strongly calcareous, moderately alkaline (pH 8.2); gradual, wavy boundary; horizon 9 to 21 inches thick.

Cca--18 to 60 inches, pink (5YR 8/4) loam, yellowish red (5YR 5/6) when moist; massive; slightly hard, friable when moist, slightly sticky and nonplastic when wet; no roots; many threads and soft masses of lime, decreasing in number below depth of 38 inches; strongly calcareous; strongly alkaline (pH 8.5).

The A horizon has hues of 5YR and 7.5YR, a value of 4 or 5 when dry, and a chroma of 3 or 5. The B2 horizon has hues of 5YR and 7.5YR, values of 5 or 6 when dry and 4 or 5 when moist, and chromas of 4 to 6. The B2 horizon ranges from loam to clay loam. The C horizon has hues of 5YR and 7.5YR and values of 6 to 8 when dry and 5 to 6 when moist. The C horizon ranges from loam to clay loam.

Quay soils are used for range, wildlife, and water supply.

Riverwash

Riverwash (RH) is level and nearly level. It occurs along the stream channels of the major streams in the county. Included in mapping are small areas of Guadalupe, Bippus, and Tivoli soils.

This land type consists of sand, gravel, cobblestones, and boulders along the channels of such streams as the Canadian River, La Cinta Creek, Ute Creek, Bueyeros Creek, Arroyo del Cejito, Arroyo del Alamo, Mosquero Creek, Tequesquite Creek, and Carrizo Creek. It is subject to periodic overflow. There is shifting of soil materials during normal high water. The hazard of water erosion is very severe. This land type is barren of vegetation other than a few annual weeds and a few saltcedars.

This land type is used mainly for water supply. Pools of water within areas of this land type are sources of water for livestock and wildlife. Some tracts are used as a source of sand and gravel. (Dryland capability unit VIIIw-1)

Rough Broken Land

Rough broken land (RK) is steep to very steep and occurs in the southeastern part of the county along Ute Creek. Included in mapping are areas of Vernon, Lacita, and Latom soils and Rough broken and stony land.

This land type consists of rough breaks and escarpments that are composed of red-bed shales and clays, as well as some interbedded sandstone. The ridges above the escarpments are commonly covered with water-worn gravel. These areas are characterized by active geologic erosion. Numerous gullies and drainageways are cutting back into the red-bed shales, clays, and sandstones.

Runoff is very rapid, and the hazard of water erosion is severe. The water-supplying capacity during the growing season is about 4 to 6 inches. Runoff is 9 to 11 inches. Fertility is low.

This land type is used for range, wildlife, water supply, and recreation. It is a source of silt sedimentation. (Dryland capability unit VIIs-2; Hills range site)

Rough Broken and Stony Land

Rough broken and stony land (Rn) (RO) consists of steep and very steep soils. It occurs in the

western, southwestern, and north-central parts of the county in the medium-intensity survey and in the north-central part of the county in the low-intensity survey.

In the medium-intensity area, this mapping unit consists of very shallow, steep to very steep soils on side slopes and in deep canyons, as well as the adjoining areas that are rough and stony. The surface is nearly covered with escarpments, outcrops, and boulders of sandstone and some shale.

In the low-intensity survey, this unit consists of very shallow, steep to very steep soils along the margins of basalt-capped mesas. Below the cap of basalt are many sandstone and shale outcrops and boulders.

Patchy pockets of soil, called meadows, occur within the area. The meadows consist of very shallow to deep, loamy soils. A few of the meadows occupy as much as 20 percent of a given area mapped as this unit, but more commonly the meadows make up only about 5 percent.

Included in mapping in the medium-intensity survey are areas of Travessilla, Carnero, and Berthoud soils. Included in the low-intensity survey are areas of Apache and Travessilla soils.

Runoff is very rapid, and the hazard of water erosion is moderate to severe. The water-supplying capacity during the growing season is 6 to 8 inches. Runoff is 8 to 9 inches. Fertility is low.

This land type is used for range, wildlife, water supply, and recreation. (Dryland capability unit VIIs-2; Breaks range site)

Springer Series

The Springer series consists of well-drained soils that have a fine sandy loam subsoil. These soils formed in unconsolidated, sandy, wind-laid and alluvial deposits on uplands. Slopes are 0 to 9 percent. The vegetation is mainly mid and tall grasses, forbs, and shrubs. Elevations range from 4,000 to 4,800 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Amarillo and Tivoli series.

Typically, the surface layer is brown and reddish-brown loamy fine sand about 18 inches thick. The subsoil is yellowish-red light fine sandy loam about 14 inches thick. The substratum is brown loamy fine sand. The soil is noncalcareous to depths of 24 to more than 65 inches.

Springer soils are used mainly for range, wildlife, and recreation. A few tracts are used for irrigated farming.

Springer loamy fine sand, 1 to 9 percent slopes (SP).--This soil is gently undulating to gently rolling. It occurs in the eastern part of the county. Included in mapping are areas of Amarillo and Tivoli soils.

This soil has moderately rapid permeability. Runoff is very slow. The hazard of soil blowing is severe. Roots can penetrate to a depth of about 60 inches or more. The water-supplying capacity during the growing season is 12 to 15 inches. Runoff is about 1 inch. Fertility is moderate.

Representative profile, 25 feet west of trail, 0.35 mile north of intersection of trails in the SW1/4 sec. 1, T. 15 N., R. 33 E.:

A11--0 to 7 inches, brown (7.5YR 4/3) loamy fine sand, dark brown (7.5YR 3/3) when moist; weak, fine, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; many fine roots; noncalcareous, mildly alkaline (pH 7.6); clear boundary; horizon 5 to 12 inches thick.

A12--7 to 18 inches, reddish-brown (5YR 5/4) loamy fine sand, reddish brown (5YR 4/4) when moist; weak, fine, granular structure; soft, very friable when moist, nonsticky and nonplastic when wet; many fine roots; noncalcareous, mildly alkaline (pH 7.6); gradual boundary; horizon 5 to 15 inches thick.

B2t--18 to 32 inches, yellowish-red (5YR 5/6) light fine sandy loam, yellowish red (5YR 4/6) when moist; weak, coarse, prismatic and weak, medium, subangular blocky structure; slightly hard, friable when moist, nonsticky and nonplastic when wet; common fine roots; slight organic stains along root channels; patchy clay films; noncalcareous, mildly alkaline (pH 7.8); clear boundary; horizon 11 to 30 inches thick.

C--32 to 65 inches, brown (7.5YR 5/4) loamy fine sand, brown (7.5YR 4/4) when moist; massive; soft, very friable when moist, nonsticky and nonplastic when wet; few fine roots; noncalcareous, mildly alkaline (pH 7.8).

The A horizons have hues of 5YR to 10YR, values of 4 to 6 when dry, and chromas of 3 to 5. The B2t horizon has a hue of 5YR or 7.5YR, a value of 5 or 6 when dry, and chromas of 4 to 6. The B2t horizon is light fine sandy loam to heavy fine sandy loam. The lower part of the B2t horizon is noncalcareous to slightly calcareous. The C horizon has a hue of 7.5YR to 10YR, values of 5 to 7 when dry and 4 to 6 when moist, and chromas of 4 to 6. The C horizon ranges from noncalcareous to moderately calcareous with none to common threads of lime. Buried soils of medium- and fine-textured material are common below a depth of 48 inches.

This soil is used for range and wildlife. (Dryland capability unit VIe-5; Deep Sand range site)

Springer-Amarillo association (0 to 5 percent slopes) (SR).--This association consists of about 50 percent Springer loamy fine sand, 1 to 5 percent slopes, and 40 percent Amarillo loamy fine sand, 1 to 3 percent slopes. The remaining 10 percent is Mansker, Portales, and Tivoli soils (pl. II, bottom).

The Springer soil is similar to Springer loamy fine sand, 1 to 9 percent slopes, but it is gently undulating.

The Amarillo soil is nearly level to gently undulating. It is similar to Amarillo fine sandy loam, but the surface layer is a brown loamy fine sand about 8 inches thick. Runoff is very slow, and the hazard of soil blowing is severe. The water-supplying capacity during the growing season is 12 to 15 inches. Runoff is about 1 inch.

About 5 percent of this association, east of Bueyeros, has a light fine sandy loam surface layer.

The soils in this association are used mainly for range and wildlife. A few small tracts north of Logan are used for irrigated sorghums and irrigated pasture. (Dryland capability unit VIe-5; Deep Sand range site)

Springer-Amarillo association, severely eroded (0 to 3 percent slopes) (SS).--This association consists of low hummocks, severely eroded soils, and blowout areas. The soils of this association consist of about 30 percent Springer loamy fine sand that has 2 to 4 feet of loamy fine sand accumulated on the surface; about 25 percent Amarillo sandy clay loam, severely eroded; about 15 percent Amarillo loamy fine sand that has 1 to 3 feet of loamy fine sand accumulated on the surface; and about 15 percent Springer fine sandy loam, severely eroded. The remaining 15 percent is Mansker, Portales, and Tivoli soils.

Blowout holes cut into the limy substratum are common. The pattern and composition of soils vary from one area to another. These areas are abandoned fields formerly under dryfarmed cultivation. The erosion hazard is severe to very severe. The low hummocks are mostly stabilized by shrubs and grasses. The blowout areas have little or no vegetation.

These soils are used for range, wildlife, and recreation. Blowout holes are commonly a source of Indian artifacts. For brief periods, water accumulates in the blowout holes after heavy showers. (Springer part, dryland capability unit VIIe-1, Sand Hills range site; Amarillo part, dryland capability unit VIe-5, Deep Sand range site)

Tapia Series

The Tapia series consists of well-drained soils that have a sandy clay loam to heavy loam subsoil. These soils formed in calcareous, loamy, wind-laid and alluvial material over very limy deposits on the mesa. Slopes are 0 to 3 percent. The vegetation is mainly short and mid grasses, forbs, and shrubs. Elevations range from 5,400 to 5,800 feet. The average annual precipitation is 14 to 17 inches, the average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Dalhart and Dumas series.

Typically, the surface layer is brown fine sandy loam about 6 inches thick. The subsoil is reddish-brown and brown sandy clay loam about 19 inches thick. The substratum is very pale brown, indurated caliche. The soil is noncalcareous to depths of 11 to 20 inches. In places the surface layer is loam about 3 inches thick.

Tapia soils are used for range, wildlife and water supply.

Tapia complex (0 to 3 percent slopes) (Ta).--The soils in this complex are level to gently undulating. They occur in the north-central part of the county.

This complex consists of about 85 percent Tapia fine sandy loam, 0 to 3 percent slopes, and 10 percent Tapia loam, alkali, 0 to 1 percent slopes. Included small areas of Dalhart and Dioxice soils make up the remaining 5 percent.

Tapia fine sandy loam is level to gently undulating. Tapia loam, alkali, occurs in oblong or round, slightly depressional spots 10 to 100 feet in diameter.

Tapia fine sandy loam is moderately permeable. Runoff is slow, and the hazard of soil blowing is moderate. Effective rooting depth to indurated caliche is 20 to 36 inches. The water-supplying capacity during the growing season is 12 to 14 inches. Runoff is 2 to 3 inches. Fertility is moderate.

Tapia loam, alkali, is similar to Tapia fine sandy loam except that commonly the surface layer is eroded to the extent that the sandy clay loam subsoil is exposed. It is alkali affected, dispersed, and slowly permeable. Runoff is slow in these depressed areas. Fertility is low.

Representative profile of Tapia fine sandy loam, 0.45 mile south and 45 feet west of the NE. corner of NE1/4 sec. 12, T. 21 N., R. 28 E.:

A1--0 to 6 inches, brown (10YR 4/3) fine sandy loam; dark brown (10YR 3/3) when moist; weak, fine, granular structure; slightly hard, very friable when moist, nonsticky and nonplastic when wet; many fine roots; noncalcareous, mildly alkaline (pH 7.6); clear boundary; horizon 5 to 7 inches thick.

B2t--6 to 20 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, very coarse, prismatic structure parting to weak, fine and medium, subangular blocky structure; very hard, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; patchy clay films; noncalcareous, mildly alkaline (pH 7.7); clear boundary; horizon 11 to 15 inches thick.

B3ca--20 to 25 inches, brown (7.5YR 5/4) sandy clay loam, brown (7.5YR 4/4) when moist; moderate, medium and fine, granular structure; hard, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many medium to coarse caliche fragments; strongly calcareous, moderately alkaline (pH 8.2); abrupt boundary; horizon 4 to 14 inches thick.

Ccam--25 inches, very pale brown (10YR 8/3), strongly cemented to indurated caliche that is less cemented below a depth of about 4 feet.

The A horizon has a hue of 7.5YR or 10YR, a value of 4 or 5 when dry, and a chroma of 2 or 3. The A horizon ranges from fine sandy loam to loam. The B horizon has values of 4 to 6 when dry, The texture of the B horizon is dominantly sandy clay loam but ranges to heavy loam. The depth to indurated caliche ranges from 20 to 36 inches.

This complex is used for range, wildlife, and water supply. (Dryland capability unit VIe-8; Sandy range site)

Tivoli Series

The Tivoli series consists of excessively drained soils that are fine sand throughout. These soils formed in sandy wind-laid deposits on uplands. Slopes are 1 to 9 percent. The vegetation is mainly tall grasses, forbs, and shrubs. Elevations range from 4,100 to 4,700 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Springer and Amarillo series.

Typically, the surface layer is pale-brown fine sand about 10 inches thick. The next layer is light yellowish-brown fine sand to a depth of 60 inches or more (see pl. III, top).

Tivoli soils are used for range and wildlife. Some areas contain Indian artifacts.

Tivoli fine sand (1 to 9 percent slopes) (TF).--This soil is undulating to rolling. It occurs in the sand hills in the eastern part of the county. Included in this mapping unit are areas of Springer and Amarillo soils.

This soil is rapidly permeable. Runoff is very slow. The hazard of soil blowing is very severe. Roots can penetrate to a depth of about 60 inches or more. The water-supplying capacity during the growing season is 12 to 15 inches. Runoff is about 1 inch. Fertility is low.

Representative profile, 0.15 mile north of a clump of cottonwood trees in the NW1/4 sec. 2, T. 15 N., R. 32 E.:

A1--0 to 10 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grain; loose when dry and when moist, nonsticky and nonplastic when wet; many fine roots; noncalcareous, neutral (pH 7.1); gradual boundary; horizon 8 to 16 inches thick.

C--10 to 72 inches, light yellowish-brown (10YR 6/4) fine sand, yellowish brown (10YR 5/6) when moist, single grain; loose when dry and when moist, nonsticky and nonplastic when wet; common fine roots; noncalcareous, neutral (pH 7.5).

The A horizon has hues of 7.5YR and 10YR, a value of 5 or 6 when dry, and a chroma of 3 or 4. The C horizon has hues of 7.5YR and 10YR and values of 5 to 7 when dry and 4 to 6 when moist. This soil generally occupies duned relief but includes areas of deep, loose sands that are not duned. Areas adjacent to major streams may be slightly calcareous because of carbonate recharge from recent wind-laid deposits.

This soil is used for range, wildlife, and, to a limited extent, recreation. (Dryland capability unit VIIe-1; Sand Hills range site)

Tivoli-Springer complex (1 to 9 percent slopes) (TG).--The soils in this complex are undulating to rolling. They occur in the southeastern part of the county.

This complex is about 60 percent Tivoli fine sand, 3 to 9 percent slopes, and 20 percent Springer loamy fine sand, 1 to 5 percent slopes. The Tivoli soil is undulating to rolling and occupies duned relief. The Springer soil is undulating and occurs in complex patterns between the dunes. This soil is similar to the one described as representative of the Springer series, except that it is less sloping.

About 15 percent of the complex is included in small areas of Amarillo soils, and about 5 percent is Mansker and Portales soils.

The soils in this complex are used for range, wildlife, and recreation. (Both soils in dryland capability unit VIIe-1; Tivoli part, Sand Hills range site; Springer part, Deep Sand range site)

Travessilla Series

The Travessilla series consists of well-drained soils that are 4 to 15 inches deep over bedrock. These soils formed in material weathered from sandstone. Slopes are 0 to 9 percent. The vegetation is mainly short and mid grasses, forbs, shrubs, and small trees. Elevations range from 4,600 to 5,700 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Carnero and Berthoud series.

Typically, the surface layer is brown stony loam about 6 inches thick. Abruptly under the surface layer is sandstone bedrock.

Travessilla soils are used for range, wildlife, and water supply.

Travessilla stony loam, 0 to 9 percent slopes (Tr) (TS).--This soil is nearly level to moderately steep in both the medium-intensity and low-intensity surveys. It occurs in the west-central and western parts of the county in the medium-intensity survey, and in the east-central part of the county in the low-intensity survey. Included in mapping in the medium-intensity survey are areas of Carnero and Potter soils and Rough broken and stony land. Included in the low-intensity survey are areas of Rough broken and stony land, which make up 15 percent of the acreage, and areas of Carnero soils, which make up 5 percent.

This soil is moderately permeable. Runoff is rapid, and the hazard of water erosion is moderate. The effective rooting depth to bedrock is 4 to 15 inches. The water-supplying capacity during the growing season is 7 to 9 inches. Runoff is 7 to 8 inches. Fertility is low.

Representative profile, 195 feet north and 990 feet west of the SE. corner of sec. 27, T. 20 N., R. 25 E.:

A1--0 to 6 inches, brown (7.5YR 4/4) stony loam, dark brown (7.5YR 3/3) when moist; moderate, fine and very fine, granular structure; soft, friable when moist, nonsticky and nonplastic when wet; many fine roots; 30 percent of the surface is covered with sandstone fragments; 20 percent sandstone gravel and stones; noncalcareous, mildly alkaline (pH 7.5); abrupt boundary; horizon 4 to 15 inches thick.

R--6 inches, light-brown (7.5YR 6/4), fractured sandstone bedrock, becoming more massive with depth.

The A horizon has hues of 5YR to 10YR and values of 4 or 5 when dry and 3 or 4 when moist. The A horizon ranges from loam or fine sandy loam to stony loam. It is 5 to 35 percent sandstone gravel and stones and is noncalcareous to moderately calcareous. Barren exposures of bedrock are common. The sandstone bedrock is noncalcareous to weakly calcareous. Depth to bedrock is 4 to 15 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIIs-1; Shallow Sandstone range site)

Tricon Series

The Tricon series consists of well-drained soils that have a heavy clay loam to light clay subsoil. These soils formed in loamy old alluvium and windlaid deposits on the mesa. Slopes are 0 to 3 percent. The vegetation is mainly short grasses and forbs. Elevations range from 5,000 to 5,900 feet. The average annual precipitation is 14 to 17 inches, average annual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the La Brier and Dioxice series.

Typically, the surface layer is dark grayish-brown loam about 6 inches thick. The subsoil is dark grayish-brown and grayish-brown heavy clay loam and brown clay loam about 22 inches thick. The substratum is pinkish-gray loam that is high in lime content and overlies pinkish-white, indurated caliche. The soil is noncalcareous to a depth of 9 to 21 inches.

Tricon soils are used for range, wildlife, water supply, and dryfarmed crops.

Tricon loam (0 to 3 percent slopes) (Tt).--This soil is level and nearly level. It occurs in the west-central part of the county. Included in mapping are areas of Dioxice, La Brier, and Campus soils.

This soil is slowly permeable. Runoff is slow. The hazard of soil blowing is moderate. The effective rooting depth to indurated caliche is 20 to 40 inches. The water-supplying capacity during the growing season is 12 to 14 inches. Runoff is 2 to 3 inches. Fertility is moderate.

Representative profile, 30 feet south of power pole, 0.5 mile west of the NE. corner of sec. 1, T. 19 N., R. 27 E.:

A1--0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; noncalcareous, mildly alkaline (pH 7.6); clear boundary; horizon 5 to 8 inches thick.

B21t--6 to 14 inches, dark grayish-brown (10YR 4/2) heavy clay loam, dark brown (10YR 3/3) when moist; moderate, coarse, prismatic and moderate, medium, subangular blocky structure; very hard, firm when moist, sticky and plastic when wet; many fine roots; thin continuous clay films; noncalcareous, moderately alkaline (pH 8.0); clear boundary; horizon 4 to 9 inches thick.

B22t--14 to 21 inches, grayish-brown (10YR 5/2) heavy clay loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic and moderate, fine, subangular blocky structure; very hard, extremely firm when moist, sticky and plastic when wet; common fine roots; few distinct nodules of caliche; thin patchy clay films; slightly calcareous, moderately alkaline (pH 8.1); gradual boundary; horizon 5 to 8 inches thick.

B3ca--21 to 28 inches, brown (7.5YR 5/3) clay loam, dark brown (7.5YR 4/3) when moist; moderate, fine, subangular blocky structure; very hard, extremely firm when moist, sticky and plastic when wet; few fine roots; common faint threads of lime; common distinct caliche nodules; moderately calcareous, moderately alkaline (pH 8.3); gradual boundary; horizon 6 to 8 inches thick.

C1ca--28 to 32 inches, pinkish-gray (7.5YR 6/2) loam, brown (7.5YR 5/4) when moist; massive; hard, friable when moist, nonsticky and nonplastic when wet; few fine roots; 20 to 30 percent calcium carbonate and caliche fragments; strongly calcareous, strongly alkaline (pH 8.6); clear boundary; horizon 6 to 7 inches thick.

C2cam--32 inches, pinkish-white (7.5YR 8/2), indurated caliche, becoming softer below a depth of about 50 inches.

The A horizon has a value of 4 or 5 when dry and a chroma of 2 or 3. The B2t horizon ranges from heavy clay loam to light clay. The Cca horizon has hues of 7.5YR and 10YR and values of 5 to 8 when dry and 4 to 6 when moist. Depth to indurated caliche ranges from 20 to 40 inches but is mainly 30 to 40 inches.

This soil is used for range, dryfarmed crops, wildlife, and water supply. (Dryland capability unit IVs-1; Loamy 1 range site)

Tricon complex (0 to 3 percent slopes) (Tu).--This complex consists of level and nearly level soils in the central part of the county. It is about 85 percent Tricon clay loam, 0 to 3 percent slopes, and 10 percent Tricon clay loam, alkali, 0 to 1 percent slopes. The remaining 5 percent is Dioxice soils.

Tricon clay loam is level and nearly level. It is similar to Tricon loam, but it has a clay loam surface layer about 4 inches thick and indurated caliche occurs at about 25 inches. Effective rooting depth is 20 to 30 inches. Tricon clay loam, alkali, occurs in round or oblong, slightly depressional spots that are 10 to 100 feet in diameter. It is similar to Tricon loam, but commonly the surface layer is eroded to the extent that clay loam subsoil is exposed. It is alkali affected, dispersed, and very slowly permeable. Runoff is slow in these depressional spots. Effective rooting depth is 16 to 26 inches. Fertility is low.

This complex is used for range, wildlife, and water supply. The alkali soils occur in such intricate patterns that the complex is not suitable for cultivation. (Dryland capability unit VIs-1; Loamy 1 range site)

Tricon soils, eroded (0 to 3 percent slopes) (Tv).--The soils in this undifferentiated group are level and nearly level. They occur in old formerly cultivated fields in the central part of the county. Included in mapping are areas of La Brier and Dioxice soils and Tricon clay loam, alkali.

The soils in this undifferentiated group are similar to Tricon loam, but the surface layer and part of the subsoil have been removed by soil blowing so that the clay subsoil is exposed. Some patches of the original loam surface layer remain. Adjacent spots may have an accumulation of several inches of loam or clay loam material. A few caliche nodules are commonly scattered on the surface. Runoff is medium. The hazard of soil blowing is moderate. The water-supplying capacity during the growing season is 9 to 11 inches. Runoff is 5 to 6 inches.

This undifferentiated group is used for range, wildlife, and water supply. (Dryland capability unit VIe-1; Loamy 1 range site)

Tucumcari Series

The Tucumcari series consists of well-drained soils that have a heavy clay loam to light clay subsoil. These soils formed in old alluvium derived from red-bed shale and sandstone. Slopes are 0 to 3 percent. The vegetation is mainly short grasses and forbs. Elevations range from 4,000 to 4,600 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Quay and Ima series.

Typically, the surface layer is reddish-brown loam about 8 inches thick. The subsoil is reddish-brown, calcareous heavy clay loam about 40 inches thick. The substratum is light reddish-brown, calcareous clay loam. The soil is noncalcareous to depths of 0 to 20 inches.

Tucumcari soils are used for range, wildlife, and water supply.

Tucumcari-Quay association (0 to 3 percent slopes) (TW).--The soils in this association are nearly level and level. They occur in the southern part of the county west of Ute Creek.

This soil association is about 60 percent Tucumcari loam, 0 to 3 percent slopes, and 35 percent Quay loam, 1 to 3 percent slopes. The remaining 5 percent are Lacita and Vernon soils.

The Tucumcari soil is level and nearly level. It has moderately slow permeability. Runoff is slow. The hazard of soil blowing is moderate. Roots can penetrate to a depth of about 60 inches or more. The water-supplying capacity during the growing season is 11 to 13 inches. Runoff is 2 to 3 inches. Fertility is moderate.

The Quay soil is nearly level. It is similar to the Quay loam described as representative for the Quay series. Permeability is moderate. Runoff is medium, and the erosion hazard is moderate. Rooting depth to the zone of strong lime is 14 to 24 inches. The water-supplying capacity during the growing season is 8 to 10 inches. Runoff is 5 to 6 inches. Fertility is moderate.

Representative profile of Tucumcari loam, 98 yards southeast of windmill in the SE1/4 sec. 6, T. 15 N., R. 31 E.:

A1--0 to 8 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/3) when moist; moderate, medium, granular structure; hard, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; noncalcareous, moderately alkaline (pH 7.9); gradual boundary; horizon 4 to 15 inches thick.

B21t--8 to 18 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 3/4) when moist; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; very hard, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; few faint threads of lime; patchy clay films; moderately calcareous, moderately alkaline (pH 8.0); clear boundary; horizon 4 to 11 inches thick.

B22t--18 to 28 inches, reddish-brown (5YR 5/4) heavy clay loam, reddish brown (5YR 4/4) when moist; strong, medium, prismatic structure parting to moderate, medium, angular blocky; very hard, friable when moist, sticky and plastic when wet; few fine roots; thin nearly

continuous clay films; common, fine, distinct lime nodules; strongly calcareous, moderately alkaline (pH 8.2); clear boundary; horizon 4 to 11 inches thick.

B3ca--28 to 48 inches, reddish-brown (5YR 5/4) heavy clay loam, reddish brown (5YR 4/4) when moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; very hard, friable when moist, sticky and plastic when wet; few fine roots; thin nearly continuous clay films; many distinct threads of lime and lime nodules; strongly calcareous, moderately alkaline (pH 8.3); gradual boundary; horizon 6 to 22 inches thick.

C--48 to 60 inches, light reddish-brown (2.5YR 6/4) clay loam, red (2.5YR 4/6) when moist; massive; very hard, firm when moist, sticky and plastic when wet; no roots; many small concretions of lime, strongly calcareous, moderately alkaline (pH 8.4).

The A horizon has hues of 7.5YR and 5YR and values of 4 and 5 when dry. The A horizon ranges from loam to light silty clay loam. Locally, the A horizon may be calcareous. The B horizon has hues of 5YR and 2.5YR, values of 5 and 6 when dry, and chromas of 3 and 4 when dry. The B horizon ranges from heavy clay loam to light clay. The clay content of this horizon is 35 to 43 percent. Fragments of sandstone and siltstone and lenses of fine gravel may occur in the subsoil and substratum. Buried soils are common.

The soils in this association are used for range, wildlife, and water supply. The Quay soils are a source of silt sedimentation. (Tucumcari part, dryland capability unit VIs-1; Quay part, dryland capability unit VIe-3; both soils in Loamy 2 range site)

Vermejo Series

The Vermejo series consists of moderately well drained soils that are clay throughout. These soils formed mainly from shale and limestone sediments. Slopes are 0 to 3 percent. The vegetation is mainly short and mid grasses and forbs. Elevations range from 5,600 to 5,900 feet. The average annual precipitation is 14 to 17 inches, average annnual air temperature is 54° to 57° F., and the frost-free season is 150 to 180 days. The associated soils are in the Litle and Penrose series.

