SOIL SURVEY OF

Otero County, Colorado

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Colorado Agricultural Experiment Station

Issued March 1972

Major fieldwork for this soil survey was done in the period 1962-65. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1966. This survey was made cooperatively by the Soil Conservation Service, the Forest Service, and the Colorado Agricultural Experiment Station. It is part of the technical assistance furnished to the East Otero, West Otero, and Timpas Soil 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, United States Department of Agriculture, 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 Otero County are shown on the detailed map at the back of this publication. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

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

Finding and Using Information

The "Guide to Mapping units" can be used to find information. 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 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 soils from the soil descriptions and from the discussions of the capability units and range sites.

Community planners and others can read about soil areas as sites for picnics, camping, and other recreation in the section "Management of Soils for Recreation."

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

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

Foresters and others can refer to the section "Management of Soils for Woodland and Windbreaks," where soils that are better suited to trees are mentioned, and trees and shrubs suitable for planting are named.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain 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 Otero County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the County."

Cover picture: Furrow irrigation of Rocky Ford silty clay loam, 0 to 1 percent slopes, a desirable soil for vegetable crops.

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SOIL SURVEY OF OTERO COUNTY, COLORADO

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE AND
FOREST SERVICE, IN COOPERATION WITH COLORADO AGRICULTURAL EXPERIMENT STATION

OTERO COUNTY is in southeastern Colorado (fig. 1). Its total land area is 810,880 acres or about 1,267 square miles. The estimated 1964 population was 24,600. The county is characterized by a semiarid climate, a 160-day frost-free growing season, a 10- to 14-inch average yearly rainfall, and altitudes of 3,965 to 5,150 feet. The topography ranges from gently undulating plains to limestone and sandstone escarpments and canyons. Three rivers flow through the county; they are the Purgatoire and Apishapa Rivers, and the Arkansas River, which is the lifeblood of the irrigated area.

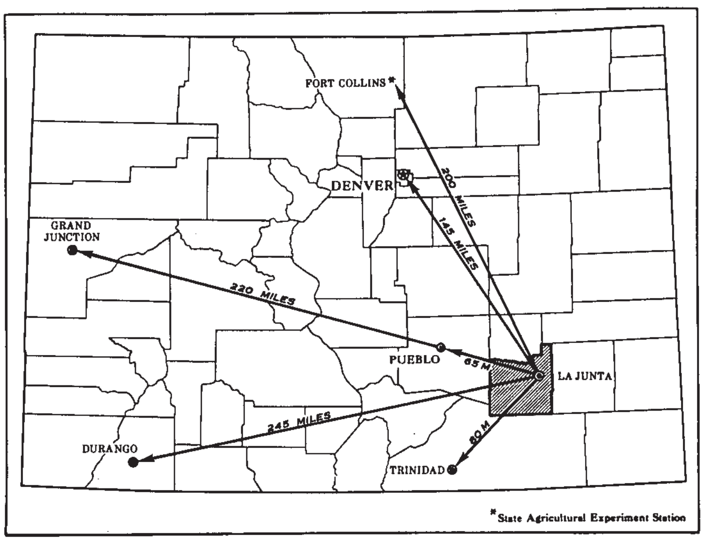


Figure 1.--Location of Otero County in Colorado.

The county is crossed from east to west by U.S. Highway No. 50 and a branch of the Atchison, Topeka and Santa Fe Railway. The main line of the railway goes southwest from La Junta. U.S. Highway No. 350 and Colorado Highway No. 10 run southwest from La Junta. The major towns of the county are located along U.S. Highway No. 50 and near the Arkansas River. From east to west, they are La Junta, Swink, Rocky Ford, Vroman, Manzanola, and Fowler. La Junta, the largest town, is the county seat.

The economy of the county is based almost entirely on ranching, farming, and related businesses. The county contains 79,500 acres of irrigated farmland, most of which lies in the Arkansas River valley. The major source of irrigation water is the Arkansas River. Irrigation water is in short supply.

The irrigated crops grown are feed and forage crops, cereal crops, vegetable crops, and sugar beets. Vegetable crop seed is processed and distributed worldwide by local seed firms. The most widely known product is the seed for the Rocky Ford melon. The Arkansas Valley Branch of the Colorado State Experiment Station is located at Rocky Ford; this station, in operation continuously since 1888, does development work on irrigated crops. The American Crystal Sugar Company has its sugar beet research station at Rocky Ford.

162,000 of the rangeland part of the county is in the Comanche National Grassland. This grassland is managed by the Forest Service, and grazing privileges are leased to ranchers who have adjacent holdings.

Soil scientists made this survey to learn what kinds of soil are in Otero 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. In the county, they observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the underlying materials, 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.

Soils that have profiles almost alike make up a soil series (7) 1/. 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. Rocky Ford and Minnequa, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil 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, Numa clay loam, 0 to 1 percent slopes, is one of several phases within the Numa 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 in 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 Otero County: soil complexes, undifferentiated soil groups, and soil variants.

A soil complex consists of areas of two or more soils, so intricately mixed 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. Glenberg-Bankard sandy loams, 0 to 1 percent slopes, 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." Kim and Wiley loams, 1 to 9 percent slopes, is an example.

A soil variant has properties different enough to justify a new soil series but is of such limited known extent that establishing a new series is not considered practical. An example in this county is Numa loam, gravel subsoil variant, 5 to 9 percent slopes.

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

The soil scientists set up trial groups of soils on the basis of yield and practice tables and other data they have collected. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

1/ Underscored numbers in parentheses refer to Literature Cited. p. 80

The general soil map at the back of this survey shows, in color, the soil associations in Otero 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 five soil associations in Otero County are discussed in the following pages

1. Vona-Olney-Dwyer Association

Deep, nearly level to undulating, well-drained to excessively drained, loamy and sandy soils on uplands

The largest area of this association is located east of the Apishapa River in the western part of the county. Other smaller areas are located near the Arkansas River which flows east through the county. The soils developed from limy fine sands that apparently were blown out of the drainage channels as the landscape gradually formed (fig. 2).

This association embodies about 10 percent of the county. The Vona soils comprise about 40 percent of it; the Olney soils, about 25 percent; and the Dwyer soils, about 20 percent. Otero, Harvey, and Stoneham soils, and small areas of Minnequa, Shingle, or Cascajo soils, make up the rest.

Vona soils are gently undulating to nearly level. They have a sandy loam surface layer and subsoil, but the subsoil is somewhat finer textured than the surface layer. Vona soils are lime free down to a depth of 15 inches. Olney soils are nearly level. They have a sandy loam surface layer and a sandy clay loam subsoil. They are free of lime to a depth of 12 inches. Dwyer soils are loamy sand throughout the profile and have the most nearly undulating relief. The depth to lime ranges from 18 inches to 3 feet.

Nearly all of this association is used as range. Only a small area in the vicinity of Holbrook Reservoir is irrigated. The principal vegetation consists of blue grama, side-oats grama, Indian ricegrass, galleta, sand dropseed, bluestem grasses, and wild legumes. In most areas, yucca and sand sage are plentiful. Well-regulated grazing is the most effective and cheapest conservation practice. Brush control may be of value in places. Tracts that were farmed by homesteaders many years ago need reseeding. Stock water can be obtained from wells, or from pits dug in areas of Olney soils.

2. Minnequa-Penrose Association

Nearly level to steep, well-drained to excessively drained, loamy soils that are moderately deep to very shallow over limestone or marl; on uplands

This association is largely comprised of nearly level to gently undulating loams and silty clay loams on plains and of channery loams on limestone breaks and escarpments (fig. 3). Areas of this association are drained by dry creek channels at intervals a few miles apart. Nearly level terraces along the creeks are more than a half-mile wide in some places.

This is the largest of the five associations; it embodies about 53 percent of the county. Minnequa soils comprise about 36 percent of the association, and the Penrose soils, about 19 percent. The rest consists largely of Tyrone, Manvel, and Manzanola soils, together with minor areas of Cadoma, Haverson, Limon, Samsil, and Shingle soils.

Minnequa soils are nearly level to gently undulating loams and silty clay loams that have a very high content of lime. They are underlain by parent limestone at depths ranging from 20 to 40 inches. Penrose soils are only 6 to 20 inches deep to limestone, and their surface is strewn with angular fragments of limestone. Penrose soils are mainly near the southern boundary of the association, in a long narrow strip that extends diagonally from the southwest corner of the county to the Otero-Bent County line south of La Junta.

Nearly all of this association is used as range. A small part comprised mostly of Minnequa soils in the La Junta vicinity is irrigated. The dominant range grasses are blue grama, buffalograss, and galleta. Maintaining high-quality range that helps prevent surface runoff is the best management practice. Mechanical practices such as pitting and contour furrowing can help reduce runoff if the range is in poor condition. Obtaining stock water is a problem because most of it comes from small dams and pits which sometimes go dry. In some places, water can be obtained from wells dug along the creeks.

3. Travessilla-Kim-Wiley Association

Very shallow, excessively drained, loamy soils on sandstone bluffs and deep, well-drained, loamy soils on bordering foot slopes and ridgetops

This association is located in the southeastern part of the county and is drained by the Purgatoire River. It occupies an area of nearly level to gently undulating plains dissected by drainageways that have steep side slopes and canyonlike walls of sandstone rock outcrop (fig. 4).

This association embodies about 10 percent of the county. Travessilla soils comprise about 42 percent, and Kim and Wiley soils, together, about 33 percent of the association. A complex of Travessilla soils and sandstone rock outcrops comprises about 17 percent, and the deep Baca, Haverson, and Manzanola soils and the shallow, highly erodible Shingle soils occupy the rest.

Travessilla soils are sandy loams that are only a few inches deep over sandstone. Kim soils are deep, limy loams that developed from limy parent material weathered from sandstone. Wiley soils are deep, limy loams that developed in wind-deposited silts overlying parent material weathered from sandstone, which is at a depth of 40 inches or more.

All of this association is used as range. The principal vegetation consists of blue grama, sideoats grama, bluestem, galleta, needlegrass, and cholla cactus. Small juniper trees, however, are most conspicuous. Deferred grazing helps to maintain the vigor and productivity of the plants. Stock water can be obtained from shallow wells in drainageways, from deeper wells bored through the underlying Dakota sandstone, or from small dams and pits.

4. Harvey-Stoneham-Cascajo Association

Deep, gently sloping, well-drained, loamy soils and moderately steep, excessively drained, gravelly soils; on uplands

This association occupies nearly level to gently sloping plains in the northeastern part of the county and high terraces and gravelly escarpments bordering the valleys of the Arkansas and Apishapa Rivers.

It embodies about 12 percent of the county. Harvey soils comprise about 50 percent; the Stoneham soils, about 20 percent; and Cascajo soils and Gravelly land, about 14 percent of the association. The rest consists of the sandy loam Olney and Otero soils along with small areas of Baca, Manvel, and Shingle soils.

Harvey soils are deep, gently sloping loams that have a prominent, very pale brown to pink layer of lime in the subsoil. Below the lime the texture in places is moderately sandy. Stoneham soils differ from Harvey soils in being somewhat less sloping and in having a well-developed, although thin, lime-free sandy clay subsoil. Cascajo soils are similar to Harvey soils but contain much more gravel and are more sloping.

Cascajo soils are a source of commercial gravel, and Harvey and Stoneham soils are well suited as range. The principal grass is blue grama. Grasses grow vigorously with average precipitation. Well regulated grazing will keep the range in good condition so that there is little surface runoff. Limited stock water can be obtained from small dams or pits or from shallow wells.

5. Rocky Ford-Numa-Kornman Association

Deep, nearly level, well-drained, loamy soils mainly on terraces

This association occupies the terraces of the Arkansas, Purgatoire, and Apishapa Rivers and the uplands in the vicinity of the town of Cheraw. The terraces along the rivers generally occur at two levels (fig. 5). The lower terrace along the Arkansas River is about a mile wide, and the upper terrace, about 25 feet above the lower one, is from 2 to 4 miles wide. Most of the towns in the county are located on the upper terrace.

This association embodies about 15 percent of the county. Rocky Ford soils comprise about 54 percent; Numa soils, about 11 percent; and an undifferentiated group of Kornman and Neesopah soils, about 10 percent of the association. The rest consists of Cascajo, Nepesta, and Limon soils on the upper terrace and Apishapa, Bloom, Las Animas, Glenberg, and Bankard soils on the lower terrace.

Rocky Ford soils are deep, well-drained, and mostly on the upper terrace. They have a thick silty clay loam surface layer and a silt loam subsoil. Numa soils are deep, well-drained, and mostly on the upper terrace. They have a thick silty clay loam surface layer and a loam substratum in which there is a prominent horizon of lime enrichment. Most areas of the Numa soils are more sloping than those of the Rocky Ford soils. The deep, well-drained Kornman and Neesopah soils have a thickly silted loamy surface layer and sandy loam subsoil. Generally, they require more frequent irrigation than Rocky Ford and Numa soils.

Most of this association is irrigated. A wide variety of feed, grain, and vegetable crops is grown, and favorable yields can be obtained even though water is in short supply at times. Irrigation water comes from ditches maintained by those who have water rights on the river. The most important management problems are controlling seep and salt accumulation and improving tilth.

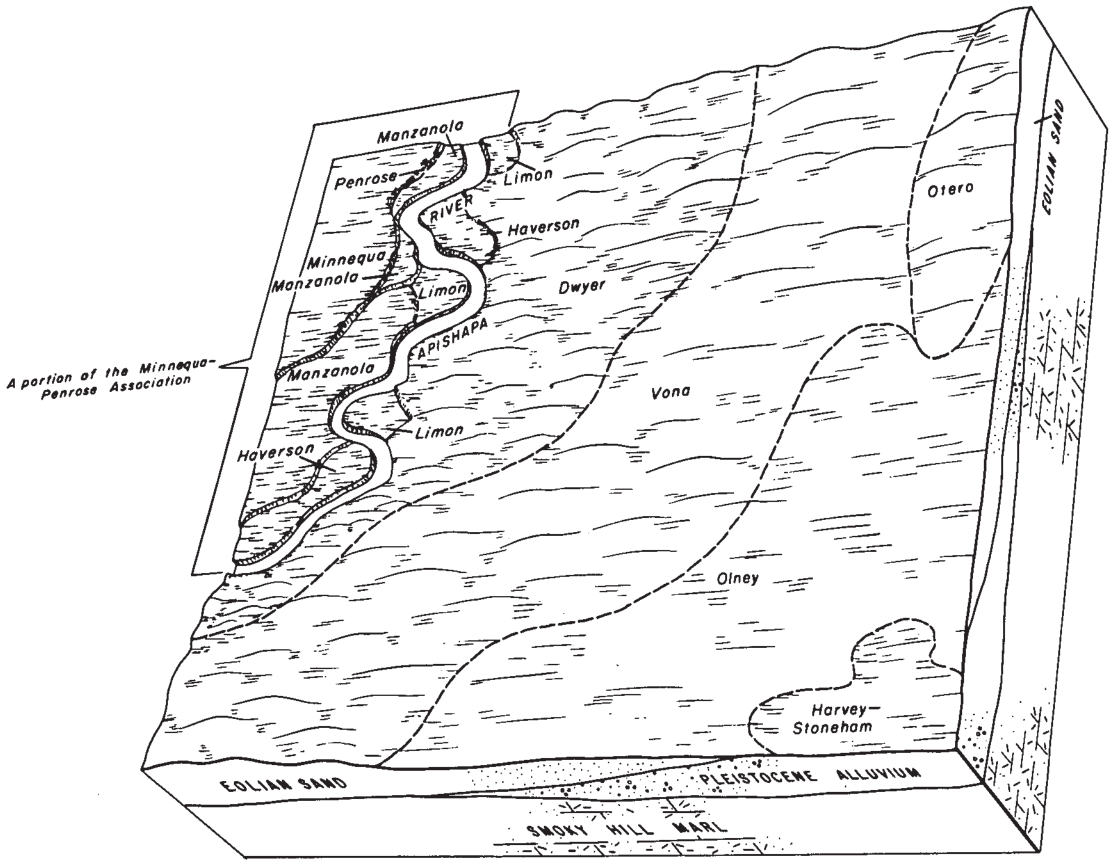


Figure 2 Vona-Olney-Dwyer association; part of Minnequa-Penrose soil association in background.

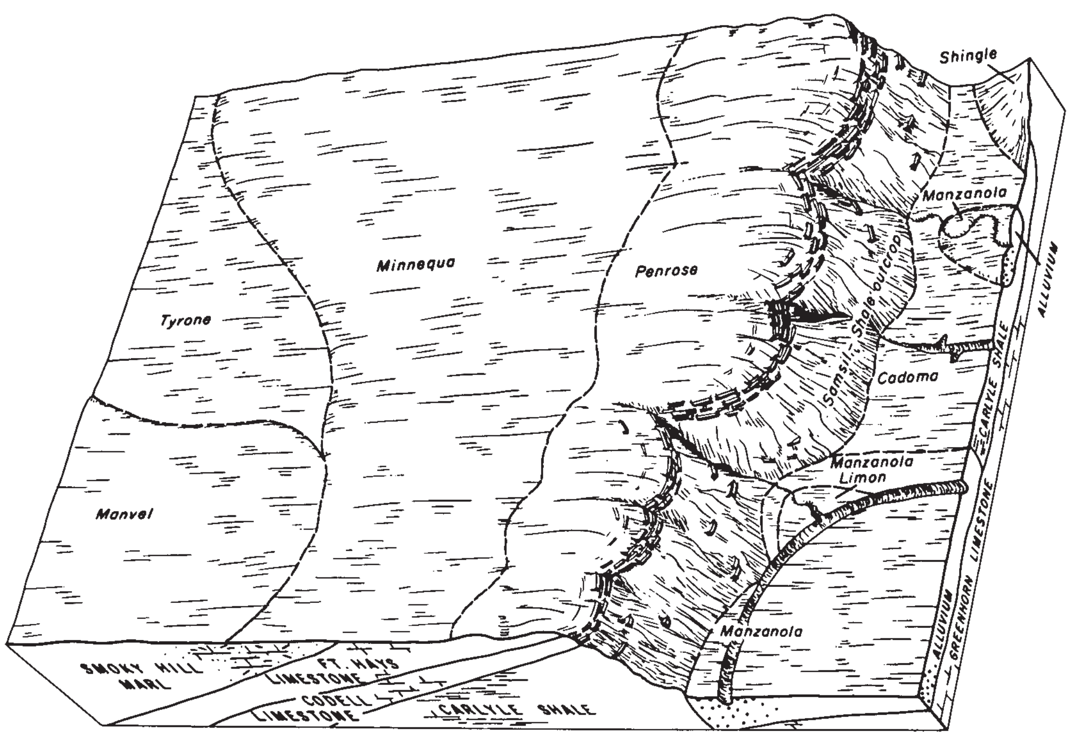


Figure 3 Minnequa-Penrose soil association.

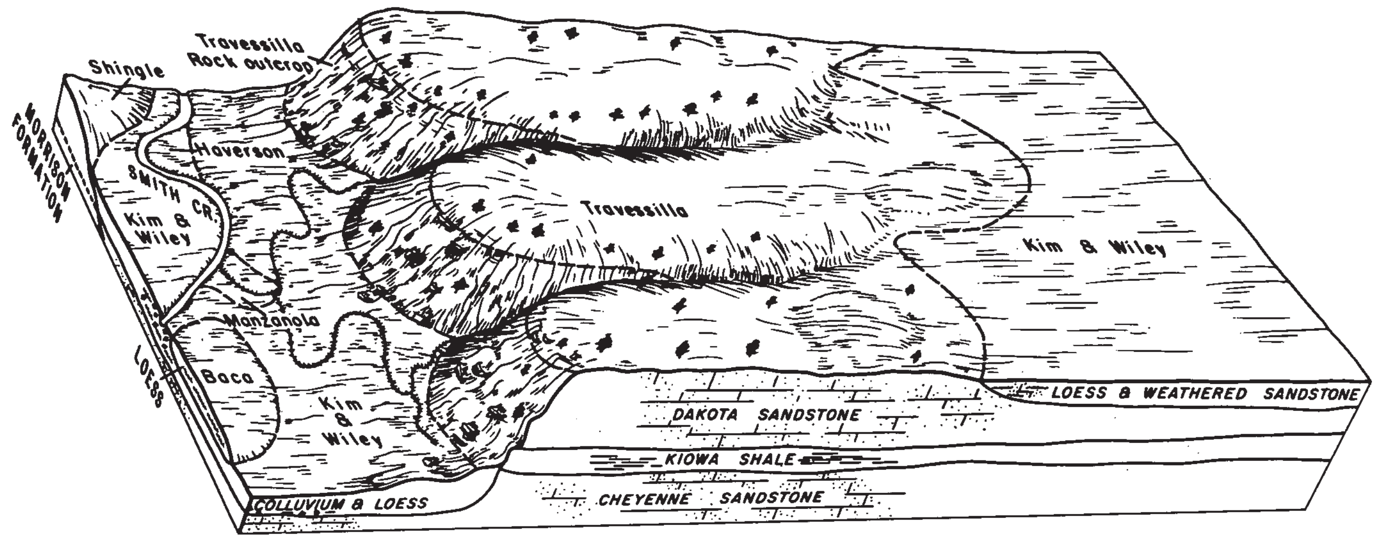


Figure 4 Travessilla-Kim-Wiley soil association.

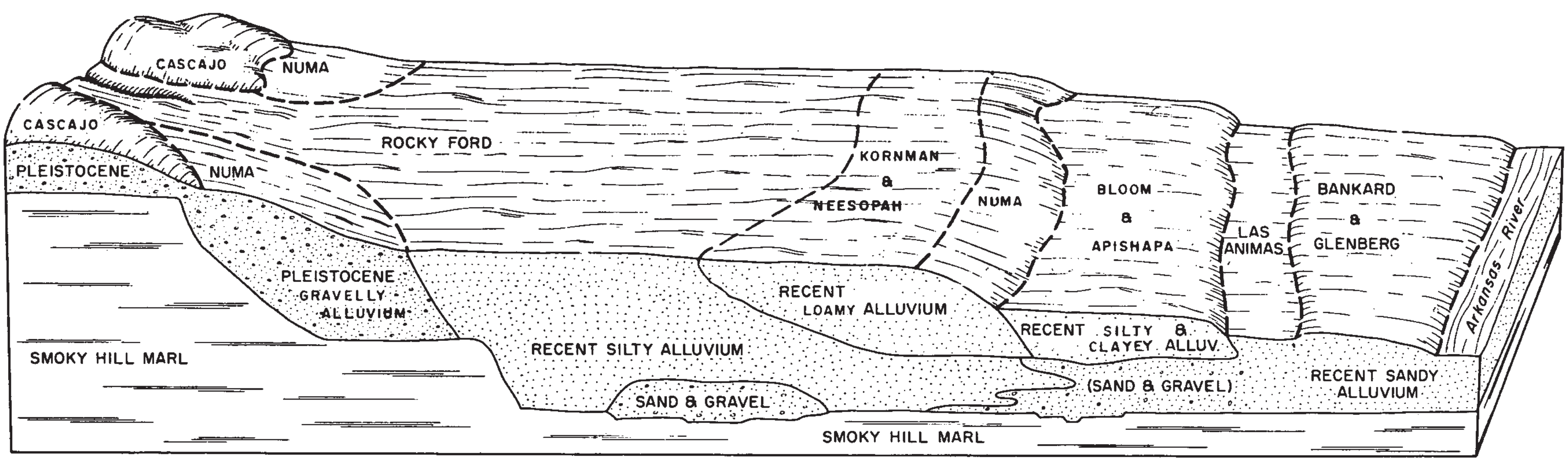


Figure 5 Rocky Ford-Numa-Kornman soil association.

DESCRIPTIONS OF THE SOILS

In this section the soils of Otero County are described in detail. The procedure is to describe first the soil series and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which the unit belongs.

Each soil series description contains a short narrative description of a profile considered representative of the series, and a much more detailed description of the same profile that scientists, engineers, and others can use in making highly technical interpretations. The colors described are for dry soil, unless otherwise noted.

Some of the terms used in the soil descriptions are defined in the Glossary, and some are defined in the section "How This Survey Was Made." The approximate acreage and proportionate extent of each soil mapped are shown in table 1. At the back of this soil survey is the "Guide to Mapping Units," which lists the mapping units in the county and shows the capability unit (irrigated, nonirrigated, or both) and range site each mapping unit is in, and the page where each of these groups is described.

The detailed soil map for this soil survey was made at two scales. A scale of 4 inches to the mile is used for the area along the Arkansas River and a scale of 2 inches to the mile for the rest. Most of the area mapped at 4 inches to the mile consists of nearly level and gently sloping soils that are irrigated.

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	Percent		Acres	Percent
Apishapa loamy sand	641	0.1	Manzanola loam, 0 to 1 percent slopes	41,800	5.1
Apishapa clay	4,327	.5	Manzanola clay loam, 1 to 3 percent slopes	7,779	1.0
Baca loam, 1 to 5 percent slopes	2,393	.3	Manzanola soils, eroded	427	.1
Bankard sand	4,584	.6	Minnequa loam, 1 to 3 percent slopes	154,678	19.1
Bloom loam	1,881	.2	Minnequa silty clay loam, 0 to 1 percent slopes	609	.1
Cadoma clay, 2 to 12 percent slopes	22,396	2.8	Minnequa silty clay loam, 1 to 5 percent slopes	3,857	.5
Cascajo soils and Gravelly land	10,685	1.3	Nepesta clay loam, 0 to 3 percent slopes	4,039	.5
Dwyer loamy sand	12,010	1.5	Numa clay loam, 0 to 1 percent slopes	2,532	.3
Glenberg loamy fine sand, 0 to 1 percent slopes	2,586	.3	Numa clay loam, 1 to 3 percent slopes	8,911	1.1
Glenberg-Bankard sandy loams, 0 to 1 percent slopes	1,378	.2	Numa clay loam, 3 to 5 percent slopes	2,639	.3
Harvey loam, wet, 0 to 3 percent slopes	1,122	.1	Numa loam, gravel subsoil variant, 5 to 9 percent slopes	342	(1/)
Harvey-Stoneham loams, 0 to 3 percent slopes	67,320	8.3	Olney sandy loam, 0 to 3 percent slopes	26,542	3.3
Haverson loam, 0 to 3 percent slopes	9,061	1.1	Olney sandy clay loam, 0 to 1 percent slopes	769	.1
Kim and Wiley loams, 1 to 9 percent slopes	25,430	3.1	Otero sandy loam, 1 to 5 percent slopes	15,301	1.9
Kornman and Neesopah loams, 0 to 1 percent slopes	4,252	.5	Penrose channery loam, 1 to 25 percent slopes	80,565	9.9
Kornman and Neesopah loams, 1 to 3 percent slopes	7,170	.9	Rocky Ford silty clay loam, 0 to 1 percent slopes	19,393	2.4
Kornman and Neesopah loams, 3 to 5 percent slopes	1,218	.2	Rocky Ford silty clay loam, 1 to 3 percent slopes	35,004	4.3
Las Animas soils	2,917	.4	Rocky Ford silty clay loam, wet, 0 to 1 percent slopes	5,546	.7
Limon silty clay loam, 0 to 3 percent slopes	3,579	.4			
Limon silty clay, 0 to 3 percent slopes	12,554	1.5			
Manvel silt loam, 0 to 3 percent slopes	43,231	5.3			

See footnote at end of table.

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	Percent		Acres	Percent
Rocky Ford silty clay loam, wet, 1 to 3 percent slopes---------	1,528	0.2	Travessilla sandy loam, 1 to 9 percent slopes----------------	28,850	3.6
Rocky Ford silty clay loam, limestone substratum, 0 to 1 percent slopes----------------	1,731	.2	Travessilla-Rock outcrop complex-------------------------	16,412	2.0
Rocky Ford silty clay loam, limestone substratum, 1 to 3 percent slopes----------------	5,086	.6	Tyrone silty clay loam, 0 to 3 percent slopes-------------	47,746	5.9
Rocky Ford loam, sand subsoil variant, 0 to 3 percent slopes------------------------	1,635	.2	Vona sandy loam, 1 to 5 percent slopes-----------------------	33,294	4.1
Samsil-Shale outcrop complex----	1,069	.1	Gravel pits, blowouts, lime and cinder dumps, and sewage lagoons----------------------	776	.1
Shingle loam, 1 to 9 percent slopes------------------------	20,430	2.6	Total----------------------	810,880	100.0
Shingle loam, gypsum variant, 1 to 9 percent slopes---------	855	.1	1/ Less than 0.05 percent.		

Apishapa Series

The Apishapa series consists of nearly level, somewhat poorly drained, slightly saline, clayey to sandy soils on low terraces of the Arkansas River and other streams. Apishapa soils are not extensive in the county.

In a typical profile the surface layer, about 12 inches thick, is grayish-brown clay. It is moderately high in content of organic matter. The next layer, about 4 inches thick, is dark grayish-brown clay. Below a depth of about 16 inches is dark-gray clay having olive-brown, dark yellowish-brown, and gray mottles. These mottles are a sign of poor drainage. Beginning at depths of about 55 inches the material is stratified, yellowish-brown and dark grayish-brown, wet sand and loamy sand. In most places, the depth to the water table coincides with the depth to sand.

Apishapa soils are subject to occasional flooding. Drainage ditches are needed in cultivated areas. The subsoil is slowly permeable and poorly aerated. Because of the moderately high organic-matter content, these soils are somewhat easier to work than most clayey soils.

Nearly all the acreage is used for irrigated crops. Salt-tolerent crops grow well, providing good management is used.

Typical profile of Apishapa clay in an irrigated field, 0.4 mile north of the center of sec. 34, T. 22 S., R. 57 W.

Ap1--0 to 7 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; moderate, coarse, crumb structure that parts to moderate, fine, crumb; very hard when dry, firm when moist, sticky when wet; strongly calcareous, pH 7.7; clear, smooth boundary.

Ap2--7 to 12 inches, grayish-brown (10YR 5/2) clay, dark grayish-brown (10YR 4/2) when moist; weak to moderate, coarse, subangular blocky structure; very hard when dry, very firm when moist, sticky and plastic when wet; strongly calcareous, pH 7.7; clear, smooth boundary.

AC--12 to 16 inches, dark grayish-brown (10YR 4/2, moist) clay; weak, coarse, subangular blocky structure; very firm when moist, plastic and sticky when wet; thin continuous clay film on vertical and horizontal ped surfaces; strongly calcareous, pH 7.7; clear, smooth boundary.

C1csg--16 to 32 inches, dark-gray (10YR 4/1, moist) clay; massive; very firm when moist, plastic and very sticky when wet; common, small, distinct, olive-brown (2.5Y 4/4, moist) mottles; thin continuous clay films on ped surfaces; numerous small gypsum crystals; strongly calcareous, pH 7.6; gradual, smooth boundary.

C2csg--32 to 55 inches, dark-gray (2.5Y 4/0, moist) clay; massive; very firm when moist, very plastic and very sticky when wet; many, medium, distinct, dark yellowish-brown (10YR 4/4, moist) and gray (10YR 5/1, moist) mottles; numerous small gypsum crystals; strongly calcareous, pH 8.0; clear, smooth boundary.

IIC3g--55 to 60 inches, dark grayish-brown (2.5Y 4/2, moist) loamy sand; massive; friable when moist; many, medium, distinct, yellowish-brown (10YR 5/6, moist) mottles; strongly calcareous.

The A horizon is typically clay, but ranges from clay to loamy sand. The depth to mottles ranges from about 15 to 30 inches. Depth to the sandy IIC horizon ranges from 42 to 72 inches. The A horizon is only mildly saline. The C horizon becomes more strongly saline with increasing depth. In most areas, the pH does not exceed 8.6.