Typically, the surface layer is brown, calcareous light clay about 4 inches thick. The next layer is grayish-brown, calcareous clay about 35 inches thick. The substratum is grayish-brown and light brownish-gray clay that contains salts and lime.

Vermejo soils are used for range, wildlife, and water supply.

Vermejo clay (0 to 3 percent slopes) (Ve).--This soil is level and nearly level. It occurs in the northwestern part of the county. Included in mapping are areas of Litle, Berthoud, and Manzano soils. Limestone or shale bedrock may occur below a depth of 45 inches.

This soil is very slowly permeable. Runoff is medium, and the hazard of water erosion is moderate. Roots can penetrate to about 60 inches or more. The water-supplying capacity during the growing season is 30 inches from precipitation and water overflow. Runoff is 5 to 6 inches. Fertility is moderate.

Representative profile, located at the bend of a gully about 120 yards north and 100 yards east of the SW. corner of the NW1/4 sec. 5, T. 21 N., R. 25 E.:

A1--0 to 4 inches, brown (10YR 4/3) light clay, dark brown (10YR 3/3) when moist; strong, fine and medium, granular structure; slightly hard, friable when moist, sticky and plastic when wet; many very fine roots; few fine limestone fragments throughout the horizon; strongly calcareous, moderately alkaline (pH 8.1); clear boundary; horizon 3 to 7 inches thick.

AC--4 to 39 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, medium, angular blocky structure; very hard, extremely firm when moist, very sticky and very plastic when wet; common very fine roots; strongly calcareous, strongly alkaline (pH 8.6); gradual boundary; horizon 17 to 40 inches thick.

C1ca--39 to 48 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; massive; very hard, very firm when moist, very sticky and very plastic when wet; no roots; many prominent threads of lime and salt; strongly calcareous, moderately alkaline (pH 8.3); clear boundary; horizon 6 to 15 inches thick.

C2cs--48 to 66 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) when moist; massive; hard, friable when moist, sticky and very plastic when wet; no roots; many prominent threads of salt and lime; strongly calcareous, moderately alkaline (pH 8.4).

The A horizon has a hue of 2.5Y or 10YR, values of 4 to 6 when dry and 3 or 4 when moist, and chromas of 1 to 3. The A horizon ranges from clay loam or silty clay loam to clay or silty clay. The AC horizon has a hue of 2.5Y or 10YR, a value of 3 or 4 when moist, and a chroma of 1 or 2. The C horizon has a hue of 2.5Y or 5Y and chromas of 2 to 4. Iron stains and mottles are none to common below 40 inches. The soil is slightly to strongly saline below a depth of 30 inches.

This soil is used for range, wildlife, and water supply. (Dryland capability unit VIew-1; Salty Bottomland range site)

Vernon Series

The Vernon series consists of well-drained soils that have a clay to silty clay subsoil overlying

shale at a depth of 6 to 20 inches. These soils formed in material weathered from red-bed clayey shale. Slopes are 1 to 5 percent. The vegetation is mainly a sparse stand of short and mid grasses and shrubs. Elevations range from 4,000 to 4,900 feet. The average annual precipitation is 13 to 16 inches, average annual air temperature is 57° to 60° F., and the frost-free season is 180 to 190 days. The associated soils are in the Montoya, Tucumcari, and Quay series.

Typically, the surface layer is reddish-brown, calcareous silty clay loam about 3 inches thick. The subsoil is red, calcareous clay about 7 inches thick. The substratum is reddish-brown clayey shale.

Vernon soils are used for range, wildlife, and water supply. They are a source of silt sedimentation.

Vernon-Shale outcrop complex, 1 to 9 percent slopes (VS).--This complex consists of about 70 percent Vernon silty clay loam, 1 to 5 percent slopes, and 25 percent Shale outcrop having slopes of 3 to 9 percent. The remaining 5 percent is Tucumcari, Montoya, Quay, and Lacita soils. This complex occurs in the Ute Creek valley.

The Vernon soil is gently sloping. It is very slowly permeable. Runoff is rapid, and the hazard of water erosion is severe. Effective rooting depth to shale is 6 to 20 inches. The water-supplying capacity during the growing season is 6 to 8 inches. Runoff is 7 to 8 inches. Fertility is low.

Shale outcrop occurs in the rolling ridges and knolls. It consists of exposures or outcroppings of calcareous red-bed shale. The silty or clayey shale is mainly reddish brown and is stratified with light gray shale. Also, outcroppings of calcareous soft sandstone or siltstone are common.

Representative profile of Vernon silty clay loam, located on the south bank of gully cut in the NW1/4 NE1/4 sec. 18, T. 14 N., R. 31 E.:

A1--0 to 3 inches, reddish-brown (2.5YR 5/4) silty clay loam, dark reddish brown (2.5YR 3/4) when moist; weak, thin, platy structure; hard, friable when moist, sticky and plastic when wet; many fine roots; strongly calcareous, moderately alkaline (pH 8.3); abrupt boundary; horizon 2 to 5 inches thick.

B2--3 to 10 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) when moist; weak, fine, subangular blocky structure; very hard, firm when moist, sticky and plastic when wet; common fine roots; strongly calcareous, strongly alkaline (pH 8.6); clear boundary; horizon 4 to 15 inches thick.

C--10 inches, reddish-brown (2.5YR 4/4) clayey shale, dark red (2.5YR 3/6) when moist; stratified with light-gray (5Y 7/2) silty shale, light olive gray (5Y 6/2) when moist; no roots; strongly calcareous; many feet thick.

The A and B horizons have a hue of 2.5YR or 5YR and a value of 3 or 4 when moist. The A horizon ranges from silty clay loam or clay loam to clay. The B horizon is silty clay or clay. Depth to shale is 6 to 20 inches.

This complex is used for range, wildlife, and water supply. It is a source of silt sedimentation. (Dryland capability unit VIIs-3; Clayey 2 range site)

Wet Alluvial Land

Wet alluvial land (0 to 3 percent slopes) (WE) consists of soils that range from loamy sand to sandy clay loam throughout. They occur in depressional areas or drainageways along small tributaries that drain westward into Ute Creek. The areas are small and scattered. Included in mapping are areas of Mansker and Portales soils.

The soils in this mapping unit are moderately slowly to rapidly permeable to the water table. Runoff is slow, and the erosion hazard is slight to moderate. The effective rooting depth is 20 to 40 inches. The water-supplying capacity during the growing season is 30 inches from precipitation, overflow, and the water table. Runoff is 3 to 4 inches. Fertility is moderate.

The soils in this unit are variable, but generally they are dark colored, calcareous, and slightly to moderately saline and have a fluctuating water table.

The water table varies from 1 to 4 feet in depth. It is at its lowest depth during June, July, and August when evaporation is highest. The water table is highest during periods of abnormally high rainfall. The water table appears to be a perched water table caused by impermeable, horizontal strata of shale beneath the soils. Poorly discernible to evident drainage patterns lead from Tivoli and Springer soils into the areas of Wet alluvial land.

The lower parts of this mapping unit are flooded seasonally. The higher parts are never flooded. The lowest depressions have seep spots or water standing much of the year. Crusts of salt on the surface are common.

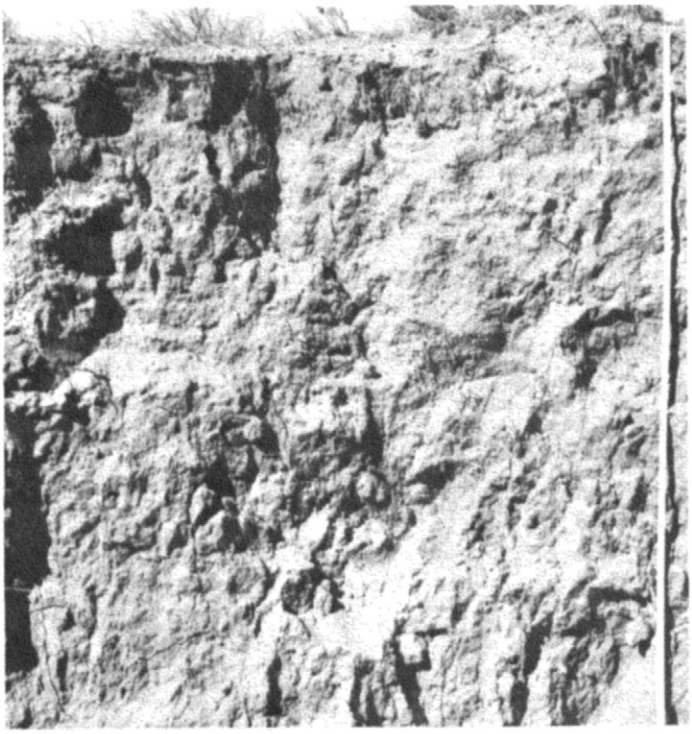
Most of the soils in this unit were derived from mixed wind-laid material and alluvial sediments. They characteristically have poor drainage because of the fluctuating water table.

The soils in this unit are used for range, native hayland, wildlife, and water supply. (Dryland capability unit VIw-3; Meadow range site)

Profile of Campus loam. A lime zone occurs at a depth of 15 inches.

Profile of a Dean soil. Beds of strongly cemented caliche occur near the surface.

Profile of Gallegos very gravelly sandy loam, 3 to 35 percent slopes. This soil has a thin surface layer and a zone of pinkish-white lime at a depth of 15 inches.



Profile of Lacita loam, 1 to 9 percent slopes. This soil formed in alluvial material.

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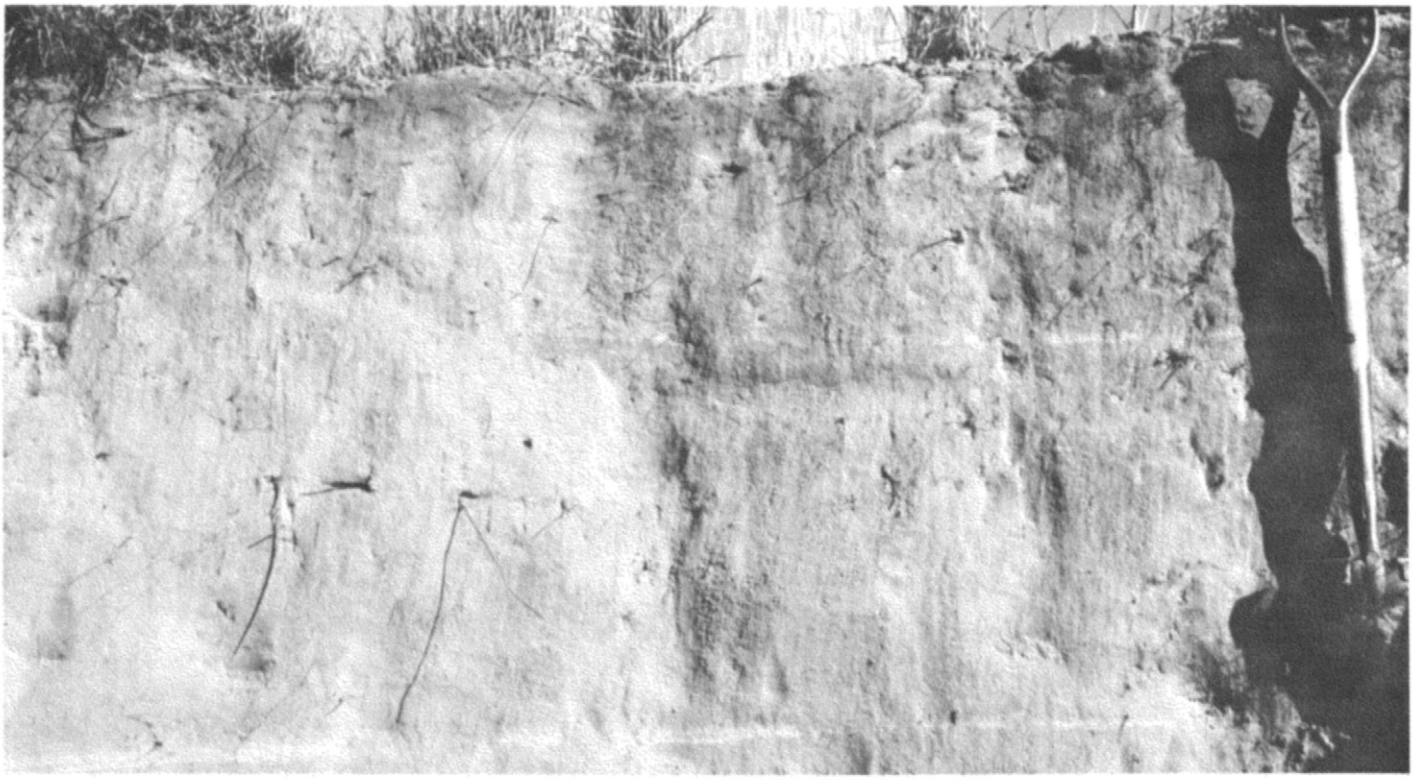
PLATE II

An area of Mansker-Portales association, gently sloping, which is in the Sandy range site.

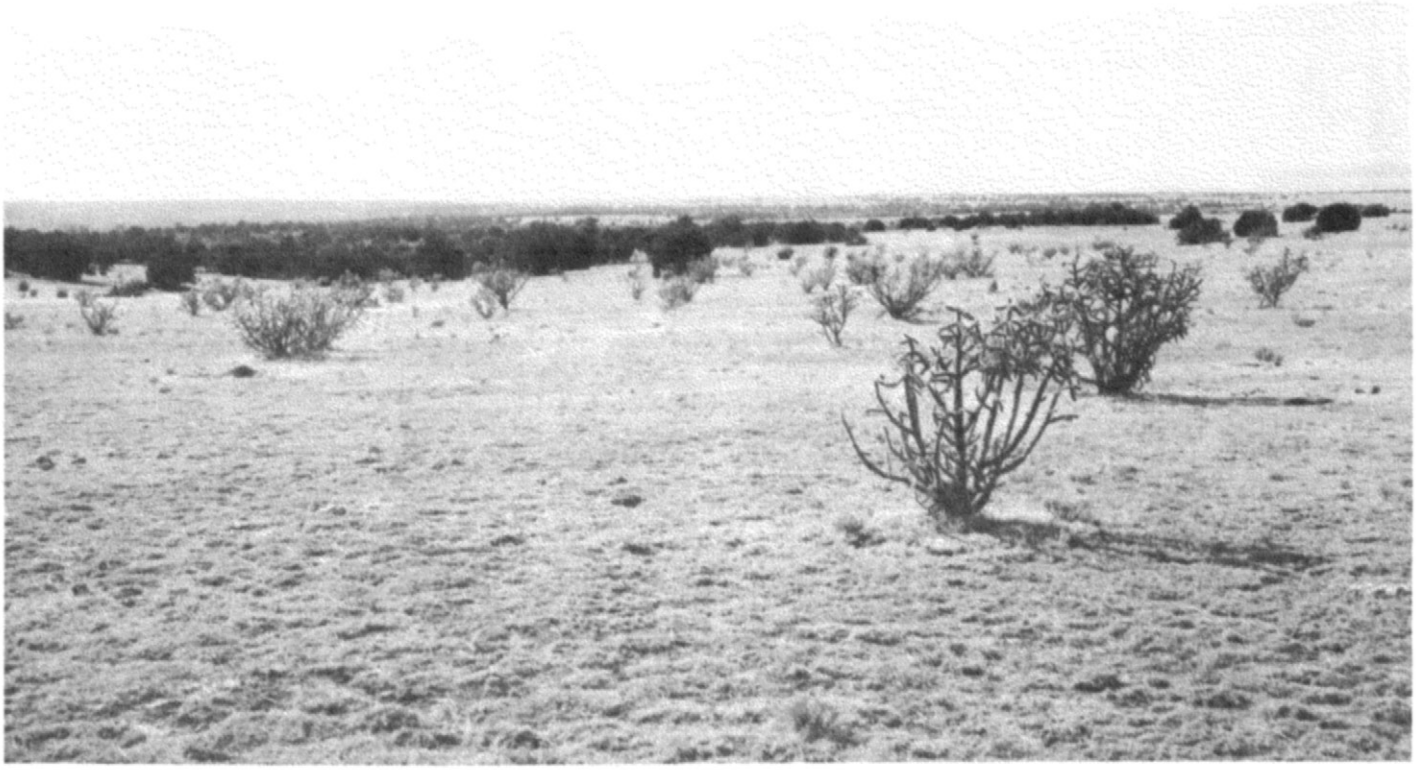
An area of Springer-Amarillo association, which is in the Deep Sand range site.



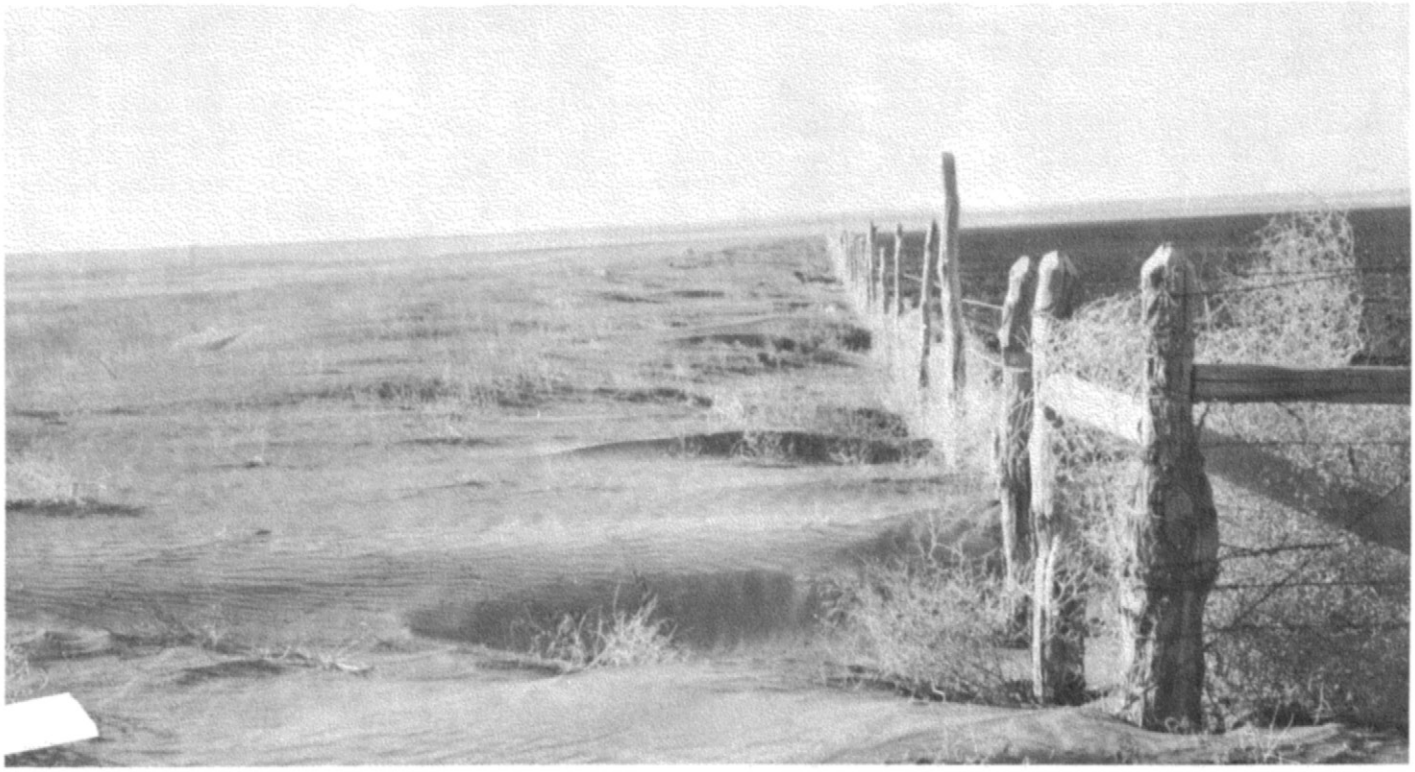
Profile of Tivoli fine sand. In many places sand extends to a depth of more then 10 feet.

An area of the Breaks range site along the Canadian River. The mapping unit is Rough broken and stony land.

PLATE IV



Cholla cactus in an area of the Loamy 1 range site. The soil is Carnero loam. In the background is an area of the Shallow Sandstone range site.



An area of Dioxice loam, 0 to 3 percent slopes, in capability unit IVec-2. Measures for the control of soil blowing are needed.

This section discusses the use and management of the soils for range, crops, wildlife, and engineering. The section includes an explanation of capability classification, discussions of the management of soils by capability units, estimates of yields of dryfarmed crops under a high level of management, and a discussion of irrigated cropland.

Range Management[2/]

The grazing of livestock is the principal land use and major source of income in Harding County. About 1,276,500 acres, or 93 percent of the county, consists of rangeland. In addition, about 31,300 acres of abandoned cropland is grazed. The use of soils for crops has decreased continuously since 1930.

Cattle are the chief livestock grazed in the county, but sheep and horses also are important. In the county on January 1,1963, there were about 40,000 cattle, 2,000 sheep, and 1,300 horses and mules. About 300 of the cattle were dairy cattle (6).

Cattle herds range from a few head to several thousand in number. Ranch operations range from summer grazing of yearlings to cow-and-calf breeding ranches. Horses are raised for ranch use, rodeo stock, and racing. The success of livestock enterprises depends on the way the ranchers and farmers manage their rangeland.

In the following pages (1) land resource areas are described to help in classifying range sites; (2) range sites and condition classes are defined; (3) the range sites in the county are described; and (4) a glossary of plant names is given.

Land Resource Areas For Range Site Classification

Harding County is divided into land resource areas 1 and 2 for the purpose of classifying range sites (fig. 6).

A land resource area is a geographic area that is characterized by a particular combination or pattern of soils, elevation, climate, and topography. Variations in these features result in different kinds of grassland. An average annual precipitation of 15 inches is relatively uniform throughout the county. Elevation ranges from about 3,900 feet near the southeast corner of the county to about 6,100 feet along the northern boundary.

Land resource area 1 is in the northern and western parts of the county. It consists of a relatively level plateau or mesa that has an elevation ranging from about 5,400 feet at its southern edge to 6,100 feet at its northern. Land resource area 2 is a valley area in the southern and eastern parts of the county. The deeply incised canyon of the Canadian River separates land resource areas 1 and 2 in the western part of the county. These land resource areas join along a high, abrupt rock escarpment on the west side of the valley of Ute Creek. From one resource area to the other, the annual average temperature and the length of growing season differ significantly.

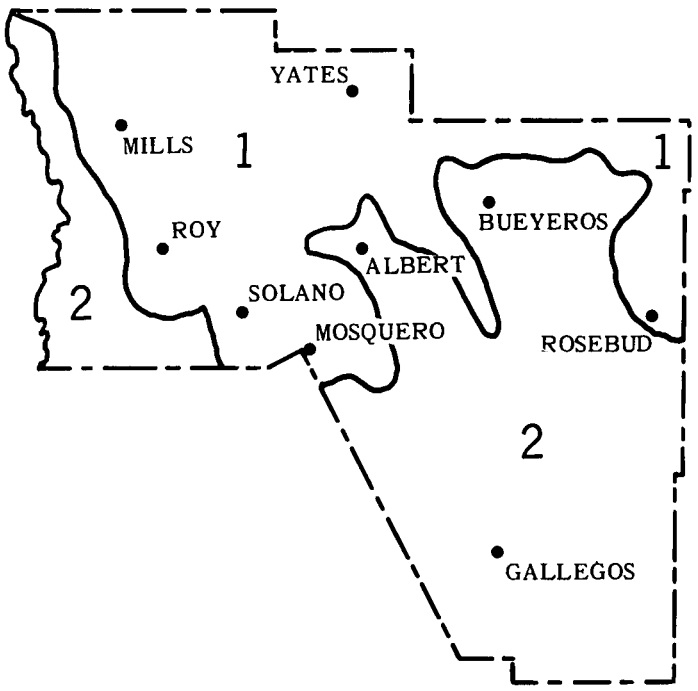


Figure 6.--Division of Harding County into resource areas for the purpose of range site classification.

The average frost-free season in land resource area 1 (mesa) averages about 165 days. Damaging frosts have occurred as late as June 1 and as early as September 5. This part of the county has been covered with snow for as long as 2 1/2 months.

Land resource area 2 (valley) is lower than land resource area 1. In area 2, the frost-free season is about 185 days and extends from April 20 to October 22. Snow seldom lies on this resource area for more than 2 weeks.

Mesquite, black grama, burrograss, and littleleaf sumac are common in the mixed prairie grassland and grow in many parts of land resource area 2.

These plants do not grow in the land resource area 1. Western wheatgrass is important on the grassland consisting of the loam, clay loam, and clay soils of the mesa area, but this species is rare or lacking on the upland range sites of the

2/ By ERASMUS W. WILLIAMS and DANIEL L. MERKEL, range conservationists, Soil Conservation Service.

lower valley part of the county. The common and scientific names of native plants common in Harding County are shown in the plant glossary at the end of this subsection and in a Forest Service publication (11).

The lower valley area consists principally of large ranches that are operated as cattle breeding units for producing high-quality feeder calves and yearlings. Several of the largest herds of purebred, registered Herefords in the United States are in this part of Harding County.

The ranches on the mesa are more variable than those of the valley area in size and type of operation. They range from small, combined wheat and row-crop dryfarming and grazing units to large cattle and sheep ranches. The type of operation on cattle ranches also is more variable and ranges from cow-calf breeding to spring and summer grazing of yearlings that are brought in from outside the county.

Range Sites And Condition Classes

Range sites are distinctive kinds of rangeland that have different capability for producing native plants. Each range site has a characteristic plant community and, unless materially altered by physical deterioration, retains its ability to reproduce this plant community. Rangeland consists of soils on which the potential plant community is mainly native grasses, forbs, and shrubs that are valuable forage and are produced in sufficient quantity to justify their use for grazing.

The productive capacity of a range site, like that of all farmland, depends on the combined effects of the soils and climate that are characteristic to the site. Because of this combination, a range site has a characteristic potential plant community. The site retains its capacity to produce this plant community as long as the environment is not changed.

Range condition refers to the composition of the present vegetation in a given range site in relation to the composition of potential natural vegetation. It is expressed in terms of range condition classes. Four classes are defined, each representing a degree of deterioration in the plant cover. A site is in excellent condition if 76 to 100 percent of the stand is of the same composition as the potential stand. It is in good condition if the percentage is between 51 and 75, fair condition if the percentage is between 26 and 50, and is in poor condition if the percentage is less than 25.

Under prolonged excessive grazing, the more palatable plants are commonly replaced by less desirable plants. Range plants are classified in three broad categories that are based on response to grazing. The categories are identified as decreasers, increasers, and invaders.

Decreasers are plants that decrease in relative abundance under continuous close grazing. They are mostly perennials that are sought out by livestock because they are the most palatable. They normally are dominant species in the climax plant community.

Increasers are plants that normally increase in abundance as the decreasers decline. Increasers commonly are the shorter, less productive or less palatable members of the climax plant community. Their forage value ranges from high to low.

Invaders are plants that become established only after the more desirable vegetation has been depleted. They are not part of the potential plant community for the particular range site, but they may be normal components of this community on other range sites in the same general area. Invaders most commonly are annual weeds, herbaceous perennials, and woody shrubs or trees.

For effective planning of range management, it is necessary to know not only the present condition of the range but the trend, that is, whether the condition is improving or deteriorating. Signs of a trend toward deterioration include the appearance of bare spots, the crusting and compaction of the soil, erosion, the formation of hummocks, a decline in vigor and a reduction in proportion of the better range plants, and invasion by plants not native to the site. Signs of a trend toward improvement include the presence in the stand of seedlings and plants of different ages, an improvement in the vigor of the better range plants, and an increase in the proportion of the better plants in the stand and a decrease in the proportion of invaders.

Descriptions of Range Sites

To aid the ranchers of Harding County in recognizing the potential production of their rangeland, and in evaluating the present range condition, each range site is briefly described. Each description gives (1) soil characteristics that influence the kinds of plants that grow, (2) the potential plant community of the site, including the important decreasers and increasers, (3) the plant community typical of range in poor condition, (4) the feasibility of range improvement, and (5) the yields that can be expected.

The soil series represented are named in the description of each range site, but this does not necessarily mean that all the soils in a given series 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.

Active dune land and Riverwash are not included in the range sites, because they are not suited to rangeland.

Bottomland Range Site

The site consists of soils that have a loam or sandy loam surface layer and a clay loam or loam subsoil. The soils are well drained, and slopes are 0 to 3 percent. These soils have moderately slow permeability, slow runoff, and high water-supplying capacity. Soils in this site are in the Manzano series.

Decreasers make up about 60 percent of the vegetation when this range site is in excellent

condition. The main decreaser plants are western wheatgrass, alkali sacaton, vine-mesquite, little bluestem, side-oats grama, and switchgrass. Increasers make up about 40 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, buffalograss, galleta, inland saltgrass, sand dropseed, silver bluestem, and sand sagebrush.

When this site is in poor condition, plants generally dominant are blue grama, buffalograss, and galleta. Blue grama, sand dropseed, sand sagebrush, and small soapweed (yucca) normally are dominant where the surface layer is sandier and range condition is poor.

The soils in this site are suitable for mechanical brush control, diversions, and farm ponds.

If the range is in excellent condition, the total annual production of all plants is 3,500 pounds per acre, air-dry weight, in favorable years and 1,000 pounds in unfavorable years. Of this annual production, 95 percent is usable by cattle.

Breaks Range Site

Only Rough broken and stony land is in this range site (see pl. III, bottom). This land type is stony and has rapid runoff and low water-supplying capacity. Slopes range from 25 to 80 percent.

Decreasers make up about 40 percent of the vegetation when this range site is in excellent condition. The main decreaser plants are little bluestem, side-oats grama, black grama, mountain muhly, needle-and-thread, big bluestem, alkali sacaton, western wheatgrass, and switchgrass. Increasers make up about 60 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, hairy grama, spike muhly, galleta, and wolftail. About 20 percent of the increasers consists of one-seed juniper, pinyon pine, skunkbush sumac, mountain-mahogany, western thimbleberry, wavyleaf oak, littleleaf mockorange, and Apacheplume.

Generally dominant when this site is in poor condition are one-seed juniper, pinyon pine, wavyleaf oak, and small soapweed (yucca). The understory is blue grama, galleta, three-awn, tridens, sand dropseed, and sleepygrass.

Carefully planned stock trails can be constructed on the soils in this site. In many places farm ponds can be built at the edges of the site.

When this site is in excellent condition, the total annual production of all plants is 1,200 pounds per acre, air-dry weight, in favorable years and 600 pounds in unfavorable years. If the range is in excellent condition, the total annual production of plants that provide forage for cattle is 840 pounds, air-dry weight, in favorable years and 450 pounds in unfavorable years.

Clayey 1 Range Site

Litle clay loam is the only soil in this range site. This soil has a clay loam surface layer and a clay subsoil. It is well drained and has slopes of 1 to 9 percent. Permeability is slow, runoff is rapid, and the water-supplying capacity is low to moderate.

Decreasers make up about 40 percent of the vegetation when this site is in excellent condition. The main decreaser plants are western wheatgrass and alkali sacaton. Increasers make up about 60 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, buffalograss, galleta, ring muhly, mat muhly, fourwing saltbush, and winterfat.

In poor condition, the site supports nearly solid stands of galleta in many places and some low, sodlike blue grama, buffalograss, mat muhly, and ring muhly.

The soil in this site is suitable for contour furrowing, pitting, and range seeding.

If the range is in excellent condition, the total annual production of all plants is 1,600 pounds per acre air-dry weight in favorable years, and is 500 pounds in dry years. On range in excellent condition, the total annual prodction of plants that provide forage for cattle is 1,524 pounds, air-dry weight, in favorable years and 400 pounds in dry years.

Clayey 2 Range Site

This site consists of soils that have a silty clay loam surface layer and a clay subsoil. The soils are well drained, and slopes range from 1 to 9 percent. These soils are very slowly permeable, have rapid runoff, and have low water-supplying capacity. In this site are soils in the Vernon series and Shale outcrop, a miscellaneous land type.

Decreasers make up about 40 percent of the vegetation when this range site is in excellent condition. The main decreaser plants are alkali sacaton, side-oats grama, and black grama. Increasers make up about 60 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, tobosa, little bluestem, hairy grama, tridens, burrograss, three-awn, and broom snakeweed.

Dominant when the site is in poor condition are tobosa, three-awn, burrograss, broom snakeweed, mesquite, and one-seed juniper.

The soils in this site commonly need the construction of erosion control structures.

If the range is in excellent condition, the total annual production of all plants is 700 pounds per acre, air-dry weight, in favorable years, and is 250 pounds in unfavorable years. On range

in excellent condition, the total annual production of plants that provide forage for cattle is 675 pounds, air-dry weight, in favorable years and 200 pounds in unfavorable years.

Deep Sand Range Site

This site consists of soils that have a loamy fine sand surface layer over a sandy clay loam to light fine sandy loam layer. The soils are well drained and have slopes of 0 to 9 percent. These soils have moderate to moderately rapid permeability, slow to very slow runoff, and moderate water-supplying capacity. Soils in this site are in the Amarillo, Otero, and Springer series.

Decreasers make up about 50 percent of the vegetation when this range site is in excellent condition. The main decreaser plants are little bluestem, side-oats grama, sand bluestem, needle-and-thread, switchgrass, and black grama. Increasers make up about 50 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, hairy grama, red lovegrass, sand dropseed, three-awn, sand sagebrush, and small soapweed (yucca).

If this site is in poor condition, dominant plants are sand sagebrush, small soapweed (yucca), sand muhly, ear muhly, three-awn, annual weeds, perennial weeds, sand dropseed, red lovegrass, and mesquite.

The soils in this site are suitable for mechanical brush control.

If the range is in excellent condition, the total annual production of all plants is 2,000 pounds per acre, air-dry weight, in favorable years, and is 1,000 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 1,900 pounds, air-dry weight, in favorable years and 900 pounds in unfavorable years.

Hills Range Site

Rough broken land is the only mapping unit in this site. This land consists of red-bed shale and clay that have interbedded sandstone. Slopes range from 25 to 70 percent. Runoff is very rapid, and the water-supplying capacity is low.

Decreasers make up about 50 percent of the vegetation when this site is in excellent condition. The main decreaser plants are little bluestem, side-oats grama, and black grama. Increasers make up about 50 percent of the vegetation when the site is in excellent condition. The main increasers are hairy grama, tobosa, mat muhly, three-awn, and broom snakeweed.

If this site is in poor condition, plants generally dominant are tobosa, mat muhly, three-awn, broom snakeweed, mesquite, and western ragweed.

Carefully planned stock trails can be constructed on the soils in this site.

If the range is in excellent condition, the total annual production is 500 pounds per acre, air-dry weight, in favorable years and 100 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 475 pounds, air-dry weight, in favorable years and 75 pounds in unfavorable years.

Loamy 1 Range Site

This site consists of soils that have a loam or clay loam surface layer over a loam to clay layer (see pl. IV, top). The soils are well drained, and slopes are 0 to 9 percent. These soils have moderate to slow permeability, slow to medium runoff, and moderate water-supplying capacity. They are in the Berthoud, Campus, Carnero, Dioxice, Dumas, La Brier, Manzano, and Tricon series.

Decreasers make up about 25 percent of the vegetation when this site is in excellent condition. The main decreaser plant is western wheatgrass. Increasers make up about 75 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, galleta, and buffalograss.

Dominant on this site in poor condition is a low sodlike growth of blue grama and buffalograss, as well as patches of galleta and ring muhly and scattered cholla and pricklypear cactus.

The soils in this site are suitable for chiseling, contour furrowing, debris basins, mechanical brush control, pitting, and range seeding.

If the range is in excellent condition, the total annual production of all plants is 1,500 pounds per acre, air-dry weight, in favorable years, and is 400 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 1,450 pounds per acre, air-dry weight, in favorable years and 350 pounds in unfavorable years.

Loamy 2 Range Site

This site consists of soils that have a loam or clay loam surface layer over loam to clay layers. The soils are well drained, and slopes are 0 to 9 percent. These soils have moderate to slow permeability and moderate water-supplying capacity. They are in the Bippus, Kinkead, Lacita, Tucumcari, and Quay series. Runoff is slow to rapid on the Lacita soils and is slow to medium on the other soils.

Decreasers make up about 30 percent of the vegetation when this site is in excellent condition. The main decreasers are black grama, side-oats grama, and vine-mesquite. Increasers make up about 70 percent of vegetation when the site is in excellent condition. The main increasers are blue grama, tobosa, buffalograss, silver bluestem, broom snakeweed, and three-awn.

Dominant on this site in poor condition is a low sodlike stand of blue grama and buffalograss and

heavy stands of broom snakeweed, mesquite, prickly-pear, and cholla cactus. The stand of blue grama and buffalograss has patches of tobosa and ring muhly.

The soils in this site are suitable for chiseling, contour furrowing, debris basins, mechanical brush control, pitting, and range seeding.

If the range is in excellent condition, the total annual production of all plants is 1,200 pounds per acre, air-dry weight, in favorable years and 350 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 1,150 pounds, air-dry weight, in favorable years and 300 pounds in unfavorable years.

Malpais Range Site

Apache stony loam, 1 to 9 percent slopes, is the only soil in this range site. It is shallow and has a stony loam surface layer and a loam subsoil over basalt bedrock at a depth of 8 to 19 inches. This soil is well drained and has slopes of 1 to 9 percent. It has moderate permeability, medium runoff, and moderate water-supplying capacity.

Decreasers make up approximately 75 percent of the vegetation when this site is in excellent condition. The main decreaser plants are little bluestem, big bluestem, side-oats grama, and western wheatgrass. Increasers make up about 25 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, galleta, buffalograss, western thimbleberry, currant, fringed sagebrush, New Mexican yucca, and mountain-mahogany.

If this site is in poor condition, dominant plants are blue grama, buffalograss, galleta, fringed sagebrush, New Mexican yucca, and broom snakeweed.

The soils in this site are too shallow and stony to be suitable for mechanical measures for improving the range.

If the range is in excellent condition, the total annual production of all plants is 1,900 pounds, air-dry weight, per acre in favorable years and 600 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 1,800 pounds, air-dry weight, in favorable years and 550 pounds in dry years.

Meadow Range Site

This site consists of saline soils that have a silt loam to loamy fine sand surface layer over a silty clay loam to loamy fine sand layer. The soils are somewhat poorly drained and have a fluctuating water table at a depth of 1 to 4 feet. Slopes are 0 to 5 percent. These soils have slow to rapid permeability, slow to medium runoff, and high water-supplying capacity. This site consists of Manzano loam, wet variant, and Wet alluvial land.

Decreasers make up about 75 percent of the vegetation when this site is in excellent condition. The main decreaser plants are switchgrass, yellow indiangrass, big bluestem, and little bluestem. Increasers make up about 25 percent of the vegetation when the site is in excellent condition. The main increasers are alkali sacaton, inland saltgrass, blue grama, rushes, silver bluestem, sand dropseed, and spike dropseed.

If this site is in poor condition, the main plants are inland saltgrass, silver bluestem, blue grama, spike dropseed, sand dropseed, sweetclover, cocklebur, western ragweed, American licorice, broom snakeweed, fireweed, and Russian-thistle.

The soils in this site are suitable for constructing farm ponds and seeding the range.

If the range is in excellent condition, the total annual production of all plants is 6,000 pounds per acre, air-dry weight, in favorable years and 3,000 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 5,100 pounds, air-dry weight, in favorable years and 2,550 pounds in unfavorable years.

Salt Flats Range Site

This site consists of saline or alkali soils that have a clay loam surface layer over a clay layer. The soils are somewhat poorly drained or well drained. Slopes are 0 to 3 percent. These soils have very slow permeability, slow or very slow runoff, and moderate to high water-supplying capacity. They are in the Church and Kinkead series.

Decreasers make up about 80 percent of the vegetation when the site is in excellent condition. The main decreaser plants are alkali sacaton, western wheatgrass, and blue grama. Increasers make up about 20 percent of the vegetation when the site is in excellent condition. The main increasers are inland saltgrass, alkali muhly, four-wing saltbush, silver bluestem, and tumble windmillgrass.

If this site is in poor condition, the main plants are inland saltgrass, alkali muhly, cholla cactus, fireweed, Russian-thistle, and broom snakeweed.

The soils of this site are suitable for range seeding.

If the range is in excellent condition, the total annual production of all plants is 3,000 pounds per acre, air-dry weight, in favorable years and 500 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 2,800 pounds, air-dry weight, in favorable years and 450 pounds in unfavorable years.

Salty Bottomland Range Site

This site consists of soils that have a clay surface layer and subsoil. The soils are moderately

well drained or well drained. Slopes range from 0 to 3 percent. These soils have very slow permeability, medium runoff, and high water-supply capacity. Also, they receive runoff from higher soils. Soils in this site are in the Montoya and Vermejo series.

Decreasers make up about 75 percent of the vegetation when the site is in excellent condition. The main decreaser plants are alkali sacaton, western wheatgrass, and vine-mesquite. Increasers make up about 25 percent of the vegetation when the site is in excellent condition. The main increasers are galleta, tobosa, blue grama, alkali muhly, mat muhly, inland saltgrass, and four-wing saltbush.

If this site is in poor condition, dominant plants are galleta, tobosa, blue grama, buffalograss, mat muhly, and inland saltgrass. Burrograss and mesquite grow at the lower elevations.

The soils in this site are suitable for range seeding and mechanical brush control.

If the range is in excellent condition, the total annual production of all plants is 5,000 pounds per acre, air-dry weight, in favorable years and 700 pounds in unfavorable years. On range in excellent condition, total annual production of plants that provide forage for cattle is 4,500 pounds, air-dry weight, in favorable years and 600 pounds in unfavorable years.

Sand Hills Range Site

This site consists of soils that have a fine sand or loamy fine sand surface layer over a light fine sandy loam to fine sand layer. These soils are well drained to excessively drained, and slopes are 1 to 9 percent. Permeability is moderately rapid to rapid, runoff is very slow, and water-supplying capacity is moderate. Soils in this site are in the Springer and Tivoli series.

Decreasers make up about 70 percent of the vegetation when this site is in excellent condition. The main decreasers are sand bluestem, little bluestem, side-oats grama, needle-and-thread, plains bristlegrass, black grama, switchgrass, and yellow indiangrass. Increasers make up about 30 percent of the vegetation when the range is in excellent condition. The main increasers are blue grama, hairy grama, spike dropseed, sand dropseed, three-awn, silver bluestem, red lovegrass, sand sagebrush, small soapweed (yucca), western soapberry, American plum, and skunkbush sumac.

If the range is in poor condition, dominant plants are sand dropseed, three-awn, tumble lovegrass, sand sagebrush, small soapweed (yucca), queen's delight, and pricklypear.

The soils in this site are unsuitable for mechanical measures that improve range, because the surface layer is loamy fine sand and fine sand.

If the range is in excellent condition, the total annual production of all plants is 1,800 pounds per acre, air-dry weight, in favorable years and 900 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 1,300 pounds, air-dry weight, in favorable years and 720 pounds in unfavorable years.

Sandy Range Site

This site consists of soils that have a fine sandy loam or loam surface layer over a fine sandy loam to sandy clay loam or light clay loam layer. The soils are well drained and have slopes of 0 to 9 percent. These soils have slow to medium runoff and moderate water-supply capacity. Soils in this site are in the Amarillo, Berthoud, Campus, Dalhart, Guadalupe, Ima, Karde, Latom, Mansker, Otero, Portales, Quay, and Tapia series. The Karde soils have moderately slow permeability, and the other soils have moderate to moderately rapid permeability.

Decreasers make up about 65 percent of the vegetation when the site is in excellent condition. The main decreaser plants are little bluestem, side-oats grama, needle-and-thread, New Mexico feathergrass, and black grama. Increasers make up about 35 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, hairy grama, sand dropseed, sand sagebrush, and small soapweed (yucca).

If this site is in poor condition, dominant plants are low sodlike blue grama, hairy grama, buffalograss, galleta, sand dropseed, three-awn, sand muhly, and small soapweed (yucca).

The soils in this site are suitable for reseeding and mechanical brush control, except in areas of Latom fine sandy loam where sandstone crops out.

If the range is in excellent condition, the total annual production of all plants is 1,750 pounds per acre, air-dry weight, in favorable years and is 1,000 pounds in unfavorable years. On range in excellent condition, the total annual production plants that provide forage for cattle is 1,650 pounds, air-dry weight, in favorable years and is 925 pounds in unfavorable years.

Shallow 1 Range Site

This site consists of soils that have a clay loam to fine sandy loam or a gravelly loam to stony loam surface layer over caliche or bedrock. Campus gravelly loam, 1 to 25 percent slopes, occurs in this range site and is gravelly loam throughout. The soils in this site are well drained and occupy slopes of 0 to 25 percent. These soils have slow to moderate permeability, medium to rapid runoff, and moderate water-supplying capacity. Soils in this site are in the Campus, Dean, Pastura, and Penrose series.

Decreasers make up about 50 percent of the vegetation when this site is in excellent condition. The main decreaser plants are side-oats grama, little bluestem, needle-and-thread, New Mexico feathergrass, and big bluestem. Increasers make up about 50 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, hairy grama, silver bluestem, three-awn, wolftail, skunkbush sumac, wavyleaf oak, fringed sagebrush, and broom snakeweed.

If the range is in excellent condition, total annual production of all plants is 1,200 pounds per acre, air-dry weight, in favorable years and is 400 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 900 pounds air-dry weight, in favorable years and 300 pounds in unfavorable years.

Shallow 2 Range Site

This site consists of shallow or gravelly soils that have a fine sandy loam to very gravelly sandy loam surface layer. The soils are well drained and occupy slopes of 1 to 35 percent. These soils have moderate to rapid permeability, medium to rapid runoff, and low to moderate water-supplying capacity. Soils in this site are in the Gallegos and Potter series.

Decreasers make up about 60 percent of the vegetation when this site is in excellent condition. The main decreaser plants are black grama, side-oats grama, little bluestem, needle-and-thread, and New Mexico feathergrass. Increasers make up about 40 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, hairy grama, tobosa, sand dropseed, and catclaw mimosa.

If this site is in poor condition, dominant plants are blue grama, tridens, three-awn, catclaw mimosa, Apache-plume, littleleaf sumac, skunkbush sumac, one-seed juniper, and mesquite.

The soils in this site are too gravelly or shallow for the use of mechanical measures that improve the range.

If the range is in excellent condition, the total annual production of all plants is 1,200 pounds per acre, air-dry weight, in favorable years and is 350 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 1,100 pounds, air-dry weight, in favorable years and 250 pounds in unfavorable years.

Shallow Sandstone Range Site

Travessilla stony loam, 0 to 9 percent slopes, is the only soil in this range site. This soil consists of stony loam that overlies sandstone bedrock at a depth of 4 to 15 inches. It is well drained and occupies slopes of 0 to 9 percent. Permeability is moderate, runoff is rapid, and water-supplying capacity is low to moderate.

Decreasers make up about 60 percent of the vegetation when this site is in excellent condition. The main decreaser plants are side-oats grama, little bluestem, sand bluestem, big bluestem, and New Mexico feathergrass. Increasers make up about 40 percent of the vegetation when the site is in excellent condition. The main increasers are blue grama, hairy grama, silver bluestem, wolftail, one-seed juniper, skunkbush sumac, and wavyleaf oak.

If this site is in poor condition, dominant plants are blue grama, hairy grama, silver bluestem, wolftail, one-seed juniper, wavyleaf oak, skunkbush sumac, and pinyon pine.

The soils in this site are too shallow for the use of mechanical measures that improve the range.

If the range is in excellent condition, the total annual production of all plants is 1,600 pounds per acre, air-dry weight, in favorable years and 450 pounds in unfavorable years. On range in excellent condition, the total annual production of plants that provide forage for cattle is 1,500 pounds, air-dry weight, in favorable years and 400 pounds in unfavorable years.

Plant Glossary

Following is a list of plant names, other than those of domestic grain, that are used in this soil survey. Most of these plants are mentioned in the preceding subsection "Descriptions of Range Sites."

Common name	Scientific name
Alkali muhly	Muhlenbergia asperifolia
Alkali sacaton	Sporobolus airoides
American licorice	Glyeyrrhiza lepidota
American plum	Prunus americana
Apache-plume	Fallugia paradoxa
Bermudagrass	Cynodon dactylon
Big bluestem	Andropogon gerardii
Black grama	Bouteloua eriopoda
Blue grama	Bouteloua gracilis
Broom snakeweed	Gutierrezia sarothrae
Buffalograss	Buchloe dactyloides
Burrograss	Scleropogon brevifolius
Catclaw mimosa	Mimosa biuncifera
Cholla	Opuntia spp.
Cocklebur	Xanthium spp.
Currant	Ribes spp.
Ear muhly	Muhlenbergia arenacea
Fireweed	Epilobium angustifolium
Four-wing saltbush	Atriplex canescens
Fringed sagebrush	Artemisia frigida
Galleta	Hilaria jamesii
Hairy grama	Bouteloua hirsuta
Inland saltgrass	Distichlis stricta
Little bluestem	Andropogon scoparius
Littleleaf sumac	Rhus microphylla
Littleleaf mockorange	Philadelphus microphyllus
Mat muhly	Muhlenbergia richardsonis
Mesquite	Prosopis juliflora
Mountain muhly	Muhlenbergia montana
Mountain-mahogany	Cercocarpus spp.
Needle-and-thread	Stipa comata
New Mexican yucca	Yucca neomexicana
New Mexico feathergrass	Stipa neomexicana
One-seed juniper	Juniperus monosperma
Pingue	Hymenoxys richardsonii
Pinyon pine	Pinus edulis
Pricklypear	Opuntia spp.

Queen's delight-------	Stillingia sylvatica
Red lovegrass---------	Eragrostis oxylepis
Ring muhly------------	Muhlenbergia torreyi
Rushes----------------	Juncus spp.
Russian-thistle-------	Salsola kali
Sand bluestem---------	Andropogon hallii
Sand dropseed---------	Sporobolus cryptandrus
Sand muhly------------	Muhlenbergia arenicola
Sand sagebrush--------	Artemisia filifolia
Side-oats grama-------	Bouteloua curtipendula
Silver bluestem-------	Andropogon saccharoides
Skunkbush sumac-------	Rhus trilobata
Sleepygrass-----------	Stipa robusta
Small soapweed (yucca)	Yucca glauca
Spike dropseed--------	Sporobolus contractus
Spike muhly-----------	Muhlenbergia wrightii
Sweetclover-----------	Melilotus spp.
Three-awn-------------	Aristida spp.
Tobosa----------------	Hilaria mutica
Tridens---------------	Tridens spp.
Tumble lovegrass------	Eragrostis sessilispica
Tumble windmillgrass--	Chloris verticillata
Vine-mesquite---------	Panicum obtusum
Wavyleaf oak----------	Quercus undulata
Western ragweed-------	Ambrosia psilostachya
Western soapberry-----	Sapindus drummondii
Western thimbleberry--	Rubus parviflorus
Western wheatgrass----	Agropyron smithii
Winterfat-------------	Eurotia lanata
Wolftail--------------	Lycurus phleoides
Yellow indiangrass----	Sorghastrum nutans

Management of Cropland

This subsection discusses farming in Harding County, capability groups of soils, management of soils by capability units, predicted yields on dryfarmed soils, and use and management of irrigated cropland. Variation in the amount of effective rainfall is a major factor to be considered in determining how the soils can be used or managed.

Farming

The acreage of cropland in Harding County has decreased from an all-time peak of about 98,000 in 1925. In 1963, only about 13,000 acres remained in dryfarmed crops. About 37,000 acres of cropland were in the Conservation Reserve program, and nearly all of this was seeded to grass mixtures for range. It is estimated that more than 80 percent of the 37,000 acres will remain in grass.

The land taken out of cultivation between 1925 and 1963 is primarily used as grassland. These areas are locally called go-back land, but only part of this acreage has been reseeded to grass.

Winter wheat is the major dryfarmed cash crop. Millet cut as hay or used as forage has increased in recent years. Broomcorn, forage sorghum, and grain sorghum are grown in a small acreage. A few small areas are irrigated and used for alfalfa, bermudagrass, grain sorghum, forage sorghum, and winter wheat.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of crops. The soils are grouped according to their limitations when used for crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of 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, for forest trees, or engineering.

In the capability system, all kinds of soils are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

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. (No soils in Harding County are in class I.)

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices. (No soils in Harding County are in class II.)

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both. (No soils in Harding County are in class III.)

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

Class V soils are subject to little erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife. (No soils in Harding 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.

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.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply, or to 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, IVe. The letter e shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; 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. For some soils, climate and one of the other kinds of limitation have about equal importance, and the subclass symbol shows both kinds; IVec is an example.

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, or recreation.

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, IVe-1, or VIe-5. 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 paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management By Capability Units

In this subsection the capability units are described, use of the soils is given, and management is suggested. The capability units are not numbered consecutively, because the grouping is statewide, and not all the capability units in the State are represented in this County. In each description the soil series represented in the unit are mentioned, but this does not necessarily mean that all the soils of the series are in the 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.

Capability Unit IVe-1

This unit consists of well-drained soils that have a sandy clay loam subsoil. These soils are in the Amarillo and Dalhart series. They formed on uplands in old alluvium and mixed, sandy, wind-laid deposits. Slopes are 0 to 3 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. These soils are moderately permeable. Runoff is slow to medium. The hazard of soil blowing is moderate where cover is not maintained. The water-supplying capacity during the growing season is 10 to 14 inches. Roots can penetrate to a depth of 60 inches or more when moisture is present. Fertility is moderate.

These soils are used for range, wildlife, water supply, and dryfarmed crops. Small tracts are used for irrigation. The soils are suited to forage millet, forage sorghum, grain sorghum, and small grains. Alternate use of wheat and fallow is better suited than continuous wheat. Stubble-mulch tillage slows surface runoff, increases the rate of water intake, and reduces loss of moisture, soil material, and nutrients. Emergency tillage, as a last resort to reduce soil blowing, may be needed when amounts of plant residues are small. Contour farming and level terraces on slopes of more than 1 percent reduce runoff and erosion. Mechanical and chemical means of controlling both annual and perennial weeds are being used.

The soils in this unit are suitable for growing field and homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are well suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit IVec-1

This unit consists of well-drained soils that have a clay loam subsoil. These soils are in the Bippus, Dumas, and Manzano series. They formed in alluvium and loamy wind-laid deposits on terraces or uplands. Slopes are 0 to 3 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 180 days. These soils have moderate to moderately slow permeability. Runoff is slow. The hazard of soil blowing is moderate where cover is not maintained. The water-supplying capacity during the growing season is 10 to 14 inches. Roots can penetrate to a depth of 60 inches or more when moisture is present. Fertility is moderate ot high.

These soils are used mainly for range, dryfarmed crops, wildlife, and water supply. Small tracts are used for irrigation. The soils are suited to small grains, forage millet, forage sorghum, and grain sorghum. Alternate use of wheat and fallow is better suited than continuous wheat. Stubble-mulch tillage slows surface runoff, increases the rate of water intake, and reduces loss of moisture, soil material, and nutrients. Emergency tillage, as a last resort to reduce soil blowing, may be needed when amounts of plant residues are small. Contour farming and level terraces on slopes of more than 1 percent reduce runoff and erosion. Mechanical and chemical means of controlling both annual and perennial weeds are being used.