Apishapa soils are associated with Limon and Las Animas soils and with wet phases of the Rocky Ford soils. The Apishapa soils are most like the Limon soils, but they are not so well drained and they are somewhat darker colored.

Apishapa loamy sand (0 to 1 percent slopes) (Aa).--The profile of this soil differs from that described as typical for the series in having a light brownish-gray loamy sand surface layer about 15 inches thick. The next layer is dark grayish-brown clay loam to clay. Below a depth of about 30 inches is wet sand or clay. This soil is on low terraces of the Arkansas River. Areas are up to 200 acres in size.

The principal inclusion is Glenberg loamy fine sand, 0 to 1 percent.

Rangeland areas have a water table at a depth ranging from a few inches to 3 feet. The vegetation is saltgrass, weeds, and saltcedar. Farmed areas have been drained. The surface layer is droughty and low in fertility. There is a high wind erosion hazard in cultivated areas. (Irrigated capability unit IIIew-4; nonirrigated capability unit VIw-1; Salt Meadow range site)

Apishapa clay (0 to 1 percent slopes) (Ac).--This soil has the profile described as typical for the series. It occurs as areas up to 600 acres in size, mostly on low terraces of the Arkansas River.

The principal inclusions are Rocky Ford silty clay loam, wet, 0 to 1 percent slopes, and Limon silty clay, 0 to 3 percent slopes. Total inclusions account for about 15 percent of each mapped area.

This is a fertile soil. Plant nutrients are not easily lost by leaching or erosion. Because of the clayey texture, the soil readily compacts when tilled. It is poorly aerated below the surface layer and is not well suited to deep-rooted crops or to crops having a low salt tolerance. (Irrigated capability unit IIIs-1; nonirrigated capability unit VIw-1; Salt Meadow range site)

Baca Series

The Baca series consists of deep, well-drained, nearly level to gently sloping soils that developed in light-colored limy silt loam or silty clay loam material. All of these soils are in nonirrigated parts of the county and are not extensive.

In a typical profile the surface layer, about 5 inches thick, is mainly light brownish-gray loam. It is soft when dry and very friable when moist. The subsoil is about 11 inches thick. The upper part is dark-brown clay loam. The lower part is pale-brown silty clay loam. Both of these layers break to vertically elongated pieces about an inch in diameter. The pieces are hard when dry. The upper part is firm when moist, and the lower part is friable when moist. The underlying material is light yellowish-brown silty clay loam grading to clay loam.

Baca soils have a good water-intake rate, moderately slow permeability, a high water-holding capacity, and medium runoff. These are moderately fertile soils that are not readily leached of plant nutrients. The erosion hazard is slight if these soils are used as range.

The entire acreage in Otero County is used as range. The principal grasses are blue grama and galleta.

Typical profile of Baca loam, 1 to 5 percent slopes, in an area of native range, 0.2 mile north and 0.05 mile east of the southwest corner of sec. 18, T. 22 S., R. 55 W.

A11--0 to 3 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, thin, platy structure that parts to weak, very fine, crumb; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A12--3 to 5 inches, grayish-brown (10YR 5/2) silt loam, dark brown (10YR 4/3) when moist; weak, medium, platy structure; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B2t--5 to 10 inches, dark-brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard when dry, firm when moist; thin clay films on surface of soil aggregates; noncalcareous; clear, smooth boundary.

B3ca--10 to 16 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; moderate, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard when dry, friable when moist; thin patchy clay films on vertical faces of soil peds; strongly calcareous; gradual, smooth boundary.

C1ca--16 to 32 inches, light yellowish-brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; soft medium concretions of segregated lime; strongly calcareous; gradual, smooth boundary.

C2--32 to 60 inches, light yellowish-brown (10YR 6/4) gritty clay loam, yellowish brown (10YR 5/6) when moist; massive; slightly hard when dry, friable when moist; strongly calcareous.

The A horizon ranges from 4 to 7 inches in thickness, and the B2 horizon from 3 to 10 inches. Soils that have the thickest B horizon are mostly in the southeastern part of the county. There are no restrictive layers in the C horizon.

Baca soils are associated with Stoneham, Olney, Kim, and Wiley soils. They are most like the Wiley soils, but differ in being slightly finer textured, darker colored, and lime free in the upper part of the subsoil. They have a thicker subsoil than Stoneham soils. Baca soils differ from Olney soils in having a clay loam subsoil weathered from eolian silt, whereas Olney soils have a sandy clay loam subsoil weathered from eolian sand and silt.

Baca loam, 1 to 5 percent slopes (BcB).--This soil has the profile described as typical for the series. It occurs in the northeastern and southeastern parts of the county. Areas are up to 800 acres in size. In most areas slopes are less than 3 percent.

The principal inclusions are Kim and Wiley loams, 1 to 9 percent slopes. They make up about 10 percent of each mapped area.

This soil has few limitations if used as range. The range can be kept in good condition by reducing runoff, so that water enters the soil and is available to plant roots. (Nonirrigated capability unit VIe-1; Loamy Plains range site)

Bankard Series

Soils of the Bankard series are sandy, excessively drained, droughty, and easily eroded. They occur on low terraces of the Arkansas River and other streams. Occasionally they are covered with floodwater. They are not extensive.

In a typical profile the upper 14 inches is pale-brown loose sand but ranges to silty clay loam. Below a depth of about 14 inches is stratified sand and gravel.

Bankard soils are low in fertility and have a very low water-holding capacity. Water infiltrates rapidly. The erosion hazard is severe.

The entire acreage is in grass. Good management is needed. The native vegetation is sand dropseed, saltgrass, forbs, weeds, saltcedar, and cottonwoods.

Typical profile of Bankard sand on a low terrace of the Purgatoire River, 0.23 mile east of the center of sec. 26, T. 26 S., R. 54 W.

A1--0 to 4 inches, pale-brown (10YR 6/3) sand, dark grayish brown (10YR 4/2) when moist; weak, fine, crumb structure; soft when dry, very friable when moist; strongly calcareous; abrupt, wavy boundary.

C1--4 to 14 inches, pale-brown (10YR 6/3) sand, brown, (10YR 5/3) when moist; single grain; loose when dry or moist; strongly calcareous; gradual, wavy boundary.

C2--14 to 60 inches, stratified sand and gravel; estimated less than 50 percent gravel.

The A horizon ranges from sand to silty clay loam in texture and from 2 to 6 inches in thickness. The C horizon ranges from sand to gravelly sand in texture.

Bankard soils are associated with Glenberg and Las Animas soils. They are most like the Glenberg soils but are sandier.

Bankard sand (0 to 3 percent slopes) (Bk).--This soil has the profile described as typical for the series. It occurs as areas up to 80 acres in size.

Inclusions of Glenberg loamy fine sand, 0 to 1 percent slopes, make up as much as 15 percent of each mapped area.

This soil has a low water-holding capacity and low fertility. Wind erosion is a severe hazard. Stream overflows deposit sand and silt or cut channels. After flooding, weeds become the most abundant plants in many places. The vegetation on this soil varies so much from place to place that it cannot be classified as a range site. (Irrigated capability unit IVs-8; nonirrigated capability unit VIe-6)

Bloom Series

The Bloom series consists of nearly level, poorly drained silty clay loams that are on broad drainageways or low stream terraces. These soils are not extensive in the county.

In a typical profile the surface layer, about 4 inches thick, is gray loam. The transitional layer, about 5 inches thick, is light brownish-gray mottled loam that is friable when moist. This layer also contains seams of fine crystalline soluble salts. The substratum to a depth of about 4 feet is pale-brown silty clay loam with gray and yellowish-brown mottles. Below a depth of about 47 inches is yellowish-brown silt loam with gray mottles.

Bloom soils are wet because of the waste and seep water from irrigation canals. They are difficult to drain because of their low position. There is little erosion hazard.

All of the acreage is used as range. The principal grasses are alkali sacaton and saltgrass.

Typical profile of Bloom loam in a salt-meadow range, 0.15 mile south and 50 feet west of the northeast corner of sec. 18, T. 23 S., R. 57 W.

01--1 inch to 0, gray (10YR 6/1) loam, very dark gray (N 3/0) when moist; decomposed organic matter and silt; calcareous; clear, smooth boundary.

A1--0 to 4 inches, gray (10YR 6/1) loam, dark gray (10YR 4/1) when moist; weak, medium to fine, crumb structure; hard when dry, very friable when moist; common, fine, gray (10YR 5/1) mottles; strongly calcareous; clear, smooth boundary.

AC--4 to 9 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, thick, platy structure that parts to weak, fine, subangular blocky; hard when dry, very friable when moist; common, large, faint, pale-brown (10YR 6/3) mottles when dry and common, medium, faint, gray (10YR 5/1) mottles when moist; small nests of fine gypsum crystals common; strongly calcareous; clear, smooth boundary.

C1g--9 to 18 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; very hard when dry, very friable when moist; common, medium, distinct, gray (10YR 5/1, moist) and yellowish-brown (10YR 5/6) mottles; many small nests of fine gypsum crystals and salt threads; roots common to depth of 18 inches; strongly calcareous; clear, smooth boundary.

C2g--18 to 47 inches, pale-brown (10YR 6/3) silty clay loam, yellowish brown (10YR 5/4) when moist; massive; hard when dry, very friable when moist; common, large, distinct, gray (10YR 5/1) mottles; few small nests of gypsum crystals; strongly calcareous; gradual, smooth boundary.

C3g--47 to 60 inches, yellowish-brown (10YR 5/4, moist) silt loam; massive; very friable when moist; common, large, distinct, gray (10YR 5/1) mottles; strongly calcareous.

The texture of the various horizons ranges from loam to silty clay loam. The depth to water table ranges from a few inches to about 3 feet.

Bloom soils are associated with Las Animas soils and with wet phases of Rocky Ford soils. Bloom soils are not so sandy in the C horizon as the poorly drained Las Animas soils, and they are less well drained than Rocky Ford soils.

Bloom loam (0 to 1 percent slopes) (Bm).--This soil has the profile described as typical for the series. Its areas are elongated and up to 200 acres in size. In places there are marshy spots.

The principal inclusions are Rocky Ford silty clay loam, wet, 0 to 1 percent slopes, and Las Animas soils. Total inclusions account for a minor percentage of each mapped area.

This soil, in some seasons, is so wet that grass cannot be grazed by livestock. Field drainage ditches are needed, but some areas lie so low in relation to streams that drainage outlets are not possible. The salt grasses that grow on this soil are most palatable in spring. At this season the soil is likely to be the wettest. (Irrigated capability unit IIIw-1; nonirrigated capability unit VIw-1; Salt Meadow range site)

Cadoma Series

The Cadoma series consists of well-drained, clayey, mainly sloping soils that formed in material weathered from alkaline shale. Areas of this soil are in the southern part of the county on nonirrigated uplands.

In a typical profile the surface layer, about 3 inches thick, is grayish-brown clay that is sticky when wet. The subsoil is about 10 inches thick, and most of it is light brownish-gray silty clay. When the subsoil is dry it is extremely hard; when moist, it swells to a dense, slowly permeable mass. The light brownish-gray, gypsiferous silty clay substratum, about 7 inches thick, has weathered from olive-brown alkaline shale that underlies these soils at a depth ranging from 20 to 40 inches.

Cadoma soils have a slow intake rate, rapid surface runoff, and slow permeability. There is a high water erosion hazard.

The entire acreage is used as range. Alkali sacaton, galleta, and blue grama are the principal grasses.

Typical profile of Cadoma clay, 2 to 12 percent slopes, in an area of range, near the center of sec. 13, T. 24 S., R. 54 W.

A--0 to 3 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; moderate, thin, platy structure; hard when dry, friable when moist, sticky when wet; strongly calcareous, pH 8.6; clear, smooth boundary.

B1--3 to 7 inches, dark grayish-brown (2.5Y 4/2) clay, olive brown (2.5Y 4/3) when moist; weak to moderate, medium to fine, subangular blocky structure; extremely hard when dry, firm when moist; continuous clay film on vertical ped surfaces; strongly calcareous, pH 9.0; clear, smooth boundary.

B2--7 to 13 inches, light brownish-gray (10YR 6/2) silty clay, light olive brown (2.5Y 5/4) when moist; weak to moderate, medium and coarse, subangular blocky structure; extremely hard when dry, firm when moist; thin continuous clay film on ped surfaces; small lenses of crystalline gypsum; strongly calcareous, pH 9.6; clear, smooth boundary.

Ccs--13 to 20 inches, light brownish-gray (10YR 6/2) silty clay, light olive brown (2.5Y 5/4) when moist; weak, coarse, subangular blocky structure; extremely hard when dry, firm when moist; thin patchy clay films on ped surfaces; shale fragments and crystalline gypsum scattered throughout the horizon; strongly calcareous, pH 8.8; clear, smooth boundary.

R--20 to 60 inches, olive-brown (2.5Y 4/4) platy shale.

The depth to shale ranges from 20 to 40 inches and is generally shallowest on the steeper slopes.

Cadoma soils are associated with Samsil, Shingle, Penrose, Minnequa, Manzanola, and Tyrone soils. They are most like Samsil and Shingle soils. They differ from them in being deeper to shale. They are more clayey than Shingle soils.

Cadoma clay, 2 to 12 percent slopes (CaD).--This soil has the profile described as typical for the series. Areas of this soil are up to 300 acres in size.

The principal inclusions are Shingle loam, 1 to 9 percent slopes, and the Samsil-Shale outcrop complex.

Water intake is slow and runoff is high. The water erosion hazard is high. Areas of this soil that occupy gentle slopes at the base of limestone escarpments receive additional runoff.

This alkaline soil grows mostly alkali sacaton, a grass with a bunchy growth habit. There is a relatively high proportion of bare surface area between grass clumps. Maintaining a good grass cover will help reduce sheet and gully erosion and improve water intake. (Nonirrigated capability unit VIe-2; Alkaline Plains range site)

Cascajo Series

The Cascajo series consists of sloping to hilly, excessively drained, gravelly soils. For the most part, Cascajo soils are on gravelly escarpments bordering the valley of the Arkansas River.

In a typical profile the surface layer, about 6 inches thick, is gravelly loam. In the upper part it is light brownish gray and has a loose consistence when dry. In the lower part it is dark brown and has a soft consistence when dry. The next layer, about 15 inches thick, is very pale-brown cobbly, very gravelly loam. It is rich in lime and has a thick lime coating on the bottom surface of pebbles and cobbles. Underlying the above horizon is stratified sand and gravel. From about 36 to 45 inches is brownish-yellow silty clay that is very strongly calcareous and contains many lime concretions. In places, these soils are underlain by pale-yellow soft shale at varying depths.

Because of the steep slope of these soils, surface runoff is rapid. These soils are rapidly permeable, have a low water-holding capacity, and are subject to a moderate water erosion hazard.

Most of the acreage is part of areas used as range. The native vegetation is made up of blue grama, galleta, side-oats grama, yucca, snakeweed, and cholla cactus. These soils are a good source of commercial gravel.

Typical profile of Cascajo soil in an area of range and gravel pits, 530 feet west and 500 feet south of the northeast corner of sec. 26, T. 23 S., R. 57 W.

A11--0 to 3 inches, light brownish-gray (10YR 6/2), gravelly loam, dark grayish brown (10YR 4/2) when moist; weak, thin, platy structure that parts to weak, very fine, crumb; loose when dry, very friable when moist; roots common; noncalcareous; abrupt, smooth boundary.

A12--3 to 6 inches, dark-brown (10YR 4/3) gravelly loam, dark brown (10YR 3/3) when moist; moderate, very fine, crumb structure; soft when dry, very friable when moist; roots common; noncalcareous; clear, smooth boundary.

C1ca--6 to 21 inches, very pale brown (10YR 7/3) cobbly, very gravelly loam, light yellowish brown (10YR 6/4) when moist; structureless; hard when dry, very friable when moist; roots common; thick lime coating on bottom of pebbles and cobbles; strongly calcareous; clear, wavy boundary.

C2--21 to 36 inches, banded calcareous sands and gravel; clear, wavy boundary.

IIC3--36 to 45 inches, brownish-yellow (10YR 6/6) silty clay, yellowish brown (10YR 5/6) when moist; structureless; hard when dry, firm when moist; many, coarse, prominent lime concretions; very strongly calcareous; gradual, smooth boundary.

R--45 to 60 inches, pale-yellow (2.5Y 7/4) shale, pale olive (2.5Y 6/4) when moist; medium and coarse, platy Smoky Hill marl; very strongly calcareous.

Depth to underlying shale ranges from 1 to several feet. In places the sand and gravel layer contains lenses of pale-brown silty clay that is up to 18 inches thick or seams of crystalline gypsum that are 1 to 5 inches thick.

Cascajo soils are associated with Harvey and Otero soils. They differ from them in being more sloping and gravelly.

Cascajo soils and Gravelly land (2 to 25 percent slopes) (Cg).--This mapping unit occurs mainly on ridges and short, steep slopes bordering the irrigated valley land along the Arkansas River. Most of the acreage occurs in elongated areas up to about 60 rods wide and 200 acres in size. About 75 percent of each area has a profile similar to that described as typical for the Cascajo series. About 25 percent is disturbed areas, gravel pits, or eroded side slopes of V-shaped drainages.

The principal inclusions are Harvey-Stoneham loams, 0 to 3 percent slopes, and Otero sandy loam, 1 to 5 percent slopes. Total inclusions account for about 10 percent of each mapped area.

This mapping unit is used for range and as a source of commercial gravel, but it does not make a productive range site because of the droughtiness of the soils. Most areas are too small to fence off from other range. The soils are suited for uses such as hay and feedlots or building sites, and as potential habitat for upland game birds and rabbits. (Nonirrigated capability unit VIIs-2; Gravel Breaks range site)

Dwyer Series

The Dwyer series consists of deep, undulating, excessively drained, sandy soils of the uplands. They are mostly in the west-central nonirrigated part of the county and are moderately extensive.

In a typical profile the surface layer, about 11 inches thick, is pale-brown to brown loamy sand. It has a loose consistence when dry or moist. The transitional layer, about 7 inches thick, is brown loamy sand, slightly hard when dry and friable when moist. It, like the surface layer, is free of lime. The substratum below a depth of about 18 inches is limy, light yellowish-brown or very pale brown loamy sand. From 18 to 25 inches the substratum has a loose consistence when dry or moist. Below a depth of 25 inches, it is slightly hard when dry and very friable when moist.

Because of the rapid intake rate and rapid permeability of Dwyer soils there is almost no surface runoff. These soils have low water-holding capacity, and the hazard of wind erosion is high where grasses are overgrazed.

All of the acreage is used as range. The native grasses are mainly sand bluestem, blue grama, galleta, Indian ricegrass, and side-oats grama.

Typical profile of Dwyer loamy sand in an area of range, 0.15 mile south and 0.04 mile east of the northwest corner of sec. 15, T. 25 S., R. 59 W.

A11-0 to 4 inches, pale-brown (10YR 6/3) loamy sand, dark grayish brown (10YR 4/2) when moist; weak, coarse, crumb structure that parts to single grain; loose when dry or moist; noncalcareous; clear, smooth boundary.

A12--4 to 11 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) when moist; weak, coarse, crumb structure that parts to single grain; loose when dry or moist; noncalcareous; clear, wavy boundary.

AC--11 to 18 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; noncalcareous; clear, wavy boundary.

C1--18 to 25 inches, light yellowish-brown (10YR 6/4) loamy sand, brown (10YR 4/3) when moist; single grain; loose when dry or moist; strongly calcareous; clear, wavy boundary.

C2ca--25 to 42 inches, very pale brown (10YR 7/4) loamy sand, yellowish brown (10YR 5/4) when moist; single grain; slightly hard when dry, very friable when moist; very strongly calcareous; clear, smooth boundary.

C3--42 to 60 inches, very pale brown (10YR 7/4) loamy sand, yellowish brown (10YR 5/4) when moist; massive; slightly hard when dry, very friable when moist; very strongly calcareous.

The thickness of the A horizon ranges from 5 to 12 inches. The texture of the C horizon ranges from loamy sand to sand. In some places these soils are calcareous at the surface, but in most places they are leached to a depth of 12 to 20 inches.

Dwyer soils are associated with Vona and Otero soils. They are more sandy than those soils.

Dwyer loamy sand (1 to 9 percent slopes) (Dw).--This soil has the profile described as typical for the series. Most areas of it lie just east of the Apishapa River in the west-central part of the county. Some areas are as much as 1,000 acres in size.

The principal inclusion is Vona sandy loam, 1 to 5 percent slopes.

This soil is so porous that all of the rainwater enters it. It has no drainage pattern and is subject to little hazard of water erosion, but the hazard of wind erosion is severe. Blowouts can develop around stock-watering places, on vehicle or stock trails, or in areas severely overgrazed.

All of the acreage is used as range. The major management problem is to keep the range in good enough condition that it will not be invaded by weeds or excessive amounts of sagebrush. These plants sap the moisture needed by the deep-rooted, native, mid-tall grasses. (Nonirrigated capability unit VIe-5; Deep Sands range site)

Glenberg Series

The Glenberg series consists of somewhat excessively drained, nearly level sandy loams or loamy sands on low terraces of rivers and creeks. These soils are occasionally flooded.

In a typical profile the surface layer, about 6 inches thick, is light brownish-gray, loose loamy fine sand. The upper 30 inches of the substratum is pale-brown or light brownish-gray stratified loamy fine sand and fine sandy loam. It is loose or slightly hard when dry and very friable when moist. The underlying material is pale-brown sand. The depth to the underlying sand ranges from about 15 to 50 inches.

These soils have a rapid intake rate, little surface runoff, and moderately rapid permeability. They are moderate to low in fertility and easily leached of plant nutrients. Wind erosion is a hazared if these soils are cultivated.

Most of the acreage is used as range. The native vegetation is mainly western wheatgrass, sand dropseed, inland saltgrass, cottonwood trees, tamarisk, and weeds.

Typical profile of Glenberg loamy fine sand, 0 to 1 percent slopes, in an area of river-bottom range, 0.15 mile north and 0.10 mile east of the center of sec. 28, T. 22 S., R. 57 W.

A1--0 to 6 inches, light brownish-gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak to moderate, medium, platy structure; loose when dry, very friable when moist; roots abundant; strongly calcareous; clear, smooth boundary.

C1--6 to 14 inches, pale-brown (10YR 6/3) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, thick, platy structure that parts to weak, medium, subangular blocky; loose when dry, very friable when moist; roots common; common, medium, faint, yellowish-brown (10YR 5/4) mottles; strongly calcareous; clear, wavy boundary.

C2--14 to 28 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; very weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; roots common to depth of 20 inches; strongly calcareous; abrupt, smooth boundary.

C3--28 to 36 inches, light brownish-gray (10YR 6/2) fine sandy loam; dark grayish brown (10YR 4/2) when moist; structureless; slightly hard when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

C4--36 to 60 inches, pale-brown (10YR 6/3) sand; dark grayish brown (10YR 4/2) when moist; structureless; loose when dry or moist; strongly calcareous.

The A horizon ranges from about 4 to 12 inches in thickness and from loamy sand to sandy loam in texture. In places the C horizon contains strata of grayish-brown silty clay loam up to 2 inches thick.

Glenberg soils are associated with Bankard, Las Animas, and Rocky Ford soils. They are not so sandy as the Bankard soils or the poorly drained Las

Animas soils, but they are more sandy than Rocky Ford soils.

Glenberg loamy fine sand, 0 to 1 percent slopes (GbA).--This soil has the profile described as typical for the series. Areas of it range from about 10 to 200 acres in size.

The surface layer of this soil is droughty, but the sandy material below a depth of about 30 inches is usually moist. Water is available for deep-rooted plants such as alfalfa.

Presently this soil is not very productive of range forage because of drought and a high proportion of cottonwoods, brush, and weeds. It can be more productive if leveled, cleared, and converted to nonirrigated or irrigated pasture. All locally adapted crops can be grown if there is adequate water and if erosion is controlled. Where irrigated, this soil requires frequent light irrigation. (Irrigated capability unit IIIe-9; nonirrigated capability unit VIe-6; Sandy Bottomland range site)

Glenberg-Bankard sandy loams, 0 to 1 percent slopes (GkA).--This complex is located on low river terraces in areas up to 80 acres in size. About 75 percent of each area is Glenberg sandy loam, and 25 percent is Bankard sandy loam.

The Glenberg soil in this complex has a profile similar to that described for the series, but the surface layer is sandy loam. The Bankard soil has a profile similar to that described for the Bankard series but has a surface layer of sandy loam 2 to 6 inches thick.

The soils in this complex are droughty and low in fertility. In places they are occasionally flooded.

The native vegetation, made up of sand dropseed, blue grama, cottonwoods, and tamarisk, is not productive, because of the droughtiness. When farmed, these soils have a high wind erosion hazard and require frequent irrigation. (Irrigated capability unit IVs-7; nonirrigated capability unit VIe-6; Sandy Bottomland range site)

Harvey Series

The Harvey series consists of deep, well-drained, gently sloping loams on the uplands. They are extensive soils in the nonirrigated part of the county but are of minor extent in the irrigated part.

In a typical profile the surface layer, about 5 inches thick, is grayish-brown loam that is soft when dry and friable when moist. The loam subsoil, about 11 inches thick, is brown in the upper part and pale brown in the lower part. It is hard when dry but very friable when moist. The material below a depth of about 16 inches is very pale brown loam that grades to sandy loam. This layer contains an abundance of lime in the form of soft white nodules and streaks in the soil material and as coatings on the surface of pebbles.

Harvey soils have a moderate intake rate, and surface runoff is moderate to slow. Permeability is moderate. Under native grass, the erosion hazard is slight, but overuse of the range increases the rate of runoff and the rate of sheet erosion.

This acreage is used almost entirely as range. The native vegetation is mainly blue grama, galleta, and buffalograss. A few areas lie within the irrigated area and are seeped. Here, sacaton and salt grasses are dominant.

Typical profile of Harvey loam in an area of native range, 0.4 mile north and 150 feet west of the southeast corner of sec. 36, T. 23 S., R. 57 W.

A1--0 to 5 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, platy structure that parts to weak, medium, crumb; soft when dry, friable when moist; noncalcareous; abrupt, smooth boundary.

B2--5 to 8 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; moderate, coarse, subangular blocky structure; hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B3--8 to 16 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; hard when dry, very friable when moist; strongly calcareous; clear, wavy boundary.

C1ca--16 to 30 inches, very pale brown (10YR 7/4) loam, light yellowish brown (10YR 6/4) when moist; massive; very hard when dry, very friable when moist; soft lime nodules and mycelia, and lime-coated pebbles; strongly calcareous; gradual, wavy boundary.

C2ca--30 to 40 inches, very pale brown (10YR 7/4) sandy loam, light yellowish brown (10YR 6/4) when moist; massive; very hard when dry, very friable when moist; soft lime nodules and mycelia, and lime-coated pebbles; strongly calcareous; gradual, wavy boundary.

C3ca--40 to 50 inches, very pale brown (10YR 7/4) loamy sand, light yellowish brown (10YR 6/4) when moist; massive; loose when dry or moist; strongly calcareous; clear, wavy boundary.

C4ca--50 to 60 inches, very pale brown (10YR 8/3) sandy loam, light yellowish brown (10YR 6/4) when moist; massive; slightly hard when dry, very friable when moist; strongly calcareous.

The texture of the A horizon ranges from sandy loam to loam. The depth to the Cca horizon ranges from about 10 to 20 inches.

Harvey soils are associated with Cascajo, Olney, and Stoneham soils. They differ from Cascajo soils in being medium textured rather than coarse textured. Harvey soils developed from parent materials similar to the parent materials of Stoneham and Olney soils, but Harvey soils do not have so well-developed a subsoil or B2t horizon as the Stoneham and Olney soils.

Harvey loam, wet, 0 to 3 percent slopes (HaB).--This soil has a profile similar to that described as typical for the series, except salts are visible on the surface. It is in the irrigated section of the county in areas up to 200 acres in size.

This soil is seasonally wet because of seep from irrigation canals or irrigation waste water. When the seep water evaporates it leaves in places a white, thin, patchy crust of salts on the surface.

Most of the acreage is used as range. The native grasses are inland saltgrass and alkali sacaton. Some areas have been farmed from time to time, but are not productive, because of the salinity. This soil is well suited to irrigated or nonirrigated pasture. (Irrigated capability unit IIew-1; nonirrigated capability unit VIw-1; Salt Meadow range site)

Harvey-Stoneham loams, 0 to 3 percent slopes (HsB).--This complex is on uplands, mostly in the northern half of the county in areas up to 1,200 acres in size. About 75 percent of each area is Harvey loam, wet, and about 25 percent is Stoneham loam.

The Harvey soil in this soil complex has the profile similar to that described as typical for the series. The Stoneham soil has the profile described as typical for the Stoneham series.

The principal inclusions are Olney sandy loam, 0 to 3 percent slopes, and Manvel silt loam, 0 to 3 percent slopes. Total inclusions account for about 20 percent of each mapped area.

This is a good soil for range. The porous surface layer takes water well, and there is high water-holding capacity in the subsoil. There is a high hazard of sheet erosion in overgrazed areas. Stock-water pits in this soil may need sealing. (Nonirrigated capability unit VIe-1; Loamy Plains range site)

Haverson Series

The Haverson series consists of deep, well-drained, nearly level loams on stream terraces in the nonirrigated part of the county.

In a typical profile the surface layer, about 6 inches thick, is pale-brown loam. It is soft when dry and very friable when moist. Below the surface layer and extending to a depth of 60 inches is stratified pale-brown loam and silt loam and light brownish-gray silt loam. The substratum is slightly hard to very hard when dry but is very friable when moist. It is easily penetrated by plant roots, air, and water.

Haverson soils have a moderate to moderately slow intake rate, medium surface runoff, moderate to moderately slow permeability, and high water-holding capacity. In places the soils are slightly saline. There is a moderate erosion hazard in the form of gullying and streambank cutting. These soils receive runoff from bordering uplands, and there is a possibility of flooding when the streams overflow.

The entire acreage is used as range. The native vegetation consists of blue grama, galleta, sand dropseed, cholla cactus, and four-wing saltbush.

Typical profile of Haverson loam, 0 to 3 percent slopes, on a stream terrace of Timpas Creek in the southwest quarter of sec. 22, T. 27 S., R. 59 W.

A1--0 to 6 inches, pale-brown (10YR 6/3) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, platy structure that parts to weak, very fine, crumb; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

C1--6 to 11 inches, pale-brown (10YR 6/3) loam, dark grayish brown (10YR 4/2) when moist; very weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C2--11 to 24 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; very weak, coarse, subangular blocky structure; hard when dry, very friable when moist; numerous fine pores; numerous small worm casts; strongly calcareous; clear, smooth boundary.

C3--24 to 42 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; weak to moderate, medium, subangular blocky structure; very hard when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C4--42 to 60 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; massive; hard when dry, very friable when moist; strongly calcareous.

The A horizon ranges from 4 to 10 inches in thickness and from silty clay loam to loam in texture. The stratification of the C horizon is weak, but commonly contains very thin lenses of fine sandy loam between the dominant silt loam and loam strata.

Haverson soils are associated with Manzanola and Limon soils. They are not so fine textured as Limon soils. They do not have a B horizon, whereas the Manzanola soils have a thick well-developed one.

Haverson loam, 0 to 3 percent slopes (HvB).--This soil has the profile described as typical for the series. Most areas of this soil occur as narrow elongated areas along intermittent streams in the range part of the county.

The principal inclusion is Limon silty clay, 0 to 3 percent slopes, which accounts for about 20 percent of each mapped area.

This soil is relatively productive of range forage because of the supplemental water it receives from runoff. The surface is usually too rough to be good for hay cutting. Erosion control structures are needed in places to control gullying. (Nonirrigated capability unit VIe-4; Saline Overflow range site)

Kim Series

The Kim series consists of well-drained, gently sloping to sloping, loamy upland soils that developed from material weathered from sandstone. In most places they are on fans and slopes below sandstone bluffs. They are extensive soils in the nonirrigated southern part of the county.

In a typical profile the surface layer, about 4 inches thick, is light brownish-gray loam that is soft when dry and very friable when moist. The underlying material to a depth of 31 inches is pale-brown or very pale brown loam. The material below a depth of about 31 inches is very pale brown sandy loam. In places it contains thin seams of crystalline gypsum and numerous small sandstone fragments.

The soils of this series have a moderate intake rate and moderate permeability. Surface runoff is medium. The wind erosion hazard is slight. In places there is deep gullying from water erosion.

The entire acreage is used as range. The main grasses are blue grama and galleta. Cholla and pricklypear cactus are thick in places.

The Kim soils in Otero County are mapped only in an undifferentiated group with Wiley soils.

Typical profile of Kim loam in an area of range, at the southeast corner of sec. 25, T. 27 S., R. 54 W.

A--0 to 4 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, thin, platy structure that parts to weak, fine, crumb; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

AC--4 to 11 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C1--11 to 16 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3) when moist; weak, medium, prismatic structure; slightly hard when dry, very friable when moist; strongly calcareous; clear, wavy boundary.

C2--16 to 31 inches, very pale brown (10YR 7/4) loam, yellowish brown (10YR 5/4) when moist; weak, coarse, prismatic structure; slightly hard when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

C3--31 to 60 inches, very pale brown (10YR 7/4) sandy loam, light yellowish brown (10YR 6/4) when moist; massive; slightly hard when dry, very friable when moist; an abundance of fine crystalline gypsum and numerous small sandstone fragments; strongly calcareous.

The texture of the various horizons ranges from silt loam to fine sandy loam. Sandstone rock underlies these soils at a depth ranging from 40 inches to many feet.

Kim soils are associated with Wiley and Travessilla soils. They are somewhat like the Wiley soils but they lack a B horizon and are less silty.

Kim and Wiley loams, 1 to 9 percent slopes (KmC).--This undifferentiated group is located on nearly level to sloping areas of the nonirrigated uplands in the vicinity of sandstone outcrops and canyons. Areas are up to 1,000 acres in size. Kim soils are on fans and slopes below sandstone bluffs, and Wiley soils are mostly on ridges above the bluffs. About 60 percent of each area is Kim loam, and about 40 percent is Wiley loam. There are small inclusions of Harvey-Stoneham loams, 0 to 3 percent slopes, and Travessilla-Rock outcrop complex.

The Kim soil in this unit has the profile described as typical for the series. The Wiley soil in this unit has the profile described as typical for the Wiley series.

These soils have a high water-holding capacity and a moderate intake rate. The wind erosion hazard is slight to moderate when these soils are in native vegetation.

All of the acreage is used as range. The principal vegetation is blue grama, galleta, sand dropseed, muhly, alkali sacaton, western wheatgrass, and cholla and pricklypear cactus. The main management problems are maintaining good range condition and reducing erosion. (Nonirrigated capability unit VIe-; Loamy Plains range site)

Kornman Series

The Kornman series consists of deep, well-drained soils that have a thick loamy surface layer over sandy loam. They are extensive soils in the irrigated part of the county.

In a typical profile the highly fertile surface layer, about 13 inches thick, is grayish-brown loam that becomes thick and dark from use of muddy irrigation water. It is hard and cloddy when dry but friable when moist. The upper 7 inches of the substratum is brown limy sandy loam that is hard when dry but very friable when moist. The material between depths of 20 and 56 inches is pale-brown stratified loamy sand and sandy loam. It has a soft or loose consistence when dry and is easily penetrated by plant roots. Below a depth of 56 inches is yellowish-brown clay loam that is firm when moist and contains a few lime concretions.

The surface layer has a medium to moderately slow intake rate and moderate water-holding capacity. It is highly fertile. The substratum, low in fertility, has moderately rapid permeability and low water-holding capacity. There is a moderate water erosion hazard on slopes of more than about 1 percent.

Kornman soils are well suited to all locally adapted crops. These soils require more frequent irrigation than soils that have a finer textured layer below the surface layer.

Kornman soils in Otero County are mapped only in three undifferentiated soil groups with Neesopah soils.

Typical profile of Kornman loam in an irrigated field, 0.28 mile east and 0.08 mile south of the center of sec. 22, T. 23 S., R. 56 W.

Ap--0 to 7 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that parts to weak, fine, crumb; hard when dry, friable when moist; strongly calcareous, pH 7.7; clear, smooth boundary.

Ap2--7 to 13 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that parts to moderate, medium, angular blocky;

hard when dry, friable when moist; strongly calcareous, pH 7.6; clear, smooth boundary.

C1--13 to 20 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; hard when dry, very friable when moist, pebbles common up to 5 millimeters in diameter; strongly calcareous, pH 7.8; clear, smooth boundary.

C2--20 to 46 inches, pale-brown (10YR 6/3) loamy sand, brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; soft when dry, very friable when moist; few pebbles up to 2 inches in diameter; strongly calcareous, pH 7.8; clear, gradual boundary.

C3--46 to 56 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; very friable when moist; strongly calcareous; clear, wavy boundary.

IIC4--56 to 60 inches, yellowish-brown (10YR 5/4, moist) clay loam; massive; firm when moist; few medium lime concretions; strongly calcareous.

The A horizon ranges from 10 to 20 inches in thickness and from light clay loam to loam in texture. The stratified C horizon is sandy loam, but in places it contains thin strata that range from clay loam to sand.

Kornman soils are associated with Rocky Ford, Neesopah, and Numa soils. They are most like the Neesopah soils except that they are calcareous throughout the profile and do not have a B horizon.

Kornman and Neesopah loams, 0 to 1 percent slopes (KnA).--Areas of this undifferentiated group are located in the irrigated part of the county, mostly south of the Arkansas River and along U.S. Highway 50. Areas of it range from about 40 to 480 acres in size. The soils of this unit have a loam surface layer about 18 inches thick. Below this to a depth of about 48 inches is pale-brown sandy loam grading to loamy sand.

The principal inclusion is Rocky Ford silty clay loam, 0 to 1 percent slopes, which accounts for about 15 percent of each mapped area.

These soils have high fertility, are moderately permeable, and have a moderate water-holding capacity.

The acreage of this unit is well suited to all locally adapted crops. The only management problems are in maintaining good tilth and getting good distribution of irrigation water. (Irrigated capability unit IIs-1)

Kornman and Neesopah loams, 1 to 3 percent slopes (KnB).--Most areas of this unit occur throughout the irrigated part of the county in areas ranging from 20 to 160 acres in size.

The Kornman soil in the unit has the profile described as typical for the series. The Neesopah soil in this unit has the profile described as typical for the Neesopah series.

The principal inclusion is Vona sandy loam, 1 to 5 percent slopes, which accounts for about 15 percent of each mapped area.

The soils of this unit have a fertile, easily worked surface layer about 12 inches thick. The subsoil has moderately rapid permeability and low water-holding capacity.

Although the acreage of this unit is suited for all locally adapted crops, because of soil droughtiness it is best suited for alfalfa, sorghum, corn, and melons. There is a loss of plant nutrients by leaching, water erosion, and cropping. (Irrigated capability unit IIe-1)

Kornman and Neesopah loams, 3 to 5 percent slopes (KnC).--This unit occurs mostly in the western irrigated part of the county. These soils have an easily worked loamy surface layer about 10 inches thick. Below this to a depth of about 30 inches is pale-brown sandy loam or loamy sand. The underlying material is light yellowish-brown loamy sand or light brownish-gray fine gravel.

The principal inclusion is Vona sandy loam, 1 to 5 percent slopes, which accounts for about 20 percent of each mapped area.

This unit is droughty, very erodible, and low in fertility. It is best suited for alfalfa, sorghum, or small grain. Short irrigation runs and small heads of water are needed to reduce erosion. (Irrigated capability unit IIIe-2)

Las Animas Series

The Las Animas series consists of poorly drained soils on the bottom of broad upland drainages or low creek and river terraces. They are not extensive soils in the county.

In a typical profile the surface layer, about 7 inches thick, is gray and varies widely in texture. The substratum to a depth of about 30 inches is gray and dark-gray sandy loam and light brownish-gray loamy sand. It contains many dark-brown, strong-brown, gray, and yellowish-brown mottles, which indicate wetness and poor drainage. Below 30 inches is strongly calcareous, brown, moist sand that contains many gray mottles.

Las Animas soils are saline and usually wet. There is little hazard of water or wind erosion. The depth to water table varies seasonally. These soils are occasionally flooded.

Most of the acreage is used as range. Alkali sacaton, inland saltgrass, and tamarisk make up most of the vegetation.

Typical profile of Las Animas soils in salt-meadow range, 0.1 mile north and 20 feet east of the southwest corner of sec. 8, T. 22 S., R. 54 W.

A1--0 to 7 inches, gray (10YR 5/1) silty clay, dark gray (10YR 4/1) when moist; weak, thick, platy structure that parts to moderate, very fine, subangular blocky; very hard when dry, firm when moist, sticky when wet; roots abundant; numerous fine salt threads; strongly calcareous; abrupt, smooth boundary.

C1g--7 to 13 inches, gray (10YR 6/1) sandy loam, dark gray (10YR 4/1) when moist; massive; slightly hard when dry, very friable when moist; many, medium, distinct, dark-brown (7.5YR 4/4, moist) and strong-brown (7.5YR 5/6, moist) mottles; strongly calcareous; clear, smooth boundary.

C2g--13 to 26 inches, light brownish-gray (10YR 6/2) loamy sand, brown (10YR 5/3) when moist; single grain; soft when dry, very friable when moist; many, coarse, faint, gray (10YR 5/1, moist) mottles; roots common to 26 inches; strongly calcareous; clear, smooth boundary.

C3g--26 to 30 inches, dark-gray (5Y 4/1, moist) coarse sandy loam; massive; very friable when moist; many, coarse, prominent, yellowish-brown (10YR 5/4, moist) mottles; strongly calcareous; clear, smooth boundary.

IIC4g--30 to 60 inches, brown (10YR 5/3, moist) sand; many, coarse, faint, gray (10YR 5/1, moist) mottles; strongly calcareous.

The texture of the A horizon ranges from loamy sand to silty clay. The texture of the C horizon ranges from sandy loam to loamy sand. The depth to water table ranges from a few inches to about 3 feet.

Las Animas soils are associated with Bankard and Glenberg soils. They are poorly drained, whereas Bankard and Glenberg soils are excessively drained.

Las Animas soils (0 to 3 percent slopes) (Lm).--These soils occur in irregularly shaped or long narrow areas along streams. The areas range from a few to 500 acres in size.

Included in mapping are areas of Bloom loam that make up to as much as 15 percent of any area mapped.

All of the acreage is used as range. These are productive soils if not too much of the ground cover is tamarisk and willow trees. Production could be increased by seeding to adapted grasses and using the soils as irrigated or nonirrigated pasture. (Irrigated capability unit IVw-2; nonirrigated capability unit VIw-1; Salt Meadow range site)

Limon Series

The Limon series consists of deep, well-drained, nearly level, slightly saline, clayey (pl. 1, top) soils on creek or river terraces that are seldom or never flooded.

In a typical profile the surface layer, about 12 inches thick, is light brownish-gray silty clay that is very hard and cloddy when dry, very firm when moist, and sticky when wet. The substratum to a depth of about 40 inches is light brownish-gray or light yellowish-brown silty clay. It is very hard when dry, very firm when moist, and sticky when wet. Threads and small seams of fine crystalline gypsum are usually visible in both the upper and lower part. Below 40 inches is pale-brown loam or silty clay loam that is hard when dry and friable when moist. Threads and seans of crystalline gypsum are present.

Limon soils have slow water intake and a slow rate of permeability. They have high water-holding capacity. Surface runoff on these silty clay soils is medium, even though there is little slope. These soils are clayey and difficult to cultivate. The hazard of erosion is high.

These soils are used for irrigated crops and for range. About one-third of the acreage is irrigated. The principal crops are alfalfa, sorghum, barley, and onions. The native range vegetation consists of alkali sacaton, blue grama, galleta, inland saltgrass, and greasewood. These soils respond to practices that improve the tilth of the soil and thereby permit better movement of water and air in the soil.

Typical profile of Limon silty clay, 0 to 3 percent slopes, in an irrigated field, 0.25 mile east and 300 feet north of the southwest corner of sec. 26, T. 23 S., R. 56 W.

Ap--0 to 12 inches, light brownish-gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate, coarse, granular structure that parts to moderate, fine, granular; very hard when dry, very firm when moist; strongly calcareous, pH 7.9; clear, smooth boundary.

C1--12 to 22 inches, light brownish-gray (2.5Y 6/2) silty clay, olive brown (2.5Y 4/3) when moist; massive; very hard when dry, very firm when moist, sticky when wet; few fine lime concretions; few fine threads of fine crystalline gypsum; strongly calcareous, pH 7.9; clear, smooth boundary.

C2--22 to 40 inches, light yellowish-brown (2.5Y 6/4) silty clay, olive brown (2.5Y 4/4) when moist; massive; very hard when dry, very firm when moist, sticky when wet; few fine lime concretions; few fine threads of fine crystalline gypsum; strongly calcareous, pH 7.9; clear, smooth boundary.

C3--40 to 50 inches, pale-brown (10YR 6/3) loam, dark grayish brown (10YR 4/2) when moist; massive; hard when dry, friable when moist; few fine threads of fine crystalline gypsum; strongly calcareous.

The A horizon ranges in thickness from about 4 to 17 inches and in texture from clay to loam. The texture of the C horizon ranges from clay to loam, and more than 35 percent of the material is clay. The depth to the loam substratum ranges from 3 to many feet.

Limon soils are associated with Rocky Ford and Manzanola soils. They differ from them in being finer textured and more saline.

Limon silty clay loam, 0 to 3 percent slopes (LnB).--The profile of this soil is similar to that described as typical for the series except that it is somewhat more silty and less clayey. This soil occurs as irrigated farmland, mostly along Timpas Creek in areas up to 100 acres in size.

The principal inclusions are Rocky Ford silty clay loam, 1 to 3 percent slopes, and Limon silty clay, 0 to 3 percent slopes.

This soil has a slow intake rate and moderately slow permeability. It is easier to work and manage than Limon silty clay, 0 to 3 percent slopes.

This acreage is well suited for all but the least salt-tolerant crops, such as beans and vine crops. Maintaining soil tilth is as important as maintaining fertility. There is little loss of plant nutrients because of leaching. (Irrigated capability unit IIs-1)

Limon silty clay, 0 to 3 percent slopes (LoB).--This soil has the profile described as typical for the series. In a few places not irrigated, however, the surface layer is about 4 inches thick. This soil occupies nearly level stream terraces and slopes that in few places exceed 1 percent. Areas of this soil range from about 40 to 500 acres in size.

In irrigated areas the principal inclusion is Rocky Ford silty clay loam, 0 to 1 percent slopes, which accounts for about 5 percent of each mapped area. In nonirrigated areas the principal inclusions are Haverson loam, 0 to 3 percent slopes, and Manzanola loam, 0 to 1 percent slopes, which account for about 5 to 10 percent of each mapped area.

When farmed, this soil is readily compacted by heavy machinery. Soil compaction affects crop yields more than any other factor. There is little loss of plant nutrients from leaching or erosion.

This soil is best suited for small grain, sorghum, and irrigated pasture. It can be used, however, for all but the least salt-tolerant crops, such as beans and vine crops. On rangeland, management involves controlling erosion and preventing an increase in the amount of greasewood. Practices that reduce runoff are beneficial. Range reseeding is difficult because of the salinity of the soil and the clayey texture of the surface layer. (Irrigated capability unit IIIs-1; nonirrigated capability unit VIs-1; Salt Flat range site)

Manvel Series

Soils of the Manvel series are deep, well-drained, nearly level silt loams on the nonirrigated uplands. They formed in silty material over gypsiferous silty clay. The depth to the marl is several feet.

In a typical profile the surface layer, about 4 inches thick, is light brownish-gray silt loam. It is soft when dry and very friable when moist. The subsoil, about 20 inches thick, is brown or pale-brown silt loam that is hard or very hard when dry and very friable when moist. Below a depth of 42 inches is pale-yellow silty clay that contains visible fine crystalline gypsum.

Manvel soils have a moderate intake rate, medium to slow surface runoff, and moderate permeability. They have a high water-holding capacity, and there is little hazard of erosion. The subsoil is moderately to strongly alkaline. The salinity and amount of gypsum increase with depth.

All of the acreage is used as range. The principal grasses are blue grama and galleta.

Typical profile of Manvel silt loam, 0 to 3 percent slopes, in native range, 225 feet south and 200 feet east of the northwest corner of sec. 8, T. 25 S., R. 55 W.

A--0 to 4 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium, platy structure that parts to weak, very fine, crumb; soft when dry, very friable when moist; strongly calcareous, pH 7.7; clear, smooth boundary.

B21--4 to 10 inches, brown (10YR 5/3) silt loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; hard when dry, very friable when moist; strongly calcareous, pH 7.6; clear, smooth boundary.

B22--10 to 24 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; moderate, medium, subangular blocky structure; very hard when dry, very friable when moist; strongly calcareous, pH 8.0; clear, smooth boundary.

C1--24 to 42 inches, pale-brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) when moist; weak, coarse, subangular blocky structure; very hard when dry, very friable when moist; strongly calcareous, pH 8.1; clear, smooth boundary.

C2cacs--42 to 60 inches, pale-yellow (2.5Y 7/4) silty clay, light yellowish brown (2.5Y 6/4) when moist; massive; slightly hard when dry, very friable when moist; visible fine crystalline gypsum; strongly calcareous, pH 7.9.

In some locations the A horizon has a few limestone fragments on the surface. The B2 horizon ranges in thickness from 18 to 28 inches, and in texture from silt loam to silty clay loam.

Manvel soils are associated with Minnequa, Shingle, and Tyrone soils. They differ from Minnequa soils in being deeper to parent rock and in having a well structured subsoil. They have a less well-developed subsoil than Tyrone soils and are not so alkaline.

Manvel silt loam, 0 to 3 percent slopes (MaB).--This soil has the profile described as typical for the series. It occurs in nearly level areas ranging up to 1,000 acres or more in size.

The principal inclusions are Tyrone silty clay loam, 0 to 3 percent slopes, and Minnequa loam, 1 to 3 percent slopes. Together these inclusions account for about 15 percent of each mapped area.

All of the acreage is used as range. The main concerns in management are keeping the range in good condition and controlling surface runoff. Runoff increases on overgrazed range but can be retarded by applying mechanical water conservation practices. (Nonirrigated capability unit VIe-1; Loamy Plains range site)

Manzanola Series

The Manzanola series consists of deep, well-drained, nearly level, loamy soils on stream terraces and fans. They are extensive soils of the nonirrigated part of the county.

In a typical profile the surface layer, about 3 inches thick, is light brownish-gray loam that is slightly hard when dry and very friable when moist. The subsoil, about 30 inches thick, is brown to pale-brown clay loam. It parts to vertically elongated pieces about an inch in diameter. The pieces are hard and very hard when dry and firm when moist. The material below a depth of 33 inches is light yellowish-brown clay loam that contains fine gypsum crystals.

Manzanola soils have a moderate intake rate, medium surface runoff, moderately slow permeability, and high water-holding capacity. Occasionally these soils receive runoff water from higher ground or are flooded with water from streams. The water erosion hazard is moderate to high.

All of this acreage is used as range. The principal grasses are blue grama, galleta, and alkali sacaton. Fourwing saltbush is present in most areas.

Typical profile of Manzanola loam, 0 to 1 percent slopes, in an area of native range, 0.15 mile south of the northeast corner of sec. 9, T. 25 S., R. 56 W.

A--0 to 3 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, platy structure that parts to moderate, medium, crumb; slightly hard when dry, very friable when moist; very strongly calcareous, pH 7.7; abrupt, smooth boundary.

B21t--3 to 9 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak to moderate, medium, prismatic structure that parts to weak to moderate, medium, subangular blocky; hard when dry, firm when moist; thin continuous clay skins; very strongly calcareous, pH 7.8; clear, smooth boundary.

B22t--9 to 18 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard when dry, firm when moist; thin continuous clay films; very strongly calcareous, pH 7.9; clear, smooth boundary.

B3ca--18 to 33 inches, pale-brown (10YR 6/3) clay loam, yellowish brown (10YR 5/4) when moist; weak to moderate, coarse, prismatic structure that parts to moderate, medium, subangular blocky; very hard when dry, firm when moist; thin patchy clay films; common medium lime concretions; very strongly calcareous, pH 8.1; gradual, smooth boundary.

Cca--33 to 60 inches, light yellowish-brown (10YR 6/4) clay loam, dark yellowish brown (10YR 4/4) when moist; structureless; hard when dry, firm when moist; few fine gypsum crystals at depths of from 50 to 60 inches; very strongly calcareous.

Both loam and clay loam A horizons are common. The B horizon is silty clay loam or silty clay, 18 to 30 inches thick. The C horizon in places is strongly alkaline and ranges from clay loam to loam in texture.

Manzanola soils are associated with Baca, Limon, Minnequa, Haverson, and Tyrone soils. They are most like the Baca soils except that they have thicker subsoils and contain lime in all of the horizons.

Manzanola loam, 0 to 1 percent slopes (MbA).--This soil has the profile described as typical for the series. It occurs on nearly level creek terraces in elongated areas up to 1,000 or more acres in size. The stream channel passes through areas of this soil, but flooding is seldom.

The principal inclusions are Haverson loam, 0 to 3 percent slopes, and Limon silty clay, 0 to 3 percent slopes, which are most likely to be near the stream channel. These inclusions account for about 5 percent of each mapped area.

This soil is above average in fertility. It has high water-holding capacity, and the water is readily released to plant roots. In places there is severe erosion as floodwater washes over streambanks. Nearly all areas have varying amounts of fourwing saltbush. (Nonirrigated capability unit VIe-4; Saline Overflow range site)

Manzanola clay loam, 1 to 3 percent slopes (McB).--This soil has the profile resembling that described as typical for the series, but it has a clay loam surface layer and is more sloping. It occurs as areas up to 400 acres in size on toe slopes that are usually below limestone breaks and escarpments.

The principal inclusions are Manvel silt loam, 0 to 3 percent slopes, and Cadoma clay, 2 to 12 percent slopes. Taken together these inclusions account for less than 5 percent of each mapped area.

Surface runoff is faster and water intake is slower than on Manzanola loam, 0 to 1 percent slopes. The water erosion hazard is high. In places there are many shallow gullies.

The principal native grass is galleta, and there are lesser amounts of blue grama and western wheatgrass. Reducing runoff helps to control erosion and to increase production of grass. (Nonirrigated capability unit VIe-1; Loamy Plains range site)

Manzanola soils, eroded (0 to 3 percent slopes) (Md2).--This soil occurs on creek terraces in areas up to 60 acres in size.

On about two-thirds of the area, the surface layer and most of the subsoil layer has been removed by wind and water erosion. There is little or no vegetation on such surfaces. Surface runoff is rapid, and water intake is slow. The hazard of additional erosion is high.

Most areas of this soil have been farmed without irrigation. They are of little value in their present condition and need to be reseeded to adapted grasses. (Nonirrigated capability unit VIs-1; Salt Flat range site)

Minnequa Series

The Minnequa series consists of moderately deep, well-drained, loamy upland soils that developed in material weathered from limestone or marl. This is the most extensive series in the county.

In a typical profile the surface layer, about 7 inches thick, is light brownish-gray or pale-brown loam. The substratum, about 22 inches thick, is light yellowish-brown silt loam that is hard when dry and friable when moist. The underlying material is white or pale-brown loam weathered from limestone or marl which underlies these soils at a depth of about 3 feet.

Minnequa soils have a moderate intake rate, moderate permeability, and medium surface runoff. The rooting zone and water-holding capacity is somewhat limited because of the depth. The erosion hazard is moderate to high.

Most of the acreage is used as range. The native vegetation consists of blue grama and galleta. Some areas of these soils are irrigation farmed.

Typical profile of Minnequa loam, 1 to 3 percent slopes, in native range, 0.1 mile south of the northwest corner of sec. 18, T. 23 S., R. 59 W.

A1--0 to 2 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, thin, platy structure; soft when dry, very friable when moist; strongly calcareous, pH 7.8; abrupt, smooth boundary.

AC--2 to 7 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; massive to weak, medium, subangular blocky structure; slightly hard when dry, friable when moist; visible disseminated lime and a few fine limestone chips; pH 7.5; clear, wavy boundary.

C1ca--7 to 29 inches, light yellowish-brown (10YR 6/4) silt loam, yellowish brown (10YR 5/4) when moist; massive to weak, coarse, subangular blocky structure; hard when dry, friable when moist; few, medium and coarse mottles of lime; few limestone chips; pH 7.6; gradual, smooth boundary.

C2ca--29 to 35 inches, white (10YR 8/2) loam, very pale brown (10YR 7/4) when moist; massive; slightly hard when dry, friable when moist; strongly calcareous, pH 7.9; clear, wavy boundary.

R--35 to 60 inches, gypsiferous Smoky Hill marl.

The thickness of the A horizon ranges from 3 inches on some of the rangeland to 14 inches on some of the irrigated land. The texture of the surface layer ranges from loam to silty clay loam. The depth to the limestone or marl ranges from about 20 to 40 inches.

Minnequa soils are associated with Manvel, Penrose, and Tyrone soils. They differ from Penrose soils in being deeper than 20 inches to limestone. They differ from Manvel soils in being shallower than 40 inches to limestone and usually a little more sloping.

Minnequa loam, 1 to 3 percent slopes (MeB).--This soil has the profile described as typical for the series. It occurs on the uplands throughout the county. Areas range from a few acres to well over 1,000 acres in size.

The principal inclusions are Manvel silt loam, 0 to 3 percent slopes, and Penrose channery loam, 1 to 25 percent slopes. The Manvel silt loam accounts for about 20 percent of this soil. The Penrose channery loam occurs in only very small amounts.

This soil is moderately fertile and has moderate water-holding capacity. The depth to limestone or marl normally is less than 40 inches.

All of the acreage is used as range. If the range is overgrazed, runoff increases and less water enters the soil. The grasses need to be managed so that productivity is maintained by reducing runoff. On sparsely grassed range mechanical practices such as chiseling and pitting help reduce runoff.(Nonirrigated capability unit VIe-1; Loamy Plains range site)

Minnequa silty clay loam, 0 to 1 percent slopes (MnA).--The profile of this soil differs from that described as typical for the series in having a surface layer about 14 inches thick and in being finer textured. The surface layer has been silted by irrigation water. This soil occurs as irregularly shaped areas up to 80 acres in size.

The principal inclusions are Shingle loam, 1 to 9 percent slopes, and Rocky Ford silty clay loam, limestone substratum, 0 to 1 percent slopes. The Shingle loam accounts for less than 5 percent of each mapped area, and the Rocky Ford silty clay loam, limestone substratum, accounts for about 10 percent of each mapped area.

This soil is slightly saline. The depth to limestone or marl ranges from about 20 to 40 inches.

All of the acreage is irrigation farmed, and it is difficult to manage for irrigation because of restricted internal drainage. Tile drains are needed for efficient crop production. Without improved drainage, this soil is best suited to irrigated pasture or crops that are least expensive to produce. Crops with low salt tolerance are not well adapted. (Irrigated capability unit IIIs-1)

Minnequa silty clay loam, 1 to 5 percent slopes (MnC).--The profile of this soil differs from that described as typical for the series in having a surface layer about 12 inches thick and in being finer textured. The surface layer has been silted by irrigation. This soil occurs in irregularly shaped areas up to 40 acres in size.

The principal inclusion is Penrose channery loam, 1 to 25 percent slopes, which is very shallow to limestone. Inclusions account for less than 10 percent of each mapped area.

This soil is slightly saline, and the hazard of water erosion is moderate to severe. The depth to limestone or marl ranges from about 20 to 36 inches.

This soil is best suited to irrigated pasture or small grain. It is irrigation farmed, and because of the restricted internal drainage, should not be overirrigated. (Irrigated capability unit IIIe-1)

Neesopah Series

The Neesopah series consists of deep, well-drained, loamy soils that have a thick surface layer silted by irrigation water. They occur mostly in the western part of the county.

In a typical profile the surface layer, about 12 inches thick, is grayish-brown and dark grayish-brown loam that is hard and cloddy when dry but friable when moist. The subsoil, about 19 inches thick, is brown sandy loam that is free of lime in the upper part. The lower part is pale-brown fine sandy loam or loam that contains lime. The material below a depth of 31 inches is limy pale-brown fine sandy loam, loamy fine sand, and loamy sand. In places it contains layers of pale-brown loam or silt loam.

Neesopah soils have a fertile surface layer that takes water readily and is easily worked. The subsoil has moderately rapid permeability and is somewhat droughty. Both the subsoil and underlying material are readily penetrated by plant roots.

These soils are well suited to all locally adapted crops. All of the acreage is irrigated.

The Neesopah soils in Otero County are mapped only in three undifferentiated soil groups with Kornman soils. The mapping units are described under the Kornman series.

Typical profile of Neesopah loam in an irrigated field, 1,200 feet east and 600 feet south of the northwest corner of sec. 22, T. 22 S., R. 59 W.

Ap1--0 to 6 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, very coarse to fine, crumb structure; very hard when dry, friable when moist; strongly calcareous, pH 7.5; clear, smooth boundary.

Ap2--6 to 12 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that parts to moderate, fine, crumb; hard when dry, friable when moist; strongly calcareous, pH 7.5; abrupt, smooth boundary.

B2t--12 to 21 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure that parts to weak, fine, subangular blocky; hard when dry, very friable when moist; noncalcareous, pH 7.4; clear, smooth boundary.

B3ca--21 to 31 inches, pale-brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak to moderate, medium, subangular blocky structure; slightly hard when dry, very friable when moist; few diffuse lime spots; very strongly calcareous, pH 7.6; gradual, smooth boundary.

C1ca--31 to 46 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; common diffuse lime spots; very strongly calcareous, pH 7.5; gradual, smooth boundary.

C2--46 to 56 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; structureless; very friable when moist; strongly calcareous; clear, smooth boundary.

C3--56 to 60 inches, pale-brown (10YR 6/3) loamy sand, brown (10YR 5/3) when moist; structureless; very friable when moist; strongly calcareous.

The thickness of the A horizon ranges from 12 to 18 inches, and the texture ranges from a light clay loam to sandy clay loam and loam. The B2t horizon is weakly structured and ranges in thickness from 6 to 12 inches.

Neesopah soils are associated with Kornman, Rocky Ford, and Numa soils. They are most like the Kornman soils, but they differ from them in having a lime-free and somewhat darker colored upper subsoil. They have coarser textured subsurface layers than the Rocky Ford and Numa soils.

Nepesta Series

The Nepesta series consists of deep, well-drained soils that have a thick clay loam surface layer silted by irrigation water.

In a typical profile the surface layer, about 10 inches thick, is grayish-brown clay loam that is cloddy and hard when dry but friable when moist. The brown sandy clay loam to clay loam subsoil, about 16 inches thick, is hard when dry and friable when moist. The underlying material is pale-brown loam or yellowish-brown sandy loam. Lime occurs in the upper part as mottles and streaks.