The soils in this unit are suitable for growing field and homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are well suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit IVec-2

This unit consists of well-drained soils that have a clay loam subsoil over caliche at a depth of 20 to 40 inches. These soils are in the Dioxice and Dumas series. They formed on uplands in loamy old alluvium and wind-laid deposits. Slopes are 0 to 3 percent. The average annual precipitation is 14 to 17 inches, and the frost-free season is 150 to 180 days. These soils have moderately slow permeability. Runoff is slow. The hazard of soil blowing is moderate where cover is not maintained. The water-supplying capacity during the growing season is 12 to 14 inches. Effective rooting depth is 20 to 40 inches. Fertility is moderate.

These soils are used mainly for range, wildlife, water supply, and dryfarmed crops. Small tracts are used for irrigation. The soils are suited to small grains, forage millet, forage sorghum, and grain sorghum. Alternate use of wheat and fallow is better suited than continuous wheat. Stubble-mulch tillage slows surface runoff, increases the rate of water intake, and reduces loss of moisture, soil material, and nutrients (see pl. IV, bottom). Emergency tillage, as a last resort to reduce soil blowing, may be needed when amounts of plant residues are small. Contour farming and level terraces on slopes of more than 1 percent reduce runoff and erosion. Mechanical and chemical means of controlling both annual and perennial weeds are being used.

The soils in this unit are suitable for growing field and homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit IVs-1

This unit consists of well-drained soils that have a clay loam or clay subsoil. These soils are in the La Brier and Tricon series. They formed in alluvium and were modified by silty wind-laid deposits on alluvial fans and uplands. Slopes are 0 to 3 percent. The average annual precipitation is 14 to 17 inches, and the frost-free season is 150 to 180 days. These soils are slowly permeable. Runoff is slow. The hazard of soil blowing is moderate where cover is not maintained. The water-supplying capacity during the growing season is 12 to 14 inches. Roots can penetrate to a depth of 20 to 60 inches or more if moisture is present. Fertility is moderate to high.

These soils are used for range, wildlife, water supply, and dryfarmed crops. They are suited to small grains, forage millet, forage sorghum, and grain sorghum. Alternate use of wheat and fallow is better suited than continuous wheat. Stubble-mulch tillage slows surface runoff, increases the rate of water intake, and reduces loss of moisture, soil material, and nutrients. Emergency tillage, as a last resort to reduce soil blowing, may be needed when amounts of plant residues are small. Contour farming and level terraces on slopes of more than 1 percent reduce runoff and erosion. Mechanical and chemical means of controlling both annual and perennial weeds are being used.

The soils in this unit are suitable for growing field and homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are well suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIe-1

This unit consists of well-drained soils that have a clay loam subsoil. These soils are in the Berthoud, Dioxice, Dumas, and Tricon series. They formed mainly in old alluvium on uplands or alluvial fans. Slopes are 0 to 5 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 180 days. These soils have moderate to slow permeability. Runoff is medium, and the erosion hazard ranges from moderate to severe when cover is not maintained. In some areas in old formerly cultivated fields, these soils have been damaged by soil blowing. The water-supplying capacity during the growing season is 8 to 11 inches. Rooting depth is 20 to 60 inches. Fertility is moderate.

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

The soils in this unit are suitable for growing field and homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are well suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIe-2

This unit consists of well-drained soils that have a fine sandy loam surface layer over layers of fine sandy loam, loam, or sandy clay loam. These soils are in the Berthoud, Dalhart, Guadalupe, and Otero series. They formed in alluvium on terraces or in alluvium and mixed, sandy, wind-laid deposits on uplands. Slopes are 0 to 5 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. These soils have moderate to moderately rapid permeability. Runoff is slow to medium, and the erosion hazard is

moderate to severe when cover is not maintained. The Dalhart soil occurs in old formerly cultivated fields and has been severely eroded by soil blowing. The water-supplying capacity during the growing season is 8 to 13 inches. Roots can penetrate to a depth of 20 to 60 inches or more. Fertility is low to moderate.

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

The soils in this unit are suitable for growing homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are well suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIe-3

This unit consists of well-drained soils that have a loam surface layer over layers of loam or silt loam. These soils are in the Lacita and Quay series. They are in valleys where they formed on silty alluvial fans. Slopes are 0 to 9 percent. The average annual precipitation is 13 to 16 inches, and the frost-free season is 180 to 190 days. These soils have moderate to moderately slow permeability. Runoff is medium to rapid, and the erosion hazard is moderate to severe where cover is not maintained. The water-supplying capacity during the growing season is 7 to 10 inches. Rooting depth is 14 to 60 inches. Fertility is low to moderate.

These soils are used for range, wildlife, and water supply. They are a source of silt sedimentation.

The soils in this unit are suitable for growing homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are well suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIe-4

This unit consists of well-drained, calcareous, loamy soils. These soils are in the Campus, Dean, Karde, Mansker, and Portales series. They formed on uplands in old alluvium that has been reworked by wind or in mixed, calcareous, wind-laid sediments over caliche. Slopes are 0 to 9 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. These soils have moderate to slow permeability. Runoff ranges from slow to medium, and the erosion hazard is moderate to severe. The water-supplying capacity during the growing season is 7 to 14 inches. Rooting depth is 5 to 30 inches for the Campus and the Mansker soils, 5 to 14 inches for the Dean soils, 60 inches or more for the Karde soils, and 20 to 40 inches for the Portales soils. Fertility is low to moderate.

These soils are used for range, wildlife, and water supply. Some areas of Campus soils were formerly used for dryfarming.

Except for Dean soils, the soils in this unit are suitable for growing field and homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIe-5

This unit consists of well-drained soils that have a sandy surface layer over layers of sandy clay loam or fine sandy loam. These soils are in the Amarillo, Otero, and Springer series.

The soils in this unit formed in alluvium and mixed, sandy, wind-laid deposits on alluvial fans or uplands. Slopes are 0 to 9 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. These soils are moderately to moderately rapidly permeable. Runoff is very slow to slow, and the erosion hazard is severe where cover is not maintained. The water-supplying capacity during the growing season is 12 to 15 inches. Rooting depth is 60 inches or more if moisture is present. Fertility is moderate.

These soils are used mainly for range, wildlife, and water supply. Small tracts of Amarillo soils are used for irrigated crops.

The soils in this unit are suitable for growing field and homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are well suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIe-6

This capability unit consists only of the mapping unit, Ima and Quay soils. These soils are well drained, are calcareous, and have a fine sandy loam surface layer and a sandy loam to loam subsoil. They formed on alluvial fans in valleys in old alluvium and mixed, sandy, wind-laid deposits. Slopes are 1 to 5 percent. The average annual precipitation is 13 to 16 inches, and the frost-free season is 180 to 190 days. These soils have moderate to moderately rapid permeability. Runoff is medium, and the erosion hazard is moderate where cover is not maintained. The water-supplying capacity during the growing season is 8 to 10 inches. Roots can penetrate to a depth of 60 inches or more if moisture is present. Fertility is moderate.

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

The soils in this unit are suitable for growing homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIe-7

This unit consists of well-drained soils that have layers of gravelly loam to very gravelly sandy clay loam below the surface layer. These soils are in the Campus and Gallegos series. They formed in gravelly alluvium on old dissected terraces. Slopes are 1 to 35 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. These soils are moderately to rapidly permeable. Runoff is rapid, and the hazard of water erosion is moderate to severe where cover is not maintained. The water-supplying capacity during the growing season is 6 to 9 inches. Rooting depth extends to a zone of strong lime at a depth of 8 to 30 inches. Fertility is low.

These soils are used for range, wildlife, and water supply. They are a potential source of gravel.

The soils in this unit are too gravelly to be suitable for growing homestead windbreaks.

Capability Unit VIe-8

This unit consists of well-drained soils that have a fine sandy loam surface layer over layers of loam or sandy clay loam. These soils are in the Latom and Tapia series. They formed on uplands in material weathered from sandstone bedrock on or in calcareous, loamy, wind-laid and alluvial deposits. Slopes are 0 to 5 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. These soils have moderate permeability. Runoff is slow to medium, and the erosion hazard is moderate where cover is not maintained. The water-supplying capacity during the growing season is 8 to 14 inches. Effective rooting depth extends to bedrock or indurated caliche 14 to 30 inches below the soil surface. Fertility is moderate to low.

These soils are used for range, wildlife, and water supply. They are moderately suitable for growing homestead windbreaks. The rooting depth limits suitability for windbreaks. Two-row plantings of one-seed juniper and Siberian elm are best suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIe-9

Litle clay loam is the only soil in this capability unit. This soil is well drained, is saline, and has a clay subsoil. It formed in material weathered from shale on uplands. Slopes are 1 to 9 percent. The average annual precipitation is 14 to 17 inches, and the frost-free season is 150 to 180 days. This soil is slowly permeable. Runoff is medium to rapid, and the hazard of water erosion is moderate to severe where cover is not maintained. The water-supplying capacity during the growing season is 8 to 9 inches. Effective rooting depth extends to shale 20 to 40 inches below the soil surface. Fertility is low.

This soil is used for range, wildlife, and water supply. It is a source of silt sedimentation.

The soil in this unit is poorly suited to growing windbreaks because of limited rooting depth, salinity, and the clay subsoil.

Capability Unit VIs-1

This unit consists of well-drained soils that have a heavy clay loam or clay subsoil. These soils are in the Kinkead, La Brier, Tricon, and Tucumcari series. They formed in old alluvium on alluvial fans and uplands. Slopes are 0 to 3 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. Except for the Tucumcari soil, these soils are slowly permeable. The Tucumcari soil has moderately slow permeability. Runoff is slow to medium, and the erosion hazard is moderate where cover is not maintained. La Brier loam, eroded, has been damaged by soil blowing. The water-supplying capacity during the growing season is 9 to 14 inches. Rooting depth is 20 to 60 inches or more. Fertility is moderate.

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

The soils in this unit are suitable for growing field and homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIs-3

This unit consists of well-drained, droughty soils that have a clay loam subsoil. These soils are in the Carnero series. They formed in material weathered from sandstone and wind-laid material on uplands. Slopes are 0 to 5 percent. The average annual precipitation is 14 to 16 inches, and the frost-free season is 150 to 180 days. These soils are moderately permeable. Runoff is medium, and the erosion hazard is moderate where cover is not maintained. The water-supplying capacity during the growing season is 9 to 11 inches. Effective rooting depth is 20 to 40 inches. Fertility is moderate.

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

The soils in this unit are suitable for growing field and homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are well suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIs-6

Apache stony loam, 1 to 9 percent slopes, is the only soil in this unit. It is well drained, is stony, and has a loam subsoil. It formed in wind-laid or water-deposited material and in material

weathered from basalt on uplands. The average annual precipitation is 14 to 17 inches, and the frost-free season is 150 to 180 days. This soil is moderately permeable. Runoff is medium, and the erosion hazard is slight. The water-supplying capacity during the growing season is 9 to 11 inches. Effective rooting depth to bedrock is 8 to 19 inches. Fertility is high.

This soil is used for range, wildlife, and water supply. It is too shallow and too stony to be suitable for windbreaks.

Capability Unit VIs-7

Kinkead clay loam, alkali, is the only soil in this unit. It is well drained, is affected by salts and alkali, and has a clay subsoil. This soil formed in old alluvium on alluvial fans. Slopes are 0 to 3 percent. The average annual precipitation is 13 to 16 inches, and the frost-free season is 180 to 190 days. This soil is very slowly permeable. Runoff is slow to medium, and the erosion hazard is moderate where cover is not maintained. The water-supplying capacity during the growing season is 16 to 23 inches. Effective rooting depth is about 60 inches or more if moisture is present. Fertility is low.

This soil is used for range, wildlife, and water supply. This soil is poorly suited to homestead windbreaks because of the salts, alkali, and clay subsoil.

Capability Unit VIw-1

This unit consists of well-drained soils that have a clay loam or loam subsoil. These soils are in the Manzano series. They formed in alluvium in drainageways and on fans. Slopes are 0 to 3 percent. The average annual precipitation is 14 to 17 inches, and the frost-free season is 150 to 180 days. These soils have moderately slow permeability. Runoff is slow, and the erosion hazard is moderate where cover is not maintained. The water-supplying capacity during the growing season is 20 to 30 inches. Rooting depth is about 60 inches if moisture is present. Fertility is moderate to high.

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

The soils in this unit are suitable for growing homestead windbreaks. Two-row plantings of one-seed juniper and Siberian elm are well suited to these soils. Irrigation or additional water is essential during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIw-2

Church clay loam is the only soil in this unit. It is somewhat poorly drained, is saline, and has a clay subsoil. The soil in this unit formed in fine-textured, calcareous, moderately alkaline, water-laid sediments on low benches that surround large enclosed basins or playas. Slopes are 0 to 2 percent. The average annual precipitation is 14 to 17 inches, and the frost-free season is 150 to 180 days. This soil is very slowly permeable. Runoff is very slow. The hazard of soil blowing is moderate where cover is not maintained. The water-supplying capacity during the growing season is 20 to 30 inches. Water is received in precipitation and as additional runoff from surrounding slopes. Roots can penetrate to a depth of about 60 inches or more if moisture is present. Fertility is moderate.

This soil is used for range and wildlife, and it has limited use for water supply and recreation. It is poorly suited for growing homestead or field windbreaks because of the saline clay subsoil.

Capability Unit VIw-3

This unit consists of somewhat poorly drained, saline soils that have a silty clay loam to loamy sand subsoil and a high water table. In the unit are soils of the Manzano series, wet variant, and Wet alluvial land.

The soils in this unit formed in mixed wind-laid and alluvial sediments on bottom lands and side slopes. Slopes are 0 to 5 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. These soils are moderately slowly to rapidly permeable between the surface and the water table and are slowly permeable below the water table. Runoff is slow to medium, and the erosion hazard is slight to moderate where cover is not maintained. The water-supplying capacity is 30 inches. Water is received in precipitation, in floods, and from the water table. Effective rooting depth is 20 to 60 inches. Fertility is moderate.

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

The soils in this unit are suitable for growing homestead windbreaks. Three-row plantings of one-seed juniper, cottonwood, and Siberian elm are suited to these soils. Irrigation may be needed during the period of establishment. Protection is needed to prevent grazing and burning.

Capability Unit VIew-1

This unit consists of moderately well drained or well drained clayey soils. These soils are in the Montoya and Vermejo series.

The soils in this unit formed in alluvium on lower fans and bottom lands. Slopes are 0 to 3 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. These soils are very slowly permeable. Runoff is medium, and the erosion hazard is moderate where cover is not maintained. The water-supplying capacity during the growing season is 25 to 30 inches. Water is received in precipitation and from flooding. Roots can penetrate to a depth of 60 inches or more. Fertility is moderate.

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These soils are used for range, wildlife, and water supply. They are poorly suited to homestead and field windbreaks because of the clay.

Capability Unit VIIe-1

This unit consists of well-drained to excessively drained soils that have a loamy fine sand to fine sand surface layer over layers of fine sandy loam to fine sand. These soils are in the Springer and Tivoli series. They formed in sandy wind-laid deposits on uplands. Slopes are 0 to 9 percent. The average annual precipitation is 13 to 16 inches, and the frost-free season is 180 to 190 days. These soils are moderately rapid to rapidly permeable. Runoff is very slow, and the erosion hazard is severe to very severe where cover is not maintained. The water-supplying capacity is 12 to 15 inches during the growing season. Rooting depth is 60 inches or more. Fertility is low to moderate.

These soils are used for range, wildlife, and, to a limited extent, recreation. They are too erodible and too excessively drained to be suitable for growing windbreaks.

Capability Unit VIIs-1

This unit consists of well-drained, shallow soils. These soils are in the Pastura, Penrose, and Travessilla series. They formed in mixed alluvium and wind-laid deposits or in material weathered from interbedded limestone and shale or sandstone on uplands. Slopes are 0 to 12 percent. The average annual precipitation is 14 to 17 inches, and the frost-free season is 150 to 180 days. These soils are moderately permeable. Runoff is medium to rapid, and the hazard of water erosion is moderate where cover is not maintained. The water-supplying capacity during the growing season is 7 to 11 inches. Effective rooting depth is 4 to 20 inches. Fertility is low to moderate.

These soils are used for range, wildlife, and water supply. They are too shallow to be suitable for growing windbreaks.

Capability Unit VIIs-2

This unit consists of Rough broken land and Rough broken and stony land that are made up of steep and very steep, very shallow soils underlain by bedrock. These soils formed in material weathered from red-bed shale, clay, and interbedded sandstone, basalt, and sandstone. They are on breaks that have slopes of 25 to 80 percent. The average annual precipitation is 13 to 17 inches, and the frost-free season is 150 to 190 days. Runoff is very rapid, and the hazard of water erosion is moderate to severe where cover is not maintained. The water-supplying capacity during the growing season is 4 to 8 inches. Fertility is low.

These land types are used for range, wildlife, water supply, and recreation. They are a source of silt sedimentation in some places. They are too shallow, too stony, and too steep to be suitable for growing windbreaks.

Capability Unit VIIs-3

This capability unit consists of only Vernon-Shale outcrop complex, 1 to 9 percent slopes. The soil in this complex is well drained, is shallow, and has a clay subsoil.

The soil in this unit formed in material weathered from red-bed clayey shale on uplands. Slopes are 1 to 9 percent. The average annual precipitation is 13 to 16 inches, and the frost-free season is 180 to 190 days. This soil is very slowly permeable. Runoff is rapid, and the hazard of water erosion is severe where cover is not maintained. The water-supplying capacity during the growing season is 6 to 8 inches. Effective rooting depth extends to shale at a depth of 6 to 20 inches. Fertility is low.

This soil is used for range, wildlife, and water supply, and it is a source of silt sedimentation. It is too shallow and clayey to be suitable for growing windbreaks.

Capability Unit VIIIe-1

This unit consists only of Active dune land. This land type is made up of wind-shifted sand dunes that have slopes of 1 to 9 percent. The average annual precipitation is 13 to 16 inches, and the frost-free season is 180 to 190 days. Active dune land is very rapidly permeable. Runoff is slow. The hazard of soil blowing is very severe. Little or no vegetation grows. Fertility is low.

This land type is used to a limited extent for wildlife and for locating Indian artifacts. It is not suitable for growing windbreaks.

Capability Unit VIIIw-1

Riverwash is in this unit. It consists of sandy, gravelly, cobbly, and bouldery alluvium along stream channels. The average annual precipitation is 13 to 17 inches, and the frost-free season is 170 to 190 days. Riverwash is subject to periodic flooding and to the shifting of soil material during normal high water. It is barren of vegetation except for annual weeds and some saltcedar.

This land type is used for water supply and, in a few places, as a source of sand and gravel. It is unsuitable for growing windbreaks.

Predicted Yields

The predicted average yields of the principal dry-farmed crops grown in Harding County are listed in table 2. Soils used only for range are not listed.

TABLE 2.--PREDICTED AVERAGE YIELDS OF PRINCIPAL CROPS PER ACRE UNDER A HIGH LEVEL OF MANAGEMENT

[Only the arable soils in Harding County are listed in this table. Dashed lines indicate that the crop generally is not suited to the soil]

Soil	Winter wheat	Forage millet	Forage sorghum	Grain sorghum
	Bu.	Tons 1/	Tons 1/	Lb.
Amarillo fine sandy loam	8	1.4	1.4	1,000
Dalhart fine sandy loam	9	1.5	1.5	-----
Dioxice loam, 0 to 3 percent slopes	10	1.2	----	-----
Dumas loam, 0 to 3 percent slopes	11	1.3	----	-----
Dumas loam, thin solum, 0 to 3 percent slopes	10	1.1	----	-----
La Brier loam	10	1.2	----	-----
Manzano and La Brier soils (Manzano part only)	9	1.0	----	-----
Tricon loam	9	1.1	----	-----

1/ Tons, air-dry weight.

Irrigated farming is not extensive in the county, and data on yields of irrigated crops are not listed.

The yields shown in table 2 are those expected under a high level of management. A high level of management provides use of stubble-mulch tillage or crop residue, a conservation cropping system, and where needed, terracing and contour farming. If necessary, emergency tillage is used to control soil blowing. The soil is tilled when the moisture content is such that clods form but that compaction of the soil is not excessive. Suitable crop varieties are planted at the proper time and in a well-prepared seedbed. Insects, diseases, and weeds are controlled. Grazing cattle are removed early in spring from fields in winter wheat.

The yields in table 2 are estimates based on data received from farmers, the county agricultural agent, the agricultural census, and technicians of the Soil Conservation Service. The yields are long-term averages of dryfarmed crops in droughty and favorable years. On the same soil in Harding County, yields vary greatly from year to year and depend largely on the amount and distribution of rainfall. On a soil that produces about 30 bushels of wheat per acre in a favorable year, a crop can fail as readily in a dry year as on a soil that produces only 15 bushels in a favorable year.

In dry years the yields at a high level of management may not be much more than those that would be obtained under normal management. Management at a high level, however, helps control erosion that would lower yields in succeeding favorable years.

Irrigated Cropland

A small percentage of the cropland in Harding County is irrigated. Irrigation water is primarily obtained from wells, but some water is from streams such as Ute Creek.

About 900 acres near Rosebud and another 900 acres in the southeastern corner of the county are irrigated by sprinklers. At these places Amarillo fine sandy loam is the main irrigated soil.

Less than 100 acres in the vicinity of Yates are surface irrigated from field ditches. Here the main irrigated soils are La Brier loam; Dioxice loam, 0 to 3 percent slopes; and Dumas loam, 0 to 3 percent slopes.

Alfalfa, winter wheat, forage sorghum, and grain sorghum are the main crops irrigated. They respond well to irrigation, and crop growth is better than that for dryland crops. Organic matter can be regularly supplied by returning all crop residues to the soil. Small grain and sorghum respond to additions of nitrogen. New seedlings of alfalfa respond to phosphorus fertilizer. Mechanical and chemical means of controlling both annual and perennial weeds are used on irrigated soils.

About 67 percent of the soils in Harding County are classified as suitable for irrigation (5), though the irrigated acreage is small. Large expansion of irrigation does not appear probable. In many places underground sources of water are at a great depth. Water available for plants has a high salt content, and water from reservoirs and streams is limited. In each field limitations differ. Technical help on irrigation can be obtained from the county extension agent or from technicians of the Soil Conservation Service.

Management of Wildlife [3/]

Indians, as well as the early settlers, found abundant wildlife in the area that is now Harding County. These early hunters sought buffalo, deer, antelope, quail, dove, prairie chicken, and other wildlife. But wildlife decreased because hunting regulations were few, rangeland was overgrazed, and fences were erected as the county was settled. In recent years, however, new importance has been placed on the value of wildlife, and wildlife habitat generally has increased.

The abundance and distribution of wildlife in any area of soils is considerably determined by the nature and suitability of the habitat. The intensity of land use for crops and livestock forage directly affects the kind, quality, and amount of wildlife habitat and, therefore, the kind and number of wildlife.

The 14 soil associations in Harding County have been placed in four wildlife suitability groups. A wildlife group consists of soils that have similar wildlife population and about the same potential for wildlife habitat. The soil associations are described in the section "General Soil Map" and are shown on that map at the back of this survey.

The descriptions of the wildlife suitability groups that follow provide general information on the distribution of wildlife and wildlife habitat. These descriptions help in planning land use and in selecting land to be acquired for a wildlife program. They also help in making special interpretations for local publications.

Wildlife Suitability Group 1

This group consists of soil associations 12 and 14. It is made up of nearly level to moderately steep soils that are shallow and moderately deep to sandstone and of very shallow, stony, steep to very steep land types. The group covers about 21 percent of the county.

This group of soils occurs along the Canadian River in the western part of the county and along Ute, Tequesquite, Carrizo, Bueyeros, and Mosquero Creeks in the central part. It also occurs in the southwestern and northeastern parts of the county.

The Canadian River has cut a gorge several hundred feet deep into the Las Vegas Plateau. The head of this gorge is a few miles north of Harding County, and the gorge meanders southwestward for a travel distance of about 80 miles. Its course can be traveled only on horseback or on foot. Land adjacent to the gorge has many warm-season grasses and browse. The major browse plants are wavyleaf oak, mountain-mahogany, Apache-plume, wild grape, and four-wing saltbush. Browse consists of the leaves, buds, twigs, and bark of woody plants.

Rocky mountain mule deer is the main big game animal native to this wildlife suitability group. The Barbary sheep are primarily confined to the area along the Canadian River. These animals were stocked in the Canadian River area in 1950, and they became legal big game in 1955. Mountain-mahogany is the most palatable browse for both Barbary sheep and deer, but wavyleaf oak is the key browse plant in managing this habitat for both big game and domestic livestock. Big game animals and domestic livestock should be reduced well below the carrying capacity of this habitat if management is based on mountain-mahogany. Mountain-mahogany will continue to be overused where full use is made of wavyleaf oak. In some of the rugged country, browse is accessible only to Barbary and domestic sheep. A more even distribution of grazing is needed on the fully accessible areas, rather than sharp adjustments to total animal populations.

Wildlife Suitability Group 2

This group consists of associations 3, 4, and 13. In the group are loamy, nearly level to gently undulating or gently sloping soils that formed in valley fill, and gravelly, undulating to hilly soils. The group covers about 15 percent of the county.

The soil associations in this group occur on the eastern toe of the escarpment that runs north and south through the center of the county. The soils are transitional between areas that primarily are deer habitat and areas of antelope, scaled quail, and dove habitat.

The western part of this transitional area has a mixed cover of grasses, pinyon pine, and juniper and a scattering of wavyleaf oak. Farther to the east is more open grassland and scattered small soapweed, cactus, and mesquite.

Deer, antelope, scaled quail, and mourning dove are the game species that frequent the habitat of this wildlife group. Deer are most abundant along the western part, and antelope, quail, and dove along the eastern part.

Proper rangeland management benefits the wildlife in this suitability group. Landowners along the western part of the group are in a favorable position to develop recreational facilities and take advantage of the scenic and wildlife potential of the adjacent escarpment area.

Wildlife Suitability Group 3

This group consists of associations 1, 2, 5, 6, 8, and 11. In these associations are loamy and calcareous soils around playa lakes; calcareous soils underlain by caliche; loamy to sandy soils; and loamy soils that are shallow or moderately deep to caliche or basalt. These soils are nearly level to rolling or moderately steep. This group makes up 38 percent of the county and is the most extensive group in the county.

[3/] By JOHN N. FARLEY, biologist, Soil Conservation Service.

The soils in this group occur at elevations of 4,800 to 6,100 feet. A large area is west of the escarpment and is locally called the hardlands or mesa. A smaller area is in the northeastern part of the county. The acreage of cultivated soils is larger in this group than in any other in the county.

The early homesteaders operated small farms for both crops and grazing. In the last two decades, many of these small units have been combined into larger units. Evidence of this early period of growth is still seen in abandoned buildings and corrals in varying stages of deterioration. Ponds, springs, or windmills pumping water are common around many of the abandoned headquarters. Still growing around the headquarters are ornamental and protective plantings of shrubs and trees. Also, a number of small, abandoned areas of cropland are naturally revegetating. The present owners continue to remove the many fences no longer needed.

The most abundant game in this group are scaled quail, mourning dove, and antelope. Playa lakes often have shallow water during years when rainfall is above average in summer. Migrating flocks of ducks and geese use these playa lakes.

In this wildlife group, food for quail and dove is plentiful. Cropland fields, including those that have crop stubble and those reverting to grass, provide abundant seed. Among the plants that grow naturally are crotons, wild buckwheat, sunflower, Russian-thistle, and sand dropseed.

Quail and dove are seen most frequently in the vicinity of abandoned headquarters and farmsteads. These birds are protected by the trees and shrubs around the headquarters.