Nepesta soils have a high water-holding capacity, have high fertility, and are relatively easy to work. There is little hazard of erosion.

These soils are well suited to all locally adapted crops. All of the acreage is irrigated.

Typical profile of Nepesta clay loam, 0 to 3 percent slopes, in an irrigated field, 700 feet east and 600 feet south of the center of sec. 20, T. 22 S., R. 54 W.

Ap1--0 to 6 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist, dark grayish brown (10YR 4/2) when crushed; weak, coarse, subangular blocky structure that parts to weak, fine, crumb; hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

Ap2--6 to 10 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist, dark grayish brown (10YR 4/2) when crushed; weak, coarse, subangular blocky structure that parts to weak, medium, crumb; hard when dry, friable when moist; strongly calcareous; abrupt, smooth boundary.

B1--10 to 16 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard when dry, very friable when moist; thin patchy clay films on ped surfaces; noncalcareous; clear, smooth boundary.

B2t--16 to 20 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; strong, medium, prismatic structure that parts to strong, medium, subangular blocky; hard when dry, friable when moist; thin continuous clay films on ped surfaces; noncalcareous; clear, smooth boundary.

B3ca--20 to 26 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard when dry, friable when moist; thin patchy clay films on ped surfaces; few medium lime concretions; strongly calcareous; clear, smooth boundary.

C1ca--26 to 36 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, very friable when moist; few, medium, white mottles of lime; strongly calcareous; clear, smooth boundary.

C2--36 to 60 inches, yellowish-brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) when moist; massive; slightly hard when dry, very friable when moist; strongly calcareous.

The A horizon ranges in thickness from 10 to 14 inches. The B2 horizon ranges in thickness from 3 to 10 inches and in texture from sandy clay loam to clay loam.

Nepesta soils are associated with Rocky Ford and Numa soils. They differ from them in having a strongly structured sandy clay loam subsoil.

Nepesta clay loam, 0 to 3 percent slopes (NeB).--This soil has the profile described as typical for the series. Most of this soil is in the vicinity of Cheraw in areas up to 400 acres in size. Most of it has slopes of less than 1 percent.

The principal inclusion is Numa clay loam, 0 to 1 percent slopes, which accounts for less than 10 percent of each mapped area.

All of the acreage is irrigated. Use of crop residues and green-manure crops helps to maintain the tilth of the surface layer. Using as few tillage operations as possible, especially when the soil is wet, helps keep the subsoil from compacting. Growing deep-rooted crops in the rotation helps to maintain permeability. (Irrigated capability unit IIs-1)

Numa Series

The Numa series consists of deep, well-drained clay loams that have a thick surface layer silted by irrigation water (pl. 2, left). These soils are on the irrigated part of the county.

In a typical profile the fertile surface layer, about 14 inches thick, is light brownish-gray light clay loam that is cloddy and hard when dry, but friable when moist. The upper 17 inches of the substratum is pale-brown or light-brown loam and sandy clay loam that is easily penetrated by plant roots, air, and water. Below a depth of about 31 inches is pink sandy clay loam to light-brown sandy loam that contains in the upper part an abundance of lime in the form of small nodules and as coatings on pebbles.

Numa soils are moderately to highly fertile, have a high water-holding capacity, and are relatively easy to work. There is a moderate to high water erosion hazard where slopes are 1 percent or more.

These soils are well suited to all locally adapted crops. The entire acreage is irrigated.

Typical profile of Numa clay loam, 1 to 3 percent slopes, on irrigated farmland, 150 feet east and 40 feet north of the southwest corner of sec. 18, T. 23 S., R. 57 W.

Ap1--0 to 9 inches, light brownish-gray (10YR 6/2) light clay loam, dark grayish brown (10YR 4/2) when moist; moderate, very fine to very coarse, crumb structure; hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

Ap2--9 to 14 inches, light brownish-gray (10YR 6/2) light clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure that parts to weak, fine, subangular blocky; very hard when dry, friable when moist; strongly calcareous; abrupt, smooth boundary.

C1ca--14 to 19 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; lime concretions less than 5 millimeters in diameter cover less than 2 percent of the area; very strongly calcareous; clear, wavy boundary.

C2ca--19 to 31 inches, light-brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 5/4) when moist; weak, coarse, subangular blocky structure; very hard when dry, friable when moist; common medium lime concretions; very strongly calcareous; clear, wavy boundary.

C3ca--31 to 46 inches, pink (7.5YR 7/4) sandy clay loam, brown (7.5YR 5/4) when moist; massive; soft when dry, friable when moist; common medium lime concretions; visible lime disseminated throughout the horizon; a few lime-coated pebbles; clear, wavy boundary.

C4--46 to 60 inches, light-brown (7.5YR 6/4) sandy loam, brown (7.5YR 5/4) when moist; massive; soft when dry, very friable when moist; very strongly calcareous.

The thickness of the A horizon ranges from about 10 to 14 inches. Depth to the calcium carbonate accumulation ranges from 10 to 18 inches.

Numa soils are associated with Rocky Ford and Kornman soils. They differ from Rocky Ford soils in having more lime in the somewhat coarser textured upper C horizon. They differ from Kornman soils in having a loam rather than sandy loam upper C horizon.

Numa clay loam, 0 to 1 percent slopes (NmA).--This soil has a profile similar to that described as typical for the series except that in places the surface layer is loam. It occurs as irregularly shaped areas up to 80 acres in size that are scattered throughout the county.

The principal inclusion is Rocky Ford silty clay loam, 0 to 1 percent slopes, which accounts for about 20 percent of each area.

This soil is fertile and free of salts. The erosion hazard is slight, and plant nutrients are not readily lost by leaching and erosion.

The acreage is suited to all locally adapted crops. The cloddy surface layer needs to be worked well to prepare a seedbed. (Irrigated capability unit IIs-1)

Numa clay loam, 1 to 3 percent slopes (NmB).--This soil has the profile described as typical for the series. In places the surface layer is loam. This soil is in irregularly shaped areas up to 160 acres in size.

The principal inclusions are Rocky Ford silty clay loam, 1 to 3 percent slopes, and Kornman and Neesopah loam, 1 to 3 percent slopes. The Rocky Ford soils account for about 15 percent, and the Kornman and Neesopah soils about 5 percent, of each mapped area.

This soil is easily worked, and the hazard of water erosion is moderate. In places small wet spots appear as seep water from irrigation laterals that moves through the moderately sandy substratum.

The acreage is suited to all locally adapted crops. Land leveling is needed in most places. (Irrigated capability unit IIe-1)

Numa clay loam, 3 to 5 percent slopes (NmC).--The profile of this soil differs from that described as typical for the series in having thinner layers of soil. The surface layer, about 10 inches thick, ranges from loam to clay loam. In places the substratum is a gravelly loam beginning at a depth of about 16 inches. Areas of this soil do not exceed about 40 acres in size.

The principal inclusion is Kornman loam, which accounts for about 20 percent of each mapped area.

The water erosion hazard on this soil is high. Plant nutrients are lost through erosion.

This acreage is best suited for crops that help reduce erosion. (Irrigated capability unit IIIe-2)

Numa loam, gravel subsoil variant, 5 to 9 percent slopes (NvD).--This strongly sloping soil is loam, but it is underlain by limy gravel at a depth ranging from 16 to 36 inches. It occurs in narrow strips up to 20 acres in size.

The principal inclusions are Kornman and Neesopah loams, 3 to 5 percent slopes, and Numa clay loam, 3 to 5 percent slopes. Taken together these inclusions account for about 20 percent of each mapped area.

This soil has moderate fertility and moderate water-holding capacity. The water erosion hazard is high. Plant nutrients are lost through erosion.

This acreage is best suited to irrigated pasture or small grain. (Irrigated capability unit IVe-1)

Olney Series

The Olney series consists of deep, well-drained, nearly level, loamy soils that are mostly in the nonirrigated part of the county.

In a typical profile the surface layer, about 4 inches thick, is light brownish-gray sandy loam that is soft when dry but very friable when moist. The subsoil, about 12 inches thick, is brown and light brownish-gray sandy clay loam and clay loam (pl. 2, right). The upper 3 inches of the subsoil has a subangular blocky structure that parts to a crumb structure, but the lower 11 inches is prismatic that parts to subangular blocky. The material below a depth of about 16 inches is pale-brown loam and sandy loam that is easily penetrated by plant roots, air, and water.

Olney soils have slow surface runoff, moderately rapid intake rate, and moderate permeability. They have moderate to high water-holding capacity. When these soils are used as range, there is little hazard of erosion.

Most of this acreage is used as range. The principal grasses are blue grama, side-oats grama, sand dropseed, and needle-and-thread. Some areas in the irrigated section of the county are farmed. These soils are well suited to irrigation farming.

Typical profile of Olney sandy loam, 0 to 3 percent slopes, in an area of native range, 100 feet north and 50 feet west of the southeast corner of sec. 5, T. 23 S., R. 54 W.

A1--0 to 4 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, crumb structure; soft when dry, very friable when moist; noncalcareous, pH 7.8; clear, smooth boundary.

B1--4 to 7 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure that parts to weak, fine, crumb; slightly hard when dry, friable when moist; noncalcareous, pH 7.4; clear, smooth boundary.

B2t--7 to 10 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard when dry, friable when moist; thin continuous clay skins on vertical and horizontal ped surfaces; noncalcareous, pH 7.4; clear, smooth boundary.

B3ca--10 to 16 inches, light brownish gray (10YR 6/2) clay loam, brown (10YR 5/3) when moist; weak, medium, prismatic structure that parts to weak, medium, subangular blocky; slightly hard when dry, friable when moist; thin patchy clay films on vertical ped surfaces; common coarse mottles of lime and also disseminated lime; pH 7.7; gradual, smooth boundary.

C1ca--16 to 24 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; common coarse mottles of lime and also disseminated lime; pH 7.8; gradual, smooth boundary.

C2--24 to 60 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; few fine mottles of lime and also disseminated lime; strongly calcareous.

The A horizon ranges in thickness from 4 to 8 inches and in texture from sandy loam to sandy clay loam. The B2t horizon ranges from 3 to 8 inches in thickness. The texture of the C horizon ranges from sandy clay loam to loamy sand.

Olney soils are associated with Vona and Stoneham soils. They are most like the Stoneham soils but differ in having a thicker, more strongly structured subsoil. They differ from Vona soils in having a sandy clay loam subsoil rather than a sandy loam.

Olney sandy loam, 0 to 3 percent slopes (OlB).--This soil has the profile described as typical for the series. The surface is nearly level to slightly concave. It occurs in the northeast and west-central parts of the county as elongated or circular areas ranging up to 800 acres in size.

The principal inclusions are Harvey-Stoneham loams, 0 to 3 percent slopes, and Vona sandy loam, 1 to 5 percent slopes. Total inclusions account for about 10 percent of each mapped area.

Olney soils are among the best of the range soils because of the slow surface runoff. Because of the gentle slope and moderately rapid intake rate, most of the rainwater enters the soil and is available to plants. The principal grass is blue grama.

In places there are rectangular eroded areas up to 80 acres in size. These areas have been dry-farmed, and red three-awn, a poor forage grass, has grown back. These areas need reseeding at a time when moisture conditions are favorable. (Nonirrigated capability unit VIe-3; Sandy Plains range site)

Olney sandy clay loam, 0 to 1 percent slopes (OnA).--The profile of this soil differs from that described as typical for the series in having a grayish-brown sandy clay loam surface layer about 8 inches thick. Most of the acreage is in the vicinity of Holbrook Reservoir in areas ranging from 10 to 160 acres in size.

The principal inclusions are Numa clay loam, 0 to 1 percent slopes, which accounts for about 5 percent of each mapped area, and Nepesta clay loam, 0 to 3 percent slopes, which accounts for about 10 percent of each mapped area.

This soil has a friable, easily worked surface layer. It does not compact excessively from tillage. The erosion hazard is slight. The irrigation water supply is usually short in the part of the county where this acreage occurs. (Irrigated capability unit I-1)

Otero Series

The Otero series consists of deep, somewhat excessively drained, gently sloping to undulating sandy loams on uplands. Nearly all of the acreage is in the nonirrigated part of the county.

In a typical profile the surface layer, about 4 inches thick, is light brownish-gray sandy loam that is soft when dry but very friable when moist. The transitional layer, about 5 inches thick, is pale-brown sandy loam that is slightly hard when dry but very friable when moist. Roots are abundant to a depth of about 8 inches. The underlying material, below a depth of about 9 inches, is pale-brown or very pale-brown sandy loam and fine sandy loam that contains strata of loam and sandy clay loam. It is easily penetrated by plant roots, air, and water.

Otero soils have a moderately rapid intake rate, slow surface runoff, moderately rapid permeability, and moderate water-holding capacity. The wind erosion hazard is moderate to high.

Nearly all of the acreage is used as range. Small areas overlap onto irrigated land. The native vegetation consists of blue grama, sand dropseed, galleta, and yucca.

Typical profile of Otero sandy loam, 1 to 5 percent slopes, in an area of range, 0.15 mile south and 0.2 mile east of the northwest corner of sec. 34, T. 23 S., R. 54 W.

A--0 to 4 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, crumb structure that parts to weak, fine, crumb; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

AC--4 to 9 inches, pale-brown (10YR 6/3) sandy loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; roots abundant to a depth of 8 inches; strongly calcareous; gradual, smooth boundary.

C1ca--9 to 18 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; moderate, coarse, subangular blocky structure; hard when dry, friable when moist; few fine mottles of lime; strongly calcareous; clear, smooth boundary.

C2ca--18 to 40 inches, pale-brown (10YR 6/3) sandy loam, yellowish brown (10YR 5/4) when moist; weak, coarse, prismatic structure that parts to weak, coarse, subangular blocky; very hard when dry, friable when moist; roots common to depth of 36 inches; few medium mottles of lime; strongly calcareous; gradual, smooth boundary.

C3--40 to 50 inches, light yellowish-brown (10YR 6/4) loam, yellowish brown (10YR 5/4) when moist; massive; hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

C4--50 to 60 inches, very pale brown (10YR 7/4) sandy clay loam, light yellowish brown (10YR 6/4) when moist; massive; hard when dry, very friable when moist; strongly calcareous.

The texture of the C horizon ranges from loam to sandy clay loam or loamy fine gravel.

Otero soils are associated with Vona and Cascajo soils. They are most like Vona soils. They differ in being calcareous throughout the profile, whereas Vona soils are not calcareous in the upper part. Vona soils also have a B horizon, but the Otero soils do not.

Otero sandy loam, 1 to 5 percent slopes (OtC).--This soil has the profile described as typical for the series. It is mostly in the western part of the county in areas up to 900 acres in size.

The principal inclusion is Vona sandy loam, 1 to 5 percent slopes. In places there are pebbles or small limestone fragments scattered about on the surface. Total inclusions account for less than 15 percent of each mapped area.

This soil is moderate in fertility and water-holding capacity. It needs careful management that maintains enough cover to reduce water erosion. (Irrigated capability unit IIIe-8; nonirrigated capability unit VIe-3; Sandy Plains range site)

Penrose Series

The Penrose series consists of shallow and very shallow, excessively drained, gently sloping to steep and hilly channery loams that developed in material weathered from limestone. These are extensive soils in the part of the county that is range.

In a typical profile the surface layer, about 5 inches thick, is grayish-brown channery loam. Many limestone fragments up to 6 inches in diameter are scattered on the surface. The transitional layer, about 6 inches thick, is light brownish-gray channery loam that contains abundant roots to a depth of about 7 inches. Below a depth of about 11 inches is parent limestone rock. This rock has weathered into rectangular blocks that part into small fragments and chips.

The surface runoff of Penrose soils is rapid because they are steep. They have a low water-holding capacity, and the water erosion hazard is high.

All of the acreage is used as range. The sparse native vegetation includes bigelow sage, needlegrass, blue grama, side-oats grama, squirreltail, three-awn, Indian ricegrass, snakeweed, and yucca.

Typical profile of Penrose channery loam, 1 to 25 percent slopes, in an area of range, 0.3 mile north and 0.25 mile east of the southwest corner of sec. 26, T. 24 S., R. 54 W.

A--0 to 5 inches, grayish-brown (10YR 5/2) channery loam, dark grayish brown (10YR 4/2) when moist; weak, fine and medium, crumb structure; soft when dry, very friable when moist; channers cover about 50 percent of surface and comprise about 30 percent of the volume; strongly calcareous; clear, irregular boundary.

AC--5 to 11 inches, light brownish-gray (10YR 6/2) channery loam, dark grayish brown (10YR 4/2) when moist; weak, very fine, crumb structure; soft when dry, very friable when moist; roots abundant to depth of 7 inches, and common to a depth of 12 inches; channers comprise about 40 percent of the volume; strongly calcareous; gradual, wavy boundary.

R--11 to 60 inches, platy, flaggy, fractured limestone of the Fort Hayes formation.

The depth to bedrock ranges from about 6 to 18 inches.

Penrose soils are associated with Minnequa soils. They differ from those soils in being very shallow or shallow rather than moderately deep, and they are more sloping.

Penrose channery loam, 1 to 25 percent slopes (PeE).--This soil has the profile described as typical for the series. This soil also includes areas of channer-covered steep escarpments of shale outcrop immediately below ledges of limestone outcrop.

The principal inclusions are Minnequa loam and Manvel silt loam. Taken together, these inclusions account for about 10 percent of each mapped area.

This soil unit has rapid surface runoff and a low water-holding capacity. The range plants do not grow vigorously. If the range is overgrazed in dry years, it is very slow to recover, even in wet years. (Nonirrigated capability unit VIIs-3; Limestone Breaks range site)

Rocky Ford Series

The Rocky Ford series consists of deep, well-drained, nearly level, silty soils that have thick surface layers silted by muddy irrigation water (pl. 3, top). They are the most extensive soil series of the irrigated land.

In a typical profile the fertile surface layer, about 18 inches thick, is grayish-brown silty clay loam that is cloddy and hard when dry and friable when moist. The upper 12 inches of the substratum is pale-brown silt loam. It is easily penetrated by plant roots, air, and water. The substratum below a depth of 30 inches is pale-brown silt loam that normally becomes somewhat coarser textured as depth increases.

Rocky Ford soils are fertile. They have a moderate to high water-holding capacity, lay well for irrigation, and are relatively easy to manage. Plant nutrients are not easily lost through leaching. There is a moderate water erosion hazard on slopes of 1 percent or more. The surface is difficult to work when dry.

These soils are well suited to all locally adapted crops. All of the acreage is irrigated.

Typical profile of Rocky Ford silty clay loam, 0 to 1 percent slopes, in an irrigated field, 1,200 feet north and 100 feet east of the southwest corner of sec. 3, T. 23 S., R. 57 W.

Ap1--0 to 8 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that parts to moderate, medium to very fine, crumb; hard when dry, friable when moist; very strongly calcareous, pH 7.7; clear, smooth boundary.

Ap2--8 to 18 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; very strongly calcareous, pH 7.7; abrupt, smooth boundary.

C1--18 to 30 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; very strongly calcareous, pH 7.7; gradual, smooth boundary.

C2--30 to 60 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist; very strongly calcareous, pH 7.8.

The A horizon ranges in thickness from 9 to 20 inches and in texture from silt loam to silty clay loam. The C horizon ranges in texture from loam to silt loam. Some areas have limestone or marl at a depth of 3 1/2 feet. The sandy subsoil variant is much sandier in the C horizon than other Rocky Ford soils.

Rocky Ford soils are associated with Kornman, Neesopah, and Numa soils. They differ from Kornman and Neesopah soils in having silt loam rather than sandy loam subsurface layers. They differ from Numa soils in having silt loam rather than loam subsurface layers, and they lack the prominent horizon of lime accumulation that occurs in the substratum of Numa soils.

Rocky Ford silty clay loam, 0 to 1 percent slopes (RfA).--This soil has the profile described as typical for the series. It occurs throughout the county on high terraces of the rivers. Areas range up to about 1,000 acres in size.

The principal inclusion is Kornman and Neesopah loam, 0 to 1 percent slopes, which accounts for about 10 percent of each mapped area.

This soil is well suited to high-value cash crops. It is fertile and free of harmful salts. Under some ditch systems that have an unreliable water supply, this soil is not silted so much and the surface layer is less clayey and more friable. The lower end of irrigated fields is usually the most thickly silted and difficult to work. The most important management need, in addition to good management of irrigation water, is to improve and maintain tilth. Plant nutrients removed by cropping should be replaced by fertilizing. (Irrigated capability unit IIs-1)

Rocky Ford silty clay loam, 1 to 3 percent slopes (RfB).--The profile of this soil differs from that described as typical for the series in having a surface layer only about 12 inches thick. The texture of the surface layer ranges from silty clay loam to loam. This soil occurs throughout the county, on high terraces of the rivers, in areas up to 500 acres in size.

The principal inclusion is Kornman and Neesopah loams, 1 to 3 percent slopes, which accounts for about 5 percent of each mapped area.

This soil is free of harmful salts and has a high water-holding capacity. There is a moderate water erosion hazard because of the slope. Water erosion can cause both loss of topsoil and plant nutrients.

This acreage is well suited to all locally adapted crops. Management of irrigation water that reduces erosion and loss of plant nutrients is needed. (Irrigated capability unit IIe-1)

Rocky Ford silty clay loam, wet, 0 to 1 percent slopes (RgA).--The profile of this soil differs from that described as typical for the series in being slightly saline and in having a substratum about 3 feet from the surface that is layered with sandy materials. The depth to the water table ranges from 3 to 5 feet. This soil occurs on low terraces of the Arkansas River or in swales or concave positions on the higher terraces. Areas are up to 100 acres in size.

The principal inclusion is Rocky Ford silty clay loam, 0 to 1 percent slopes, which accounts for about 20 percent of each mapped area.

This is a fertile, easily worked soil. It is suited to all crops grown in the area except those having very low salt tolerance. An annual irrigation for purpose of leaching salts from the surface soil is desirable. (Irrigated capability unit IIws-1)

Rocky Ford silty clay loam, wet, 1 to 3 percent slopes (RgB).--The profile of this soil differs from that described as typical for the series in being slightly saline and slightly seepy. This soil occurs on low terraces of the Arkansas River as elongated areas up to 40 acres in size.

The principal inclusion is Kornman and Neesopah loams, 1 to 3 percent slopes, which accounts for about 20 percent of each mapped area.

This soil is suited for all locally adapted crops except those with low salt tolerance, such as beans and vine crops. It is a fertile, easily worked soil. An annual irrigation to leach salts from the surface layer is desirable. Water erosion is a moderate hazard because of the slope. (Irrigated capability unit IIew-1)

Rocky Ford silty clay loam, limestone substratum, 0 to 1 percent slopes (R1A).--The profile of this soil differs from that described as typical for the series in being underlain by limestone or marl at depths ranging from 3 1/2 to about 6 feet. Most areas of this soil are located on the irrigated land south of Swink. Areas range up to 800 acres in size.

The principal inclusion is Minnequa silty clay loam, 0 to 1 percent slopes, which accounts for less than 5 percent of each mapped area.

This soil is not readily leached of plant nutrients, and the hazard of water erosion is slight. The limestone material restricts the internal drainage and creates a seep hazard. Some areas have excessive subsoil wetness that creates poor aeration. This is harmful to the deep roots of alfalfa and sugar beets.

This soil is suited for all except the least salt-tolerant crops, such as beans and vine crops. To avoid drainage problems, irrigations should be light. (Irrigated capability unit IIIs-1)

Rocky Ford silty clay loam, limestone substratum, 1 to 3 percent slopes (R1B).--The profile of this soil differs from that described as typical for the series in being underlain by limestone or marl at depths ranging from 3 1/2 to 6 feet. Most of this soil is located on the irrigated land south of Swink in areas ranging up to 800 acres in size.

The principal inclusion is Minnequa silty clay loam, 1 to 5 percent slopes, which accounts for less than 5 percent of each mapped area.

This soil is not readily leached of plant nutrients, and the hazard of water erosion is moderate. The limestone material restricts internal drainage and creates a seep hazard. Some areas have excessive subsoil wetness that creates poor aeration. This is harmful to the deep roots of alfalfa and sugar beets.

This soil is suited for all but the least salt-tolerant crops, such as beans and vine crops. Only light irrigation is suitable; otherwise, seep spots form. (Irrigated capability unit IIIe-1)

Rocky Ford loam, sand subsoil variant, 0 to 3 percent slopes (RmB).--The profile of this soil differs from that described as typical for the series in having a loam surface layer and a sand substratum 18 to 36 inches from the surface. This soil occurs as small irregularly shaped areas up to 40 acres in size.

The principal inclusion is Kornman and Neesopah loams, 1 to 3 percent slopes, which accounts for about 20 percent of each mapped area.

This soil, although easily worked, is somewhat droughty and subject to erosion. Plant nutrients are lost by leaching and erosion. It is difficult to keep optimum soil moisture for crops because of the low water-holding capacity of the sand substratum.

This soil is best suited to sorghum, alfalfa, or small grain, or to irrigated pasture. Frequent irrigation is needed to maintain optimum moisture content. (Irrigated capability unit IIIs-2)

Samsil Series

The Samsil series consists of very shallow, somewhat excessively drained, undulating to gently sloping, clayey soils that developed from dark-gray or olive-brown shale. They are in the nonirrigated part of the county.

In a typical profile the surface layer, about 2 inches thick, is light brownish-gray clay. It is hard when dry, firm when moist, and sticky when wet. The substratum, about 6 inches thick, is olive clay that is extremely hard when dry and very firm when moist. Below a depth of about 8 inches is olive-brown or very dark-gray shale having a platy structure that resists penetration of plant roots, air, and water.

Samsil soils have slow intake and rapid surface runoff. The water erosion hazard is high. The shale parent material contains the mineral selenium, which when taken up by plants is poisonous to livestock. Livestock avoid selenium-bearing plants if other forage is available.

All of the acreage is used as range. These soils are not very productive. The principal grasses are alkali sacaton and galleta.

Typical profile of a Samsil clay in native range, 0.1 mile west and 0.5 mile south of the northeast corner of sec. 9, T. 24 S., R. 54 W.

A--0 to 2 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; moderate, fine, granular structure; hard when dry, firm when moist, sticky when wet; strongly calcareous; clear, smooth boundary.

C--2 to 8 inches, olive (5Y 4/3) clay, dark olive gray (5Y 3/2) when moist; massive; extremely hard when dry, very firm when moist; strongly calcareous; clear, smooth boundary.

R--8 to 60 inches, olive-brown (2.5Y 4/4), platy shale, very dark gray (5Y 3/1) when moist.

The depth to shale ranges from less than 2 inches in eroded areas to 12 inches on some grassed areas.

Samsil soils are associated with Cadoma, Minnequa, and Penrose soils, and Shale outcrop. They are most like the Cadoma soils, but differ from them in being very shallow to shale rather than moderately deep.

Samsil-Shale outcrop complex (1 to 12 percent slopes) (Sc).--This complex is located in small areas seldom exceeding 40 acres in size. Areas of this complex are undulating to rolling.

About 55 percent of the acreage has a profile similar to that described as typical for the Samsil series. About 40 percent of the acreage is eroded areas of dark-gray shale.

The principal inclusion is Cadoma clay, 2 to 12 percent slopes, which accounts for about 5 percent of each mapped area.

Surface runoff is rapid, and the water erosion hazard is high. The shale restricts root growth. The major management problems are improving the vegetation and reducing runoff. (Nonirrigated capability unit VIIs-1; Shaly Plains range site)

Shingle Series

The Shingle series consists of shallow and very shallow, somewhat excessively drained loams that formed in material weathered from soft gypsiferous shale. These soils occur throughout most of the county.

In a typical profile the upper 7 inches is light-gray loam. It is soft or hard when dry but friable when moist. The substratum, about 5 inches thick, is pale-yellow clay loam that is hard when dry and friable when moist. The soft parent shale below a depth of about 12 inches is light gray or light yellowish brown. It lies in thin platy layers and contains an abundance of finely crystalline gypsum.

Shingle soils are low in fertility. They have moderate intake and low water-holding capacity. Surface runoff is rapid because of the scant vegetation. The erosion hazard is high.

Most of the acreage is used as range. A few small areas are in irrigated fields. The native vegetation consists mostly of galleta, blue grama, sacaton, and greasebush.

Typical profile of Shingle loam, 1 to 9 percent slopes, in an area of range, 0.25 mile north of the southwest corner of sec. 12, T. 24 S., R. 54 W.

A1--0 to 2 inches, light-gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/4) when moist; weak, thick, platy structure that parts to moderate, very fine, crumb; soft when dry, friable when moist; strongly calcareous; abrupt, smooth boundary.

AC--2 to 7 inches, light-gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

Ccs--7 to 12 inches, pale-yellow (5Y 7/3) clay loam, pale olive (5Y 6/4) when moist; massive; hard when dry, friable when moist; abundant tiny gypsum crystals; strongly calcareous; clear, smooth boundary.

R--12 to 60 inches, light-gray, thin, platy, gypsiferous shale.

Depth to shale ranges from 2 to 20 inches. Color ranges from light gray to light yellowish brown.

Shingle soils are associated with Manvel, Minnequa, and Penrose soils. They differ from Manvel and Minnequa soils in being very shallow or shallow to parent shale. They differ also in having gypsiferous clay loam to loam below the surface layer. They differ from Penrose soils in being developed from soft shale rather than hard limestone, and they do not have channery rock fragments on the surface.

Shingle loam, 1 to 9 percent slopes (SgC).--This soil has the profile described as typical for the series. It occurs throughout the county on gentle slopes. Most areas are less than 160 acres in size, but few areas are more than 600 acres.

The principal inclusion is Minnequa loam, 1 to 3 percent slopes, which accounts for less than 10 percent of each mapped area.

This acreage supports only a sparse vegetation in most areas. The few small areas that occur in irrigated fields seldom produce a harvestable crop. Grass seeding is difficult because there is little vegetative cover and because soil temperatures are likely to be very high. If runoff is reduced, the vegetation becomes more dense. (Irrigated capability unit VIe-1; nonirrigated capability unit VIIs-1; Shaly Plains range site)

Shingle loam, gypsum variant, 1 to 9 percent slopes (ShC).--The profile of this soil differs from that described as typical for the series in having powdery or finely crystalline gypsum in the subsoil. This soil occurs only in the southeastern corner of the county. Most of it is in an irregularly shaped area of about one square mile along Smith Creek.

Areas of this soil produce little forage for grazing and are highly erodible. Stock-water ponds should not be located in this soil, as it contains lenses of gypsum that create a high hazard of piping. (Nonirrigated capability unit VIIs-1; Shaly Plains range site)

Stoneham Series

The Stoneham series consists of deep, well-drained, gently sloping loams and sandy loams of the uplands. These are extensive soils used for range.

In a typical profile the surface layer, about 5 inches thick, is light brownish-gray loam. It is slightly hard when dry but very friable when moist. The sandy clay loam subsoil, about 7 inches thick, is hard when dry but friable when moist. The upper 3 inches of the subsoil has a prismatic structure that parts to subangular blocky. Below a depth of about 12 inches is pale-brown and light yellowish-brown, moderately alkaline loam and sandy clay loam that are rich in lime in the form of nodules and streaks and as coatings on pebbles. There are no restrictive layers.

Stoneham soils have a moderate intake rate and moderate permeability. Surface runoff is slow because of the gentle slopes. These soils have a high water-holding capacity. The erosion hazard is slight.

All of the acreage is used as range. The native vegetation includes blue grama, galleta, and buffalograss.

The Stoneham soils in Otero County are mapped only in a complex with Harvey soils.