Antelope has repopulated much of this wildlife group, mainly because of the hunting management and stocking policies of the New Mexico Game and Fish Department. This native game animal was nearly eliminated from all of New Mexico before modern game management began and before game laws were enforced. Antelope has benefited by change in land ownership and use because fences no longer needed on the large ranches have been removed.

Migrating waterfowl do not use the playa lakes as much as they did in the past. In some places changes in land use had a marked effect on the migration routes of waterfowl. The amount of food available to ducks and geese was greatly reduced when many fields formerly used for winter wheat or other crops were reseeded to native grasses.

Chicosa Lake, a large playa used for recreation, is in this wildlife suitability group. The lake is spring fed, and it receives additional water from a watershed enlarged by a diversion. When extra water is needed, it can be pumped from nearby wells. Chicosa Lake has a recreation pool of about 40 surface acres that is used by many New Mexico and out-of-State visitors. The lake is privately owned, but its fishery is managed by the State Game and Fish Department. Public access is provided by a cooperative agreement between the owner and the department. The development of Chicosa Lake is an excellent example of people working together to provide recreation.

Wildlife Suitability Group 4

This group consists of associations 7, 9, and 10. In these associations are nearly level to rolling soils that have a fine sandy loam to fine sand surface layer. This group covers about 26 percent of the county. It occurs in the sandhills of the eastern and southeastern parts of the county and includes the sandy areas adjoining and between these hills.

The soils in this group provide habitat for scaled quail, mourning dove, and antelope. Some people concerned with game believe that water is a controlling factor if scaled quail, mourning dove, and antelope are to increase significantly.

Early settlers found prairie chicken in this wildlife group, but the population of these birds decreased rapidly. Inadequate rangeland management in early times and lax game laws have resulted in the elimination of the prairie chicken from Harding County.

The soils in most of this wildlife suitability group are used as range, but a few areas are cultivated. If rangeland management is good, the vegetation is mainly sand bluestem, little bluestem, sideoats grama, black grama, and needle-and-thread. Where the range has been continually overused, the main plants are blue grama, hairy grama, sand muhly, sand dropseed, three-awn, small soapweed (yucca), sand sagebrush, and pricklypear.

The changes in plant cover have not greatly affected the wildlife potential of this group. Because the soils are susceptible to severe damage by soil blowing, any trend indicating further deterioration of plant cover should be closely watched.

Soils in Engineering[4/]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, drainage systems, and sewage disposal systems. Among the properties most important to the engineer are permeability, shear strength, compaction characteristics, drainage, shrink-swell characteristics, grain size, plasticity, and pH. Topography and depth of unconsolidated materials also are important.

The information in this survey can be used to--

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in the planning of agricultural drainage systems, farm ponds, irrigation systems, terraces, waterways, and diversion terraces.

4/ By WILEY MILLER, area engineer, Soil Conservation Service.

3. Make preliminary evaluations of soil conditions that will aid in selecting highway and airport locations, the routing of pipelines, underground cable, or other utility installations, and in planning detailed investigations of selected locations.
4. Locate probable sources of gravel, sand, and other construction materials.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soil units for cross-country movements of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photographs for the purpose of making maps and reports that will be more useful to engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

With the use of the soil map for identification, these interpretations can be useful for many purposes. It should be emphasized that they do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and excavations deeper than the depths of layers here reported. Even in these situations, however, the soil map is useful in planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Much of the information in this subsection is in tables 3, 4, and 5. Estimates of engineering properties of soils are in table 3, and engineering interpretations of these properties are in table 4. Table 5 gives test data of value to engineers. These test data and other information in this survey are used as a basis for the estimates in tables 3 and 4.

Some of the terms used in this publication have a special meaning to soil scientists that may not be familiar to engineers. Many such terms are defined in the Glossary at the back of this survey and in the "Soil Survey Manual" (8).

Engineering Classification Systems

Two systems of classifying soils for engineering purposes are in general use. Both are used in this survey. These classification systems are explained in the PCA Soil Primer (7).

Many highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (1). In this system, classification is based on highway performance as indicated by the gradation, liquid limit, and plasticity index of the soil. All soil materials are classified in seven principal groups designated A-1 through A-7. The best materials for use in subgrades (gravelly soils of high shear strength) are classified as A-1, and the poorest (clayey soils having low shear strength when wet) are classified A-7. The relative engineering values of soils within each group are indicated by group index numbers. Group indexes range from 0 for the best materials to 20 for the poorest.

Some engineers prefer to use the Unified Soil Classification System that was established by the Waterways Experiment Station, Corps of Engineers (12). This system is based on identification of soils according to their texture and plasticity and their performance as engineering construction materials. In the Unified system SW and SP are clean sands, SM and SC are sands that have fines of silt and clay, ML and CL are silts and clays that have a low liquid limit, and MH and CH are silts and clays that have a high liquid limit.

The estimated classification of all the soils is given in table 4 for both the Unified and AASHO systems.

Estimated Properties of the Soils

Table 3 gives the estimated properties of the soils in Harding County that affect engineering work. The information in this table was based on data compiled for the soil survey and the test data shown in table 5.

Depth to bedrock or cemented caliche is measured in feet from the surface and is the range in which bedrock or caliche occurs in most areas of a particular soil. Bedrock is considered the solid or fractured rock that generally underlies the soil and other unconsolidated material. Cemented caliche is material that is strongly cemented with calcium carbonate and that does not soften when wet for a long time.

Depth from surface gives the depth to the significant layers for which properties have been estimated. Those layers are described in the section "Descriptions of the Soils." The estimates of properties of these significant layers given in the succeeding columns are ranges in values for a typical soil profile. Variations from these values are to be expected.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is made up of particles less than 2.0 millimeters in diameter. The terms "sand," "silt," and "clay," and some some other terms used in the USDA textural classification are defined in the Glossary at the back of this survey.

The coarse fraction consisting of particles of more than 3 inches in diameter was not measured in the mechanical analysis. The percentages were obtained by field observation at the time the soil samples were collected.

The estimated percentage of soil material passing sieves No. 4, No. 10, and No. 200 reflects the normal range for a soil series. Because grain size of any soil varies considerably, it should not be assumed that the range shown in the table applies to all samples of a specific soil, nor that the engineering classification invariably is as shown.

Permeability relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on texture, structure, and porosity of the soil. Plowpans, surface crusts, and other properties resulting from the use of the soils are not considered.

Available water capacity is 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 capacity and the amount at wilting point. In table 3 it is expressed in inches of water per inch of soil.

Reaction refers to the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and relative terms used to describe soil reaction are explained in the Glossary.

Salinity affects the suitability of a soil for crops, its stability where used as a construction material, and its corrosiveness to other materials. Estimates of salinity are based on estimates of electrical conductivity of the saturated soil extract.

Shrink-swell potential is an indication of the volume change to be expected of the soil material when the moisture content of the material changes. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures built in, on, or with such materials.

Corrosivity ratings in table 3 indicate the potential danger to uncoated metal or concrete structures through chemical action that dissolves or weakens the structural material. Structural materials may corrode when buried in soil, and a given material corrodes in some kinds of soil more rapidly than in others. Extensive installations that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than are installations entirely in one kind of soil or soil horizon.

Small tracts of Bippus loam and Guadalupe fine sandy loam are subject to flooding. Church clay loam has a seasonal water table at a depth of 3 to 6 feet. Manzano loam, wet variant, and Wet alluvial land have a seasonal water table at a depth of 1 to 4 feet.

Interpretations of Engineering Properties of the Soils

Table 4 gives estimates of the suitability of the soils for specified uses and lists soil properties that affect construction of highways, farm facilities, buildings, and sewage disposal systems. Detrimental or undesirable features are emphasized, but very important desirable features also may be listed. The ratings and other interpretations in this table are based on estimated engineering properties of the soils in table 3; on available test data, including those in table 5; and on field experience. Although the information applies only to the soil depths indicated, it is reasonably reliable to a depth of about 6 feet for most soils and to greater depths for some.

Topsoil is a term used to designate a fertile soil or soil material, ordinarily rich in organic matter, used as a topdressing for lawns, gardens, roadbanks, and the like. The ratings indicate suitability for such use.

The ratings for sand and gravel are based on the probability that delineated areas of the soil contain deposits of sand and gravel. The ratings do not indicate the quality or size of the deposits.

Road fill is material used to build embankments. The ratings indicate performance of soil material moved from borrow areas for this purpose.

Highway location is influenced by features of the undisturbed soil that affect construction and maintenance of highways. The soil features listed, both favorable and unfavorable ones, are the principal features that affect the geographic location of highways.

Farm pond reservoir areas are affected mainly by loss of water through seepage. The soil features listed are those that influence such seepage. Farm pond embankments serve as dams. The soil features of both the subsoil and substratum are those important to the use of soils for constructing embankments.

Pitting, chiseling, and contour furrowing serve to loosen the soil and retain water from rainfall and snow melt. The intake rate and permeability of the soil and the stability of clods are the soil features considered.

Irrigation is on a small total acreage in Harding County. Ratings of the available water capacity and of water-intake rates have been given for soils under irrigation.

The available water capacity in inches for a 60-inch soil depth and the corresponding ratings are as follows:

Available water capacity	Rating
Less than 3.75 inches	Very low
3.75 to 5 inches	Low
5 to 7.5 inches	Moderate
More than 7.5 inches	High

Irrigation intake rates in inches per hour, and the corresponding ratings are as follows:

Intake rate	Rating
0.0 to 1.0	Slow
1.0 to 2.5	Moderate
2.5+	High

Terraces and diversions are low structures designed to retain or divert water. The soil features listed in table 4 are those that affect the use of the soil as material for embankments.

Foundations for low buildings are affected chiefly by features of the undisturbed soil that influence its capacity to support low buildings that have normal foundation loads.

[Riverwash (RH), Rough broken land (RK), Rough broken and stony land (Rn, RO), and Wet alluvial land (WE) are so

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or this reason it is necessary to follow carefully the instructions

Soil series and map symbols 1/	Depth to bedrock or indurated caliche	Depth from surface (typical profile)	Classification			Coarse fraction greater than 3 inches	Percentage passing sieve--	
			Dominant USDA texture	Unified	AASHO		No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
	Feet	Inches				Percent		
Active dune land: AC.	>5	0-60	Sand----------	SP-SM	A-3	------	100	80-100
Amarillo: AM-------	>5	0-65	Sandy clay loam---	SC or CL	A-4 or A-6	------	100	100
Apache: Ap---------	½-1½	0-12	Stony loam--------	ML or CL	A-4 or A-6	25-35	80-90	70-80
		12	Basalt bedrock.					
Berthoud: Bd, BE, BH.	>5	0-12	Loam or fine sandy loam.	ML	A-4	------	100	95-100
		12-60	Clay loam and sandy clay loam.	CL	A-6	------	100	95-100
Bippus: BP---------	>5	0-60	Clay loam---------	CL	A-6	------	100	100
*Campus:								
Ca, Cb, Cc, CD, CE, Cf, Cg, CN. For properties of the Dean soil in CN, refer to Dean series.	>5	0-18	Loam----------	ML or CL	A-4	------	100	100
		18-60	Loam----------	ML or CL	A-4	------	100	100
Cm----------	>5	0-60	Gravelly loam-----	SC or SM	A-4	------	70-80	65-75
Carnero:								
Co, Cr----------	1.5-3.5	0-36	Clay loam---------	CL	A-6	------	100	100
		36	Sandstone bedrock.					
Cs, Ct---------- Properties listed here are for the 15 percent of Cs and Ct respectively, that is alkali affected. For properties of the remaining 85 percent of Cs and Ct, refer to data for Co and Cr preceding.	1.5-2.5	0-26	Clay loam and heavy clay loam.	CL or CH	A-6 or A-7	------	100	100
		26	Sandstone bedrock.					

See footnotes at end of table.

variable that estimates were not made. The symbol > means greater than; the symbol < means less than]

more kinds of soil. The soils in such mapping units may have different properties and limitations, and for for referring to other series that appear in the first column of this table]

Percentage passing sieve--Continued		Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity of untreated pipe
No. 40 (0.042 mm.)	No. 200 (0.074 mm.)						
		Inches per hour	Inches per inch of soil	pH	Millimhos per cm.		
55-65	0-10	>20.0	0.04-0.06	6.6-7.8	0-1	Low----------	Low.
90-100	40-65	0.63-2.0	0.14-0.16	7.4-8.4	0-1	Moderate-------	Moderate.
60-70	50-60	0.63-2.0	0.07-0.12	7.9-8.4	0-1	Moderate-------	Low.
85-95	50-65	0.63-2.0	0.14-0.17	7.9-8.4	0-1	Low----------	Low.
85-100	55-75	0.63-2.0	0.17-0.19	7.9-8.4	0-1	Moderate-------	Moderate.
90-100	70-80	0.63-2.0	0.19-0.21	7.4-8.4	0-1	Moderate-------	Moderate.
85-95	60-75	0.63-2.0	0.16-0.18	7 9-8.4	0-1	Moderate-------	Moderate.
85-95	60-75	0.63-2.0	---------	7.9-8.4	0-1	Moderate-------	Moderate.
60-70	40-50	0.63-2.0	0.07-0.12	7.9-8.4	0-1	Low----------	Low.
95-100	90-100	0.63-2.0	0.19-0.21	6.6-8.4	0-1	Moderate-------	Moderate.
95-100	95-100	<0.06	0.03-0.05	8.5-9.0	4-8	Moderate to high.	High.

Soil series and map symbols 1/	Depth to bedrock or indurated caliche	Depth from surface (typical profile)	Classification			Coarse fraction greater than 3 inches	Percentage passing sieve--	
			Dominant USDA texture	Unified	AASHO		No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
	Feet	Inches				Percent		
Church 2/: Cu--------	>5	0-11	Clay loam---------	ML or CL	A-6	------	100	100
		11-60	Clay----------	CH	A-7	------	100	100
Dalhart: Da, Db----	>5	0-60	Sandy clay loam and heavy loam.	CL	A-6	------	100	100
Dean: Dd, DE-------	0.5-1.0	0-6	Stony loam--------	ML or CL	A-4	0-15	80-90	75-85
		6	Strongly cemented gravelly caliche.					
Dioxice: Df, Dg, Dh.	>5	0-35	Clay loam---------	ML or CL	A-6 or A-7	------	100	100
		35-60	Loam----------	ML or CL	A-6 or A-7	------	100	100
Dumas: Dm, DN, Do, Dr, Du, DV.	>5	0-36	Clay loam and silty clay loam.	ML or CL	A-6	------	100	100
		36-60	Clay loam---------	CL	A-6	------	100	100
Gallegos: GA--------	>5	0-21	Very gravelly sandy loam and very gravelly clay loam.	GC	A-1	0-10	40-45	25-35
		21-60	Gravelly sandy loam.	GW-GM	A-1	0-10	40-50	35-45
Guadalupe: GU------	>5	0-80	Fine sandy loam---	SM or SC	A-4	------	100	100
*Ima: IM---------- For properties of Quay soil in IM, refer to Quay series.	>5	0-47	Fine sandy loam and sandy loam.	SM or SC	A-2 or A-4	------	100	100
Karde: Ka----------	>5	0-60	Loam and light clay loam.	ML or CL	A-4 or A-6	------	100	100
Kinkead: KC--------	>5	0-42	Clay----------	CH	A-7	------	100	100
		42-60	Sandy clay loam--	CL	A-6	------	100	100
Kinkead, alkali 2/: KK.	>5	0-60	Clay----------	CH	A-7	------	100	100
La Brier: La, LB, Lc, Ld.	>5	0-8	Loam or clay loam.	ML or CL	A-4	------	100	100
		8-31	Clay----------	CH	A-7	------	100	100
		31-72	Clay loam--------	ML or CL	A-7	------	100	100

See footnotes at end of table.

Percentage passing sieve--Continued		Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity of untreated pipe
No. 40 (0.042 mm.)	No. 200 (0.074 mm.)	Inches per hour	Inches per inch of soil	pH	Millimhos per cm.		
95-100	95-100	0.06-0.20	0.19-0.21	7.9-8.4	2-4	High----------	High.
95-100	95-100	<0.06	0.14-0.17	7.9-9.0	4-8	High----------	High.
95-100	50-60	0.63-2.0	0.14-0.16	7.4-8.6	0-1	Moderate------	Moderate.
60-70	50-60	0.06-0.2	0.08-0.14	7.9-8.5	0-1	Low-----------	Low.
95-100	90-100	0.20-0.63	0.19-0.21	7.4-8.4	0-1	Moderate------	Moderate.
95-100	90-100	0.20-0.63	---------	8.5-9.0	0-1	Moderate------	Moderate.
85-95	70-80	0.20-0.63	0.19-0.21	7.4-7.8	0-1	Moderate------	Moderate.
85-95	70-80	0.20-0.63	---------	7.9-9.0	0-1	Moderate------	Moderate.
20-30	15-25	2.0-6.3	0.07-0.09	7.9-8.4	0-1	Low-----------	Low.
25-35	5-15	6.3-20.0	0.04-0.06	7.9-8.4	0-1	Low-----------	Low.
70-85	40-50	2.0-6.3	0.13-0.15	7.9-9.0	0-1	Low-----------	Low.
60-85	30-50	2.0-6.3	0.11-0.15	7.9-9.0	0-1	Low-----------	Low.
85-95	60-75	0.2-0.63	0.16-0.18	7.9-8.4	2-8	Moderate------	Moderate to high.
95-100	65-75	0.06-0.20	0.14-0.16	6.6-7.8	0-2	High----------	High.
95-100	50-60	0.20-0.63	0.14-0.16	7.4-8.4	2-4	Moderate------	Moderate.
95-100	65-75	<0.06	0.03-0.05	8.5-9.0	2-8	High----------	High.
95-100	80-100	0.63-2.0	0.16-0.18	6.6-7.3	0-1	Moderate------	Low.
95-100	90-100	0.06-0.20	0.14-0.16	6.6-7.8	0-1	High----------	High.
95-100	90-100	0.20-0.63	0.17-0.19	7.9-8.4	0-2	Moderate------	Moderate.

Soil series and map symbols 1/	Depth to bedrock or indurated caliche	Depth from surface (typical profile)	Classification			Coarse fraction greater than 3 inches	Percentage passing sieve--	
			Dominant USDA texture	Unified	AASHO		No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
	Feet	Inches				Percent		
Lacita: LE---------	>5	0-70	Loam or silt loam.	ML or CL	A-4	------	100	100
Latom: LF----------	1-2	0-16	Fine sandy loam and loam.	SM or SC	A-4	------	100	100
		16	Sandstone bedrock.					
Litle: Lt----------	1.5-3.5	0-10	Clay loam---------	CL	A-6	------	100	100
		10-24	Clay----------	CL	A-7	------	100	100
		24	Clayey shale.					
*Mansker: MA, MK---- For properties of Portales soil in MA, and for Potter soil in MK, refer to Portales and Potter series.	>5	0-14	Loam----------	ML	A-4	------	100	100
		14-60	Loam----------	ML or CL	A-4	------	100	100
*Manzano 2/: Mm, Mn, Mo. For properties of La Brier soil in Mo, refer to La Brier series.	>5	0-60	Clay loam and loam.	CL	A-4 or A-6	------	100	100
Manzano, wet variant 2/: Mr.	>5	0-72	Silty clay loam---	ML or CL	A-7	------	100	100
Montoya 2/: MT-------	>5	0-60	Clay----------	CH	A-7	------	100	100
Otero: Or, Os, OT--	>5	0-28	Fine sandy loam---	SM	A-4	------	100	100
		28-65	Loamy sand--------	SM	A-2	------	100	100
Pastura: PA, Pc----	0.5-1.5	0-10	Loam and gravelly loam.	ML or CL	A-6	------	65-80	60-75
		10	Indurated caliche.					
Penrose: Pe--------	0.5-1.5	0-6	Clay loam---------	ML or CL	A-6	0-10	90-100	80-90
		6	Limestone bedrock.					
Portales---------- Mapped only in an association with Mansker soils.	>5	0-21	Fine sandy loam and loam.	ML or CL	A-4	------	100	100
		21-60	Loam----------	ML or CL	A-4	------	100	100

See footnotes at end of table.

Percentage passing sieve--Continued		Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity of untreated pipe
No. 40 (0.042 mm.)	No. 200 (0.074 mm.)	Inches per hour	Inches per inch of soil	pH	Millimhos per cm.		
95-100	90-100	0.20-0.63	0.17-0.19	7.9-9.0	2-4	Moderate------	Moderate.
70-85	40-50	0.63-2.0	0.13-0.15	7.9-8.4	0-2	Low----------	Low to moderate.
95-100	90-100	0.20-0.63	0.19-0.21	7.4-8.4	0-2	Moderate-------	Moderate.
95-100	90-100	0.06-0.20	0.14-0.16	7.9-8.4	2-8	High----------	High.
85-95	60-75	0.63-2.0	0.14-0.17	7.9-8.4	0-1	Moderate-------	Moderate.
85-95	60-75	0.63-2.0	---------	7.9-9.0	0-1	Moderate-------	Moderate.
85-100	60-80	0.20-0.63	0.19-0.21	7.4-8.4	0-1	Moderate-------	Moderate.
95-100	85-95	0.20-0.63	0.17-0.19	7.9-8.4	2-8	Moderate-------	High.
90-100	75-95	<0.06	0.14-0.16	7.9-9.0	2-8	High----------	High.
60-85	35-50	2.0-6.3	0.13-0.15	7.9-8.4	0-1	Low----------	Low.
50-75	15-30	6.3-20.0	0.09-0.10	7.9-8.4	0-1	Low----------	Low.
55-70	50-65	0.63-2.0	0.12-0.14	7.9-8.4	0-1	Low----------	Low.
75-85	60-70	0.63-2.0	0.17-0.19	7.9-9.0	2-4	Moderate-------	Moderate.
85-95	50-60	0.63-2.0	0.14-0.17	7.9-8.4	0-1	Moderate-------	Moderate.
85-95	50-60	0.63-2.0	---------	8.5-9.0	0-1	Moderate-------	Moderate.

Soil series and map symbols 1/	Depth to bedrock or indurated caliche	Depth from surface (typical profile)	Classification			Coarse fraction greater than 3 inches	Percentage passing sieve--	
			Dominant USDA texture	Unified	AASHO		No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
	Feet	Inches				Percent		
Potter----------	0.5-1.0	0-8	Fine sandy loam---	SM or SC	A-4	------	100	70-85
Mapped only in an association with Mansker soils.		8	Strongly cemented, fractured, platy caliche.	--------	--------	------	------	-----
Quay----------	>5	0-18	Loam----------	ML or CL	A-4	------	100	100
Mapped only in a an undifferentiated group with Ima soils and in an association with Tucumcari soils.		18-60	Loam----------	ML or CL	A-4	------	100	100
*Springer: SP, SR, SS.	>5	0-18	Loamy fine sand---	SM	A-2	------	100	100
		18-32	Fine sandy loam---	SM	A-2 or A-4	------	100	100
For properties of Amarillo soil in SR and SS, refer to Amarillo series.		32-65	Loamy fine sand---	SM	A-2	------	100	100
Tapia: Ta----------	1.5-3.0	0-25	Sandy clay loam---	CL	A-6	------	100	100
		25	Indurated caliche.					
Properties listed here are for the 10 percent of Ta that is affected by alkali. For properties of the remaining 90 percent of Ta, refer to data for Ta preceding.	1.5-2.5	0-25	Sandy clay loam---	CL	A-2	------	100	100
		25	Indurated caliche.					
*Tivoli: TF, TG-----	>5	0-72	Fine sand---------	SM	A-2	------	100	85-100
For properties of Springer soil in TG, refer to Springer series.								

See footnotes at end of table.

OF THE SOILS--Continued

Percentage passing sieve--Continued		Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity of untreated pipe
No. 40 (0.042 mm.)	No. 200 (0.074 mm.)	Inches per hour	Inches per inch of soil	pH	Millimhos per cm.		
55-70	40-50	0.63-2.0	0.13-0.15	7.9-8.4	0-1	Low----------	Low.
------	-----	--------	--------	8.5-9.0	---	----------	
85-95	60-75	0.63-2.0	0.12-0.17	7.9-8.4	0-1	Moderate-------	Moderate.
85-95	60-75	0.63-2.0	---------	8.5-9.0	0-1	Moderate-------	Moderate.
75-85	15-25	6.3-20.0	0.07-0.09	7.4-7.8	0-1	Low----------	Low.
80-90	20-40	2.0-6.3	0.13-0.15	7.4-7.8	0-1	Low----------	Low.
75-85	15-25	6.3-20.0	0.07-0.09	7.4-7.8	0-1	Low----------	Low.
80-90	50-60	0.63-2.0	0.14-0.16	7.4-8.4	0-1	Moderate-------	Moderate.
85-95	50-60	0.06-0.20	0.04-0.05	8.5-9.0	4-8	Moderate-------	High.
65-80	15-25	6.3-20.0	0.05-0.07	6.6-7.8	0-1	Low----------	Low.

Soil series and map symbols 1/	Depth to bedrock or indurated caliche	Depth from surface (typical profile)	Classification			Coarse fraction greater than 3 inches	Percentage passing sieve--	
			Dominant USDA texture	Unified	AASHO		No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
	Feet	Inches				Percent		
Travessilla: Tr, TS.	0.5-1.0	0-6 6	Stony loam------- Sandstone bedrock.	ML	A-4	25-35	85-95	75-85
Tricon:								
Tt, Tv----------	1.5-3.5	0-32 32	Heavy clay loam and clay loam. Indurated caliche.	CL	A-6 or A-7	------	100	100
Tu---------- Properties listed here are for the 10 percent of Tu that is affected by alkali. For properties of the remaining 90 percent of Tu, refer to data for Tt and Tv preceding.	1.5-2.5	0-24 24	Clay loam-------- Indurated caliche.	CH	A-7	------	100	100
*Tucumcari: TW----- For properties of Quay soil in TW, refer to Quay series.	>5	0-18 18-60	Heavy clay loam-- Heavy clay loam and clay loam.	ML or CL CL	A-4 or A-6 A-6 or A-7	------ ------	100 100	100 100
Vermejo 2/: Ve------	>5	0-66	Clay----------	CH	A-7	------	100	100
Vernon: VS--------	0.5-1.5	0-10 10	Clay---------- Clayey shale.	CL or CH	A-7	------	100	100

1/ See soil descriptions elsewhere in this publication for information about kind of underlying rock and other detailed information about the soils.

Percentage passing sieve--Continued		Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity of untreated pipe
No. 40 (0.042 mm.)	No. 200 (0.074 mm.)	Inches per hour	Inches per inch of soil	pH	Millimhos per cm.		
65-75	50-60	0.63-2.0	0.07-0.12	7.4-7.8	0-1	Low----------	Low.
90-100	70-80	0.06-0.20	0.19-0.21	7.4-8.4	0-1	High----------	High.
95-100	90-100	<0.06	0.04-0.05	8.5-9.0	4-8	High----------	High.
95-100	65-75	0.63-2.0	0.19-0.21	7.9-8.4	0-1	Moderate------	Moderate.
95-100	75-85	0.20-0.63	0.18-0.20	7.9-8.4	1-4	High----------	High.
90-100	75-95	<0.06	0.10-0.12	7.9-8.4	1-15+	High----------	High.
90-100	75-95	<0.06	0.14-0.17	7.9-9.0	1-4	High----------	High.

2/ Soils are subject to flooding.

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TABLE 4.--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 necessary to follow carefully the instructions for referring

Soil series and map symbols	Suitability as a source of--			Soil features affecting--		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds	
					Reservoir area	Embankment 1/
Active dune land: AC.	Poor: low fertility; low available water capacity; highly erodible.	Good for fine sand: poorly graded.	Good if confined or soil binder is added.	Very severe soil blowing hazard; unstable unless confined; loose sand hinders hauling.	Excessively drained.	Medium shear strength; high permeability; medium to high piping hazard.
Amarillo: AM---	Poor to fair in upper foot: fine sandy loam or loamy fine sand texture; fair in subsoil.	Unsuitable: fine-grained material.	Fair to poor: moderate shrink-swell potential in subsoil; A-4 or A-6.	Fine grained material; slight to medium plasticity.	Moderate permeability.	Low permeability; medium shear strength; medium to low piping hazard.
Apache: Ap-----	Poor: coarse fragments.	Good for crushed rock below depth of 1 foot.	Fair to poor: A-4 and A-6.	Bedrock at depth of about 1 foot.	Bedrock at depth of about 1 foot.	Medium to low shear strength and permeability; medium piping hazard.
Berthoud: Bd, BE, BH.	Fair: moderate fertility.	Unsuitable: fine-grained material.	Fair to poor: moderate shrink-swell potential in subsoil; A-4 and A-6.	Fine-grained material; slight to medium plasticity.	Moderate permeability.	Medium to low shear strength and piping hazard; low permeability.
Bippus: BP-----	Fair: moderate fertility.	Unsuitable: fine-grained material.	Poor: moderate shrink-swell potential in the subsoil; A-6.	Fine-grained material; slight to medium plasticity.	Moderate permeability.	Medium to low shear strength and piping hazard; low permeability.
*Campus: Ca, Cb, Cc, CD, CE, Cf, Cg, CN. For Dean part in CN, refer to the Dean series in this table.	Poor: high in lime content, erodible.	Unsuitable: fine-grained material.	Fair: moderate shrink-swell potential; A-4.	Fine-grained material; slight to medium plasticity.	Moderate permeability.	Low to medium shear strength, piping hazard, and permeability.
Cm----------	Fair: gravelly loam.	Poor to fair for gravel.	Fair: A-4------	Undulating to hilly topography.	Gravelly; slopes of 1 to 25 percent.	Medium shear strength and piping hazard; medium to low permeability.

See footnote at end of table.

of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is to other series that appear in the first column of this table]

Soil features affecting--Continued				Susceptibility to erosion	Degree and kinds of limitations for sewage fields	Hydrologic soil group
Pitting, chiseling, and contour furrowing	Irrigation	Terraces and diversions	Foundations for low buildings			
High intake rate--	Very erodible; rolling topography.	Very rapid permeability.	Poor stability unless confined; low shear strength.	Very severe hazard of soil blowing.	Moderate: rolling topography; sands may cause contamination of water supply.	A
High intake rate--	High available water capacity; high intake rate.	High intake rate.	Moderate shrink-swell potential in subsoil.	Moderate to severe hazard of soil blowing.	Slight to moderate: moderate permeability.	B
Stony; bedrock at depth of about 1 foot.	Stony; bedrock at depth of about 1 foot.	Stony; bedrock at depth of about 1 foot.	Bedrock at depth of about 1 foot.	Slight---------	Severe: bedrock at depth of about 1 foot.	D
Features generally favorable.	Moderate intake rate; high available water capacity; gently sloping topography.	Features generally favorable.	Moderate shrink-swell potential in subsoil.	Moderate hazard of water erosion.	Slight to moderate: moderate permeability.	B
Moderate intake rate; slow runoff.	Moderate intake rate; high available water capacity.	Moderate permeability.	Moderate shrink-swell potential in subsoil.	Slight---------	Slight to moderate: moderate permeability.	B
Unstable clods---	Level to sloping topography; hazard of soil blowing; high lime content.	Sloping topography; unstable embankment.	Moderate shrink-swell potential.	Moderate hazard of soil blowing.	Slight to moderate: moderate permeability.	B
Gravelly; unstable clods.	Gravelly; low available water capacity; undulating to hilly topography.	Gravelly; undulating to hilly topography.	Low shrink-swell potential.	Severe hazard of water erosion.	Severe: undulating to hilly topography.	B

Soil series and map symbols	Suitability as a source of--			Soil features affecting--		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds	
					Reservoir area	Embankment 1/
Carnero: Co, Cr----------	Fair: moderate fertility.	Good for crushed rock below depth of 1.5 to 3.5 feet.	Poor: moderate shrink-swell potential; A-6.	Fine-grained material; slight to medium plasticity.	Bedrock at depth of 1.5 to 3.5 feet.	Medium to low shear strength and piping hazard; low permeability.
Cs, Ct---------- Properties listed here are for the 15 percent of Cs and Ct, respectively, that is affected by alkali. For properties of the remaining 85 percent of Cs and Ct, refer to data for Co and Cr preceding.	Poor: highly plastic; low fertility.	Good source for crushed rock below 1.5 to 2.5 feet.	Poor: highly plastic; A-6 and A-7.	Fine-grained material; high plasticity.	Bedrock at depth of 1.5 to 2.5 feet.	Low shear strength, permeability, and piping hazard.
Church: Cu------	Poor: high clay content.	Unsuitable: fine-grained material.	Poor: high shrink-swell potential; high plasticity; seasonal water table; A-6 and A-7.	Fine-grained material; high plasticity; subject to flooding.	Occasional flooding; seasonal water table.	Low shear strength, permeability, and piping hazard.
Dalhart: Da, Db.	Fair: moderate fertility.	Unsuitable: fine-grained material below the surface.	Poor: moderate shrink-swell potential; A-6.	Fine-grained material; slight to medium plasticity.	Moderate permeability.	Medium to low shear strength and piping hazard; low permeability.
Dean: Dd, DE----	Poor: high in carbonates; caliche below depth of 0.5 to 1.0 foot.	Good for caliche gravel.	Fair: A-4------	Rolling slopes--	Caliche below depth of 0.5 to 1.0 foot.	Medium to low shear strength and permeability; medium piping hazard.

See footnote at end of table.

Soil features affecting--Continued				Susceptibility to erosion	Degree and kinds of limitations for sewage fields	Hydrologic soil group
Pitting, chiseling, and contour furrowing	Irrigation	Terraces and diversions	Foundations for low buildings			
Features generally favorable.	Low to moderate available water capacity; bedrock at depth of 1.5 to 3.5 feet.	Bedrock at depth of 1.5 to 3.5 feet.	Moderate shrink-swell potential.	Moderate-------	Severe: bedrock at depth of 1.5 to 3.5 feet.	C
Slow intake rate--	Very low available water capacity; bedrock at depth of 1.5 to 2.5 feet.	Bedrock at depth of 1.5 to 2.5 feet.	High compressibility.	Moderate to severe.	Severe: bedrock at depth of 1.5 to 2.5 feet.	D
Slow intake rate; 0 to 2 percent slopes.	Very slow permeability; clay subsoil; saline.	Subject to occasional flooding.	High shrink-swell potential; high compressibility; seasonal water table; occasional flooding.	Moderate hazard of soil blowing.	Severe: very slow permeability; seasonal water table; occasional flooding.	D
Fine sandy loam surface layer.	High intake rate; high available water capacity.	Subject to erosion unless compacted.	Moderate shrink-swell potential.	Moderate hazard of soil blowing.	Slight to moderate: moderate permeability.	B
Caliche below depth of 0.5 to 1.0 foot.	Very low available water capacity; caliche gravel.	Caliche below depth of 0.5 to 1.0 foot.	Caliche below depth of 0.5 to 1.0 foot.	Moderate hazard of water erosion.	Severe: fractured caliche below depth of 0.5 to 1.0 foot.	D

Soil series and map symbols	Suitability as a source of--			Soil features affecting--		
					Farm ponds	
	Topsoil	Sand and gravel	Road fill	Highway location	Reservoir area	Embankment 1/
Dioxice: Df, Dg, Dh.	Fair: moderate fertility.	Unsuitable: fine-grained material.	Poor: moderate shrink-swell potential; A-6 and A-7.	Fine-grained material; slight to medium plasticity.	Moderately slow permeability.	Medium to low shear strength and permeability; medium piping hazard.
Dumas: Dm, DN, Do, Dr, Du, DV.	Fair: moderate to high fertility.	Unsuitable: fine-grained material.	Poor: moderate shrink-swell potential; A-6.	Fine-grained material; slight to medium plasticity.	Moderately slow permeability.	Medium to low shear strength; medium piping hazard; low permeability.
Gallegos: GA--	Poor because of coarse fragments.	Fair for gravel.	Good----------	Undulating to hilly topography.	Moderately rapid permeability.	Moderate to high shear strength and permeability; medium to low piping hazard.
Guadalupe: GU--	Fair: moderate fertility.	Poor for sand: must be washed.	Fair: A-4-----	Some areas subject to flooding.	Moderately rapid permeability.	Medium shear strength, permeability, and piping hazard.
*Ima: IM-------- For Quay part of IM, see Quay series.	Fair: moderate fertility.	Poor for sand: must be washed.	Good to fair: A-2 to A-4.	Features generally favorable.	Moderately rapid permeability.	Medium permeability and shear strength; medium to high piping hazard.
Karde: Ka------	Poor: high lime content; erodible.	Unsuitable: fine-grained material.	Fair: A-4 or A-6.	Fine-grained material; slight to medium plasticity.	Moderately slow permeability.	Medium to low shear strength and permeability; medium piping hazard.
Kinkead: KC----	Poor: moderate fertility; high clay content.	Unsuitable: fine-grained material.	Poor: high plasticity; high shrink-swell potential; A-6 and A-7.	Fine-grained material; high plasticity.	Slow permeability.	Low shear strength, permeability, and piping hazard.

See footnote at end of table.

Soil features affecting--Continued				Susceptibility to erosion	Degree and kinds of limitations for sewage fields	Hydrologic soil group
Pitting, chiseling, and contour furrowing	Irrigation	Terraces and diversions	Foundations for low buildings			
Slow intake rate.	Slow intake rate; moderate to high available water capacity.	Must be graded.	Moderate shrink-swell potential.	Moderate to severe hazard of soil blowing.	Severe: moderately slow permeability.	B
Slow intake rate.	Slow intake rate; moderate to high available water capacity.	Features generally favorable.	Moderate shrink-swell potential.	Moderate hazard of water erosion on slopes; severe erosion hazard in eroded areas.	Severe: moderately slow permeability.	B
Very gravelly; undulating to hilly topography.	Very gravelly; undulating to hilly topography.	Very gravelly--	Features generally favorable.	Moderate to severe hazard of water erosion.	Severe: undulating to hilly topography.	B
Fine sandy loam soil material.	Moderate intake rate; moderate available water capacity.	Short, gently undulating slopes.	Features generally favorable; small areas subject to flooding.	Moderate hazard of soil blowing.	Slight----------	B
Fine sandy loam and sandy loam material.	Sloping: moderate available water capacity.	Susceptible to soil blowing and siltation.	Features generally favorable.	Moderate------	Slight----------	B
Unstable clods; high lime content.	Gentle to rolling slopes; high lime content.	Short slopes; susceptible to soil blowing.	Medium to high compressibility.	Moderate------	Severe: sloping topography; moderately slow permeability.	B
Slow intake rate.	Slow intake rate; high available water capacity.	Slow permeability.	High shrink-swell potential.	Moderate------	Severe: slow permeability.	C

Soil series and map symbols	Suitability as a source of--			Soil features affecting--		
					Farm ponds	
	Topsoil	Sand and gravel	Road fill	Highway location	Reservoir area	Embankment 1/
Kinkead, alkali: KK.	Poor: alkali; saline; highly plastic; low fertility.	Unsuitable: fine-grained material.	Poor: high plasticity; high shrink-swell potential; A-7.	Fine-grained material; high plasticity; subject to flooding.	Very slow permeability.	Low shear strength, permeability, and piping hazard.
La Brier: La, LB, Lc, Ld.	Fair: moderate fertility; high clay content.	Unsuitable: fine-grained material.	Poor: high plasticity; high shrink-swell potential; A-7.	Fine-grained material; high plasticity.	Slow permeability.	Low shear strength and permeability; low to medium piping hazard.
Lacita: LE-----	Poor: low fertility.	Unsuitable: fine-grained material.	Fair: low to medium plasticity; A-4.	High dispersion; moderate to severe erosion hazard.	Moderately slow permeability.	Medium to low shear strength and permeability; medium to high piping hazard.
Latom: LF------	Fair: moderate fertility.	Fair for crushed rock below depth of 1 to 2 feet.	Fair: A-4-----	Bedrock below depth of 1 to 2 feet.	Bedrock below depth of 1 to 2 feet.	Medium shear strength; permeability, and piping hazard.
Litle: Lt------	Poor: high clay content.	Unsuitable: fine-grained material.	Poor: high shrink-swell potential; A-6 and A-7.	Fine-grained material; high plasticity.	Clayey shale below depth of 1.5 to 3.5 feet.	Low shear strength, permeability, and piping hazard.
*Mansker: MA, MK-- For Portales part of MA, see Portales series; for Potter part of MK, see Potter series.	Poor: high lime content; erodible.	Unsuitable: fine-grained material.	Fair: slight to medium plasticity; A-4.	Fine-grained material; slight to medium plasticity.	Moderate permeability.	Medium to low shear strength and permeability; medium to high piping hazard.
*Manzano: Mm, Mn, Mo. For La Brier part of Mo, see La Brier series.	Fair to good: moderate to high fertility.	Unsuitable: fine-grained material.	Fair to poor: moderate shrink-swell potential; A-4 and A-6.	Fine-grained material; medium plasticity; subject to flooding.	Some areas subject to flooding; moderately slow permeability.	Medium to low shear strength and piping hazard; low permeability.

See footnote at end of table.

Soil features affecting--Continued				Susceptibility to erosion	Degree and kinds of limitations for sewage fields	Hydrologic soil group
Pitting, chiseling, and contour furrowing	Irrigation	Terraces and diversions	Foundations for low buildings			
Very slow permeability; alkali; saline.	Slow intake rate; very slow permeability; alkali; saline.	Dense clayey subsoil; unstable embankments.	High shrink-swell potential.	Moderate-------	Severe: very slow permeability.	D
Slow intake rate.	Slow intake rate; high available water capacity.	Slowly permeable.	High shrink-swell potential.	Moderate: hazard of soil blowing.	Severe: slow permeability.	C
Unstable clods; subject to siltation.	Sloping; high available water capacity.	Subject to siltation.	Medium compressibility.	Moderate to severe hazard of water erosion.	Severe: sloping; moderately slow permeability.	B
Fine sandy loam surface layer.	Bedrock below depth of 1 to 2 feet; very low available water capacity.	Bedrock below depth of 1 to 2 feet.	Bedrock below depth of 1 to 2 feet.	Moderate-------	Severe: bedrock below depth of 1 to 2 feet.	D
Slow intake rate.	Slowly permeable; clayey shale below depth of 1.5 to 3.5 feet.	Slowly permeable; clayey shale below depth of 1.5 to 3.5 feet.	High shrink-swell potential.	Moderate to severe hazard of water erosion.	Severe: slow permeability.	C
Unstable clods---	Moderate intake rate; moderate available water capacity.	Susceptible to soil blowing; unstable embankment.	Medium compressibility.	Moderate hazard of soil blowing.	Slight to moderate: moderate permeability.	B
Short, nearly level and level slopes.	Some areas subject to flooding.	Moderately slow to slow permeability.	Moderate shrink-swell potential.	Moderate to severe.	Severe: flood hazard; moderately slow permeability.	C

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Soil series and map symbols	Suitability as a source of--			Soil features affecting--		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds	
					Reservoir area	Embankment 1/
Manzano, wet variant: Mr.	Poor to fair: slightly saline.	Unsuitable: fine-grained material.	Poor: medium plasticity; seasonal high water table; A-7.	Fine-grained material; seasonal high water table; subject to flooding.	Subject to flooding; moderately slow permeability.	Medium to low shear strength and permeability; medium piping hazard.
Montoya: MT----	Poor: high clay content.	Unsuitable: fine-grained material.	Poor: high plasticity; high shrink-swell potential; A-7.	Fine-grained material; high plasticity.	Subject to flooding; very slow permeability.	Low shear strength, permeability, and piping hazard.
Otero: Or, Os, OT.	Poor to fair: fine sandy loam or loamy fine sand surface layer.	Poor for sand--	Good to fair: A-2 and A-4.	Features generally favorable.	Moderately rapid permeability.	Medium permeability, shear strength, and piping hazard.
Pastura: PA, Pc.	Poor: indurated caliche at depth below 0.5 to 1.5 feet.	Good for crushed caliche.	Poor: A-6-----	Indurated caliche below depth of 0.5 to 1.5 feet.	Indurated caliche below depth of 0.5 to 1.5 feet.	Medium to low shear strength and permeability; medium to high piping hazard.
Penrose: Pe----	Poor: bedrock at depth below 0.5 to 1.5 feet.	Good for crushed rock below depth of 0.5 to 1.5 feet.	Poor: A-6-----	Gently sloping to strongly sloping.	Bedrock below depth of 0.5 to 1.5 feet.	Medium to low shear strength and permeability; medium piping hazard.
Portales-------- Portales soils are in Mansker-Portales mapping unit MA.	Fair: moderate fertility.	Unsuitable: fine-grained material.	Fair: slight to medium plasticity; A-4.	Fine-grained material; slight to medium plasticity.	Moderate permeability.	Medium to low shear strength and permeability; medium to high piping hazard.
Potter---------- Potter soils are in Mansker-Potter mapping unit MK.	Poor: high in carbonates; 0.5 to 1 foot to caliche.	Fair for caliche gravel.	Fair: A-4-----	Fractured, platy caliche below depth of 0.5 to 1 foot.	Moderate permeability.	Medium permeability and shear strength; medium to high piping hazard.

See footnote at end of table.

Soil features affecting--Continued				Susceptibility to erosion	Degree and kinds of limitations for sewage fields	Hydrologic soil group
Pitting, chiseling, and contour furrowing	Irrigation	Terraces and diversions	Foundations for low buildings			
Short slopes; seasonal high water table.	Moderately slow permeability; somewhat poorly drained; saline.	Moderately slow permeability; somewhat poorly drained.	Somewhat poorly drained; subject to flooding; moderate shrink-swell potential.	Slight--------	Severe: water table at depth of 1 to 4 feet.	C
Subject to siltation.	Subject to flooding; very slow permeability.	Subject to piping.	High shrink-swell potential.	Moderate hazard of water erosion.	Severe: very slow permeability; subject to flooding.	D
Fine sandy loam or loamy fine sand surface layer.	Sloping; moderate available water capacity.	Susceptible to soil blowing; short slopes.	Features generally favorable.	Moderate to severe hazard of soil blowing.	Slight: may contaminate ground water.	B
Indurated caliche below depth of 0.5 to 1.5 feet.	Very low available water capacity; indurated caliche below depth of 0.5 to 1.5 feet.	Indurated caliche below depth of 0.5 to 1.5 feet.	Indurated caliche below depth of 0.5 to 1.5 feet.	Moderate hazard of water erosion.	Severe: indurated caliche below depth of 0.5 to 1.5 feet.	D
Bedrock below depth of 0.5 to 1.5 feet.	Very low available water capacity; bedrock at depth of 0.5 to 1.5 feet.	Bedrock below depth of 0.5 to 1.5 feet.	Moderate shrink-swell potential.	Moderate hazard of water erosion.	Severe: bedrock below depth of 0.5 to 1.5 feet.	D
Fine sandy loam surface layer.	Moderate intake rate; moderate to high water capacity.	Susceptible to soil blowing.	Medium compressibility.	Moderate hazard of soil blowing.	Slight to moderate: moderate permeability.	B
Fractured, platy caliche below depth of 0.5 to 1 foot.	Very low available water capacity; fractured, platy caliche below depth of 0.5 to 1 foot.	Fractured, platy caliche below depth of 0.5 to 1 foot.	Fractured, platy caliche below depth of 0.5 to 1 foot.	Moderate hazard of water erosion.	Severe: caliche below depth of 0.5 to 1 foot.	C

Soil series and map symbols	Suitability as a source of--			Soil features affecting--		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds	
					Reservoir area	Embankment 1/
Quay---------- Quay soils are only in mapping units IM and TW.	Fair: moderate fertility.	Unsuitable: fine-grained material.	Fair: slight to medium plasticity; A-4.	Fine-grained material; slight to medium plasticity.	Moderately permeable.	Medium to low shear strength and permeability; medium to high piping hazard.
Riverwash: RH--	Poor because of high sand content.	Poor to fair source of sand and gravel.	Fair to good: seasonal water table in some places.	Subject to flooding.	Pervious material; subject to flooding.	Too variable to be rated.
Rough broken land: RK.	Poor because of coarse fragments; highly erodible.	Poor to unsuitable: fine-grained material; shaly.	Poor: generally high shrink-swell potential.	Steep and very steep slopes.	Steep and very steep slopes.	Too variable to be rated.
Rough broken and stony land: Rn, RO.	Poor because of coarse fragments.	Good for crushed rock.	Good----------	Steep and very steep slopes.	Coarse fragments; steep and very steep slopes.	Too variable to be rated.
*Springer: SP, SR, SS. For Amarillo part of SR and SS, see Amarillo series.	Poor: moderate available water capacity; erodible.	Poor to fair for sand.	Good to fair: A-2 and A-4.	Features generally favorable.	Moderately rapid permeability.	Medium permeability and shear strength; medium to high piping hazard.
Tapia: Ta-------	Fair: moderate fertility.	Unsuitable: fine-grained material.	Poor: A-6------	Indurated caliche at depth of 1.5 to 3.0 feet.	Indurated caliche below depth of 1.5 to 3.0 feet.	Medium to low shear strength and piping hazard; low permeability.
Interpretations listed here are for the 10 percent of Ta that is affected by alkali. For interpretations of the remaining 90 percent of Ta, refer to the data for Ta preceding.	Poor: low fertility; alkali.	Unsuitable: fine-grained material.	Poor: highly plastic; A-6.	Fine-grained material; highly plastic.	Indurated caliche below depth of 1.5 to 2.5 feet.	Medium to low shear strength and piping hazard; low permeability.

See footnote at end of table.

Soil features affecting--Continued				Susceptibility to erosion	Degree and kinds of limitations for sewage fields	Hydrologic soil group
Pitting, chiseling, and contour furrowing	Irrigation	Terraces and diversions	Foundations for low buildings			
Subject to siltation; unstable clods.	Sloping; moderate available water capacity.	Susceptible to soil blowing and siltation.	Medium compressibility.	Moderate-----	Slight to moderate: moderate permeability.	B
Features generally unfavorable.	Features unfavorable; subject to flooding.	Subject to flooding.	Subject to flooding.	Severe-------	Severe: subject to flooding.	
Steep and very steep slopes.	Very low available water capacity; steep and very steep slopes.	Steep and very steep slopes; unstable embankments.	Erodible; very steep slopes.	Severe hazard of water erosion.	Severe: steep and very steep slopes.	D
Stony, steep and steep slopes.	Stony; very low available water capacity; steep and very steep slopes.	Stony; steep and very steep slopes.	Steep and very steep slopes.	Moderate to severe hazard of water erosion.	Severe: steep and very steep slopes.	D
High intake rate; loamy fine sand surface layer.	High intake rate; moderate available water capacity.	Susceptible to soil blowing.	Fair stability-	Severe hazard of soil blowing.	Slight----------	B
Fine sandy loam surface layer; moderately permeable.	Moderate intake rate; low available water capacity.	Moderate permeability.	Moderate shrink-swell potential.	Moderate hazard of soil blowing.	Severe: indurated caliche below depth of 1.5 to 3.0 feet.	C
Slow intake rate--	Slow intake rate; low available water capacity; low fertility; alkali and saline.	Slow permeability.	Moderate shrink-swell potential; high compressibility.	Moderate hazard of soil blowing.	Severe: slow permeability; indurated caliche below depth of 1.5 to 2.5 feet.	C

Soil series and map symbols	Suitability as a source of--			Soil features affecting--		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds	
					Reservoir area	Embankment 1/
*Tivoli: TF, TG--For Springer part of TG, see Springer series.	Poor: low fertility; high sand content; severely erodible.	Fair to good for fine sand.	Good if confined or soil binder is added.	Very severe hazard of soil blowing; unstable unless confined; loose sand hinders hauling.	Rapid permeability.	Medium shear strength, permeability, and piping hazard.
Travessilla: Tr, TS.	Poor because of coarse fragments.	Good for crushed rock.	Fair: A-4-----	Bedrock below depth of 0.5 to 1.0 foot.	Bedrock below depth of 0.5 to 1.0 foot.	Bedrock below depth of 0.5 to 1.0 foot.
Tricon: Tt, Tv---------	Fair: moderate fertility; moderately high clay content.	Unsuitable: fine-grained material.	Poor: medium plasticity; A-6 and A-7.	Fine-grained material; medium plasticity.	Indurated caliche below depth of 1.5 to 3.5 feet.	Indurated caliche below depth of 1.5 to 3.5 feet.
Tu---------- Interpretations listed here are for the 10 percent of Tu that is affected by alkali. For interpretations of remaining 90 percent of Tu, refer to data for Tt and Tv preceding.	Poor: low fertility; alkali.	Unsuitable: fine-grained material.	Poor: high shrink-swell potential; A-7.	Fine-grained material; high plasticity.	Indurated caliche below depth of 1.5 to 2.5 feet.	Indurated caliche below depth of 1.5 to 2.5 feet.
*Tucumcari: TW----For Quay part of TW, see Quay series.	Fair: moderate fertility.	Unsuitable: fine-grained material.	Poor: high shrink-swell potential; A-6 and A-7.	Fine-grained material; medium plasticity.	Features generally favorable.	Moderately slow permeability.

See footnote at end of table.

Soil features affecting--Continued				Susceptibility to erosion	Degree and kinds of limitations for sewage fields	Hydrologic soil group
Pitting, chiseling, and contour furrowing	Irrigation	Terraces and diversions	Foundations for low buildings			
Fine sand surface layer; susceptible to soil blowing.	Low available water capacity; rapid permeability; undulating to rolling slopes; erodible.	Susceptible to soil blowing.	Poor stability unless confined; medium shear strength	Very severe hazard of soil blowing.	Moderate: undulating to rolling slopes; sands allow contamination of water supplies in some places.	A
Medium to low shear strength and permeability; high piping hazard.	Stony; very low available water capacity.	Bedrock below depth of 0.5 to 1.0 foot.	Bedrock below depth of 0.5 to 1.0 foot.	Moderate hazard of water erosion.	Severe: bedrock below depth of 0.5 to 1.0 foot.	D
Medium to low shear strength and piping hazard; low permeability.	Slow intake rate; moderate available water capacity.	Slow permeability.	High shrink-swell potential.	Moderate hazard of soil blowing.	Severe: slow permeability; indurated caliche below depth of 1.5 to 3.5 feet.	C
Low permeability, piping hazard, and shear strength.	Very slow intake rate; low available water capacity; alkali; saline.	Very slow permeability.	High shrink-swell potential.	Moderate-------	Severe: very slow permeability; indurated caliche below depth of 1.5 to 2.5 feet.	D
Medium to low shear strength and piping hazard; low permeability.	Moderate to slow intake rate; high available water capacity.	Moderately slow permeability.	High shrink-swell potential.	Moderate hazard of soil blowing.	Severe: moderately slow permeability.	B

Soil series and map symbols	Suitability as a source of--			Soil features affecting--		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds	
					Reservoir area	Embankment 1/
Vermejo: Ve-----	Poor: high clay content.	Unsuitable: fine-grained material.	Poor: high shrink-swell potential; A-7.	Fine-grained material; high plasticity; subject to flooding.	Subject to flooding.	Very slow permeability.
Vernon: VS-----	Poor: high clay content; low fertility.	Unsuitable: fine-grained material.	Poor: high shrink-swell potential; A-7.	Fine-grained material; high plasticity.	Shale below depth of 0.5 to 1.5 feet.	Shale below depth of 0.5 to 1.5 feet.
Wet alluvial land: WE.	Poor: saline--	Unsuitable: material is variable.	Poor: seasonal high water table.	Seasonal high water table; subject to flooding.	Seasonal high water table; subject to flooding.	Seasonal high water table; subject to flooding.

1/ Permeability ratings in this column are for the soil material when compacted.