Typical profile of Stoneham loam in an area of native range, 0.1 mile south of the northeast corner of sec. 16, T. 21 S., R. 54 W.

A1--0 to 5 inches, light brownish-gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, thin, platy structure that parts to weak, medium to fine, crumb; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B2t--5 to 8 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard when dry, friable when moist; thin patchy clay films on ped surfaces; noncalcareous; clear, smooth boundary.

B3--8 to 12 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

C1ca--12 to 16 inches, pale-brown (10YR 6/3) sandy clay loam, dark brown (10YR 4/3) when moist; massive; hard when dry, friable when moist; disseminated lime, common medium lime concretions, and lime-coated pebbles; strongly calcareous; clear, smooth boundary.

C2ca--16 to 40 inches, pale-brown (10YR 6/3) loam, yellowish brown (10YR 5/4) when moist; massive; hard when dry, friable when moist; common medium lime concretions and lime-coated pebbles; strongly calcareous; clear, wavy boundary.

C3--40 to 60 inches, light yellowish-brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) when moist; massive; hard when dry, friable when moist; strongly calcareous.

The A horizon ranges in texture from sandy loam to loam. The combined thickness of the A and B horizons ranges from 8 to 15 inches.

Stoneham soils are associated with Harvey and Olney soils. They differ from Harvey soils in having a well structured subsoil in which clay films occur. They differ from Olney soils in having a combined surface layer and subsoil thickness of no more than 15 inches. The combined thickness of the surface and subsoil layers of Olney soils exceeds 15 inches.

Travessilla Series

The Travessilla series consists of very shallow and shallow, excessively drained, gently to strongly sloping sandy loams that have developed in material weathered from parent sandstone (pl. 4, top). These soils are located in the southern, nonirrigated part of the county.

In a typical profile the surface layer, about 5 inches thick, is light brownish-gray sandy loam. It is soft when dry but very friable when moist. The substratum, about 8 inches thick, is pale-brown fine sandy loam and very pale-brown to yellow weathered sandstone. The upper part of the substratum is soft when dry but very friable when moist. The lower part is hard when dry but friable when moist. At a depth of about 13 inches is angular cobbly parent sandstone.

Travessilla soils have moderately rapid intake, medium to rapid surface runoff, and moderate permeability, but because of the shallow depth, they have low water-holding capacity. The erosion hazard is high.

All of the acreage is used as range. The principal native vegetation is blue grama, side-oats grama, sand dropseed, galleta, bluestem, muhly, cholla and pricklypear catus, yucca, and juniper trees.

Typical profile of Travessilla sandy loam, 1 to 9 percent slopes, in an area of range, 0.3 mile south and 100 feet east of the northwest corner of sec. 36, T. 27 S., R. 56 W.

A--0 to 5 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak to moderate, coarse, crumb structure that parts to weak, very fine, crumb; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

C1--5 to 9 inches, pale-brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) when moist; very weak, medium, subangular blocky structure; soft when dry, very friable when moist; roots abundant to depth of 6 inches; strongly calcareous; clear, smooth boundary.

C2--9 to 13 inches, very pale brown (10YR 7/4) to yellow (10YR 7/6) weathered sandstone, brownish yellow (10YR 6/6) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

R--13 to 60 inches, very pale brown (10YR 7/3) sandstone; lime coated on outside of fragments but lime free in interiors.

The thickness of the soil material over the bedrock ranges from about 0 to 20 inches. In places there are layers of gray shale between the sandstone layers. Stone fragments are common on the surface and throughout the profile, but they vary in number. Exposures of bare rock are commonly associated with Travessilla soils.

Travessilla soils are associated with Kim and Wiley soils. They differ in being more sloping and coarser textured, and they are shallow to parent rock.

Travessilla sandy loam, 1 to 9 percent slopes (TaC).--This gently sloping to strongly sloping soil occurs on uplands in the areas of canyons and sandstone rockland in the southern part of the county. Areas are very irregularly shaped and 20 to 1,000 acres or more in size. This soil has the profile described as typical for the series.

The principal inclusion is Kim and Wiley loams, 1 to 9 percent slopes, which accounts for about 10 percent of each mapped area. Most of this inclusion is soil of the Kim series.

Because of the slopes and the low water-holding capacity, Travessilla soils are somewhat droughty. In places water percolates into the soil between the rock fragments. Plants find some extra rooting depth in crevices.

This soil is a good site for winter pasture, because of the protection it offers from blizzards. (Nonirrigated capability unit VIIs-4; Sandstone Breaks range site)

Travessilla-Rock outcrop complex (20 to 65 percent slopes) (Tr).--This complex is on steep bouldery slopes and nearly vertical canyon walls. All of this soil is located in the southern part of the county. It occurs as elongated areas up to 1,000 acres in size. About 40 percent of the acreage has a profile similar to that described as typical for the Travessilla series, and about 20 percent consists of large boulders and rock outcrops.

The principal inclusion is Kim and Wiley loams, 1 to 9 percent slopes, which accounts for about 20 percent of each mapped area. The inclusion occurs on toe slopes and narrow canyon bottoms.

The native vegetation consists of bluestem, blue grama, side-oats grama, galleta, sand dropseed, yucca, skunkbush, and small juniper trees. The steep slopes discourage cattle from grazing a large proportion of the acreage. (Nonirrigated capability unit VIIs-4; Sandstone Breaks range site)

Tyrone Series

The Tyrone series consists of moderately deep to deep, well-drained, nearly level, strongly alkaline silty clay loams of the uplands. These are extensive soils used for range.

In a typical profile the surface layer, about 4 inches thick, is light-gray silty clay loam that is slightly hard when dry and very friable when moist. The subsoil, about 21 inches thick, is grayish-brown to pale-brown clay loam that is hard when dry and firm when moist. It is limy and moderately to strongly alkaline. The underlying material, below a depth of 25 inches, is pale-brown saline and alkaline silty clay loam to a depth of about 7 feet. In places it has formed from light yellowish-brown shale which underlies it at a depth of about 4 feet.

Tyrone soils have moderately slow intake and permeability. Surface runoff is medium. There is moderate to slight erosion hazard.

All of the acreage is used as range. In addition to alkali sacaton, the principal grasses are blue grama and galleta.

Typical profile of Tyrone silty clay loam, 0 to 3 percent slopes, in an area of range, 0.1 mile south of the northwest corner of sec. 6, T. 27 S., R. 55 W.

A1--0 to 4 inches, light-gray (10YR 7/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak to moderate, thick, platy structure that parts to weak, very fine, crumb; slightly hard when dry, very friable when moist; strongly calcareous, pH 7.9; clear, smooth boundary.

B2t--4 to 18 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure; very hard when dry, firm when moist; thin patchy clay films on aggregates; strongly calcareous, pH 8.1; gradual, wavy boundary.

B3--18 to 25 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure that parts to weak, medium, subangular blocky; very hard when dry, firm when moist; very strongly calcareous, pH 8.2; gradual, smooth boundary.

Cca--25 to 60 inches, pale-brown (10YR 6/3) silty clay loam; massive; hard when dry, firm when moist; visible disseminated salts and lime; strongly calcareous, pH 8.1.

The A horizon ranges in texture from silt loam to silty clay loam. The color ranges from light gray to pale brown. The B2t horizon ranges from about 8 to 20 inches in thickness. Shale is at a depth of about 4 feet in some places.

Tyrone soils are associated with Cadoma, Manvel, and Minnequa soils. They differ from Cadoma soils in having a clay loam rather than clay subsoil. Cadoma soils are usually less than 40 inches deep to shale. They differ from Minnequa and Manvel soils in having a finer textured, more alkaline subsoil.

Tyrone silty clay loam, 0 to 3 percent slopes (TyB).--This soil has the profile described as typical for the series. About one-third of the acreage has parent shale at a depth of 40 to 60 inches. The other two-thirds has shale at a depth of about 7 feet. This nearly level soil occupies uplands mostly in the central part of the county. Areas of it are up to 600 acres or more in size.

The principal inclusions are Minnequa loam, 1 to 3 percent slopes, and Manvel silt loam, 0 to 3 percent slopes. Taken together these inclusions account for about 10 percent of each mapped area.

This soil has high water-holding capacity but moderately slow intake. There is a relatively high percentage of bare surface area because of the bunchy growth habit of alkali sacaton. This bare surface area encourages surface runoff. Keeping the range in good condition encourages the growth of vegetation and litter and thus retards runoff. The sheet erosion hazard is moderate when the range is in poor condition. (Nonirrigated capability unit VIe-2; Alkaline Plains range site)

Vona Series

The Vona series consists of deep, somewhat excessively drained, gently undulating sandy loams on the uplands in the west-central and north-central parts of the county.

In a typical profile the surface layer, about 4 inches thick, is pale-brown sandy loam that is soft when dry and very friable when moist. The subsoil, about 24 inches thick, is brown sandy loam that is free of lime in the upper part. The lower part is pale-brown sandy loam from which the lime has not been completely removed by leaching. These layers are slightly hard when dry and very friable when moist. The underlying material below a depth of about 28 inches is very pale brown sandy loam that has a high lime content. There are no restrictive layers in the underlying material.

Vona soils have a moderately rapid intake rate, moderately rapid permeability, and moderate water-holding capacity. Nearly all of the subsoil moisture is readily available to plant roots. These soils are free of harmful salts, but they are easily leached of plant nutrients. The wind erosion hazard is moderate to high.

Most of the acreage is used as range, but small areas are irrigated. The native vegetation on range consists mainly of blue grama, galleta, sand dropseed, yucca, pricklypear, buckwheat, and sand sage.

Typical profile of Vona sandy loam, 1 to 5 percent slopes, in an area of range, 0.2 mile south of the center of sec. 13, T. 24 S., R. 59 W.

A1--0 to 4 inches, pale-brown (10YR 6/3) sandy loam, dark brown (10YR 4/3) when moist; weak, fine, crumb structure that parts to single grain; soft when dry, friable when moist; pH 7.4; clear, smooth boundary.

B2t--4 to 15 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that parts to weak, medium to coarse, subangular blocky; slightly hard when dry, friable when moist; thin patchy clay films on vertical ped surfaces; noncalcareous, pH 7.4; clear, smooth boundary.

B3ca--15 to 28 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure that parts to single grain; slightly hard when dry, very friable when moist; few, small, soft lime concretions; strongly calcareous, pH 8.1; clear, smooth boundary.

C1ca--28 to 36 inches, very pale brown (10YR 7/3) sandy loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; few, medium, soft lime concretions; strongly calcareous, pH 8.0; gradual, smooth boundary.

C2--36 to 60 inches, very pale brown (10YR 7/4) sandy loam, yellowish brown (10YR 5/4) when moist; single grain; soft when dry, very friable when moist; strongly calcareous.

The A horizon ranges from 4 to 9 inches in thickness and from loamy sand to sandy loam in texture. The thickness of the B2t horizon ranges from about 6 to 15 inches. Lime is leached to a depth of 10 to 20 inches.

Vona soils are associated with Dwyer and Olney soils. They differ from Dwyer soils in having a sandy loam substratum rather than loamy sand. Olney soils have a sandy clay loam subsoil. The structure of the Vona subsoil is not so strong as the structure of the Olney subsoil.

Vona sandy loam, 1 to 5 percent slopes (VdC).--This soil has the profile described as typical for the series. Most of this soil is used for range and is in the north-central and west-central parts of the county. Areas are up to 800 acres or more in size. Most of the irrigation is in the vicinity of Holbrook Reservoir, where the areas range from 10 to 100 acres in size.

The principal inclusion is Otero sandy loam, 1 to 5 percent slopes, which accounts for about 10 percent of each mapped area.

This soil absorbs water well, and there is little surface runoff. There is a moderate hazard of wind erosion in overgrazed areas, and plant nutrients are easily lost through leaching and erosion.

Irrigated areas are on slopes of 1 to 3 percent. Frequent irrigation is required to maintain adequate moisture for crops. On the range there are a few rectangular eroded areas up to 80 acres in size. These were once farmed and have grown back to red three-awn, a forage grass of poor quality. These eroded areas need reseeding. (Irrigated capability unit IIIe-8; nonirrigated capability unit VIe-3; Sandy Plains range site)

Wiley Series

The Wiley series consists of deep, well-drained, nearly level to gently sloping loams that have formed in eolian silts mixed with clay loam weathered from parent sandstone. They are extensive soils in the southern part of the county.

In a typical profile the surface layer, about 5 inches thick, is light brownish-gray silt loam that is soft when dry and very friable when moist. The subsoil, about 18 inches thick, is pale-brown, very pale brown, and light yellowish-brown clay loam that is hard and very hard when dry but friable when moist. The substratum, from a depth of about 23 to 44 inches, is very pale brown limy clay loam. Below this is white, fine, crystalline gypsum that is underlain by sandstone at a depth of about 48 inches.

These soils have medium surface runoff, moderate water intake, moderate permeability, and high water-holding capacity. The erosion hazard is slight.

All of the acreage is used as range. The principal grasses are blue grama, galleta, and western wheatgrass. Alkali sacaton and cholla cactus occur in places.

The Wiley soils in Otero County are mapped only in an undifferentiated group with Kim soils.

Typical profile of a Wiley soil in an area of native range, 0.3 mile south and 165 feet west of the northeast corner of sec. 25, T. 27 S., R. 56 W.

A--0 to 5 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, crumb structure that parts to moderate, fine, crumb; soft when dry, very friable when moist; roots abundant to depth of 4 inches; calcareous; clear, smooth boundary.

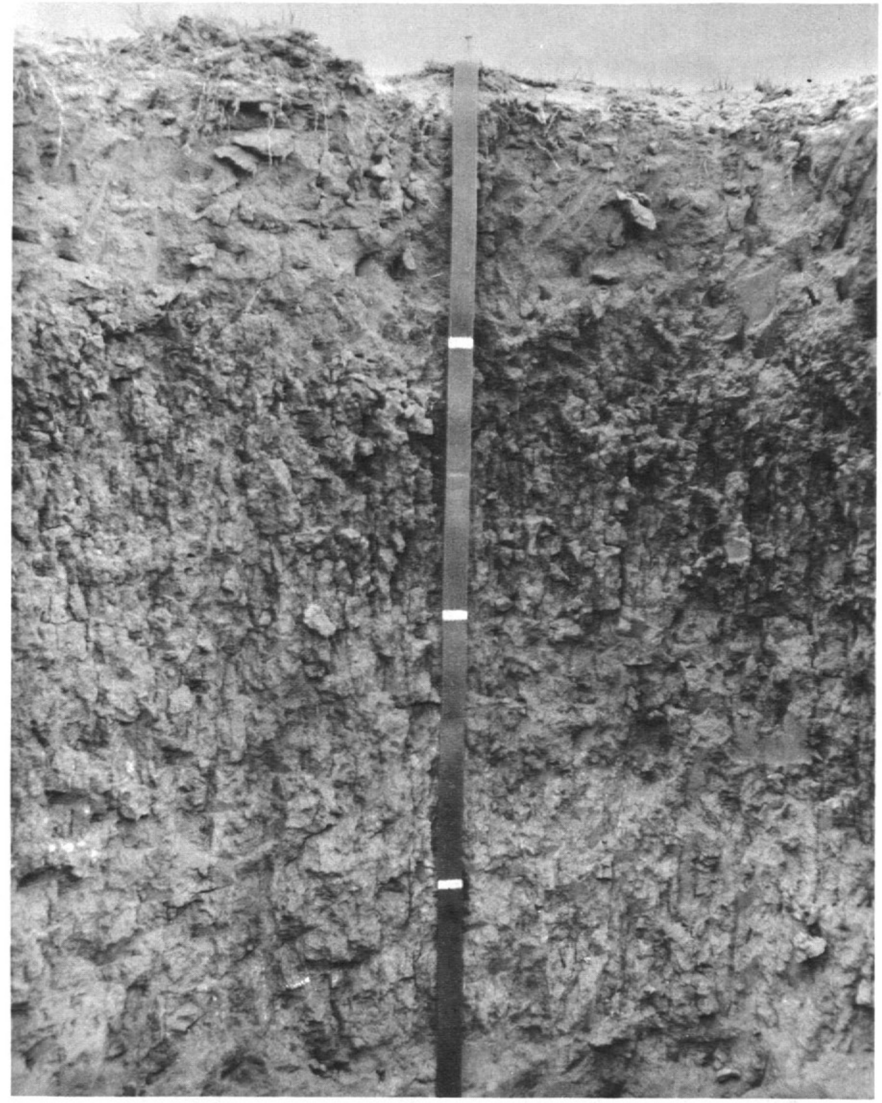
B1--5 to 8 inches, pale-brown (10YR 6/3) light clay loam, dark brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure that parts to moderate, very fine, subangular blocky; hard when dry, friable when moist, slightly sticky when wet; strongly calcareous; clear, smooth boundary.

B2t--8 to 14 inches, light yellowish-brown (10YR 6/4) light clay loam, dark brown (10YR 4/3) when moist; moderate to strong, medium, subangular blocky; very hard when dry, friable when moist, slightly sticky when wet; thin

Plowed field of Limon silty clay, 0 to 3 percent slopes, a heavy-textured soil difficult to keep in good tilth.

Erosion of Kornman and Neesopah loams, 3 to 5 percent slopes, during a winter irrigation.

Profile of Numa clay loam, 0 to 1 percent slopes, showing a surface layer that has been thickened by silt and clay settling from muddy irrigation water.



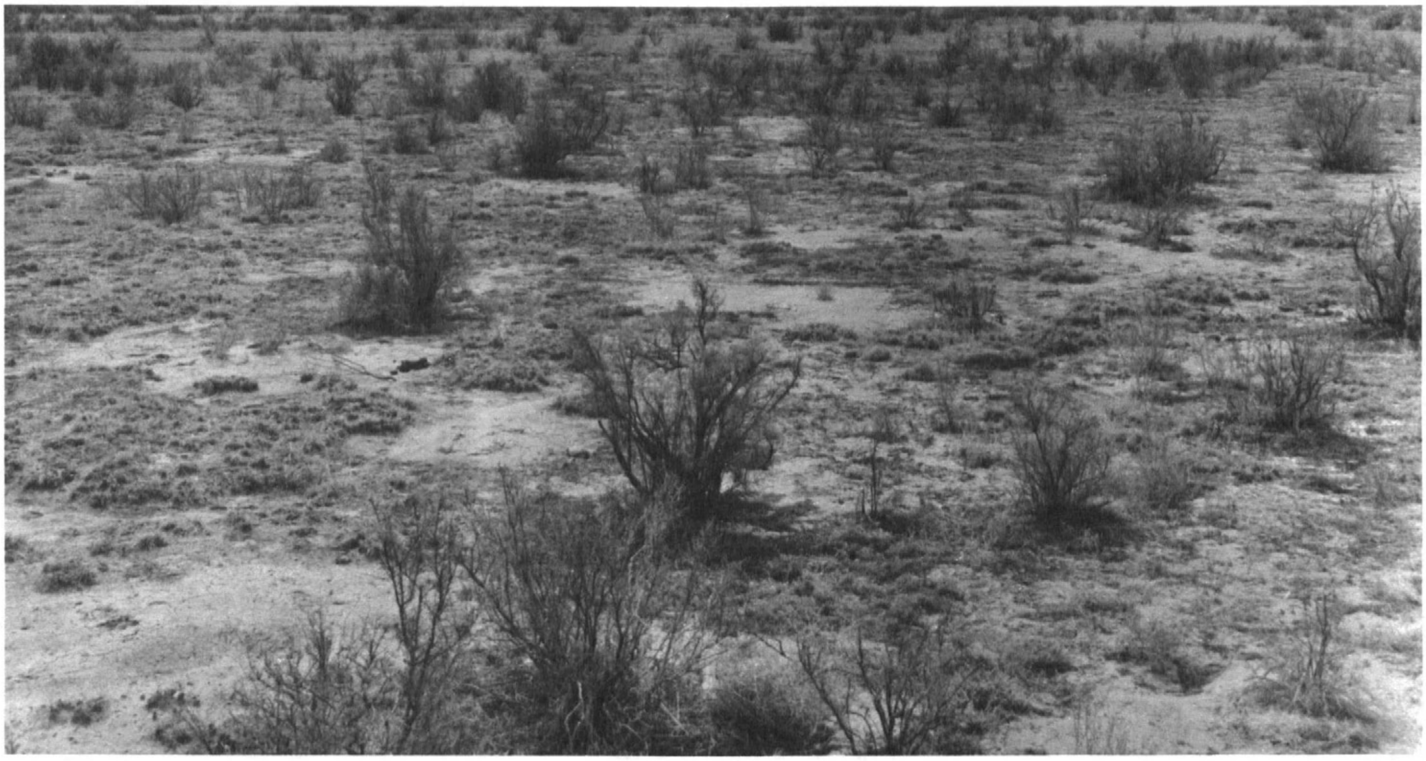
Profile of Olney sandy loam, 0 to 3 percent slopes. Strong structure of the subsoil is most evident between the top white mark and the next mark below it.

Rocky Ford cantaloups on Rocky Ford silty clay loam, 0 to 1 percent slopes, are ripening in field to be harvested for seed.

White onions on Nepesta clay loam, 0 to 3 percent slopes. The yield is about 275 hundredweight per acre.

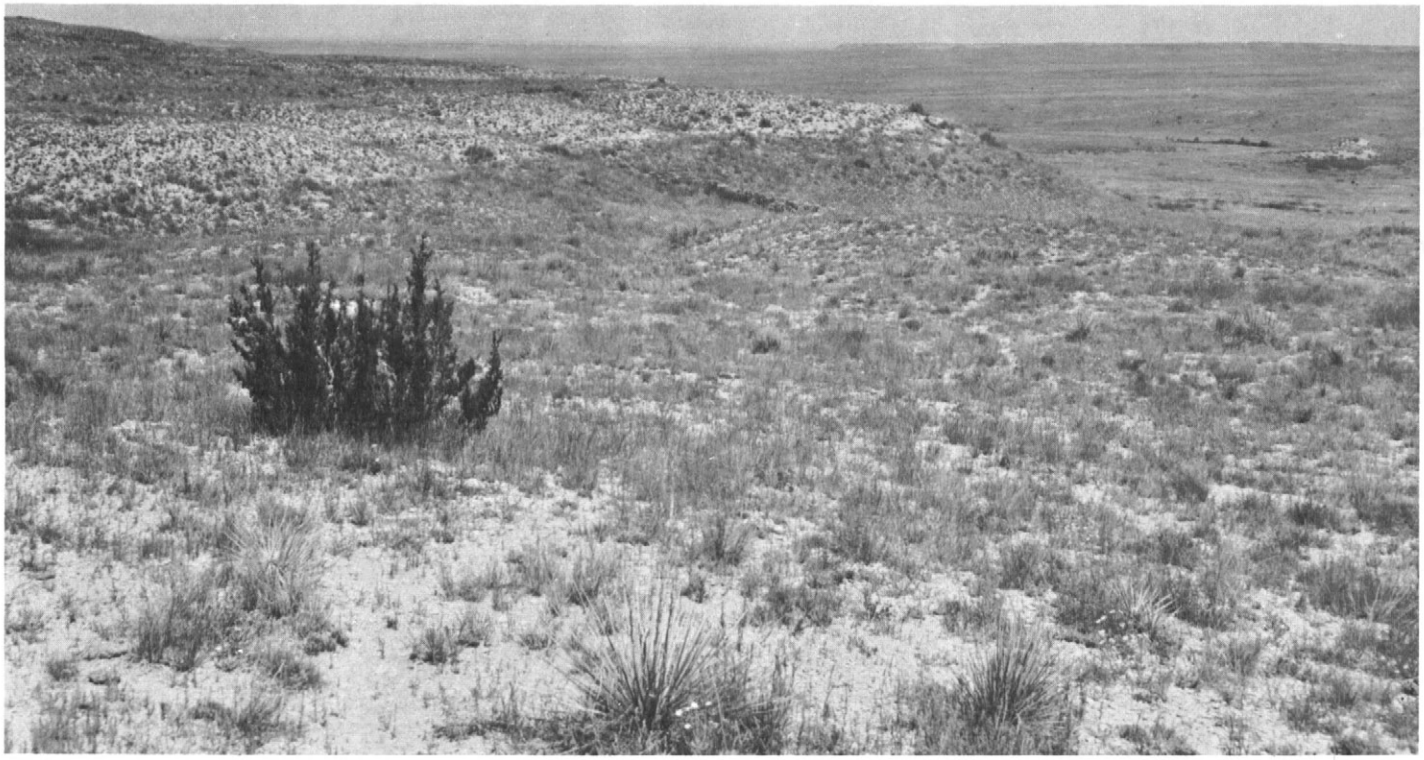
Travessilla sandy loam, 1 to 9 percent slopes, is in the Sandstone Breaks range site and is a good soil for winter pasture.

Meadow range site on Bloom loam.



Salt Flat range site on Limon silty clay, 0 to 3 percent slopes.

Sandy Bottomland range site in foreground, on Glenberg loamy fine sand, 0 to 1 percent slopes.



Limestone Breaks range site on Penrose channery loam, 1 to 25 percent slopes.

Gravel Breaks range site on Cascajo soils and Gravelly land.

continuous clay films on ped surfaces; strongly calcareous; clear, smooth boundary.

B3ca--14 to 23 inches, very pale brown (10YR 7/4) clay loam, yellowish brown (10YR 5/4) when moist; weak to moderate, medium and fine, subangular blocky structure; very hard when dry, friable when moist; few medium mottles of lime; strongly calcareous; gradual, smooth boundary.

C1ca--23 to 32 inches, very pale brown (10YR 7/3) clay loam, yellowish brown (10YR 5/4) when moist; weak, medium, subangular blocky structure; hard when dry, very friable when moist; roots common to depth of 27 inches; few small sandstone fragments; few fine gypsum crystals; strongly calcareous; gradual, smooth boundary.

C2ca--32 to 44 inches, very pale brown (10YR 7/4) clay loam, yellowish brown (10YR 5/4) when moist; massive; soft when dry, very friable when moist; few small sandstone fragments; few fine gypsum crystals; strongly calcareous; clear, smooth boundary.

C3cs--44 to 48 inches, white (10YR 8/2) fine crystalline gypsum, very pale brown (10YR 7/4) when moist; clear, smooth boundary.

R--48 to 60 inches, Dakota sandstone.

The texture of the A horizon ranges from fine sandy loam to silt loam. The depth to parent rock ranges from about 3 to 6 feet.

Wiley soils are associated with Kim and Travessilla soils. Of these soils, they are most like the Kim soils. They differ in being somewhat finer textured and in having a B2t horizon.

USE AND MANAGEMENT OF SOILS

This section discusses the system of capability grouping used by the Soil Conservation Service, and the management of the soils in Otero County by capability groups. Irrigated capability units and yields of irrigated crops on the soils in these units are given first; next, nonirrigated capability units are discussed. Also presented is management of the soils for range, woodland, windbreaks, recreation, wildlife, and engineering works.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field 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 trees, or engineering.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and 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 use, defined thus:

Class I soils have few limitations that restrict their use.

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

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

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

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

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. (None in Otero County.)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, <u>e</u>, <u>w</u>, <u>s</u>, or <u>c</u>, to the class numeral, for example, II<u>e</u>. The letter <u>e</u> shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; <u>w</u> 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); <u>s</u> shows that the soil is limited mainly because it is shallow, droughty, or stony; and <u>c</u>, used in only some parts of the United States, but not in Otero County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by w, s, and c, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, 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, IIe-1 or IIIe-9. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Otero County are described and suggestions for the use and management of the soils are given. All those capability units made up of irrigated soils are described first, and then those capability units for soils not irrigated.

The numbering of the capability units is not consecutive because a statewide system is used in Colorado, and some of the units are not represented in the county.

Management of Irrigated Soils

About 79,500 acres of the soils in Otero County are irrigated. Most of the irrigation water is obtained by diverting water from the Arkansas River. Wells, where underground water is available, are used to supplement ditchwater. Only about half of the irrigated acreage has reliably adequate water for intensive irrigation agriculture.

The irrigated soils are used to produce cultivated crops, and grasses and legumes for hay and pasture. The principal cultivated crops are alfalfa, corn, grain sorghum, sugar beets, and small grains. Other crops grown are onions (pl. 3, bottom), pinto beans, melons, and potatoes. Specialty crops such as zinnias for seed production and tomatoes for canning are grown under contract.

Most of the irrigated soils in Otero County are irrigated by surface irrigation rather than by sprinkler. Water is delivered to the fields in ditches. Row crops are usually irrigated by the furrow method. Border, corrugation, and contour ditch methods are used to irrigate drilled and close-growing crops.

The supply of irrigation water varies greatly from year to year. Adequate facilities for storing water are lacking, and water supplies depend on stream flow. Some fields, under ditches with poor water rights, are not irrigated for 2 or more years at a time because of inadequate water supplies. During low stream flow, the water from streams carries a high percentage of salt. During high stream flow, nearly all systems carry a high silt load. Over the years, the silt has thickened the surface layer, reduced the intake rate, and caused problems of tilth and seedbed preparation.

Following are descriptions of the irrigated capability units in Otero County.

Capability Unit I-1, Irrigated

The one soil in this unit, Olney sandy clay loam, 0 to 1 percent slopes, is deep, nearly level, friable, and is on uplands. It is easy to work, moderately fertile, and well suited to irrigation. It is moderately permeable and has high water-holding capacity. There is little erosion hazard. Maintaining tilth and fertility is the major management problem.

This soil is well suited to all locally adapted crops. Corn and vegetable crops are the major crops.

This soil can be continuously row cropped. If farmed this way, it should be chiseled and subsoiled every 6 or 7 years. The return of adequate amounts of crop residue to the soil is needed to maintain tilth and the supply of organic matter and to protect the soil from erosion. Land leveling and good irrigation management are important factors.

Capability Unit IIe-1, Irrigated

This unit consists of deep, well-drained, gently sloping, medium-textured to moderately fine textured soils. These soils are in the Kornman, Neesopah, Numa, and Rocky Ford series. They make up some of the best irrigated acreages in the valley. They are fertile and free of harmful salts, and they are easy to work. The surface layer has a medium to moderately slow intake rate. Numa and Rocky Ford soils have a high water-holding capacity, but Kornman and Neesopah soils have only moderate capacities, and, under similar cropping, require more frequent irrigation. Plant nutrients are not readily lost through leaching, but may be lost through erosion. The major management problems are maintaining tilth and fertility and controlling erosion.

The soils of this unit are suitable for all locally adapted crops. For the most part, they are used for cash crops. It is suggested that sugar beets and potatoes be grown on the Rocky Ford and Numa soils because of the high water requirement of these crops. On the other hand, such crops as sorghum and alfalfa can be grown on Kornman and Neesopah soils.

These soils are suited to continuous row cropping. This practice, however, results in the greatest hazard of soil erosion and loss of plant nutrients. Crop residue needs to be utilized to help maintain the supply of organic matter; this, in turn, improves tilth, increases water intake, and helps control erosion. Green manure and barnyard manure are sources of additional organic matter. Reducing tillage to a minimum helps maintain tilth and reduces the erosion hazard.

The irrigation methods most suitable are the furrow, the corrugation, and the field-ditch method with ditches on the contour. Land leveling generally insures satisfactory distribution of water. Border irrigation is suitable for well-leveled land. Cross-slope irrigation is suggested for row crops.

Capability Unit IIew-1, Irrigated

This unit consists of deep, moderately well drained, gently sloping silty clay loams that are seeped and salty. These soils are in the Harvey and Rocky Ford series. In some areas, poor subsoil aeration affects deep-rooted crops. The main management problems are controlling water erosion and improving drainage.

These soils are suited to all but the least salt-tolerant crops, such as beans and vine crops. They are used mostly for alfalfa, sugar beets, corn, and sorghum.

These soils are easily worked and can be continuously row cropped; however, this practice increases the hazard of erosion. Use of crop residue helps to improve the supply of organic matter; this, in turn, helps to improve water intake and to reduce the hazard of erosion.

Irrigation methods suitable are the furrow, the corrugation, and the field-ditch method with ditches on the contour. Good irrigation water management in some instances includes cross-slope irrigation for row crops. Land leveling is beneficial in places. Most seep spots can be controlled by lining canals, laterals, or field ditches. In places, drainage mains and laterals are needed.

Capability Unit IIws-1, Irrigated

The one soil in this unit, Rocky Ford silty clay loam, wet, 0 to 1 percent slopes, is deep, moderately well drained, nearly level, and has been seeped. Although it is not too wet to farm, poor drainage and salt accumulation on the surface damage some crops. The main management problems are maintaining tilth and fertility and preventing additional salt accumulation.

This soil is suited to all but the least salt-tolerant crops and grasses. It is used mostly for corn, sorghum, small grain, sugar beets, and alfalfa.

This soil can be continuously row cropped, but intense cultivation can produce a compacted subsoil. Chiseling and subsoiling every 5 or 6 years help keep the subsoil open. This practice is most helpful just before planting alfalfa. Keeping the number of tillage operations to a minimum helps to maintain tilth following chiseling and subsoiling. The supply of organic matter can be maintained and tilth improved by making use of crop residue and green manure.

Irrigation methods suitable are the furrow, the corrugation, and the border methods. The border method requires a well-leveled field. In places, drainage mains or laterals are needed to remove excess water.

Capability Unit IIs-1, Irrigated

This unit consists of deep, fertile, well-drained, nearly level silty clay loams free of harmful accumulations of salts. These soils are in the Kornman, Limon, Neesopah, Nepesta, Numa, and Rocky Ford series. The water intake rate is moderately slow, although areas not as thickly silted as normal may have a medium intake rate. The water-holding capacity is moderate to high.

There is little hazard of erosion. The main management problems are improving tilth and keeping a high level of fertility.

These are among the best irrigated soils in the county. They are suited to all locally adapted crops and grasses. For the most part, they are used for cash crops.

These soils can be continuously row cropped, but intense cultivation can produce tillage pans. Chiseling and subsoiling to a depth of about 20 inches every 5 or 6 years helps break up tillage pans. This practice is the most beneficial just before planting alfalfa. Keeping the number of tillage operations to a minimum helps maintain tilth. The supply of organic matter can be maintained and tilth improved by making use of crop residue and green manure. Small-grain stubble or corn stubble, when plowed under, helps increase intake rate.

The irrigation methods suitable are the furrow, the corrugation, and the border methods. Leveling helps improve water distribution, especially where border irrigation is used.

Kornman and Neesopah soils, because of their sandy loam subsoil, show the effects of drought sooner than the other soils. Limon silty clay loam, 0 to 3 percent slopes, is the most difficult soil of this unit to manage. It has the slowest intake rate and permeability and is slightly saline. Nevertheless, the management suggestions made in this capability unit best suit this soil.

Capability Unit IIIe-1, Irrigated

This unit consists of moderately deep to deep, gently sloping silty clay loams underlain by limestone or marl that restricts internal drainage. These soils are in the Minnequa and Rocky Ford series. The intake rate is moderately slow, and permeability is moderate. Because of slow internal drainage, excess water can gather in the subsoil during irrigation and cause small seep spots. The main conservation problems are improving tilth, maintaining fertility, and preventing water erosion and seep spots.

These soils are suited to all but the least salt-tolerant crops, such as beans and vine crops. The most common crops are corn, sorghum, alfalfa, and small grain. An alternate use is for irrigated pasture. Tall fescue, tall wheatgrass, and intermediate wheatgrass are well suited.

These soils are somewhat difficult to work. Tilth can be maintained and erosion controlled with a crop rotation that provides for growing a row crop no more than 3 years in succession, and for growing a grass-legume or other close-growing crops a minimum of one-fourth of the time. Use of crop residue and green manure is suggested.

Irrigation methods suitable are the furrow, the corrugation, and the field-ditch method with ditches on the contour. Where needed, leveling helps in using water efficiently. Cross-slope irrigation helps reduce erosion. In some places, tile drains increase productivity by removing excess water from the subsoil and thus preventing seep spots. Border irrigation is suitable for irrigated pasture if there is little or no cross slope.

Capability Unit IIIe-2, Irrigated

This unit consists of deep, well-drained, gently sloping, easily worked loams and clay loams. These soils are in the Kornman, Neesopah, and Numa series. Water intake is moderate, permeability is medium to moderately rapid, and water-holding capacity is moderate to low. Plant nutrients are lost through leaching and erosion. The main management problems are controlling water erosion (pl. 1, bottom) and maintaining fertility.

These soils have severe limitations for crops with high water requirements, such as potatoes and sugar beets. The most common crops are corn, sorghum, small grain, and alfalfa. An alternate use is for irrigated pasture. Tall wheatgrass, with its extensive root system, withstands drought, and intermediate wheatgrass, because of its sod-forming habit, provides good erosion control.

A good crop rotation provides for grass, legume, or other close-growing crops to be grown one-fourth to one-half of the time and row crops no more than 2 or 3 years in succession. Crop residue used to help maintain supply of organic matter also helps control erosion.

The irrigation methods suitable are the furrow, the corrugation, and the field-ditch method with the ditches on the contour. Land leveling helps improve the distribution of water. Erosion is best controlled by irrigating with the smallest head of water.

Capability Unit IIIe-8, Irrigated

This unit consists of deep, somewhat excessively drained, gently sloping sandy loams. These soils are in the Otero and Vona series. They have a moderately rapid intake rate and permeability and moderate water-holding capacity. The erosion hazard is moderate to high, and plant nutrients are easily lost through leaching. The main management problems are controlling wind and water erosion and maintaining fertility.

These soils are suited to feed crops, irrigated pasture, and wildlife habitat. They are used mostly for feed crops. Alfalfa is well suited because the stands remain dense for a long time, give good erosion control, and make efficient use of irrigation water, which is usually in short supply. On irrigated pasture, tall and intermediate wheatgrass withstand drought and help control erosion.

There is little hazard of compaction on these soils. Crop residue and winter cover crops help control wind and water erosion and help maintain the supply of organic matter.

Irrigation water can be applied by sprinklers, from contour ditches, and in furrows and corrugations. Because of the moderately rapid intake, it is important that the surface be planed or leveled to get good distribution of water. The length of irrigation runs needs to be relatively short. Fewer plant nutrients are lost if irrigation is light but frequent.

Capability Unit IIIe-9, Irrigated

The one soil in this unit, Glenberg loamy fine sand, 0 to 1 percent slopes, is deep, somewhat excessively drained, nearly level, easily worked, and is on stream terraces. It has a rapid intake rate, moderately rapid permeability, and moderate to low water-holding capacity. The substratum below a depth of about 3 feet is usually moist with water that comes from a deep water table. This soil is low in fertility and is easily leached of nutrients. The wind erosion hazard is high if the soil is farmed. The main management problems are increasing productivity and controlling wind erosion.

This soil is suited to most irrigated crops for which there is adequate water. Alfalfa is well suited because it makes efficient use of water and helps control erosion. This soil is also suited to irrigated and nonirrigated pasture and to wildlife habitat. Wheatgrass, bromegrass, and orchardgrass are well adapted. Pasture and hay planting helps increase production. Planting of deep-rooted legumes and grasses helps make use of moisture in the substratum.

Sprinkler irrigation is best suited to this soil because its surface is uneven and erosion is a hazard. In places, irrigation water can be obtained from shallow wells. Weed control helps in establishing pasture or hay.

Capability Unit IIIew-4, Irrigated

The one soil in this unit, Apishapa loamy sand, is deep, somewhat poorly drained, nearly level, and is on river terraces. It has a rapid intake rate, has slow permeability, and is underlain by wet sand. This soil is low in fertility, and where not drained, is wet and saline. Where drained and farmed, the hazard of wind erosion is high. The main management problems are increasing production and controlling wind erosion.

This soil is suited to irrigated pasture and crops. It is used mostly for pasture. Seeding of pasture and hay helps to increase production. Tall wheatgrass and switchgrass are suited to wet areas. Areas that are drier or have been drained can be planted to intermediate wheatgrass, tall wheatgrass, or tall fescue.

Frequent, light sprinkler irrigation is suggested for maintaining optimum moisture. Corrugations can be used on leveled pasture. Drainage of the higher lying parts can be accomplished with main drainage ditches and laterals. Because of its low fertility, this soil needs fertilizing, especially with nitrogen.

Capability Unit IIIw-1, Irrigated

The one soil in this unit, Bloom loam, is deep, poorly drained, and nearly level. Plant growth is affected by salinity, a fluctuating water table, and seep water from irrigation canals and higher lying irrigated land. The water table ordinarily is highest in the early part of the growing season. The main management problems are reducing wetness and salinity.

This soil is suited to pasture and, where there are small marshy areas, as wildlife habitat. A well-prepared seedbed is essential for establishing pasture. Tall wheatgrass, once established, helps increase production. It is difficult to improve drainage enough to grow even the more salt-tolerant crops, such as sorghum and barley.

The most inexpensive drainage system can be used to improve the wettest areas for pasture. Open drains are usually most economical.

Capability Unit IIIs-1, Irrigated

This unit consists of deep, nearly level, fine textured and moderately fine textured soils with slow internal drainage. These soils are in the Apishapa, Limon, Minnequa, and Rocky Ford series. Water intake and permeability are slow. The surface layer is slightly saline, and salinity increases with depth. The subsoil compacts readily from tillage and is poorly aerated. The main management problems are increasing productivity and irrigating so that seepage is avoided. Minnequa and Rocky Ford soils are not as clayey and difficult to work as the Apishapa and Limon soils, but they were included because of their slow internal drainage.

These soils are suited to all but the least salt-tolerant crops. They are used mostly for sorghum, corn, sugar beets, alfalfa, and onions. Using the land for irrigated pasture avoids the expense and hazard caused by continuous cropping. With good management, grass yields of intermediate and tall wheatgrass can be as good as on soil with fewer hazards and limitations.

To improve tilth, it is necessary to avoid continuous row cropping. A good crop rotation provides a grass, a legume, or some other close-growing crop one-fourth to one-half of the time, and row crops not more than 2 or 3 years consecutively. Mechanical practices for soil conditioning are of value. The greatest benefits from chiseling and subsoiling can be expected if done just before planting alfalfa. Minimum tillage following chiseling and subsoiling helps maintain good tilth. Green-manure crops, crop residue, and grassland legumes provide organic matter and improve the porosity of the subsoil. When plowed down, small-grain stubble or corn stubble is effective for increasing water intake.

Irrigation water applied in furrows, in corrugations, or in borders is suited for these soils. Irrigation runs can be relatively long. Land leveling is needed in places. Tile drains in Minnequa and Rocky Ford soils improve the internal drainage.

Capability Unit IIIs-2, Irrigated

The one soil in this unit, Rocky Ford loam, sand subsoil variant, 0 to 3 percent slopes, is moderately deep, droughty, gently sloping, and is 18 to 36 inches deep over sand. This soil takes water well and is moderately permeable, but it has only a moderate water-holding capacity because of the sandy subsoil. Generally, crop yields are not high enough to remove great amounts of nutrients; however, nutrients are lost through erosion, leaching, and overirrigating. The erosion hazard is moderate. The main management problems are controlling erosion and managing the distribution of water well.

This soil is suited to all irrigated uses. Drought-tolerant or shallow-rooted crops are most suitable. The soil is mostly used for corn, sorghum, and alfalfa. An alternate use is for irrigated pasture. Any of the wheatgrasses are suitable.

This soil is suited for continuous row cropping. The erosion hazard, however, is lessened by growing a legume, grass, or close-growing crop one-fourth to one-half of the time. Use of crop residue helps to maintain the content of organic matter.

Water can be applied in furrows, in corrugations, or from field ditches on the contour. Frequent, light irrigations keep erosion and water loss to a minimum. Land leveling is needed in places. The depth of cuts is limited by soil depth.

Capability Unit IVe-1, Irrigated

The one soil in this unit, Numa loam, gravel subsoil variant, 5 to 9 percent slopes, is deep, well-drained, strongly sloping, and is underlain by gravel at depths of 18 to 36 inches. In places the surface layer is gravelly or cobbly. Permeability is moderate, and the water-holding capacity is moderate. The hazard of water erosion is high. Erosion removes large amounts of plant nutrients. The main concern in management is controlling water erosion.

This soil is best suited to irrigated pasture. It is suited to all locally adapted grasses, but sod-forming grasses, such as intermediate wheatgrass, provide the most erosion control. Irrigated crops, such as alfalfa, small grain, corn, or sorghum, are also suited.

In order to control erosion, a suitable rotation provides for row crops no more than 2 years in succession, and grass, legume, or other close-growing crops at least half of the time. Fertilizer is needed to increase growth of vegetation and the amount of crop residue.

Irrigation water can be applied in furrows, in corrugations, or from field ditches on the contour. The typical shape of the area is wide strips that are relatively short uphill and downhill. The soil is suitable for a small head of water, which helps control erosion. The depth of cuts in land leveling is limited by soil depth.

Capability Unit IVw-2, Irrigated

This unit consists of Las Animas soils. These are deep, poorly drained sands on stream terraces and bottoms. The water table fluctuates at a depth ranging from a few inches to 3 feet, and there is occasional flooding. Most areas are wet much of the time. The main concern in management is to increase productivity of these marginal soils.

These soils are suited to irrigated pasture and wildlife habitat. Tall wheatgrass and switchgrass are the most suitable grasses. If leached and drained, these soils are suited to crops.

A high level of management is needed to get a seedbed suitable for establishing grasses in irrigated pasture. In places, brush and weed control or clearing is needed. Habitat for waterfowl can be improved by ponding and by planting feed grains.

In dry years, irrigating with sprinklers helps to maintain production.

Capability Unit IVs-7, Irrigated

This unit consists of excessively drained, sandy and moderately sandy soils that are 15 to 36 inches deep over sand and gravel. These soils are in the Bankard and Glenberg series. Water intake is rapid, permeability is moderately rapid to very rapid, and water-holding capacity is moderate to low. Wind erosion hazard is moderate, and the soils are low in fertility. The main concerns in management are controlling erosion and increasing productivity.

These soils have many limitations if irrigated. Drought-tolerant crops, such as sorghum, are most suitable. A few small areas are farmed, but most of the acreage is used for grass. An alternate use of this land is for irrigated pasture. Intermediate and tall wheatgrass are best suited, because of their tolerance for drought.

These soils are suited to continuous row cropping. Use of crop residue helps to control erosion and to maintain the content of organic matter. Grass that is planted with a light nurse crop helps to control erosion.

Frequent, light sprinkler irrigation helps maintain soil moisture. Furrow irrigation is suited to row crops if the length of the furrows is kept short. The depth of cuts made in land leveling is limited by the soil depth. Fertilizer, especially nitrogen, is needed for favorable production.

Capability Unit IVs-8, Irrigated

The one soil in this unit, Bankard sand, is deep, excessively drained, nearly level, and is on stream terraces. Water intake is rapid, permeability is very rapid, and water-holding capacity is low. This soil is easily leached of plant nutrients, and the hazard of wind erosion is high. The main concerns in management are controlling erosion and increasing fertility and productivity.

This soil has many limitations for irrigation. It is used mostly for grass, but if well managed, it can be productive pasture. Intermediate and tall wheatgrass are best suited because of their drought tolerance. An alternate use of this soil is for crops, if there is enough irrigation water. Sorghum withstands well the short periods of drought that often occur.

Frequent irrigation is needed to help maintain soil moisture. A self-propelled sprinkler irrigation system is the most suitable. Seeding in a well-prepared seedbed with a nurse crop helps to provide erosion control. Brush and weed clearing prior to planting is needed in places. Use of crop residue helps to maintain supply of organic matter and to control erosion. Fertilizer, especially nitrogen, is needed where the soil is regularly irrigated.

Capability Unit VIe-1, Irrigated

The one soil in this unit, Shingle loam, 1 to 9 percent slopes, is gently sloping and is about 12 inches deep to gypsiferous shale. It has a moderate intake rate, moderate permeability, and low water-holding capacity. It is low in fertility and the erosion hazard is high. The main concern in management is maintaining a plant cover that controls water erosion.

This soil has many limitations for irrigation, but can be used for irrigated pasture. The wheatgrasses are the best adapted. An alternate use is for wildlife habitat.

Irrigating from corrugations or from field ditches on the contour provides the simplest and most effective distribution of water. Irrigation with the smallest head of water practical is a means of minimizing erosion. Land smoothing helps the flow of water in some places. Wildlife, such as pheasants and rabbits, can be encouraged by planting borders of irrigated fields to suitable shrubs.

Predicted Yields

Table 2 gives predicted yields per acre for the principal irrigated crops grown in the county. Yields in columns A are those that can be expected with an average level of management. Yields in columns B are those expected under a high level of management. The predictions are based upon yield records of the Arkansas Valley Branch Experiment Station at Rocky Ford, and sugar beet yield records obtained from the sugar company for individual farms.

Crops at the experiment station are grown on Rocky Ford silty clay loam, 0 to 1 percent slopes. The yield predictions for the other soils were adjusted on basis of experiment station records, knowledge of soil characteristics and qualities, and interviews with individual farmers.

The yield predictions in columns A of table 2 are those that can be expected under an average level of management. This management includes (1) adequate fertilization for sugar beets; (2) irrigation water applied carefully when available,in amount the irrigator estimates as sufficient; (3) land leveling where urgently needed, and (4) growing various crops in sequence but not in a planned rotation.

The yield predictions in columns B can be expected with improved management, which includes (1) using a crop rotation in which alfalfa or grass is maintained a minimum of 3 years; (2) keeping the number of tillage operations to a minimum so as to maintain soil physical condition; (3) maintaining fertility by fertilizing to replace all nutrients estimated to be removed by crops, erosion, and leaching; (4) managing irrigation water properly; (5) sowing good seed on a well-prepared seedbed; (6) controlling weeds and insects; and (7) completing all cultural practices at the right time.

The yields in columns B are equivalent to those at the experiment station. They have been attained or exceeded in some years by the better farm managers. The yields in columns B assume a reliable water supply equivalent to that from the Rocky Ford Canal or Catlin Canal.

Management of Nonirrigated Soils

About 695,000 acres of nonirrigated land is in Otero County, and nearly all of it is in native grass used as range. Suggestions for managing soils used for range are given in the nonirrigated capability units that follow. The effects of grazing on range plants on different kinds of soil are explained in the section "Management of Soils for Range."

None of this acreage of range is suited to dryland crop production; it is too dry and erosive. In the 1930's, thousands of acres were broken out of sod but were quickly abandoned because crop failure and erosion proved that they could not be farmed profitably. After 30 years, most of this abandoned farmland has not grown back to good native grass. Most attempts at planting in order to hasten the return to permanent grass have failed. More time and a few exceptionally wet years will be needed to get a well-established cover of desirable grass.

Pasture planting, the planting of introduced or domestic grasses and legumes, is suggested only for especially favorable areas of abandoned cropland or in areas of nonirrigated land that may receive extra water through seepage, irrigation, or natural runoff. Such favorable areas do not occur in any particular soil or capability unit. Most of the areas are small and not of great economic importance to the county.

Clayey soils that are not irrigated, but are seeped or get extra water from irrigation or runoff, can be planted to crested wheat, tall fescue, and, if occasionally under water, reed canarygrass. Sandy soils that contain extra moisture are suited to switchgrass and the wheatgrasses. Sweetclover, 1 or 2 pounds per acre, can be added to the above grasses. Strawberry clover does well on wet or salty areas. Most plantings should be made in existing cover. Sweep or lister drills and strip planting permit seeding without destroying the ground cover needed to prevent blowing or washing. Local conservation agents may be consulted for specific suggestions.

Some of these nonirrigated soils are suited to woodland, windbreaks, recreation, and wildlife.

Following are descriptions of the nonirrigated capability units in Otero County.

Capability Unit VIe-1, Nonirrigated

This unit consists of moderately deep to deep, well-drained, nearly level to gently sloping, medium-textured to fine-textured soils of the uplands. These soils are in the Baca, Harvey, Stoneham, Kim, Wiley, Manvel, and Minnequa series. Permeability is medium to moderately slow, and water-holding capacity is moderate to high. The intake rate is medium to moderately slow; it is the highest in the Harvey and Stoneham loams. Runoff following heavy thunderstorms is rapid if the range has been overgrazed. The main management problems are reducing the hazard of erosion and increasing range productivity.

Because of the wind erosion hazard, these soils are suited only to permanent grass and wildlife habitat. The entire acreage is used for grass, and blue grama and side-oats grama are the best adapted grasses. Wildlife inhabit areas of these soils along with livestock. Antelope is the most important wildlife species, and jackrabbits are numerous in some years.

Permitting accumulation of litter and mulch helps reduce runoff and the hazard of erosion and allows more water to enter the soil. Mechanical practices help retain water from rain or snowmelt, and they are most valuable on deteriorated range, especially on Manzanola and Minnequa soils. Range seeding increases forage production and reduces soil and water loss. This practice is needed on deteriorated range. Grass must be planted in a

TABLE 2.--PREDICTED AVERAGE CROP YIELDS PER ACRE OF PRINCIPAL IRRIGATED CROPS UNDER TWO LEVELS OF MANAGEMENT

[Yields in columns A are those predicted under an average level of management; yields in columns B are those predicted under a high level of management. Absence of an entry in a column indicates the crop is not suited to the soil or that it is grown only in small amounts]

Soil	Corn		Wheat		Sugar beets		Grain sorghum		Beans		Alfalfa	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Bu.	Bu.	Cwt.	Cwt.	Tons	Tons
Apishapa loamy sand------	78	90	35	40	8.0	10	72	85	6	10	2.5	4.0
Apishapa clay------------	55	70	35	45	12.0	16	50	68	8	10	2.0	3.5
Bankard sand-------------	25	45	20	33	---	--	25	50	5	15	1.5	2.5
Bloom loam---------------	15	45	15	30	---	--	20	50	--	--	1.5	2.5
Glenberg loamy fine sand, 0 to 1 percent slopes--	55	90	27	45	11.0	16	54	81	12	18	2.5	5.0
Glenberg-Bankard sandy loams, 0 to 1 percent slopes-----------------	35	60	25	40	9.0	15	50	70	10	18	2.0	4.0
Harvey loam, wet, 0 to 3 percent slopes---------	40	80	20	40	---	--	37	70	--	--	1.5	3.0
Kornman and Neesopah loams, 0 to 1 percent slopes-----------------	85	110	42	60	14.0	19	76	99	15	22	4.5	6.0
Kornman and Neesopah loams, 1 to 3 percent slopes-----------------	70	100	35	52	12.0	18	67	90	14	19	4.0	6.0
Kornman and Neesopah loams, 3 to 5 percent slopes-----------------	35	60	27	40	8.0	14	36	58	7	16	3.0	5.0
Las Animas soils---------	--	--	--	--	---	--	--	--	--	--	---	---
Limon silty clay loam, 0 to 3 percent slopes----	60	95	30	57	13.0	19	55	83	10	16	3.0	5.0
Limon silty clay, 0 to 3 percent slopes---------	40	65	25	55	10.0	15	34	58	7	10	2.0	3.5
Minnequa silty clay loam, 0 to 1 percent slopes--	40	70	25	35	8.0	12	40	68	7	10	2.5	4.0
Minnequa silty clay loam, 1 to 5 percent slopes--	35	65	25	40	7.0	11	33	67	7	12	1.5	3.0
Nepesta clay loam, 0 to 3 percent slopes-------	65	120	40	60	13.0	22	67	108	15	20	2.5	5.0
Numa clay loam, 0 to 1 percent slopes---------	65	120	40	60	14.0	22	58	108	15	20	2.5	5.0
Numa clay loam, 1 to 3 percent slopes---------	65	110	35	60	12.5	18	58	100	14	20	3.5	5.0
Numa clay loam, 3 to 5 percent slopes---------	45	85	28	40	9.0	14	45	76	9	16	2.5	4.0
Numa loam, gravel subsoil variant, 5 to 9 percent slopes---------	20	30	15	25	---	--	22	32	6	12	1.5	4.0
Olney sandy clay loam, 0 to 1 percent slopes--	85	120	35	60	14.0	21	76	108	14	21	3.0	6.0
Otero sandy loam, 1 to 5 percent slopes-------	--	--	--	--	---	--	--	--	--	--	---	---
Rocky Ford silty clay loam, 0 to 1 percent slopes-----------------	85	120	35	60	16.0	22	76	108	16	21	4.5	6.0
Rocky Ford silty clay loam, 1 to 3 percent slopes-----------------	80	120	35	60	14.0	20	67	100	15	20	4.0	6.0
Rocky Ford silty clay loam, wet, 0 to 1 percent slopes---------	85	110	38	55	15.0	22	76	99	8	12	3.0	6.0

TABLE 2.--PREDICTED AVERAGE CROP YIELDS PER ACRE OF PRINCIPAL IRRIGATED CROPS UNDER TWO LEVELS OF MANAGEMENT--Continued

Soil	Corn		Wheat		Sugar beets		Grain sorghum		Beans		Alfalfa	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Bu.	Bu.	Cwt.	Cwt.	Tons	Tons
Rocky Ford silty clay loam, wet, 1 to 3 percent slopes---------	82	100	37	55	14.5	21	72	90	8	12	3.0	5.0
Rocky Ford silty clay loam, limestone substratum, 0 to 1 percent slopes------------	60	95	40	55	14.0	20	58	90	9	15	3.0	4.5
Rocky Ford silty clay loam, limestone substratum, 1 to 3 percent slopes------------	55	90	35	50	13.0	17	50	81	8	15	2.5	4.5
Rocky Ford loam, sand subsoil variant, 0 to 3 percent slopes-------	30	60	30	45	8.0	12	27	58	9	13	1.5	3.0
Shingle loam, 1 to 9 percent slopes---------	--	--	--	--	---	--	--	--	--	--	---	---
Vona sandy loam, 1 to 5 percent slopes---------	45	90	25	40	9.0	14	40	86	11	15	2.5	5.0

well-prepared seedbed under a cover crop, as protection against erosion.

Capability Unit VIe-2, Nonirrigated

This unit consists of moderately deep to deep, well-drained, strongly alkaline, moderately fine textured to fine textured soils in the Cadoma and Tyrone series. The depth to shale ranges from about 16 inches to several feet. Permeability is slow, and the water-holding capacity is moderate to high. Runoff is rapid because of both slow intake rate and scant grass cover. All of the soil moisture is not readily available to plant roots. Water erosion is a high hazard. Reducing erosion and increasing productivity are the main concerns in management.

These soils are suited for grass and as wildlife habitat. All of the acreage is used for range. Western wheatgrass, blue grama, and alkali sacaton are the best adapted grasses. Antelope is the most important wildlife species.

Permitting accumulation of litter and mulch helps reduce runoff and the hazard of erosion and allows more water to enter the soil. Pitting and contour furrowing help retain water from rain or snowmelt. Grass must be planted in a well-prepared seedbed under a cover crop, as protection against erosion.

Capability Unit VIe-3, Nonirrigated

This unit consists of deep, well-drained to somewhat excessively drained, gently sloping to undulating sandy loams of the uplands. These soils are in the Olney, Otero, and Vona series. They have slow runoff, moderately rapid intake, and moderate water-holding capacity. Soil moisture is readily available to plant roots. The wind erosion hazard is moderate to high. Preventing erosion and maintaining the vigor and density of the grasses are the major management problems.

Because of the wind erosion hazard, these soils are suited only to permanent grass and wildlife habitat. They are all used as range. Among the adapted grasses are bluestem, side-oats grama, blue grama, and indiangrass.

Maintaining the vigor of the grass and providing litter are ways to reduce erosion. Mechanical practices, such as pitting and contour furrowing, are of little value. This site responds quickly to deferred grazing and reseeding of depleted areas. Grass must be planted in a well-prepared seedbed under a cover crop that furnishes protection against wind erosion. Brush control is of benefit on deteriorated range. Chemical treatment can be used to control the yucca that becomes prominent on badly overgrazed or eroded range.

Capability Unit VIe-4, Nonirrigated

This unit consists of deep, nearly level, slightly saline, medium-textured to moderately fine textured soils in the Haverson and Manzanola series. These soils are on stream terraces that are occasionally flooded. Areas also receive runoff from the more sloping uplands. Surface runoff is slow, but if there is a poor plant cover it is medium. Water intake is moderate, and permeability is moderate to moderately slow. In places there is severe gully erosion along the edge of drainage channels. The main management problems are controlling erosion and increasing productivity.

These soils are suited for grass and as wildlife habitat. They are all used for range. Western wheatgrass, blue grama, switchgrass, and alkali sacaton are adapted grasses. Wildlife consists mostly of jackrabbits and coyotes.

Permitting an accumulation of litter helps reduce runoff and the hazard of erosion and increases the quality and quantity of forage. On areas of deteriorated range, pitting and contour furrowing help reduce both surface runoff and the amount of sodgrass, and these practices allow the taller grass to increase. Range seeding is beneficial in deteriorated range. Grass must be planted in a well-prepared seedbed, under a cover crop that protects against soil blowing.

Capability Unit VIe-5, Nonirrigated

The one soil in this unit, Dwyer loamy sand, is deep, excessively drained, undulating, and is on uplands. It has little or no surface runoff, rapid water intake, rapid permeability, and low water-holding capacity. The wind erosion hazard is high in areas improperly used. Controlling erosion and maintaining grass production are the major management problems.

This soil is suited for grass and as wildlife habitat. Sand bluestem, little bluestem, side-oats grama, prairie sandreed, switchgrass, and indiangrass are adapted grasses. Antelope is the principal wildlife species, but if it is improved as a habitat, this soil is suited to quail.

Maintaining the vigor and quality of the range helps keep production as high as possible and slows invasion of sagebrush, which competes with grass for moisture and space. Mechanical practices are of little value on this sandy soil. Adapted grasses can be re-established on deteriorated grassland by the interseeding method, which provides for seeding grass without the normal seedbed preparation. Seedbed preparation and a cover crop are needed in badly eroded areas or in areas grown over with weeds or other annuals. Brush control following interseeding is essential. Sand sage can be controlled by mechanical or chemical means.

Capability Unit VIe-6, Nonirrigated

This unit consists of deep, somewhat excessively drained, nearly level, sandy and loamy soils on stream terraces that are occasionally flooded. These soils are in the Bankard and Glenberg series.

They have rapid water intake and moderately rapid to rapid permeability. There is little or no surface runoff. In places, water tables are within reach of deep-rooted plants. The soils are low in fertility and easily leached of plant nutrients. The wind erosion is high in unprotected areas. Increasing the production of grass is the main conservation problem.

These soils are suited for grass and as wildlife habitat. They are used mostly for range. Sand bluestem, little bluestem, side-oats grama, prairie sandreed, switchgrass, and indiangrass are adapted grasses. Because there is sufficient cover, there is a potential for deer, wild turkeys, and cottontail rabbits. With improvement, areas along the river are suited as duck habitat.

Range seeding and control of brush help increase productivity. In areas where brush has been controlled, adapted grasses can be re-established by the interseeding method. This method provides the best wind erosion control because it is not necessary to prepare a seedbed. If a seedbed is prepared, a cover crop will be needed to control wind erosion. The control of brush, mostly tamarisk, can be attempted by chemicals and burning. Structures or mechanical practices are not needed on this soil. Stock water can be obtained from shallow wells.