Soil features affecting--Continued				Susceptibility to erosion	Degree and kinds of limitations for sewage fields	Hydrologic soil group
Pitting, chiseling, and contour furrowing	Irrigation	Terraces and diversions	Foundations for low buildings			
Low shear strength, piping hazard, and permeability.	Subject to flooding; saline; very slow permeability.	Subject to flooding.	High shrink-swell potential; subject to flooding.	Moderate hazard of water erosion.	Severe: very slow permeability.	D
Low shear strength, piping hazard, and permeability.	Very slow permeability; shale below depth of 0.5 to 1.5 feet.	Very slow permeability; shale below depth of 0.5 to 1.5 feet.	High shrink-swell potential.	Severe hazard of water erosion.	Severe: very slow permeability.	D
Too variable to be rated.	Seasonal high water table; saline.	Seasonal high water table.	Seasonal high water table; subject to flooding.	Slight to moderate.	Severe: seasonal high water table; subject to flooding.	C

TABLE 5.--ENGINEERING TEST DATA

[Tests performed by the New Mexico State Highway Department in accordance with standard procedures of the American Association of State Highway Officials (AASHO)]

Soil name and location	New Mexico State Highway Department report No.	Depth from surface	Liquid limit	Plasticity index	Mechanical analysis 1/			Classification	
					Percentage passing sieve			AASHO	Unified 2/
					No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)		
		Inches	Percent						
Amarillo loamy fine sand:									
0.15 mile W. and 25 feet S. of NE. corner of NE1/4 NE1/4 sec. 26, T. 14 N., R. 33 E. (Modal)	62-8143	0-8	(3/)	(3/)	100	94	23	A-2-4(0)	SM
	62-8151	13-26	32	13	100	98	62	A-6(7)	CL
	62-8150	32-58	22	6	100	98	43	A-4(2)	SM-SC
Carnero loam:									
SW. corner of sec. 33, T. 20 N., R. 25 E. (Modal)	62-8135	0-5	25	7	100	99	96	A-4(8)	ML-CL
	62-8155	10-18	40	18	100	99	98	A-6(11)	CL
Carnero loam, alkali:									
SW. corner of sec. 33, T. 20 N., R. 25 E. (Modal)	62-8142	0-4	(3/)	(3/)	100	99	97	A-4(8)	ML
	62-8153	4-10	53	27	100	99	97	A-7-6(17)	CH
	62-8160	15-20	36	15	100	99	97	A-6(10)	CL
Dioxice loam:									
SE1/4 SE1/4 sec. 8, T. 20 N., R. 26 E. (Modal)	62-8137	4-8	40	13	100	99	97	A-6(9)	ML-CL
	62-8159	18-28	45	20	100	99	94	A-7-6(13)	ML-CL
	62-8162	35-50	42	17	100	99	97	A-7-6(11)	ML-CL
La Brier loam:									
SE1/4 NE1/4 sec. 16, T. 19 N., R. 28 E. (Modal)	62-8139	0-2	32	10	100	98	96	A-4(8)	ML-CL
	62-8152	11-20	53	27	100	99	96	A-7-6(17)	CH
	62-8161	31-60	49	23	100	99	96	A-7-6(15)	ML-CL
Lacita loam:									
SW1/4 NE1/4 sec. 23, T. 16 N., R. 30 E. (Modal)	62-8147	0-13	28	8	100	99	82	A-4(8)	CL
	62-8167	13-27	28	9	100	99	95	A-4(8)	CL
	62-8169	27-70	25	7	100	98	92	A-4(8)	ML-CL
Litle clay loam:									
NE. corner of NW1/4 SE1/4 sec. 27, T. 21 N., R. 25 E. (Modal)	62-8133	3-10	36	14	100	99	98	A-6(10)	CL
	62-8165	16-24	47	22	100	98	94	A-7-6(14)	CL
Pastura loam:									
SW1/4 SW1/4 sec. 21, T. 22 N., R. 28 E. (Deeper to caliche and contains fewer fragments than modal)	62-8140	0-6	34	12	100	99	95	A-6(9)	ML-CL
	62-8171	14-19	40	13	4/60	59	58	A-6(6)	ML-CL

TABLE 5.--ENGINEERING TEST DATA--Continued

Soil name and location	New Mexico State Highway Department report No.	Depth from surface	Liquid limit	Plasticity index	Mechanical analysis 1/			Classification	
					Percentage passing sieve			AASHO	2/ Unified
					No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)		
		Inches	Percent						
Springer fine sandy loam:									
SE1/4 NE1/4 sec. 11, T. 15 N., R. 33 E. (Surface layer thinner than in modal)	62-8134	0-5	(3/)	(3/)	100	98	16	A-2-4(0)	SM
	62-8148	5-16	(3/)	(3/)	100	98	21	A-2-4(0)	SM
	62-8168	25-55	(3/)	(3/)	100	99	17	A-2-4(0)	SM

1/ Analysis according to AASHO Designation: T 88-57 (1). Results by this procedure frequently differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size 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 the pipette method, and the material coarser than 2 millimeters is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes for soils.

2/ Soil Conservation Service and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification. An example of a borderline classification so obtained is ML-CL.

3/ Nonplastic.

4/ 66 percent passed the No. 4 sieve, and 100 percent passed the 2-inch sieve.

Susceptibility to erosion is rated according to soil erodibility by wind or water where cover is not maintained.

Sewage fields are affected mainly by permeability, location of water table, depth to bedrock or cemented caliche, and susceptibility to flooding. The degree of limitations and principal reasons for assigning moderate or severe limitations are given.

Hydrologic soil groups are used in watershed planning to estimate runoff from rainfall. A hydrologic soil group consists of soils having similar rates of infiltration by water, when wetted, and similar rates of water transmission within the soil. Soil properties are considered that influence the minimum rate of infiltration obtained for a bare soil after prolonged wetting. These properties are depth to the seasonal high water table, intake rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The influence of ground cover is treated independently, not in the hydrologic soil groups. There are four hydrologic soil groups.

Group A has low runoff potential. It consists of soils having high infiltration rates when thoroughly wetted. The soils are chiefly deep, well-drained to excessively drained sands and gravels. They have a high rate of water transmission.

Group B has moderately low runoff potential. It consists of soils having moderate infiltration rates when thoroughly wetted. The soils are chiefly moderately deep to deep, moderately well drained to well drained, and moderately fine to moderately coarse textured. These soils have a moderate rate of water transmission.

Group C has moderately high runoff potential. It consists of soils having slow infiltration rates when thoroughly wetted. The soils are chiefly those that have a layer that impedes downward movement of water, have moderately fine to moderately coarse texture, or have a water table at a moderate depth. These soils may be somewhat poorly drained.

Group D has high runoff potential. It consists of soils having slow infiltration rates when thoroughly wetted. The soils are chiefly clays that have high swelling potential, a permanent high water table, and a claypan or other clay layer at or near the surface. Also in group D are shallow soils over nearly impervious material. The soils in this group have a very slow rate of water transmission.

The suitability of soils for winter grading varies from year to year, depending on the moisture content of the soil and the temperature during winter. During some winters, soil moisture is low and little frost forms in the soil. When temperature permits, moisture can be added to provide proper conditions for earth construction. In those winters when soil moisture is high and temperatures are extreme for extended periods, earth movement is usually postponed.

At many construction sites, major soil variations may occur within the depth of proposed excavation and several soil units may be encountered within a short distance. The soil map and profile descriptions, as well as the engineering data given in this section, are useful in planning detailed surveys of soils at construction sites. Using the information in the soil survey enables the soils engineer to concentrate on the most suitable soil units. Then a minimum number of soil samples will be required for laboratory testing, and an adequate soil investigation can be made at minimum cost.

Engineering Test Data

Table 5 contains the results of engineering tests performed by the New Mexico State Highway Department on several important soils in Harding County. The table shows the specific location where samples were taken, the depth to which sampling was done, and the results of tests to determine particle-size distribution and other properties significant in soil engineering.

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 passes from semisolid to plastic. The liquid limit is the moisture content at which the material changes from plastic to liquid. 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.

Mechanical analysis shows the percentages, by weight, of soil particles that would pass sieves of specified sizes. Sand and coarser materials do not pass through the No. 200 sieve, but silt and clay do. Silt particles are larger than 0.002 millimeter in diameter, and they pass through the No. 200 sieve. Clay is that fraction passing through the No. 200 sieve that is smaller than 0.002 millimeter in diameter. The clay fraction was determined by the hydrometer method, rather than the pipette method most soil scientists use in determining the clay in soil samples.

This section discusses the factors of soil formation as they relate to the soils of Harding County and briefly explains the system of classifying soils into categories broader than series. It also contains data obtained by physical and chemical analyses of four selected soils.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent materials; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural formation that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme instances, determines it almost entirely. Time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for different kinds of horizons to form. A long time normally is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent Materials

Parent materials influence the color, texture, natural fertility, and other properties of the soil. In many places soil differences are related to differences in parent materials.

The geologic history of an area is helpful in understanding the distribution and nature of the soils in that area. Table 6 lists the geologic formations in Harding County and the materials that make up these formations (3).

Soils in the county formed in materials deposited during the Triassic, Jurassic, Cretaceous, Tertiary, and Quaternary geologic periods.

The Dockum red beds of the Triassic period are the oldest exposed formations in Harding County. About 200 million years ago, active geologic erosion occurred in large areas of the Southwest. During this period erosional sediments were deposited in stream channels and over broad alluvial flats. The Santa Rosa Formation was formed from these sediments.

The Santa Rosa Formation consists of irregular beds of red and gray shale, siltstone, and sandstone. These rocks were mainly red beds, and they are in distinct contrast to the gray and brown rocks of the younger formations. Numerous exposures of the red beds can be seen along the erosional valleys of the Canadian River and Ute Creek in Harding County. Vernon-Shale outcrop complex, 1 to 9 percent slopes, formed in materials derived from red-bed clayey shale of the Triassic period.

Arid climate prevailed during most of the Jurassic period, but late in the period, a large area that extended from the northern part of New Mexico to Montana became a swampy plain. Streams meandered widely across the swampy plain and deposited mud and silt on the flood plains. The stream channels filled with sand and gravel when the climate was tropical or subtropical.

The Morrison Formation, which lies above the Dockum red beds, consists of variegated gray-green and gray-red mudstone that has beds of sandstone.

Today exposures of the Morrison Formation can be seen in Harding County in many canyon walls that rise above the red beds. Northeast of Bueyeros several ridges and knolls are erosional remnants of the Morrison Shale and Sandstone. Rough broken and stony land shows exposures of material from the Jurassic period.

The Cretaceous period was notably a time when the sea invaded the continent. More than 50 percent of North America was submerged when the Cretaceous sea advanced. Periods of uplift subjected the highlands to accelerated weathering and erosion. The sediments built up under the waters of the Cretaceous sea and formed the Purgatoire Formation.

Accelerated erosion of the highland continued during the retreat and readvance of the Cretaceous sea. Sediments were deposited upon the flood plains of ancient rivers. Some sediments were reworked by wind, and others by the advancing sea. The Dakota Formation formed in these various sediments. Travessilla stony loam, 0 to 9 percent slopes, formed in material weathered from Dakota sandstone.

The sandstone of the Dakota Formation is the most obvious geologic feature of the Cretaceous age in the county. The resistant sandstone is characterized by one-seed juniper and pinyon pine on knobs, mesas, and hogbacks, as well as on the picturesque canyon walls and cliffs.

The Cretaceous sea readvanced over the area as the land surface submerged. The first marine deposits were on top of the Dakota Sandstone and formed the Graneros Shale. The dark-gray shale beds of the Graneros Formation are about 100 feet thick. Litle clay loam formed in material weathered from Graneros Shale.

Later marine deposits formed the thin beds of Greenhorn Limestone. The beds of light-tan or gray limestone are about 30 feet thick. Penrose soils,

TABLE 6.--GEOLOGIC MATERIALS IN HARDING COUNTY

Period[1/]	Group	Formation	Type of material
Triassic: 180 million to 225 million years ago.	Dockum red beds----	Santa Rosa----------	Dark-red sandy shale, red and gray sandstone, variegated and red shale, red or buff sandstone and siltstone.
Jurassic: 135 million to 180 million years ago.	----------	Morrison----------	Gray-green and gray-red mudstone with local thick beds of sandstone.
Cretaceous: 70 million to 135 million years ago.	Dakota----------	Purgatoire----------	Dark-gray shale and massive sandstone.
		Dakota----------	Lenticular to parallel, bedded gray shale, shaly sandstone, and sandstone; basal unit is persistent, massive sandstone.
	Benton----------	Graneros Shale-------	Dark-gray shale that has two or three thin beds of limestone.
		Greenhorn Limestone--	Light-tan or gray limestone that has thin beds of shale.
Tertiary: 1 million to 70 million years ago.	Pliocene Epoch-----	Ogallala----------	Tan sandy clay, silt, sand, and gravel locally cemented with calcium carbonate; includes post-Clayton deposits.
	Pliocene Epoch-----	Undifferentiated Clayton Basalt.	Basaltic lava flows and piles of cinders at volcanic centers.
Quaternary: Present to 1 million years ago.	Pleistocene Epoch--	Upland cover---------	Eolian clay, silt, and sand, mainly from the Ogallala Formation.
	Recent----------	Alluvium----------	Unconsolidated clay, silt, sand, and gravel.

[1/] Ages of periods are those generally accepted by geologists today but should not be considered as absolute values.

0 to 12 percent slopes, formed in material weathered from Greenhorn Limestone.

Geologic erosion stripped away most of the Graneros Shale and Greenhorn Limestone. Outcrops of these formations are confined largely to the northwest corner of the county, mainly west of State Route 39.

The Rocky Mountains were formed by a series of broad uplifts which began in the Tertiary period and continued into the Quaternary period. Erosion began to wear away the mountains. Old rivers cut their channels deeper and carried the sediments from the mountains. These sediments built up along the eastern side of the Rocky Mountains from Nebraska to Texas. The rivers and streams meandered widely across the gentle slopes, and coarse material was deposited in stream channels while finer material was spread over the flood plains. The changing velocity and shifting of streams mixed the sand, gravel, silt, and clay, and the Ogallala Formation was formed from this mixture. Dalhart fine sandy loam formed in old alluvium and sandy wind-laid material from the Ogallala Formation.

The Ogallala Formation has strata of caliche that began to form when rainwater leached calcium carbonate from the surface layer and deposited it in the subsurface layer as an evaporite (4). More material that contained calcium carbonate was deposited on the surface by the wind. Leaching continued and more caliche formed. The age of the caliche in the Ogallala Formation ranges from late Tertiary to Recent. Dean soils, 0 to 9 percent slopes, formed in material weathered from the caliche.

Intense and prolonged volcanic activity occurred in the western part of the United States during the Tertiary period. Several volcanoes erupted in the north-central part of Harding County late in the Tertiary period, and Clayton Basalt formed in the material deposited. The piles of cinders around the volcanic cones and the basaltic lava flows can still be seen today. Apache stony loam, 1 to 9 percent slopes, formed in material weathered from the Clayton Basalt.

The Pleistocene epoch or ice age ushered in the Quaternary period, but the glaciers of this period did not reach Harding County. The ice age, however, had a pronounced effect on the climate and geology of the area.

The melting snow and ice in the Rocky Mountains produced large quantities of water. Old streams were rejuvenated and new ones were formed that washed large quantities of sediments downstream. The Canadian River and Ute Creek stripped away vast quantities of the Ogallala materials. As geologic erosion continued, the Canadian River cut through the Greenhorn Limestone and Graneros Shale in the northwest corner of the county. Both the Canadian River and Ute Creek have continued the downcutting of the stream channels through the Dakota, Purgatoire, and Morrison Formations and into the Santa Rosa Formation of the Dockum red beds. In the western part of the county, the stream cutting left a large mesa bounded by the valley of the Canadian River on the west and by the valley of Ute Creek on the east.

While the streams were cut and deepened, much of the Ogallala material was reworked by wind. Thin mantles of loess were deposited on the mesa in small areas. La Brier loam formed in these silty wind-laid materials.

The sandhills in the eastern and southeastern parts of the county consist of more recent deposits. The sand forming the sandhills came from the streambeds of Ute Creek to the west and of the Canadian River to the south in Quay County. The prevailing southwest winds have shaped the sandhills into undulating and rolling dunes. Tivoli fine sand formed in these sandhills.

The erosional valleys of the large streams have created a complexity of valley fill and alluvium on the flood plains. The origin of the alluvium largely determines the character of the deposits. The alluvium from dominantly shale areas is mostly silty or clayey. Montoya clay formed in clayey alluvium. The alluvial deposits from sandstone areas or gravel and sand upland deposits are mostly sandy. Also, the speed of the water that transported the deposits affects the nature of the deposits. Coarse material is deposited near the stream channels, and finer material is deposited farther from the stream. Guadalupe fine sandy loam formed in loamy and sandy alluvium.

Climate

Harding County has a semiarid, continental climate. Most of the rainfall is from thunderstorms during the summer. The winters are usually short and have cold nights and cool days. In other seasons, nights are cool and days are warm. Winter rains are generally light.

Climate has a direct influence on soil formation. The temperature and rainfall affect the kind and amount of vegetation that grows. Organic matter decomposes more rapidly in warmer than in cooler climates. Rainfall affects the amount of leaching and clay movement in soils. Strong winds influence the formation of some soils. Warmer temperatures cause more rapid weathering of parent materials than the cooler temperatures.

The semiarid climate in the county resulted in a grassland vegetation. Many of the soils, such as the Dioxice, have a surface horizon that is dark because it is stained by decayed organic matter.

The moisture from precipitation does not move completely through the soil profile of the Dumas or other moderately fine textured soils. Calcium carbonate has been leached downward from the surface horizons and the upper part of the subsoil. A slight buildup of calcium carbonate in the lower part of the subsoil indicates that moisture may penetrate to this depth. A horizon of calcium carbonate has accumulated below the subsoil.

The fine-textured La Brier soils have a buildup of clay in the subsoil. Moisture soaking into the

soil has carried clay particles from the surface horizon into the subsoil. This is one of the processes in the formation of soils such as the La Brier.

The strong winds of this area have been responsible for the formation of the Tivoli soils. Wind has blown the sand from stream channels and deposited it in dunes. The Tivoli soils formed in the undulating to rolling topography of these sandhills.

In more recent years, wind has caused moderate to severe soil blowing on many cultivated fields. The removal of part or all of the surface horizon will be a factor that influences the development of the soil in these fields for many years.

Plant and Animal Life

Plant and animal life furnish organic matter for the soil and bring plant nutrients from lower horizons to upper ones. Vegetation is the primary component of this soil-forming factor in this survey area. Other important components are bacteria, fungi, earthworms, rodents, and man.

Harding County was a vast grassland when the first settlers arrived. Mid and tall grasses were dominant on the moderately sandy and sandy soils. Short and mid grasses were dominant on the loamy and clayey soils. In addition to its direct influence, the climate has exerted a powerful indirect influence on soil formation in the county by determining the kinds of plants that grow.

Organic matter is left on the surface in the form of the dead leaves of the grasses. The plant roots penetrate the soil and make it more porous. The decay of the roots provides large amounts of organic matter in the soils.

Typically, soils in the county, such as the Dumas, Kinkead, and Dioxice, have a darkened surface layer about 7 inches to 20 inches thick. The organic-matter staining can be seen to a depth of about 2 feet.

Earthworms feed on the organic matter in the soil. They thoroughly mix the soils in which they live.

Gophers, prairie dogs, and badgers burrow deeply into the earth. They spread the soil from their burrows over the surface. Abandoned burrows are soon filled with soil material from the surface horizon. Plant roots easily penetrate the old burrows.

Fields cultivated by Indians a thousand years ago can still be detected in parts of New Mexico. Also, more than 100,000 acres have been cultivated in Harding County since 1900. Erosion is severe on about half of the land that has been cultivated. The remaining cultivated land is moderately to slightly eroded. The effects of man and the erosion he has encouraged will have a big influence in the continued formation of these soils.

Relief

Relief refers to the differences in elevations of a land surface. It influences soil formation by controlling the movement of water on the surface.

Differences in relief influences the rate of erosion, the percolation of water into the soil, and the vigor of plant growth. These differences are reflected in thickness of the surface horizon, organic-matter content in the surface horizon, depth of solum, degree of horizon differentiation, and nature of the parent materials.

In Harding County the elevation may change as much as 800 feet within short distances in the mapping unit, Rough broken and stony land. Surface runoff on this unit is very rapid, and erosion of the soil keeps pace with the weathering of parent material.

The Berthoud soils often receive water in runoff from Rough broken and stony land, but the runoff does not slow down enough for large amounts of water to enter the soil. As a result, Berthoud soils have a surface horizon that has been slightly darkened by organic matter and a little leaching of calcium carbonates.

Kinkead soils receive runoff both from Berthoud soils and Rough broken and stony land. Kinkead soils are nearly level. They occur where much of the runoff slows down and water enters the soil. The Kinkead soils are darkened by organic matter to a much greater depth than the Berthoud soils. Calcium carbonates have been leached out of the surface horizon of Kinkead soils, and clay particles have been moved by the water from the surface horizon into the subsoil.

Time

The origin of the parent materials of some soils in Harding County dates back many millions of years, but in geologic age the soils are not old.

Time is required for soils to form from parent materials. The length of time necessary for the formation of a soil depends on the effects of the other soil-forming factors. Older soils have distinct soil horizons that reflect the movement of clay from the surface horizon into the subsoil, the leaching of calcium carbonates, and the development of structure. These soils have approached equilibrium with their environment. Younger soils show their youth, because they do not have distinct horizons.

In Harding County, the Dumas are among the older soils. They formed in a thin mantle of loess or Ogallala deposits reworked by wind during Pleistocene time. The surface horizon has been darkened by accumulation of organic matter. Water percolating through the soil profile has moved clay from the surface horizon and deposited it in the subsoil. Calcium carbonates have been leached downward.

Deposits of these carbonates have built up slightly in the lower part of the subsoil and have accumulated in larger amounts below the subsoil. Moderate, subangular blocky structure has developed in the subsoil.

In the Travessilla series are shallow soils that formed in material weathered from sandstone but that have no clearly expressed horizons. They are young soils because the bedrock from which they were derived is resistant to weathering.

The Vernon soils are young, are shallow, and formed in red-bed shale. Active erosion has nearly kept pace with the weathering of the shale parent material.

Karde soils are deep soils that formed in unconsolidated, calcareous, wind-laid parent material. Their sloping topography and young parent material contribute to their few clearly expressed soil characteristics.

The Lacita soils formed in water-transported, recently deposited, alluvial materials. The youth of these soils is apparent from the weak modification of the parent material.

Classification of the Soils

Soils are placed in narrow categories for the organization and application of knowledge about their behavior within farms, ranches, or land resource areas. They are placed in broad categories for study and comparison of large areas, such as states, regions, or continents.

The system of classifying soils currently used in the United States was adopted for general use by the National Cooperative Soil Survey in 1965 and supplemented in March 1967 and in September 1968 (9). This system is under continual study, and readers interested in its development should refer to the latest literature available.

Table 7 shows the placement of each soil series represented in Harding County into broader categories. Placement of some of the soil series in the comprehensive system, particularly in families, may change as more precise information becomes available.

The current system defines classes in terms of observable or measurable properties of soils. The properties chosen are primarily those that permit the grouping of soils that are similar in genesis. The classification is designed to encompass all soils. It has six categories. Beginning with the most inclusive, they are the order, the suborder, the great group, the subgroup, the family, and the series. These are briefly defined in the following paragraphs.

TABLE 7.--CLASSIFICATION OF SOIL SERIES 1/

Series	Family	Subgroup	Order
Amarillo----	Fine-loamy, mixed, thermic----------	Aridic Paleustalfs----------	Alfisols.
Apache------	Loamy, mixed, mesic----------	Aridic Lithic Haplustolls----------	Mollisols.
Berthoud----	Fine-loamy, mixed, mesic----------	Typic Ustochrepts----------	Inceptisols.
Bippus------	Fine-loamy, mixed, thermic----------	Cumulic Haplustolls----------	Mollisols.
Campus------	Fine-loamy, mixed, mesic----------	Typic Calciustolls 2/----------	Mollisols.
Carnero-----	Fine-loamy, mixed, mesic----------	Aridic Argiustolls----------	Mollisols.
Church------	Fine, mixed, mesic----------	Aquic Camborthids----------	Aridisols.
Dalhart-----	Fine-loamy, mixed, mesic----------	Aridic Haplustalfs----------	Alfisols.
Dean--------	Fine-loamy, carbonatic, mesic----------	Ustollic Calciorthids----------	Aridisols.
Dioxice-----	Fine-loamy, mixed, mesic----------	Aridic Calciustolls----------	Mollisols.
Dumas-------	Fine-loamy, mixed, mesic----------	Aridic Argiustolls----------	Mollisols.
Gallegos----	Loamy-skeletal, mixed, thermic----------	Ustollic Camborthids----------	Aridisols.
Guadalupe---	Coarse-loamy, mixed, thermic----------	Fluventic Ustochrepts----------	Inceptisols.
Ima---------	Coarse-loamy, mixed, thermic----------	Ustochreptic Camborthids----------	Aridisols.
Karde-------	Fine-silty, carbonatic, mesic----------	Ustic Torriorthents----------	Entisols.
Kinkead-----	Fine, mixed, thermic----------	Aridic Argiustolls----------	Mollisols.
La Brier----	Fine, mixed, mesic----------	Torrertic Argiustolls----------	Mollisols.
Lacita------	Fine-silty, mixed, calcareous, thermic---	Ustic Torriorthents----------	Entisols.
Latom-------	Loamy, mixed, calcareous, thermic--------	Lithic Ustic Torriorthents---------	Entisols.
Litle-------	Fine, mixed, mesic----------	Ustollic Camborthids----------	Aridisols.
Mansker-----	Fine-loamy, mixed, thermic----------	Aridic Calciustolls----------	Mollisols.
Manzano-----	Fine-loamy, mixed, mesic----------	Cumulic Haplustolls----------	Mollisols.
Manzano, wet variant.	Fine-loamy, mixed, calcareous, mesic-----	Cumulic Haplaquolls----------	Mollisols.
Montoya-----	Fine, mixed, thermic----------	Mollic Torrerts----------	Vertisols.
Otero-------	Coarse-loamy, mixed, calcareous, mesic---	Ustic Torriorthents----------	Entisols.

See footnotes at end of table.

TABLE 7.--CLASSIFICATION OF SOIL SERIES[1/]--Continued

Series	Family	Subgroup	Order
Pastura-----	Loamy, mixed, mesic, shallow----------	Ustollic Paleorthids----------	Aridisols.
Penrose-----	Loamy, mixed, mesic----------	Lithic Ustic Torriorthents---------	Entisols.
Portales----	Fine-loamy, mixed, thermic----------	Aridic Calciustolls----------	Mollisols.
Potter------	Loamy, carbonatic, thermic, shallow-----	Ustollic Calciorthids----------	Aridisols.
Quay--------	Fine-silty, mixed, thermic----------	Ustochreptic Calciorthids----------	Aridisols.
Springer----	Coarse-loamy, mixed, thermic----------	Udic Paleustalfs----------	Alfisols.
Tapia-------	Fine-loamy, mixed, mesic----------	Ustollic Haplargids----------	Aridisols.
Tivoli------	Mixed, thermic----------	Typic Ustipsamments----------	Entisols.
Travessilla-	Loamy, mixed, calcareous, mesic---------	Lithic Ustic Torriorthents---------	Entisols.
Tricon------	Fine, mixed, mesic----------	Aridic Petrocalcic Paleustolls-----	Mollisols.
Tucumcari---	Fine, mixed, thermic----------	Ustollic Haplargids----------	Aridisols.
Vermejo-----	Fine, mixed, calcareous, mesic----------	Ustic Torriorthents----------	Entisols.
Vernon------	Fine, mixed, thermic----------	Typic Ustochrepts----------	Inceptisols.

1/ Placement of some soil series in the current classification system, especially in families, may change as more precise information becomes available.

2/ The Campus soils in Harding County are drier than is typical for the Campus series. They are properly classified as Aridic Calciustolls.

ORDER.--Ten soil orders are recognized in the current system. These are the Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, the Entisols and Histosols, occur in many different climates. Six of the ten soil orders are represented in the Harding County. These are the Alfisols, Mollisols, Inceptisols, Aridisols, Entisols, and Vertisols.

Alfisols are soils having a clay-enriched B horizon that is high in base saturation. Examples of these soils in Harding County are in the Amarillo and Dalhart series.

Mollisols have a thick dark-colored surface layer. Most Mollisols formed under grass as did the Bippus soils in Harding County.

Inceptisols occur mostly on young, but not recent, land surfaces. Examples of Inceptisols in Harding County are in the Vernon series.

Aridisols are primarily soils of dry places. Examples in Harding County are in the Gallegos and Ima series.

Entisols are recent soils in which there has been no horizon development. Examples in Harding County are the Karde and Otero soils.

Vertisols are soils in which churning or inversion of material takes place, mainly through swelling and shrinking of clay. In Harding County, only the soils in the Montoya series are Vertisols.

SUBORDER.--Each order is divided into suborders, primarily on the basis of characteristics that seem to produce classes having genetic similarity. Mainly, these are characteristics that reflect the presence or absence of waterlogging or soil differences resulting from climate or vegetation. The climatic range is narrower than that of the orders.

GREAT GROUP.--Each suborder is divided into great groups, on the basis of uniformity in kinds and sequence of major horizons and similarity of the significant features of corresponding horizons. The horizons considered are those in which clay, iron, or humus has accumulated and those that have pans that interfere with the growth of roots and the movement of water. The features selected are the self-mulching properties of clays, soil temperature, chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like.

SUBGROUP.--Each great group is divided into subgroups, one representing the central (typic) segment of the group, and other groups, called intergrades, that have properties of one great group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any other great group, suborder, or order.

FAMILY.--Families are established within a subgroup primarily on the basis of properties that affect the growth of plants or the behavior of soils in engineering use. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES.--The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

Physical and Chemical Analyses

Data obtained by mechanical and chemical analyses for selected soils in Harding County are given in table 8. The profiles of the selected soils are described in the section "Descriptions of the Soils." The data in table 8 are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful for estimating water-holding capacity, wind erosion, fertility, tilth, and other properties significant to soil management.

The samples used to obtain the data in table 8 were collected from carefully selected pits. The percentage figures are the percentages of material passing the 2-millimeter sieve.

Standard methods of the Soil Survey Laboratory were used to obtain the data in table 8 (10). Determinations of clay were made by the pipette method. The reaction of the saturated paste was measured with a glass electrode.

TABLE 8.--ANALYTICAL DATA FOR SELECTED SOILS

[Analysis made at the New Mexico Agricultural Experiment Station. Absence of data indicates value was not determined]

Soil and location of sample	Horizon	Depth	Particle-size distribution 1/						
			Very coarse and coarse sand (2.0-0.5 mm.)	Medium sand (0.5-0.25 mm.)	Fine sand (0.25-0.1 mm.)	Very fine sand (0.1-0.05 mm.)	Silt (0.05-0.002 mm.)	Clay (less than 0.002 mm.)	Reaction saturated paste) 2/
		Inches	Percent	Percent	Percent	Percent	Percent	Percent	pH
Kinkead clay loam:	A1	0-7	0.8	4.8	23.0	15.6	27.1	28.0	7.0
Location: 400 feet	B21t	7-15	.9	3.5	16.7	10.2	22.0	46.7	7.4
N. and 1,100 feet	B22t	15-24	.8	3.3	15.6	9.5	28.1	42.7	7.8
E. of the SW. corner of sec. 33, T. 18 N., R. 30 E.	B3ca	24-42	1.4	3.8	18.2	11.4	25.3	39.9	7.8
	Cca	42-60	1.5	7.3	25.4	11.7	19.3	34.8	7.8
Litle clay loam:	A11	0-3	2.6	2.6	9.6	17.7	38.5	29.0	7.8
Location: 0.25 mile	A12	3-10	2.3	3.1	9.8	12.2	36.6	36.0	7.9
W. and 0.40 mile	B2	10-16	2.6	2.2	6.6	8.6	36.3	43.7	8.0
N. of the SE. corner of sec. 27, T. 21 N., R. 25 E.	B3	16-24	.4	.5	1.9	2.2	48.2	46.8	8.1
	C1	24-60	---	---	----	----	----	----	----
La Brier loam:	A11	0-2	---	---	----	----	----	----	----
Location: 625 yards	A12	2-8	.7	1.6	7.5	11.0	49.2	30.0	7.2
S. of the NE. corner of sec. 16, T. 19 N., R. 26 E.	B1	8-11	2.8	6.3	9.6	8.7	30.3	42.3	7.0
	B21t	11-20	.7	1.3	5.1	7.1	35.7	50.1	7.2
	B22t	20-31	.8	1.5	5.1	6.6	37.8	48.2	7.8
	B3ca	31-60	---	---	----	----	----	----	----
	Cca	60-72	---	---	----	----	----	----	----
Tucumcari loam:	A1	0-8	2.3	5.2	18.6	20.4	28.4	25.1	7.9
Location: 98 yards	B21t	8-18	1.7	4.2	14.8	15.5	31.1	32.7	8.0
SE. of windmill in the SE1/4 of sec. 6, T. 15 N., R. 31 E.	B22t	18-28	2.1	3.9	14.9	9.9	32.1	37.1	8.2
	B3ca	28-48	.8	2.6	12.9	11.4	35.6	36.7	8.3
	C	48-60	---	---	----	----	----	----	----

1/ Particle-size distribution was determined by method 3A1 (10).

2/ Reaction was determined by method 8C1b (10).

This section gives general information concerning the county. It discusses settlement, natural resources, cultural facilities, climate and farming.

Settlement of the County

Coronado, an early Spanish explorer, passed near the area that is now Harding County in 1541. The area was Spanish territory until 1821, when Mexico gained its freedom from Spain. New Mexico became United States territory in 1846.

Several cattle drives on the Goodnight Trail came through the county in the 1870's. Early settlers located at various sites of permanent water in the 1880's. Many of these settlers were descendants of the early Spanish explorers.

The Free Homestead Act of 1900 opened up thousands of acres of public land for settlement. The Dawson branch of the Southern Pacific Railroad was completed through the county in 1903. Homesteaders from Texas, Oklahoma, and other areas came in on nearly every train. The enlarged Homestead Act of 1909 provided for the homesteading of 320 acres where the land was not irrigated. Homesteads soon were seen throughout the central, northeastern, and southeastern parts of the county.

New Mexico became a State in 1912, and Harding County was organized from parts of Union and Mora Counties in 1921. Population was 4,421 in 1930, but it began to decrease during the Dust Bowl days of the 30's. In 1950, there were 3,013 people in the county. The drought-stricken years in the 1950's again caused a large decrease in population. In 1960, the population in the county was 1,874.

Mosquero, the county seat, has a population of 310. Roy, the largest town, has a population of 633. The villages of Mills, Solano, Albert, Bueyeros, Rosebud, and Gallegos still have a few inhabitants. Only a few abandoned buildings and adobe ruins mark the villages of Yates, Sabino, Reyes, and Bryantine.

Natural Resources

Soil is the most important natural resource in the county. Livestock that graze the grassland and crops produced on farms are marketable products that are derived from the soil.

In most of the county, water is adequate for domestic use and watering livestock. The underground geologic formations of Ogallala sand and gravel and the Dakota Sandstone are important water-bearing sources for wells. No extensive areas of underground water have been found in sufficient volume for irrigation.

The largest and most productive deposits of carbon dioxide in New Mexico are in the Bueyeros fields of the Ute Creek valley (2). Gas-processing plants in the county convert the carbon dioxide into dry ice, liquid gas, and bottled carbon dioxide gas. This is the only form of industry in the county.

Cultural Facilities

Roy and Mosquero have accredited high schools and grade schools. A rural grade school is at Bueyeros, and a parochial grade school is at Roy. In addition, some of the pupils in the eastern part of the county attend school at Amistad in Union County or at Logan in Quay County.

The county has six Protestant churches and two Catholic churches. The Catholic Church maintains several rural mission points.

State Route 39, a paved highway, crosses the county from the southeast corner to the northwestern part. State Highway 120 also is paved. Partially paved State Routes 65 and 102 are good farm-to-market roads. Dirt or gravel roads are on many of the section lines of the mesa. Dirt roads and trails provide access to the rest of the county.

Cattle are shipped to market by several trucking companies. Wheat is trucked mainly to the rail center of Clayton. Most of the forage crops are used locally.

Electricity is available in most of the county, but some of the more isolated headquarters do not have electricity. Telephone service is available to most of the mesa area through exchanges at Roy and Mosquero, but much of the eastern part of the county is without telephone service.

A county fair is held each year at Roy. Rodeos and horse shows are big attractions. Hunting is popular, and there are guides, lodging, and eating accomodations at Roy or Mosquero. A recreational area that has campsites and toilet facilities is at the mouth of Mills Canyon in the Canadian River Gorge.

Climate [5/]

Climate is a primary factor for the success of dryfarming in Harding County. As stated in the subsection "Predicted Yields," a soil that can produce about 30 bushels of wheat per acre when climate is favorable can fail as easily as a soil that yields only 15 bushels during a drought. Winter wheat was a failure 8 years out of 22 years, from 1926 to 1948, at the Mosquero experimental field.

Harding County has a semiarid continental climate. Data on the climate of Harding County are given in tables 9 and 10. The summers are generally mild, and most of the rainfall in a year is from thunderstorms in summer. The moisture for these showers comes in the general air circulation from the Gulf of Mexico,

5/ By FRANK E. HOUGHTON, climatologist for New Mexico, National Weather Service, U.S. Department of Commerce.

TABLE 9.--TEMPERATURE AND PRECIPITATION DATA

[All data from Roy]

Month	Temperature 1/				Precipitation 2/				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with--		Average total	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	Days	Days
January----	49	21	64	6	0.42	(3/)	1.0	1	1
February---	52	22	67	7	.43	(3/)	1.3	1	1
March------	56	25	72	11	.63	(3/)	1.9	1	1
April------	65	34	79	23	.91	(3/)	2.2	3	1
May--------	74	44	87	33	2.50	0.3	4.8	4	3
June-------	85	54	95	45	1.62	.3	3.3	4	2
July-------	86	58	95	53	2.32	.3	4.0	5	3
August-----	85	56	93	48	2.22	1.0	4.2	5	3
September--	80	49	90	41	1.71	.2	5.3	3	2
October----	69	38	81	27	1.40	(3/)	3.5	3	2
November---	57	26	72	10	.43	(3/)	1.2	1	(4/)
December---	50	21	65	8	.53	(3/)	1.6	1	1
Year-----	67	37	5/ 97	6/ -4	15.12	9.7	21.5	32	20

1/ Based on a 30-year record, 1931-60.

2/ Based on an 11-year record, April 1949-March 1961.

3/ 0.005 inch, the smallest measurable amount.

4/ Less than 0.5 day.

5/ Average annual highest maximum.

6/ Average annual lowest minimum.

TABLE 10.--PROBABILITIES OF LAST FREEZING TEMPERATURES IN SPRING AND FIRST IN FALL

[Based on data from a 15-year record, January 1948-July 1962, at Mosquero]

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than----------	April 17	April 22	April 25	May 11	May 15
2 years in 10 later than----------	April 12	April 17	April 21	May 6	May 11
5 years in 10 later than----------	March 28	April 6	April 10	April 25	May 3
Fall:					
1 year in 10 earlier than----------	November 3	October 25	October 23	October 16	September 30
2 years in 10 earlier than----------	November 9	October 31	October 27	October 18	October 5
5 years in 10 earlier than----------	November 20	November 12	November 4	October 25	October 15

about 600 miles away. Condensation is caused by convective air currents that result from strong surface heating and some lifting as the air moves over higher terrain. Winter rains fall when storms move eastward from the moisture source of the Pacific Ocean. These winter rains are generally light because precipitation removes a large amount of moisture from the air as the air passes over the coastal and inland mountains before reaching the eastern part of New Mexico.

The records for temperature and precipitation at Roy in table 9 are representative for the western and northern parts of the county. Temperatures in the southeastern part of the county, with its lower elevations, average 5° F. warmer than those shown in table 9.

An average of 29 days a year may be expected to have high temperatures of 90° or more, mainly in June, July, and August. The high temperature in a day may be expected to be below 32° on an average of 8 days a year. The temperature drops to or below 32° on an average of 143 days a year, and to or below 0° on an average of 2 days a year, usually in January and February but occasionally in November and December. The extreme high temperature recorded in Harding County was 104° at Mosquero in July 1934 and also at Roy in July 1919. An extreme low of -19° was recorded at Mosquero in January 1949 and at Roy in January 1919.

The probability of occurrence of selected temperatures after or before given dates in spring and fall are shown in table 10. This table is based on temperature recorded at Mosquero and is representative of the mesa. These dates may vary by a few days at any other specific locality in the county because of local radiation, air drainage, elevation, or special environment effects.

The average annual rainfall in Harding County is between 13 and 17 inches. The precipitation summary for Roy in table 9 is representative of the county. Nearly three-fourths of the annual average rainfall occurs during the usual growing season and comes mostly in brief thunderstorms late in the afternoon and in the evening. Extremes of rainfall include an annual total of 47.02 inches at Yates in 1941, a monthly total of 13.88 inches near Mosquero in September 1941, and a daily total of 6.45 inches at Bueyeros on September 22, 1941.

Annual snowfall totals in Harding County average between 19 and 26 inches. Extremes of snowfall include an annual total of 67.0 inches at Solano in 1958, a monthly total of 33.5 at Roy in November 1940, and a daily total of 16.0 inches on April 2, 1958.

Although measurements of other weather elements are not made at stations in Harding County, reliable estimates have been derived from observations made at nearby stations in New Mexico. Relative humidity averages close to 50 percent on an annual basis. Spring is slightly less moist, and late in summer and early in fall are slightly more moist. Winds are dominantly from the southwest and average about 12 miles per hour. Winds average slightly higher in spring and slightly lower in fall. Sunshine occurs about three-fourths of the possible hours and is distributed fairly evenly throughout the year, though there is a small increase in summer. Cloudiness averages nearly one-half sky cover, but coverage is a little less in fall. Potential evaporation from a measuring pan is nearly 85 inches a year and from a natural lake surface is nearly 61 inches. About 68 percent of the annual evaporation occurs from May through October.

Tornadoes are rare in Harding County but may be expected to occur on one day in about 2 years. A tornado occurred near Roy in 1927. Three small ones, which caused only slight damage, occurred in the county on one day in 1962.

Farming

The first settlers in Harding County were mainly cattle or sheep ranchers, but farming became important when the land was opened to homesteaders. Winter wheat, other small grains, beans, and grain sorghum were grown to help meet the need for food in the First World War.

During this time, farmers were unfamiliar with the climate, only small amounts of crop residues were left on the soil, and grassland was overgrazed. Then came the dry years and strong southwest winds. As a result, Harding County became a part of the Dust Bowl.

The depression and the Dust Bowl of the 1930's forced many farmers to abandon their farms. The Federal government bought about 55,000 acres of submarginal cropland in the Mills area and east of there. This land was supervised by the Soil Conservation Service for a number of years. Many acres were reseeded to grass. This area is now called the Kiowa Grasslands, and it is a part of the Panhandle National Grasslands. The Forest Service now supervises this area.

The enactment of the Soil Conservation District legislation in 1937 stirred the interest of many landowners in Harding County. The Mesa Soil and Water Conservation District was organized April 13, 1938, and was the first soil conservation district in New Mexico (fig. 7). The Canadian River Soil and Water Conservation District, organized April 26, 1939, covers the southeastern corner of the county. Farmers and ranchers in the eastern part of Harding County and in parts of San Miguel and Union Counties recognized the problems of water erosion, soil blowing, overgrazing of grassland, shortage of livestock watering places, and invasion of brush and noxious weeds. They organized the Ute Creek Soil and Water Conservation District on March 18, 1942. Figure 7 shows how Harding County is divided into three conservation districts.

A succession of dry years in the 1950's again forced many farmers to leave their farms. Many acres of cropland were reseeded to grass or remained idle.

About 50,000 acres or 3.5 percent of the county is cropland. Of this, about 37,000 acres have been reseeded to grass. About 95 percent of the county is rangeland or abandoned cropland that is used for grazing.

The capability of many soils in Harding County, climate limitations, and the present economic conditions indicate that the future economy of Harding County may be based largely on the grazing of livestock.

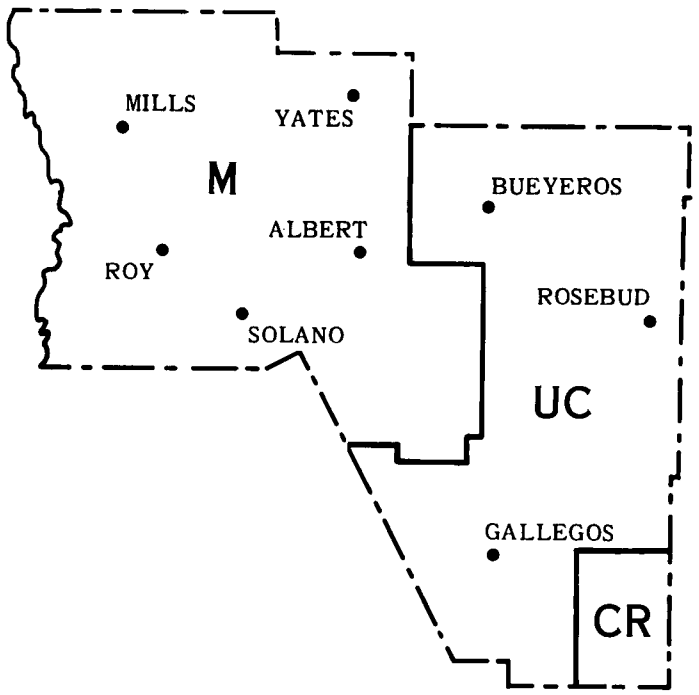

Figure 7.--Division of Harding County into soil and water conservation districts. M, Mesa District; UC, Ute Creek District; CR, Canadian River District.

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GLOSSARY

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed 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 capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum or it may be exposed at the surface by erosion.

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 of more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: Clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base 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 and brittle; little affected by moistening.

Forb. Any herbaceous plant, neither a grass nor a sedge, that is grazed on western ranches.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.--The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.--The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

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 some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.--The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.--Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles.

Percolation. The downward movement of water through the soil.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: Very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid.

Phase, soil. A subdivision of a soil, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

Profile, soil. A vertical section of the soil through all its horizons and extending 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 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid or "sour," soil is one that gives an acid reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the profile.

Shale. A sedimentary rock formed by the hardening of clay deposits.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes 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

characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. 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 (1) single grain (each grain by itself, as in dune sand) or (2) massive (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically the part of the soil below the solum.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of fine particles, are sand, loamy sand, sandy loam, loam, silt loam, silt, 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."

Valley fill. Alluvium deposited by heavily loaded streams emerging from hills or mountains and spreading sediments onto the lowland as a series of adjacent alluvial fans.

Variant, soil. A soil having properties different from those of other known soils to suggest establishing a new soil series, but a soil of such limited area that creation of a new series is not believed to be justified.

Water-supplying capacity. The amount of available water in the soil at the start of the growing season plus what is added in precipitation minus what runs off or evaporates.

GUIDE TO MAPPING UNITS

To obtain a complete description of a mapping unit, it is necessary to read the description of the mapping unit and the description of the soil series to which it belongs. In referring to a capability unit or a range site, read the introduction to the section it is in for general information about its management. Other information in this soil survey is in tables as follows:

Approximate acreage and extent, table 1, p. 120.
Predicted yields on dryfarmed soils, table 2, p. 61.
Engineering uses of soils table 3, p. 66; table 4, p. 76; and table 5, p. 92.

MEDIUM-INTENSITY SURVEY

Map symbol	Mapping unit	Described on page	Dryland capability unit		Range site	
			Symbol	Page	Name	Page
Ap	Apache stony loam, 1 to 9 percent slopes	15	VIs-6	58	Malpais	51
Bd	Berthoud loam	16	VIe-1	56	Loamy 1	50
Ca	Campus fine sandy loam	19	VIe-4	57	Sandy	52
Cb	Campus loam, 0 to 3 percent slopes	17	VIe-4	57	Loamy 1	50
Cc	Campus loam, 0 to 3 percent slopes, eroded	18	VIe-4	57	Loamy 1	50
Cf	Campus loam, 3 to 9 percent slopes	18	VIe-4	57	Loamy 1	50
Cg	Campus loam, 3 to 9 percent slopes, eroded	18	VIe-4	57	Loamy 1	50
Cm	Campus gravelly loam, 1 to 25 percent slopes	19	VIe-7	58	Shallow 1	52
Co	Carnero loam	19	VIs-3	58	Loamy 1	50
Cr	Carnero loam, eroded	20	VIs-3	58	Loamy 1	50
Cs	Carnero complex	20	VIs-3	58	Loamy 1	50
Ct	Carnero complex, eroded	20	VIs-3	58	Loamy 1	50
Cu	Church clay loam	21	VIw-2	59	Salt Flats	51
Da	Dalhart fine sandy loam	22	IVe-1	55	Sandy	52
Db	Dalhart complex, severely eroded	22	VIe-2	56	Sandy	52
Dd	Dean soils, 0 to 9 percent slopes	23	VIe-4	57	Shallow 1	52
Df	Dioxice loam, 0 to 3 percent slopes	23	IVec-2	56	Loamy 1	50
Dg	Dioxice loam, 0 to 3 percent slopes, eroded	24	VIe-1	56	Loamy 1	50
Dh	Dioxice loam, 3 to 5 percent slopes	24	VIe-1	56	Loamy 1	50
Dm	Dumas loam, 0 to 3 percent slopes	24	IVec-1	55	Loamy 1	50
Do	Dumas loam, 3 to 5 percent slopes	25	VIe-1	56	Loamy 1	50
Dr	Dumas loam, thin solum, 0 to 3 percent slopes	25	IVec-2	56	Loamy 1	50
Du	Dumas complex, 0 to 3 percent slopes, eroded	25	VIe-1	56	Loamy 1	50
Ka	Karde loam, 1 to 9 percent slopes	28	VIe-4	57	Sandy	52
La	La Brier loam	29	IVs-1	56	Loamy 1	50
Lc	La Brier loam, eroded	30	VIs-1	58	Loamy 1	50
Ld	La Brier clay loam	30	VIs-1	58	Loamy 1	50
Lt	Litle clay loam	32	VIe-9	58	Clayey 1	49
Mm	Manzano sandy loam	34	VIw-1	59	Bottomland	48
Mn	Manzano loam	33	VIw-1	59	Bottomland	48
Mo	Manzano and La Brier soils	34				
	Manzano part	--	IVec-1	55	Loamy 1	50
	La Brier part	--	VIs-1	58	Loamy 1	50
Mr	Manzano loam, wet variant	34	VIw-3	59	Meadow	51
Or	Otero loamy fine sand, 1 to 9 percent slopes	36	VIe-5	57	Deep Sand	50
Os	Otero fine sandy loam	36	VIe-2	56	Sandy	50
Pc	Pastura loam	37	VIIs-1	60	Shallow 1	52
Pe	Penrose soils, 0 to 12 percent slopes	37	VIIs-1	60	Shallow 1	52
Rn	Rough broken and stony land	39	VIIs-2	60	Breaks	49
Ta	Tapia complex	41	VIe-8	58	Sandy	50
Tr	Travessilla stony loam, 0 to 9 percent slopes	42	VIIs-1	60	Shallow Sandstone	53
Tt	Tricon loam	43	IVs-1	56	Loamy 1	50
Tu	Tricon complex	44	VIs-1	58	Loamy 1	50
Tv	Tricon soils, eroded	44	VIe-1	56	Loamy 1	50
Ve	Vermejo clay	45	VIew-1	59	Salty Bottomland	51

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GUIDE TO MAPPING UNITS--Continued

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LOW-INTENSITY SURVEY

Map symbol	Mapping unit	Described on page	Dryland capability unit		Range site	
			Symbol	Page	Name	Page
AC	Active dune land	14	VIIIe-1	60	----------	---
AM	Amarillo fine sandy loam	14	IVe-1	55	Sandy	52
BE	Berthoud fine sandy loam, 1 to 9 percent slopes	16	VIe-2	56	Sandy	52
BH	Berthoud loam, 1 to 5 percent slopes	16	VIe-1	56	Loamy 1	50
BP	Bippus loam	17	IVec-1	55	Loamy 2	50
CD	Campus loam, 0 to 9 percent slopes	18	VIe-4	57	Loamy 1	50
CE	Campus loam, 0 to 9 percent slopes, eroded	18	VIe-4	57	Loamy 1	50
CN	Campus-Dean association, gently sloping	19				
	Campus part	--	VIe-4	57	Loamy 1	50
	Dean part	--	VIe-4	57	Shallow 1	52
DE	Dean soils, 0 to 9 percent slopes	23	VIe-4	57	Shallow 1	52
DN	Dumas loam, 0 to 3 percent slopes	24	IVec-1	55	Loamy 1	50
DV	Dumas complex, 0 to 3 percent slopes eroded	25	VIe-1	56	Loamy 1	50
GA	Gallegos very gravelly sandy loam, 3 to 35 percent slopes	25	VIe-7	58	Shallow 2	53
GU	Guadalupe fine sandy loam	26	VIe-2	56	Sandy	52
IM	Ima and Quay soils	27	VIe-6	57	Sandy	52
KC	Kinkead clay loam	28	VIs-1	58	Loamy 2	50
KK	Kinkead clay loam, alkali	29	VIs-7	59	Salt Flats	51
LB	La Brier loam	29	IVs-1	56	Loamy 1	50
LE	Lacita loam, 1 to 9 percent slopes	31	VIe-3	57	Loamy 2	50
LF	Latom fine sandy loam	31	VIe-8	58	Sandy	52
MA	Mansker-Portales association, gently sloping	32	VIe-4	57	Sandy	52
MK	Mansker-Potter association, gently sloping-	33				
	Mansker part	--	VIe-4	57	Sandy	52
	Potter part	--	VIIs-1	60	Shallow 2	53
MT	Montoya clay	35	VIew-1	59	Salty Bottomland	51
OT	Otero fine sandy loam	36	VIe-2	56	Sandy	52
PA	Pastura fine sandy loam	37	VIIs-1	60	Shallow 1	52
RH	Riverwash	39	VIIIw-1	60	----------	
RK	Rough broken land	39	VIIs-2	60	Hills	50
RO	Rough broken and stony land	39	VIIs-2	60	Breaks	49
SP	Springer loamy fine sand, 1 to 9 percent slopes	40	VIe-5	57	Deep Sand	50
SR	Springer-Amarillo association	40	VIe-5	57	Deep Sand	50
SS	Springer-Amarillo association, severely eroded	41				
	Springer part	--	VIIe-1	60	Sand Hills	52
	Amarillo part	--	VIe-5	57	Deep Sand	50
TF	Tivoli fine sand	42	VIIe-1	60	Sand Hills	52
TG	Tivoli-Springer complex	42				
	Tivoli part	--	VIIe-1	60	Sand Hills	52
	Springer part	--	VIIe-1	60	Deep Sand	50
TS	Travessilla stony loam, 0 to 9 percent slopes	42	VIIs-1	60	Shallow Sandstone	53
TW	Tucumcari-Quay association	44				
	Tucumcari part	--	VIs-1	58	Loamy 2	50
	Quay part	--	VIe-3	57	Loamy 2	50
VS	Vernon-Shale outcrop complex, 1 to 9 percent slopes	46	VIIs-3	60	Clayey 2	49
WE	Wet alluvial land	46	VIw-3	59	Meadow	51

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