Capability Unit VIw-1, Nonirrigated

This unit consists of deep, poorly drained to moderately well drained, nearly level soils with textures ranging from sand to clay. These soils are in the Apishapa, Bloom, Harvey, and Las Animas series. Both water table and drainage affect vegetation. At times, the water table of Bloom and Las Animas soils is only a few inches deep; these soils are wetter than the Apishapa and Harvey soils. Because some areas are only a few inches above the streams that drain them, drainage is not feasible and flooding is a hazard. Some areas are seeped from irrigation reservoirs, canals, and waste water. The main management problem is making timely, efficient use of grasses.

These soils are suited for grass and as wildlife habitat. They are used mostly as range. Western wheatgrass, slender wheatgrass, and alkali sacaton are adapted grasses. Jackrabbits and cottontail rabbits are the most common wildlife species. When improved, some areas are suitable as a habitat for waterfowl.

Grazing at a rate which avoids invasion by weeds or brush and grazing when the native grasses are most palatable are the best management practices. Range seeding increases production and prevents reinvasion of brush and weeds. Brush, mostly tamarisk, is most effectively controlled by chemicals and burning.

Capability Unit VIs-1, Nonirrigated

This unit consists of deep, nearly level, fine-textured soils having poor tilth. These soils are in the Manzanola and Limon series. They are on stream terraces but are seldom flooded. Surface runoff is medium, even though the soils are nearly level. Both water intake and permeability are slow. The vegetation is sparse and, in places, a high percentage of it is brush. The main management problems are reducing runoff and increasing the yield of grass.

These soils are suited for grass and as wildlife habitat. They are all used as range. The best adapted grasses are western wheatgrass, alkali sacaton, and blue grama. Jackrabbits, cottontail rabbits, and predators are the only wildlife common to these areas.

Permitting accumulation of litter and mulch allows more water to enter the soil and helps reduce runoff and the hazard of erosion. Pitting and contour furrowing are valuable practices on deteriorated range, especially in eroded areas of Manzanola soil. These practices open up the soil and help retain water from rain and snowmelt. Range seeding, where successful, helps prevent soil and water loss and increases forage production. This practice is necessary in eroded areas of Manzanola soil, and it can be used in areas of Limon soil that have been cleared of brush. Because of the limitations imposed by salinity, alkalinity, and poor tilth, this unit is very difficult to improve when once overgrazed. There are no specific practices that insure success.

Capability Unit VIIs-1, Nonirrigated

This unit consists of shallow and very shallow, gently to strongly sloping, loamy and clayey soils developed from shale that underlies them at a depth ranging from 0 to 20 inches. These soils are in the Samsil and Shingle series. They are moderately to strongly saline and alkaline. The salts, texture, and scant vegetation cause slow intake and rapid runoff. Water-holding capacity is low, and the hazard of water erosion is high. The rooting zone for grass is limited. Increasing production of grass and reducing the hazard of erosion are the major management problems.

These soils are suited for grass and as wildlife habitat. They are used mostly as range. Western wheatgrass, blue grama, and alkali sacaton are adapted grasses. Wildlife, especially antelope, use these soils as part of their habitat.

Pitting and contour furrowing are useful for reducing runoff, especially on gentle slopes. Wherever there is an accumulation of litter, adapted grasses can be hand-seeded and deferment continued..

Dike diversions, especially in badly eroded areas, can serve to safely dispose of runoff water until plants become established and litter accumulates.

Capability Unit VIIs-2, Nonirrigated

This unit consists of Cascajo soils and Gravelly land. These deep, excessively drained, strongly sloping soils have rapid water intake and permeability and low water-holding capacity.

These soils have limited use for range. They are best suited as a source for commercial gravel, and they can also be used as building and feedlot sites and as wildlife habitat. Improving the cover, feed, and water supplies on these soils encourages wildlife, such as quail and cottontail rabbits.

Deferred grazing allows the plants to remain vigorous and produce seed, and it provides a feed reserve for winter use. Fencing is usually necessary to allow deferment. In places, chemical control of sand sage and yucca is beneficial.

Capability Unit VIIs-3, Nonirrigated

The one soil in this unit, Penrose channery loam, 1 to 25 percent slopes, is very shallow, excessively drained, gently sloping to steep, hilly, and contains shaly limestone fragments. The depth to limestone is only about 12 inches. Surface runoff is rapid, and the root zone for grass and the water-holding capacity are limited by the shallow depth to parent rock. The water erosion hazard is high on steep slopes. Maintaining the vigor and density of the grass is the major management problem.

This soil is suited for grass and as wildlife habitat, but because of poor cover, food, and water supplies, there is little wildlife. This soil is all used as range.

Deferred grazing allows the plants to remain vigorous and to produce a feed reserve for winter use. Mechanical practices or structures are of marginal or no benefit on this soil. Small dams in drainageways can provide stock water.

Capability Unit VIIs-4, Nonirrigated

This unit consists of steep, bouldery, sandstone outcrops and canyon walls, and shallow, excessively drained, gently sloping to strongly sloping sandy loams underlain by sandstone and shale on uplands. These soils are in the Travessilla series. Surface runoff is rapid, water intake is moderately rapid, and water-holding capacity is low. The erosion hazard is high. Management of livestock to obtain good distribution of grazing is a primary problem in managing this unit.

This soil is suited for grass and as wildlife habitat. It is all used as range, but it has a fair potential for wildlife such as antelope, deer, wild turkeys, quail, and cottontail rabbits. Food and water are usually in short supply for wildlife.

Deferred grazing, especially during the drier years, allows the plants to remain vigorous and produce seed. Land relief and juniper trees provide winter protection for livestock. Mechanical practices or structures are of marginal or no benefit on these soils. Small dams on drainageways can provide stock water.

Management of Soils for Range

Range makes up about 85 percent of Otero County, and livestock raising is a major enterprise. Cows and calves are the main livestock. Large numbers of calves are held over as winter stockers in the irrigated part of the county. The climate permits year-round grazing of the range, but supplemental feeding is necessary during winter storms and prolonged drought.

Good management of range requires that favorable growth of forage is maintained and that soil blowing and water erosion are kept to a minimum. Range deteriorates under heavy grazing, and in this county, some areas of range show that they have been overgrazed or otherwise abused. Land along the intermittent drainageways has been severely eroded. Deep arroyos have replaced once nearly level valley floors. Less palatable plants such as greasewood, tamarisk, saltgrass, shadscale, and annuals now make up the plant community. On sandy land, yucca and sand sage have increased and crowded out more palatable grasses. Heavy grazing on hardland has lowered the vigor of blue grama and caused it to become sodbound.

The semiarid climate of the county markedly influences growth of forage on all the soils. Precipitation is erratically distributed, and most of it is received during summer. Many of the rains either are of high intensity and result in excessive runoff or they come as small, ineffective showers. Dry spells are common in midsummer. Winds cause excessive evaporation and transpiration, which further reduce the beneficial effect of any precipitation that falls.

Most of the growth is made by native grasses between April and August. Frequently growth is retarded by lack of moisture early in the growing season.

Range Sites and Range Condition

To facilitate management, the soils of Otero County have been placed in range sites. A range site is an area of natural grazing land that, because of its particular combination of soil, climate, and topography, is capable of supporting a particular type and amount of native vegetation. The kinds of native plants, and how much these plants produce, make one range site differ from another. Available soil moisture is one of the most important causes of differences in plant communities on range of Otero County.

Range condition is the present state of the vegetation, compared to the potential plant community for the particular range site. This condition is determined because it provides an approximate measure of any departure from the potential that has taken place in the plant cover. It is a measure useful in planning proper management of range.

A downward trend in range condition is generally systematic under heavy grazing. The overgrazing seriously weakens and eventually destroys western wheatgrass and the other taller, more palatable, and usually more productive plants. These plants are called decreasers because they decrease under continued close grazing. Shorter, less palatable grasses, such as blue grama, that better withstand close grazing, are called increasers. They increase as the more desirable plants disappear. Under continued heavy grazing the more palatable increaser plants give way to galleta, three-awn, or other less desirable increaser plants. Even these plants, under continued heavy use, eventually are replaced by introduced or annual plants, the invaders. These invaders generally grow in disturbed areas.

Four classes of range condition are recognized, excellent, good, fair, and poor (2). On range in excellent condition, 76 to 100 percent of the plant cover consists of the original vegetation. Range in good condition has plant cover in which 50 to 75 percent of the vegetation is that originally on the site. On range in fair condition, 26 to 50 percent of the vegetation is that originally on the site; and on range in poor condition, not more than 25 percent of the original, or climax, vegetation remains. If range is in poor condition, the bulk of the vegetation is made up of weak increasers and invaders.

All four condition classes may be seen in either wet or dry years, because range condition reflects the effects of past grazing on a particular range. Continued heavy grazing through a long period of drought results in rapid decline in range condition.

Descriptions of Range Sites

In this subsection, the twelve range sites in Otero County are described. The composition of the potential plant community is given, and the principal invaders are listed.

Production is given for each of the range sites. This production is the total annual yield in pounds of air-dry forage per acre per year. These figures on pounds per acre are for all the plants growing on a site and were obtained by clipping and weighing the vegetation from plots and from field estimates.

Loamy Plains Range Site

This range site consists of deep, to moderately deep, well-drained, nearly level to gently sloping, medium-textured and moderately fine textured soils on uplands. The water-intake rate is medium to moderately slow, and the water-holding capacity is moderate to high. On overgrazed range, runoff is rapid and the soils are eroded by both wind and water. This site, the most extensive in Otero County, makes up 43 percent of the total range and is closely associated with almost all other range sites.

Blue grama and galleta make up as much as three-fourths of the cover on this site. These two increasers combine with western wheatgrass, side-oats grama, New Mexico needlegrass, four-wing saltbush, Indian ricegrass, and winterfat to form the plant community. Only minor amounts of three-awn, sand dropseed, wild alfalfa, pricklypear, snakeweed, ring muhly, and rabbitbrush are present. In spots where moisture is favorable, buffalograss occurs. Alkali sacaton occurs where soil reaction permits. Downward trend in condition is indicated by increased percentages of galleta, sodbound blue grama, three-awn, and sand dropseed. Further deterioration is indicated by a lowered density, accelerated erosion, increased amounts of annuals, and a reduction of palatable forage. The optimum ground cover is 35 percent. A higher density tends to reduce production of this site in this low rainfall zone.

If denuded, this site responds fairly well to deferment, range pitting, and range seeding. Reseeding is difficult because of erratic rainfall.

The estimated total annual air-dry yield is 500 to 1,000 pounds per acre. About three-fourths of this amount provides grazing for cattle.

Sandy Plains Range Site

This range site consists of deep, nearly level to gently undulating, moderately sandy soils. It is one of the most favorable range sites for growth of grass because the soils absorb water rapidly and have a moderate to high water-holding capacity. Soil moisture is readily released to plant roots. Erosion by wind is the most serious hazard on range that has been overgrazed. This site makes up to 11 percent of the range in Otero County. It is on uplands and is commonly associated with the Loamy Plains range site. The largest area is east of the Apishapa River.

Blue grama and sand dropseed make up approximately one-half of the plant community. Important decreasers, such as side-oats grama, needle-and-thread, sandreed, sand bluestem, and western wheatgrass, account for 30 percent of the stand. Other species are Indian ricegrass, sedge, sand sage, yucca, buckwheat, and galleta. Downward trend on this site is indicated by an increase of sand sage, yucca, cactus, sand dropseed, and evidence of active erosion by wind and water. Decreaser plants, such as side-oats grama, are low in vigor or may be absent. The optimum ground cover is 40 percent.

This site responds quickly to deferred grazing and reseeding of depleted areas and control of sand sage. Pitting, chiseling, and contour furrowing are of little value.

The estimated total annual air-dry yield is 800 to 1,200 pounds per acre. About two-thirds of this amount provides grazing for cattle.

Deep Sands Range Site

This range site consists of Dwyer loamy sand, a deep, excessively drained, undulating soil of the uplands. This soil is rapidly permeable and has deep percolation of moisture that favors deep-rooted grasses. There is a high erosion hazard. This site makes up about 2 percent of the total range and is associated with the Sandy Plains range site.

Sand reedgrass and sand bluestem make up about 50 percent of the potential plant community. Needle-and-thread, side-oats grama, little bluestem, switchgrass, and yellow indiangrass are other important decreasers. Blue grama, sand dropseed, forbs, and shrubs, such as sand sage and yucca, account for no more than one-third of the stand. Downward trend on this site is indicated by the disappearance of sand bluestem, yellow indiangrass, and other decreasers. Sand sage, cactus, and yucca become dominant on depleted range. Optimum ground cover is 30 percent.

This site responds favorably to deferment. Fairly good results may be obtained by interseeding side-oats, bluestem, and other decreaser grasses of this site. Brush control following interseeding is essential.

The estimated total annual air-dry yield is 1,200 to 2,000 pounds per acre. About 50 percent of this provides grazing for cattle.

Alkaline Plains Range Site

This range site consists of moderately deep to deep, well-drained, nearly level to sloping, strongly alkaline, moderately fine textured to fine textured soils. These soils have a high percentage of gypsum and sodium in the subsoil. They have slow intake and moderate to high water-holding capacity. There are slick spots, and the soils have a high water erosion hazard. This site makes up 10 percent of the range in Otero County. It is associated with the Loamy Plains range site.

Alkali sacaton and blue grama make up most of the potential plant community. Galleta makes up one-fourth of the plant cover. The rest is made up of Fremont's goldenweed, greasewood, pricklypear, rabbitbrush, squirreltail, and other forbs, browse plants, and grasses. Alkali sacaton has lower vigor and is less dominant in overgrazed areas, and pricklypear, Fremont's goldenweed, and greasewood increase. Large areas of bare soil and rills and gullying indicate poor range condition. The optimum ground cover is 30 percent.

When denuded of vegetation, this site is difficult to re-establish and responds very slowly to treatment. Range deferment during the growing season and pitting with an eccentric disk help to speed recovery of overgrazed range.

The estimated total annual air-dry yield is 1,500 to 2,000 pounds per acre. About two-thirds of this amount provides grazing for cattle.

Shaly Plains Range Site

This range site consists of moderately shallow to very shallow, somewhat excessively drained, undulating and gently sloping, medium-textured to fine-textured soils. These soils have a very rapid rate of runoff and low water-holding capacity. They are highly erosive, and the vegetation is sparse and low in vigor. This site makes up 3 percent of the range in Otero County and is associated with the Limestone Breaks and the Loamy Plains range sites.

Blue grama and galleta make up 40 percent of the plant community. Alkali sacaton is the most important grass, and it along with western wheatgrass, Indian ricegrass, and four-wing saltbush are the most important decreasers. Also in the vegetation are winterfat, pricklypear, cholla, greasewood, Bigelow sage, snakeweed, and shadscale. Accelerated erosion and wider spacing of decreaser plants, such as alkali sacaton, indicate a downward trend in range condition. Galleta, pricklypear, Fremont's goldenweed, snakeweed, and other plants of low palatability increase as the range condition declines. Optimum density is 30 percent.

This site responds very slowly to treatment. Deferment during the growing season is the most favorable practice. Pitting with an eccentric disk to encourage more water to enter the soils is effective if carried out with a good management program.

The estimated total annual air-dry yield is 400 to 700 pounds per acre. About one-half of this provides grazing for cattle.

Salt Flat Range Site

This range site consists of deep, well-drained, nearly level, saline, moderately fine textured to fine textured soils on stream terraces (pl. 5, top). Salinity of the soil surface and slow water intake cause much of the water that falls to runoff or evaporate rather than becoming available to plant roots. Piping and gullying by water is a hazard. This site makes up 1 percent of the range in Otero County. It is generally associated with the Saline Overflow range site.

Alkali sacaton is the dominant grass. Western wheatgrass, saltgrass, shadscale, greasewood, four-wing saltbush, blue grama, galleta, alkaligrass, Fremont's goldenweed, alkali muhly, rabbitbrush, curlycup gumweed, povertyweed, cactus, and other salt-tolerant forbs make up a small percentage of the plant community. Increased amounts of Fremont's goldenweed, greasewood, and saltgrass indicate a downward trend in range condition, as does increasingly large areas of bare soil. Optimum ground cover is 30 percent.

Because of poor tilth and high salinity, this site is very difficult to improve when once overgrazed.

The estimated total annual air-dry yield is 700 to 1,600 pounds per acre. About one-half of this provides grazing for cattle.

Salt Meadow Range Site

This range site consists of deep, moderately well drained to poorly drained, nearly level soils having a wide range in texture. These soils are located on low stream terraces and in swales (pl. 4, bottom), and the water table ranges from a few inches to a few feet in depth. The hazard of erosion is very slight. This site makes up 1 percent of the total range in Otero County and is associated with the Salt Flat and the Sandy Bottomland range sites.

The potential plant community consists mostly of alkali sacaton, switchgrass, and western wheatgrass. Alkali bluegrass, sedges, and rushes are also present. Saltgrass, foxtail barley, wild licorice, tamarisk, willows, common reed, and cottonwood trees make up minor amounts of the vegetation. A downward trend in condition is indicated by an increase in saltgrass, tamarisk, and wild licorice, and a decrease of alkali sacaton, western wheatgrass, and switchgrass.

Because of the competitive shrubs and saltgrass, this site is difficult to improve when once in poor condition. Wetness, at certain times, limits the use of this site.

The estimated total annual air-dry yield is 1,800 to 2,500 pounds per acre. About two-thirds of this provides grazing for cattle.

Saline Overflow Range Site

This range site consists of deep, well-drained, nearly level, moderately fine textured soils on terraces and in swales. These soils are subject to overflow and to severe gullying and piping. This site, which makes up 7 percent of the range in Otero County, occurs as long narrow areas parallel to streams. It is associated with the Loamy Plains and the Salt Flat range sites.

Alkali sacaton, switchgrass, western wheatgrass, and vine-mesquite make up more than 50 percent of the plant community on this site, and blue grama makes up to 40 percent. Four-wing saltbush, galleta, and sand dropseed are also present. Greasewood, annuals, pricklypear, snakeweed, and matrimony vine are common invaders. A downward trend in range condition is indicated by an increase of greasewood, matrimony vine, snakeweed, and pricklypear, and a decrease of four-wing saltbush, blue grama, switchgrass, and western wheatgrass. The optimum density is fifty percent.

With good management this site can produce forage of high value, but due to its geographic location, it is generally heavily grazed. On depleted range, interseeding is needed to maintain the better species of grass.

The estimated total annual air-dry yield is 1,200 to 1,800 pounds per acre. About two-thirds of this amount provides grazing for cattle.

Sandy Bottomland Range Site

This range site consists of deep, somewhat excessively drained, nearly level sandy loams to loamy sands on stream terraces that are subject to occasionally destructive overflows. The water table is normally below a depth of 3 feet. These soils are droughty; they have rapid water-intake rate and low water-holding capacity. They generally have a good cover of vegetation and are protected from wind erosion. This site, which makes up less than 1 percent of the range in Otero County, occurs along major drainageways such as the Arkansas and the Purgatoire Rivers (pl. 5, bottom). It is associated with the Salt Meadow range site.

The potential plant community consists mostly of mid grasses, mainly switchgrass, indiangrass, and bluestems. Most of the area is in poor condition and is dominated by saltgrass, kochia, tamarisk, willows, and cottonwood trees. The optimum ground cover is 40 percent.

Proper grazing and periodic deferment of grazing during the growing season is important in maintaining good range condition. Range in depleted or poor condition is suited to interseeding.

The estimated total annual air-dry yield is 1,800 to 2,000 pounds per acre. About two-thirds of this provides grazing for cattle.

Sandstone Breaks Range Site

This range site consists of shallow to very shallow, excessively drained, sloping, cobbly and bouldery soils developed from interbedded sandstone and shale. The water-intake rate is moderate to rapid, and water-holding capacity is low. The steep slopes create a high water erosion hazard. This site, which makes up 7 percent of the total range in Otero County, occurs mostly in the southeastern part of the county as elongated areas adjacent to canyons along the Purgatoire River. It is associated with the Loamy Plains range site.

Side-oats grama, little bluestem, big bluestem, yellow indiangrass, spike muhly, and black grama make up most of the potential plant community. Blue grama, sand dropseed, galleta, yucca, skunkbush, buckwheat, and juniper are present in lesser amounts. A downward trend in this site is indicated by an increase of blue grama, galleta, sand dropseed, and juniper, and a decrease in side-oats grama and little bluestem. The optimum ground cover is 30 percent.

Deferment of grazing is the most effective practice on this range site.

The estimated total annual air-dry yield is 600 to 1,700 pounds per acre. About one-half of this provides grazing for cattle.

Limestone Breaks Range Site

This site consists of Penrose channery loam, a very shallow, gently sloping to steep, excessively drained soil that has developed from limestone (pl. 6, top). There is little soil material for water retention and plant growth. Runoff is high, and the hazard of erosion is high. This site makes up to 12 percent of the range in Otero County and is associated with the Loamy Plains range site.

Side-oats grama, blue grama, little bluestem, New Mexico needlegrass, and Indian ricegrass make up the potential plant community. Juniper, snakeweed, and Bigelow sage are present in lesser amounts, along with numerous cushion plants, such as nailwort, low phlox, and mat loco. As grazing pressure increases, the cushion plants, juniper, Bigelow sage, and snakewood increase. The optimum ground cover is 25 percent.

Deferment of grazing during the growing season is the most effective practice for improving range condition.

The estimated total annual air-dry yield is 300 to 800 pounds per acre. About one-half of this amount provides grazing for cattle.

Gravel Breaks Range Site

This range site consists of Cascajo soils and Gravelly land, a mapping unit that is deep, excessively drained, strongly sloping, and gravelly and cobbly. The hazard of water erosion is moderate. This site makes up less than 2 percent of the range in Otero County. It is associated with the Loamy Plains range site and lies in narrow strips paralleling the Arkansas River (pl. 6, bottom).

The potential plant community is made up largely of mid grasses, such as little bluestem, side-oats grama, western wheatgrass, and tall dropseed. Shrubs such as skunkbush, yucca, rabbitbrush, wildrose, and leadplant make up most of the rest, with minor amounts of three-awn, galleta, cactus, snakeweed, and lupine. Blue grama is the dominant increaser. As range condition declines, skunkbush, yucca, and rabbitbrush increase and the mid grasses decrease. The optimum ground cover is 30 percent.

Deferment of grazing during the growing season is the most effective practice for improving range condition.

The estimated total annual air-dry yield is 1,200 to 2,000 pounds per acre. About two-thirds of this amount provides grazing for cattle.

Comanche National Grassland

Approximately 162,000 acres, or 40 percent, of the Comanche National Grassland lies within Otero County. These lands, part of the "dust bowl" of the 1930's, were purchased by the United States late in that decade. The federal acquisition program was directed toward:

(1) protecting the lands unsuitable for cultivation by returning them to a perennial forage cover;
(2) aiding the people who chose to stay on the land through development and maintenance of a stable livestock-based economy;
(3) resettling those people who were economically stranded on the land.

In 1938 the Soil Conservation Service was assigned management responsibility, and subsequently many thousands of acres of plowed and windblown soil were stabilized through reseeding. In 1954, administration was transferred to the Forest Service. The area was designated a National Grassland and became a part of the National Forest System in 1961.

Under administration of the Forest Service the range reseeding program continues at a rate of about 2,000 acres per year. Nearly 4,000 head of permitted cattle now graze under scientific management on the Grassland in Otero County. The highest purpose of grassland management is to demonstrate how land unsuitable for cultivation can be converted to grass. Use for public recreation is increasing, and the area is gaining prominence for hunting of upland birds, as well as big game. Considerable improvement of habit for quail is being done through cooperative efforts of the Forest Service and the Colorado Game, Fish, and Parks Department.

Soil and water conservation practices suitable for carrying out land use management and development are discussed in the various parts of the "Use and Management of Soils" section of this survey.

The soil areas of the Grassland are principally in the Minnequa-Penrose and Travessilla-Kim-Wiley associations. The Vona-Olney-Dwyer association constitutes a minor part of the Grassland area.

Management of Soils for Woodland and Windbreaks 2/

There are two areas of native woodland in Otero County. One is the cottonwood and tamarisk area along the Arkansas, Apishapa, and Purgatoire Rivers. Cottonwood and tamarisk provide some cover for streambank protection. They also have value for protection of livestock during occasional severe winter storms. There is no market for the wood from these trees. It is considered noncommercial.

In the second area of native woodland are juniper (cedar) trees, which grow in the hilly, steep, and rough-broken Travessilla-Kim-Wiley association in the southern part of the county. These trees are used for fence posts and occasionally for firewood. This general soil area, because of the relief and vegetation, has some use for recreation.

Tree planting is done on a very limited scale in Otero County. It is done primarily for windbreaks around farmsteads or feedlots. With improvement, there is a potential in Otero County for tree plantings to provide food and cover for wildlife.

The climate of Otero County is not favorable for tree planting. High summer temperatures, low annual precipitation, hailstorms, wind, and drifting soil

2/ Prepared by W. S. SWENSON, woodland conservationist, Soil Conservation Service.

restrain tree growth. Trees generally do not survive or grow unless additional water can be provided. Where additional moisture can be had for a windbreak planting, either by diversion of runoff water from adjacent areas or from irrigation sources, the trees can be of real benefit to landowners. Windbreaks produce many benefits. They provide protection from cold winter and spring winds; they provide shade in the summer; they help reduce the cost of heating houses; they provide food and cover for game birds and insect-eating songbirds; and they provide beauty and charm for the landscape.

Certain soils are better suited to growing trees than others. In general, the well-drained, medium-textured to coarse-textured soils, such as the Vona, Olney, Harvey, Manzanola, Rocky Ford, Numa, and Kornman soils, are best. Clayey soils, such as the Apishapa, Limon, and Cadoma, and poorly drained, saline soils, such as the Bloom and Las Animas, are poorly suited for growing trees. In fact, such soils might prohibit tree growth. Shallow soils that are over bedrock, such as the Penrose, Samsil, and Travessilla, are also unsuited for tree planting.

Because of the climatic limitations, even on the best soils, the species of trees that can be grown under nonirrigated conditions are severely limited. Rocky Mountain juniper, Austrian pine, ponderosa pine, Eastern redcedar, Siberian (Chinese) elm, Russian-olive, squawbrush (quailbush), and common lilac are the trees and shrubs that have shown the greatest ability to survive and grow.

Soils best suited for crops are also best suited for trees. On well-drained irrigated soils any adapted species can be used with reasonable assurance of success.

Clean cultivation is essential during the life of the tree on range and during establishment on irrigated land.

Tree planting sites on dryland should be summer-fallowed prior to planting. Trees should be watered at planting. In addition, wide spacings (up to 30 feet between rows), planting on the contour, or diverting water into the planting area are helpful in establishing and maintaining trees.

Windbreaks for farmstead or feedlot protection should contain at least three rows of trees and shrubs. If low-growing shrubs are planted on the windward side, the wind cannot sweep under the belt.

In general, evergreens are the best species to plant, especially on sandy soils. They live longer and provide better protection throughout the year. One or more rows of evergreens is preferred in all windbreaks. If there is adequate irrigation water available, however, the landowner may want a faster growing tree, such as Siberian (Chinese) elm, or even cottonwood.

Management of Soils for Recreation [3/]

The development of outdoor recreational enterprises in the county, other than those associated with hunting and fishing, is difficult because of the limitations imposed by the semiarid climate.

Table 3 evaluates the recreational potential in the county by soil associations. Because soil affects such aspects as growing vegetative cover, sewage disposal, drainage, and concrete structures, it is used to rate the limitations to recreational development. It should be noted that the classification of recreational potential is broad. Inclusions in a soil association may be readily adapted to a given recreational use. The general soil map at the back of this survey shows the location of the five associations in the county.

[3/] Prepared by ELDIE W. MUSTARD, biologist, Soil Conservation Service.

TABLE 3.--LIMITATIONS OF SOIL ASSOCIATIONS FOR VARIOUS RECREATIONAL USES

Soil associations	Degree of limitation for--									
	Vacation farms (dude ranches)	Picnic and sports areas	Fishing		Camp-sites, scenic areas, and nature	Hunting areas			Shooting pre-serves	Sites for rural cottages, camps, and homes
			Natural	Devel-oped		Big game	Upland game	Water-fowl		
1. Vona-Olney-Dwyer.	Severe--	Severe--	Severe--	Severe--	Severe--	Moder-ate.	Severe--	Severe--	Severe--	Severe.
2. Minnequa-Penrose.	Severe--	Severe--	Severe--	Severe--	Severe--	Moder-ate.	Severe--	Severe--	Severe--	Severe.
3. Travessilla-Kim-Wiley.	Severe--	Severe--	Severe--	Severe--	Moder-ate.	Moder-ate.	Moder-ate.	Severe--	Severe--	Severe.
4. Harvey-Stoneham-Cascajo.	Severe--	Severe--	Severe--	Severe--	Severe--	Moder-ate.	Severe--	Severe--	Severe--	Severe.
5. Rocky Ford-Numa-Kornman.	Severe--	Moder-ate.	Moder-ate.	Moder-ate.	Severe--	Severe--	Slight--	Moder-ate.	Moder-ate.	Moder-ate.

The limitations of the soil associations shown in table 3 are rated slight, moderate, and severe. A rating of slight means that the soils in the association have no important limitations to the specified use or that the limitations are not difficult to overcome. Moderate means that the soils have some limitations to the specified use, but that these limitations generally can be overcome. Some of the limiting factors are unfavorable soil texture and soil depth, stoniness, and other soil deficiencies that slow the growth of plants. A rating of severe indicates that the soils have serious limitations to the specified use. The limiting features include steep slopes, a high water table, flooding, unfavorable soil texture, acidity, and stoniness or rockiness.

Additional information useful in planning recreational developments can be found in this soil survey in the section "Engineering Uses of the Soils." Technical assistance in planning for recreational enterprises and for onsite investigations can be obtained from the local representative of the Soil Conservation Service.

Management of Soils for Wildlife [4/]

Wildlife is a product of the soil on which it lives. Poor and mismanaged soils usually support only sparse wildlife populations. The habitat largely determines the kind and number of wildlife present. It must be an area where various kinds of wildlife can find food, cover, and water.

Table 4 indicates the degree of limitation of the five soil associations as habitat for the major kinds of wildlife in the county. It is important to realize that we are talking about potential, that is, what could be there, not necessarily what is present on the land.

The overshadowing limitation to plant production, and hence to wildlife population, in Otero County is lack of moisture. Droughts are common, and as a result, essential plant products, food and cover, are uncertain and erratic. Uncertain plant production exists, even on irrigated land, because irrigation water supplies are commonly inadequate during the late part of the irrigation season.

The irrigated land, primarily in the Rocky Ford-Numa-Kornman association, offers the greatest potential for wildlife development. This area also affords the only potential for fish and waterfowl production. Irrigation farming has made possible the introduction of the ring-necked pheasant on the Rocky Ford-Numa-Kornman association. This was possible because small grain and weeds are produced year after year on soils that are irrigated. The pheasant population is limited, however, by the agricultural practice that fostered it, because there is little permanent protective, nesting, and escape cover.

The remainder of the soil associations are essentially range. Dryland farming has been tried, but has failed because moisture is limited. The pronghorn antelope share the range with cattle. The potential for antelope is favorable if range management is good. There is little competition between antelope and cattle on properly managed range. On overgrazed range, especially during periodic droughts, competition between cattle and antelope for food can be serious.

There are some mule deer and a few white-tailed deer in the county. Deer typically require habitat that provides some woody and brushy cover, such as that on the bottom lands along the Arkansas River and along Horse Creek. Mule deer generally feed on browse plants. Because there are few woody plants in the county, the potential for deer is limited. River bottom lands commonly are used for grazing cattle, although they provide little desirable forage. Their use for grazing restricts the growth of the brush and undergrowth that furnish cover for deer.

Mourning doves can be found in the Travessilla-Kim-Wiley association and the Rocky Ford-Numa-Kornman association. The mourning dove is one of the renewable natural resources not now utilized to the fullest degree. More recreational hunting could be realized from this fine game bird.

Wildlife, especially in irrigated areas, could be greatly increased by planting suitable cover plants and by providing nesting areas for game birds. Fence row burning, common in the county, is exceedingly detrimental to wildlife, especially in spring, when burning destroys the nests of game birds, rabbits, and some songbirds.

Technical advice on improvement of wildlife habitats can be obtained from the local representative of the Soil Conservation Service and from the wildlife conservation officer of the Colorado Game, Fish, and Parks Department.

Engineering Uses of the Soils [5/]

In this subsection important engineering properties of the soils in the county are estimated so that the suitability of the soils for construction purposes can be determined.

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, irrigation and drainage systems, and sewage disposal systems. Among the soil properties most important to engineers are permeability, shear strength, compaction characteristics, drainage, shrink-swell characteristics, grain size, plasticity, and reaction. Depth to water table and topography are also important.

[4/] Prepared by ELDIE W. MUSTARD, biologist, Soil Conservation Service.

[5/] RONALD I. BLEWITT, conservation engineer, Soil Conservation Service, helped prepare this section.

TABLE 4.--DEGREE OF LIMITATION OF THE SOIL ASSOCIATIONS AS HABITATS FOR THE MORE IMPORTANT WILDLIFE

Soil associations	Wildlife	Degree of limitations for--		
		Protective and escape cover		Food
		Woody	Herbaceous	
1. Vona-Olney-Dwyer.	Mourning dove-----	Not applicable----	Not applicable----	Severe.
	Scaled quail------	Moderate----------	Moderate----------	Moderate.
	Jackrabbit--------	Not applicable----	Not applicable----	Moderate.
	Antelope----------	Not applicable----	Not applicable----	Moderate.
2. Minnequa-Penrose.	Mourning dove-----	Not applicable----	Not applicable----	Severe.
	Scaled quail------	Moderate----------	Moderate----------	Moderate.
	Jackrabbit--------	Not applicable----	Not applicable----	Moderate.
	Antelope----------	Not applicable----	Not applicable----	Moderate.
3. Travessilla-Kim-Wiley.	Mourning dove-----	Not applicable----	Not applicable----	Moderate.
	Scaled quail------	None to slight----	None to slight----	Moderate.
	Cottontail--------	Moderate----------	Severe------------	Moderate.
	Jackrabbit--------	Not applicable----	Not applicable----	Moderate.
	Antelope----------	Not applicable----	Not applicable----	Moderate.
	Deer--------------	Moderate----------	Not applicable----	Severe.
	Turkey------------	Severe------------	Severe------------	Moderate.
4. Harvey-Stoneham-Cascajo.	Mourning dove-----	Not applicable----	Not applicable----	Severe.
	Scaled quail------	Moderate----------	Moderate----------	Moderate.
	Jackrabbit--------	Not applicable----	Not applicable----	Moderate.
	Antelope----------	Not applicable----	Not applicable----	Moderate.
5. Rocky Ford-Numa-Kornman.	Mourning dove-----	Not applicable----	Not applicable----	None to slight.
	Pheasant----------	None to slight----	None to slight----	None to slight.
	Bobwhite----------	Moderate----------	Moderate----------	Moderate.
	Cottontail--------	None to slight----	None to slight----	None to slight.
	Mule deer---------	Moderate----------	Moderate----------	Moderate.
	Waterfowl---------	Not applicable----	Moderate----------	None to slight.
	Fish--------------	Not applicable----	Not applicable----	Not applicable.

Information in this survey can be used to:

1. Make soil and land use studies that will aid in the selection and development of industrial, business, residential, and recreational sites.
2. Make preliminary estimates of soil properties that are significant in the planning of drainage systems, farm ponds, irrigation systems, and other soil and water conservation structures.
3. Make preliminary evaluation of soil and ground conditions that will aid in selecting locations for highways, airports, and pipelines.
4. Locate sources of sand and gravel for construction use.
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 soils for the cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs to make maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes.

With the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized, however, 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, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms of soil science used in this section may have a different meaning in engineering or may be unfamiliar to engineers. Many of these terms are defined in the Glossary.

Most of the information on engineering properties of soils and on behavior of soil in engineering structures is given in tables 5 and 6. The text, for the most part, explains systems of classifying soils for engineering and the significance of the data in the tables.

Engineering Classification Systems

The soil scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture. This system is useful only as the initial step for making engineering classifications of soils. The engineering properties of a soil must be determined or estimated after the textural classications have been made. Two systems are used by engineers for classifying soils. These are the systems used by the American Association of State Highway Officials (AASHO) (1) and the Unified system developed by the U.S. Department of Defense (8). These systems are explained briefly in the following paragraphs.

Most highway engineers classify soil materials according to the AASHO system. This system is based on actual performance of material used as a base of roads and highways. In it, soil materials are classified in seven principal groups. The groups range from A-1, gravelly soils of high-bearing capacity, to A-7, the soils least suitable, clay soils that have a low strength when wet.

Some engineers prefer to use the Unified Soil Classification System. This system is based on the identification of soils according to their texture, plasticity, and liquid limit. The soil materials are identified as (1) coarse grained, gravel (G) and sand (S); (2) fine grained, silt (M) and clay (C); and (3) highly organic (Pt). Coarse-grained soils are divided in 8 classes (GW, GP, GM, GC, SW, SP, SM, SC). Fine-grained soils are divided in 6 classes (ML, CL, OL, MH, CH, OH); there is one organic soil class (Pt). Mechanical analysis, liquid limit, and plasticity index are used to determine GM, GC, SM, SC, and the subdivisions of fine-grained soils.

Engineering Properties of Soils

A listing of all the soils in Otero County, their estimated properties significant to engineering, and their USDA and hydrologic (4) classifications are given in table 5. The estimates are for a profile typical of each soil series or for types within the series. The thickness of each horizon is shown in the column headed "Depth from surface." Following are explanations of some of the columns in table 5.

Permeability relates only to movement of water downward through undisturbed materials. The values given in table 5 are estimates based upon the soil texture as it occurs without compaction. Soils with permeability rates of less than 0.63 inch per hour are rated as having severe soil limitations for sewage disposal.

The available water capacity is the amount of water that the soil can hold between its field capacity and wilting point. When the soil is at field capacity, the amount shown in the table is the amount available to crop plants in each inch of soil, barring any made unavailable because of salts in the soil.

Reaction refers to the degree of acidity or alkalinity of a soil and is expressed in pH values. The soil pH indicates the corrosiveness of a soil and the protection needed for structures, such as pipelines, when they are placed in the soil.

In this survey, estimates of salinity of the soil are based on the electrical conductivity of the saturated soil extract and are expressed in millimhos per centimeter at 25° C. An estimate of none means that electrical conductivity is less than 2 millimhos per centimeter; slight (low), 2 to 4 millimhos; moderate, 4 to 8 millimhos; and severe (high) more than 8 millimhos.

The shrink-swell potential indicates the volume change that can be expected with change in moisture content. In general, soils classified as CH and A-7 have a high shrink-swell potential. Soils having a high shrink-swell potential, such as Cadoma clay or Limon silty clay, are not desirable locations for concrete structures.

The column headed "Hydrologic soil group" classifies soils so as to estimate the runoff potential from a watershed. The groupings are based upon the minimum rate of infiltration obtained for a bare soil after prolonged wetting. The influence of ground cover is not included. The soils are classed into four groups. Group A has a low runoff potential and includes soils with high infiltration rates or sandy and gravelly soils. Group D has a high runoff potential. It includes clayey soils, soils very shallow to bedrock, or soils with a permanent high water table. Groups B and C are intermediate between these extremes.

Engineering Interpretations

In table 6 specific soil features that may affect engineering work are pointed out. The suitability of soils as a source of topsoil, sand, gravel, and road fill is listed. Other columns in this table name the soil features that affect the location of highways, the construction of dikes and levees, farm ponds, and drainage, and irrigation structures. Soil limitations for sewage disposal and homesites are also shown.

Topsoil is presumed fertile soil or soil material, ordinarily rich in organic matter, used to top-dress roadbanks, lawns, and gardens. The suitability of a soil as a source of topsoil depends largely upon texture, thickness, and reaction. It is necessary that topsoil be of a texture that works to a good seedbed, yet contains enough clay to resist erosion on strong slopes. The thickness of suitable material determines whether or not it is economical to use the soil as a source of topsoil. Moderately alkaline topsoil is not so desirable as topsoil of neutral reaction.

The ratings for sand and gravel apply to materials that will be worked and screened.

The rating of a soil for road fill is based on the estimated classification. Road fill can be of almost any soil material. Sandy clays and sandy clay loams offer few problems in placement or compaction. Clays with a high shrink-swell potential, however, require special compaction and close moisture control both during and after construction. Sands compact well but are difficult to confine in a fill.

Flooding hazards are classed as frequent, occasional, or infrequent. The classes are based upon knowledge of the climate, terrain, and short-term familiarity with actual flood situation. Frequent flooding refers to irregular occurrences of less than 3-year frequency; occasional flooding has approximately a 10-year frequency; infrequent flooding means that a flooding hazard exists.

Some readers need broad interpretations not easily derived from table 6. The soil association map, if interpreted with caution, can be of some value for this purpose. Following are some general comments relating to soil associations in this county.

Soils in the Vona-Olney-Dwyer association are not well suited to farm ponds because they are sandy. Some limited sites can be found by boring test holes. Sites for erosion control structures are limited.

Soils in the Minnequa-Penrose association are well suited to farm ponds. The substratum of the Manvel soils is high in gypsum and consequently has limitations as material for embankments.

Soils in the Travessilla-Kim-Wiley association present some major problems in road building and pipeline construction because of the rock outcrop.

Soils in the Harvey-Stoneham-Cascajo association are reasonably well suited for farm ponds, although pond sealing may be of benefit in places. Cascajo soils are a good source of gravel.

Soils in the Rocky Ford-Numa-Kornman association are well suited to irrigation. Deep cuts can be made, and fields can be leveled to a plane with or without benches. Subsurface and surface drains are needed in some locations and can generally be installed to operate effectively.

FORMATION AND CLASSIFICATION OF THE SOILS

This section presents the outstanding characteristics of the soils of Otero County and relates them to the factors of soil formation. Physical and chemical data are limited for these soils, and the discussion of soil genesis and morphology is correspondingly incomplete. The first part of the section deals with the factors of soil formation; the second, with the processes of soil formation; and the third, with the classification of 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 the physical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and weathered, the plant and animal life, the relief, or lay of the land, and 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 accumulated soil material and slowly change it into a soil with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile

[Absence of data indicates estimate was not made. The sign > means more than. An asterisk in the first column such mapping units may have different properties and limitations, and for this reason it is necessary to follow

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification			Greater than 3 inches
			USDA texture	Unified	AASHO	
	Feet	Inches				Percent
Apishapa:						
Aa-----------	0-3	0-15	Loamy sand----------------	SM	A-2	0
		15-30	Clay----------------------	CH	A-7	0
		30-60	Clay to sand--------------	CL or SM	A-6 or A-2	0
Ac-----------	1-3	0-12	Clay----------------------	CH	A-7	0
		12-55	Clay----------------------	CH	A-7	0
		55-60	Loamy sand or sand--------	SM or SP	A-3 or A-2	0
Baca: BcB-------	>5	0-5	Loam or silt loam---------	CL	A-6	0
		5-16	Silty clay loam or clay loam.	CH	A-7	0
		16-60	Silty clay loam or clay loam.	CL	A-6	0
Bankard: Bk-----	3-5	0-14	Sand or loamy sand--------	SM	A-2	0
		14-60	Sand or gravelly sand-----	SP	A-1	0
Bloom: Bm-------	0-3	0-47	Loam or clay loam---------	CL	A-6	0
		47-60	Silt loam-----------------	ML	A-4	0
Cadoma: CaD-----	>5	0-7	Clay----------------------	CH	A-7	0
		7-20	Silty clay----------------	CH	A-7	0
		20-60	Shale.			
Cascajo soils and Gravelly land: Cg.	>5	0-6	Gravelly loam-------------	GM or SM	A-2	5-10
		6-36	Cobbly very gravelly loam.	GP, SP, GM, or SM	A-1	5-10
		36-60	Shale.			
Dwyer: Dw-------	>5	0-60	Loamy sand----------------	SP or SM	A-3 or A-2	0
*Glenberg: GbA, GkA. For properties of the Bankard soil in mapping unit GkA, refer to the Bankard series.	3-5	0-14	Loamy fine sand-----------	SM	A-2	0
		14-36	Fine sandy loam-----------	SM	A-4	0
		36-60	Sand and loamy sand-------	SP or SM	A-2	0
*Harvey:						
HaB----------	2-5	0-8	Loam or clay loam---------	ML or CL	A-4	0
		8-16	Loam----------------------	ML	A-4	0
		16-60	Loam or sandy loam--------	SM	A-2 or A-4	0
HsB---------- For Stoneham part of HsB, see Stoneham series.	>5	0-30	Loam----------------------	ML or CL	A-4	0
		30-60	Sandy loam or loam--------	SM	A-2	0

PROPERTIES OF SOILS

indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in carefully the instructions for referring to other series that appear in the first column of this table]

Percentage less than 3 inches passing sieve-- No. 10 (2.0 mm.)	No. 40 (0.4 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Hydro-logic soil group
			Inches per hour	Inches per inch of soil	pH			
90-100	75-85	10-25	2.0-6.3	0.07-0.10	7.4-7.8	Slight------	Low.	B
100	90-95	70-90	0.06-0.20	0.14-0.16	7.9-8.4	Moderate----	High.	
95-100	75-95	10-90	0.06-6.3	0.05-0.16	7.9-8.4	Moderate----	High to low.	
100	95-100	90-95	0.06-0.20	0.15-0.18	7.4-8.4	Slight------	High.	C
100	100	90-100	0.06-0.20	0.14-0.16	7.4-8.4	Slight to moderate.	High.	
90-100	80-90	0-15	>6.3	0.05-0.10	7.4-8.4	Slight------	Low.	
90-100	85-100	70-85	0.63-2.0	0.16-0.21	7.4-7.8	None--------	Moderate.	B
90-100	90-100	65-90	0.20-0.63	0.19-0.21	7.4-8.4	None--------	High.	
95-100	95-100	80-90	0.20-2.0	0.17-0.21	7.4-8.4	None--------	Moderate.	
90-100	65-95	10-35	6.3-20.0	0.05-0.09	7.4-7.8	None--------	Low.	A
55-100	40-50	0-10	6.3-20.0	0.03-0.07	7.4-7.8	None--------	Low.	
90-100	90-100	85-95	0.20-0.63	0.16-0.21	7.4-8.4	Moderate----	Moderate.	C
90-100	90-100	85-95	0.63-2.0	0.19-0.21	7.4-8.4	Moderate----	Low.	
90-100	90-100	90-100	0.06-0.63	0.17-0.21	7.9-9.0	Slight------	High.	D
100	100	90-100	0.06-0.20	0.13-0.15	8.5-9.6	Moderate----	High.	
40-50	35-45	25-35	6.3-20.0	0.08-0.12	7.4-7.8	None--------	Low.	C
35-50	20-25	0-15	6.3-20.0	0.05-0.07	7.4-7.8	None--------	Low.	
100	70-85	5-20	6.3-20.0	0.06-0.10	7.4-8.4	None--------	Low.	A
100	95-100	25-35	2.0-6.3	0.08-0.10	7.4-7.8	None--------	Low.	A
100	95-100	35-50	2.0-6.3	0.13-0.15	7.4-7.8	None--------	Low.	
100	95-100	5-25	6.3-20.0	0.05-0.08	7.4-7.8	None--------	Low.	
95-100	85-95	65-80	0.20-2.0	0.16-0.21	7.4-8.4	Moderate----	Low.	B
95-100	75-85	50-60	0.63-2.0	0.16-0.18	7.4-8.4	Moderate----	Low.	
85-95	55-80	20-50	0.63-6.3	0.10-0.16	7.4-8.4	Moderate----	Low.	
90-100	75-85	50-60	0.63-2.0	0.16-0.18	7.4-7.8	None--------	Low.	B
85-95	55-80	20-50	0.63-6.3	0.10-0.16	7.4-7.8	None--------	Low.	

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification: USDA texture	Classification: Unified	Classification: AASHO	Greater than 3 inches
	Feet	Inches				Percent
Haverson: HvB---	>5	0-60	Loam to silt loam--------	ML or CL	A-4 or A-6	0
* Kim and Wiley: KmC. For Wiley part, see Wiley series.	>5	0-31	Loam---------------------	ML or CL	A-4	0
		31-60	Loam or sandy loam--------	ML	A-4	0
Kornman and Neesopah:						
KnA----------	>5	0-18	Loam---------------------	CL	A-6	0
		18-24	Sandy loam----------------	SM	A-2 or A-4	0
		24-60	Sandy loam or loam--------	SM or ML	A-2 or A-4	0
KnB, KnC-----	>5	0-13	Loam or sandy clay loam---	CL	A-6	0
		13-20	Sandy loam----------------	SM or SC	A-2 or A-4	0
		20-60	Loamy sand or sandy loam--	SM	A-2 or A-4	0
Las Animas: Lm.	0-2	0-7	Sandy loam or silty clay--	SM or CH	A-2 or A-7	0
		7-30	Sandy loam or loamy sand--	SM	A-2	0
		30-60	Sand or loamy sand	SP or SM	A-1 or A-2	0
Limon: LnB, LoB.	>5	0-12	Silty clay loam or clay--	CH	A-7	0
		12-40	Silty clay---------------	CH	A-7	0
		40-60	Loam to clay------------	ML to CH	A-4 to A-7	0
Manvel: MaB-----	>5	0-10	Silt loam----------------	ML	A-4	0
		10-42	Silt loam or silty clay loam.	ML or CL	A-4 or A-6	0
		42-60	Silt loam to silty clay--	CL	A-6	0
Manzanola:						
MbA----------	>5	0-3	Loam---------------------	ML	A-4	0
		3-18	Silty clay loam----------	CL	A-6	0
		18-33	Silty clay loam----------	CL	A-6	0
		33-60	Clay loam or silt loam---	CL or ML	A-6 or A-4	0
McB----------	>5	0-21	Clay loam to silty clay--	CH	A-7	0
		21-44	Silty clay loam----------	CL	A-6	0
		44-60	Loam---------------------	CL	A-4	0
Md2----------	>5	0-15	Silty clay loam----------	CL	A-6	0
		15-60	Loam to clay loam--------	ML or CL	A-4 or A-6	0

Percentage less than 3 inches passing sieve--			Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Hydro-logic soil group
No. 10 (2.0 mm.)	No. 40 (0.4 mm.)	No. 200 (0.074 mm.)						
			Inches per hour	Inches per inch of soil	pH			
100	95-100	70-90	0.20-2.0	0.16-0.21	7.4-8.4	Slight-----	Moderate.	C
95-100	85-100	65-85	0.63-2.0	0.16-0.18	7.4-8.4	None-------	Low.	B
95-100	85-100	75-85	0.63-6.3	0.11-0.18	7.4-8.4	None-------	Low.	
95-100	90-100	80-90	0.20-0.63	0.16-0.20	7.4-7.8	None-------	Moderate.	B
95-100	85-95	25-45	2.0-6.3	0.11-0.13	7.4-7.8	None-------	Low.	
75-100	80-95	25-80	0.63-6.3	0.11-0.16	7.4-7.8	None-------	Low.	
95-100	85-95	60-80	0.20-0.63	0.16-2.0	7.4-7.8	None-------	Moderate.	B
95-100	85-95	25-40	0.63-6.3	0.11-0.13	7.4-7.8	None-------	Low.	
95-100	85-95	20-60	2.0-6.3	0.06-0.13	7.4-7.8	None-------	Low.	
95-100	70-90	25-90	0.20-6.3	0.10-0.20	7.9-8.4	Severe-----	Low.	B
95-100	60-90	20-30	0.63-6.3	0.06-0.13	7.9-8.4	Severe-----	Low.	
35-100	40-95	5-15	6.3-20.0	0.05-0.08	7.9-8.4	Severe-----	Low.	
100	95-100	90-95	0.06-0.20	0.15-0.17	7.9-8.4	Moderate---	High.	D
100	95-100	90-95	0.06-0.20	0.15-0.17	7.9-9.0	Moderate---	High.	
100	95-100	80-100	0.20-0.63	0.14-0.21	7.4-8.4	Slight-----	Moderate to high.	
100	100	90-100	0.63-2.0	0.19-0.21	7.4-7.8	None-------	Low.	B
100	100	90-100	0.20-2.0	0.19-0.21	7.9-8.4	Slight-----	Low.	
100	100	90-100	0.20-0.63	0.15-0.21	7.9-8.4	Severe-----	Moderate.	
100	90-100	80-90	0.63-2.0	0.16-0.18	7.4-8.4	None-------	Moderate.	B
100	100	85-95	0.20-0.63	0.19-0.21	7.4-8.4	None-------	Moderate.	
100	100	85-95	0.20-0.63	0.16-0.18	7.9-9.0	Slight-----	Moderate.	
100	100	85-95	0.20-2.0	0.15-2.0	7.9-8.4	Slight-----	Moderate.	
95-100	95-100	85-95	0.20-0.63	0.16-0.20	7.9-8.4	None-------	High.	C
100	100	85-95	0.20-0.63	0.16-0.20	7.9-8.4	Slight-----	Moderate.	
100	95-100	80-95	0.20-2.0	0.14-0.16	7.9-8.4	Slight-----	Moderate.	
100	100	85-95	0.20-0.63	0.16-0.20	7.9-8.4	Slight-----	Moderate.	C
100	100	85-95	0.20-0.63	0.16-0.21	7.9-9.0	Slight-----	Moderate.	

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification			Greater than 3 inches
			USDA texture	Unified	AASHO	
	Feet	Inches				Percent
Minnequa:						
MeB---------	>5	0-7	Loam--------------------	ML	A-4	0
		7-29	Silt loam---------------	ML	A-4	0
		29-35	Loam--------------------	ML	A-4	0
		35-60	Limestone or marl.			
MnA, MnC----	1-3	0-14	Silty clay loam---------	CL	A-6	0
		14-26	Silty clay loam---------	ML	A-4	0
		26-34	Silty clay loam---------	ML	A-4	0
		34-60	Limestone or marl.			
Nepesta: NeB---	>5	0-10	Clay loam---------------	CL	A-6	0
		10-26	Sandy clay loam or clay loam.	SC or CL	A-6	0
		26-60	Loam or sandy loam------	ML or SM	A-4	0
Numa:						
NmA, NmB, NmC.	>5	0-14	Loam or clay loam-------	CL	A-6	0
		14-46	Loam or sandy clay loam.	ML or SC	A-4 or A-6	0
		46-60	Sandy loam or loam------	SM	A-4	0
NvD---------	>5	0-20	Loam--------------------	ML or CL	A-4 or A-6	0
		20-60	Gravel or sand----------	GM or SM	A-2	0-5
Olney: OlB, OnA.	>5	0-4	Sandy loam--------------	SM	A-4	0
		4-16	Sandy clay loam or clay loam.	CL	A-6	0
		16-60	Loam or sandy loam------	ML, CL, or SM	A-4 or A-6	0
Otero: OtC------	>5	0-18	Sandy loam--------------	SM	A-2	0
		18-60	Loam to loamy sand------	ML or SM	A-4 or A-2	0
Penrose: PeE----	>5	0-11	Channery loam-----------	ML	A-4	5-10
		11-60	Limestone or shale.			
Rocky Ford:						
RfA, RfB-----	>5	0-18	Silty clay loam---------	ML or CL	A-6	0
		18-30	Silt loam---------------	ML	A-4	0
		30-60	Silt loam to very fine sandy loam.	ML	A-4	0
RgA, RgB-----	3-5	0-13	Silty clay loam---------	CL	A-6	0
		13-43	Silt loam or clay loam--	ML or CL	A-6	0
		43-60	Silty clay loam to sand.	CL or SM	A-6 or A-2	0

Percentage less than 3 inches passing sieve-- No. 10 (2.0 mm.)	No. 40 (0.4 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Hydrologic soil group
			Inches per hour	Inches per inch of soil	pH			
95-100	95-100	85-95	0.63-2.0	0.16-0.18	7.4-8.4	None------	Low.	B
95-100	95-100	85-95	0.63-2.0	0.19-2.1	7.4-8.4	Slight----	Low.	
95-100	95-100	90-95	0.63-2.0	0.15-0.17	7.9-8.4	Moderate--	Low.	
100	95-100	85-95	0.20-2.0	0.16-0.20	7.4-8.4	None------	Moderate.	B
100	95-100	85-95	0.63-2.0	0.16-0.20	7.9-8.4	Slight----	Low.	
100	95-100	80-90	0.63-2.0	0.15-0.17	7.9-8.4	Slight to moderate.	Low.	
100	95-100	70-80	0.20-0.63	0.19-0.21	7.4-7.8	None------	Moderate.	B
100	80-95	40-75	0.20-0.63	0.14-0.21	7.4-8.4	None------	Moderate.	
100	95-100	40-55	0.63-6.3	0.13-0.17	7.4-8.4	None------	Low.	
95-100	85-95	65-80	0.20-2.0	0.16-0.21	7.4-7.8	None------	Moderate.	B
95-100	70-90	40-65	0.20-2.0	0.14-0.18	7.9-8.4	None------	Low.	
95-100	55-85	35-50	2.0-6.3	0.12-0.16	7.4-8.4	None------	Low.	
90-100	75-85	50-60	0.63-2.0	0.16-0.21	7.4-7.8	None------	Low.	B
50-70	20-35	15-35	6.3-20.0	0.05-0.07	7.4-7.8	None------	Low.	
100	80-90	35-50	2.0-6.3	0.11-0.13	7.4-7.8	None------	Low or moderate.	B
100	95-100	50-60	0.63-2.0	0.14-0.16	7.4-7.8	None------	Moderate.	
100	80-95	40-70	0.63-2.0	0.11-0.18	7.4-7.8	None------	Low.	
100	80-90	25-35	2.0-6.3	0.11-0.13	7.4-8.4	None------	Low.	B
100	85-95	20-70	0.63-6.3	0.09-0.13	7.4-8.4	None------	Low.	
90-100	75-85	50-60	2.0-6.3	0.08-0.12	7.4-8.4	None------	Low.	D
100	95-100	80-90	0.20-2.0	0.19-0.21	7.4-7.8	None------	Moderate.	B
100	95-100	75-95	0.63-2.0	0.19-0.21	7.4-7.8	None------	Low.	
100	95-100	50-95	0.63-2.0	0.15-0.21	7.4-7.8	None------	Low.	
95-100	90-95	70-90	0.20-2.0	0.19-0.21	7.4-7.8	Slight to moderate.	Moderate.	C
95-100	90-100	55-90	0.20-2.0	0.14-0.20	7.4-7.8	Slight to moderate.	Moderate.	
100	90-100	10-90	0.20-6.3	0.07-0.18	7.4-8.4	Slight to moderate.	Low.	

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification			Greater than 3 inches
			USDA texture	Unified	AASHO	
	Feet	Inches				Percent
Rocky Ford--Continued.						
R1A, R1B-----	>5	0-10	Loam or clay loam-------	CL	A-6	0
		10-48	Silt loam---------------	ML	A-4	0
		48-60	Limestone or marl.			
RmB----------	>5	0-20	Loam or clay loam-------	ML or CL	A-6	0
		20-60	Sand or gravel----------	SP or SM	A-3 or A-2	0
Samsil-Shale outcrop complex: Sc.	>5	0-8	Clay--------------------	CH	A-7	0
		8-60	Shale.			
Shingle:						
SgC----------	>5	0-12	Loam or clay loam-------	ML or CL	A-6	0
		12-60	Marl or shale.			
ShC----------	>5	0-8	Loam--------------------	ML	A-4	0
		8-25	Crumbly alabaster-------	-------	-------	------
		25-60	Sandstone.			
Stoneham---------	>5	0-5	Sandy loam or loam------	ML	A-4	0
		5-16	Sandy clay loam---------	CL	A-6	0
		16-40	Loam--------------------	ML	A-4	0
		40-60	Sandy clay loam---------	SC or CL	A-6	0
Travessilla:						
TaC----------	>5	0-9	Sandy loam--------------	SC	A-2	0-10
		9-60	Sandstone			
Travessilla-Rock outcrop: Tr. Materials are so variable that their properties are not estimated.						
Tyrone: TyB------	>5	0-4	Silty clay loam---------	CL	A-6	0
		4-18	Clay loam---------------	CH	A-7	0
		18-60	Clay loam---------------	CL	A-6	0
Vona: Vd---------	>5	0-15	Sandy loam--------------	SC or ML	A-2 or A-4	0
		15-60	Sandy loam--------------	SM	A-2	0
Wiley ------------	>5	0-5	Silt loam---------------	CL or ML	A-6	0
		5-48	Clay loam---------------	CL	A-6	0
		48-60	Sandstone.			

PROPERTIES OF SOILS--Continued

Percentage less than 3 inches passing sieve--			Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Hydro-logic soil group
No. 10 (2.0 mm.)	No. 40 (0.4 mm.)	No. 200 (0.074 mm.)						
			Inches per hour	Inches per inch of soil	pH			
100	95-100	85-95	0.20-2.0	0.16-0.20	7.4-7.8	None------	Low.	B
100	95-100	90-100	0.63-2.0	0.16-0.20	7.4-8.4	Slight----	Low.	
100	90-100	70-80	0.20-2.0	0.14-0.18	7.4-7.8	None------	Low.	B
95-100	80-90	0-15	6.3-20.0	0.05-0.07	7.4-7.8	None------	Low.	
100	95-100	90-100	0.06-0.20	0.14-0.16	7.8-9.0	Moderate--	High.	D
100	95-100	95-100	0.20-0.63	0.16-0.21	7.8-8.4	Moderate--	Moderate.	D
100	95-100	80-100	0.63-2.0	0.12-0.16	7.9-8.4	High------	Low.	C
------	------	------	2.0-6.3	0.06-0.10	7.9-8.4	High------	Low.	
100	80-90	50-60	0.63-2.0	0.11-0.16	7.4-7.8	None------	Low.	B
100	95-100	50-60	0.20-0.63	0.14-0.16	7.4-7.8	None------	Moderate.	
100	95-100	50-60	0.63-2.0	0.16-0.18	7.9-8.4	None------	Low.	
95-100	70-90	40-55	0.20-0.63	0.14-0.16	7.9-8.4	None------	Low.	
50-75	40-60	20-40	2.0-6.3	0.08-0.12	7.4-7.8	None------	Low.	C
100	90-100	80-90	0.63-2.0	0.19-0.21	7.9-8.4	Slight----	Moderate.	C
100	95-100	83-95	0.20-0.63	0.17-0.21	7.9-9.0	Slight----	High.	
100	100	85-95	0.63-2.0	0.16-0.20	7.9-9.0	Moderate to severe.	Moderate.	
100	90-100	15-55	2.0-6.3	0.11-0.13	7.4-7.9	None------	Low.	B
100	75-100	15-30	2.0-6.3	0.10-0.12	7.4-8.4	None------	Low.	
95-100	95-100	85-95	0.63-2.0	0.19-2.1	7.4-8.4	None------	Low.	B
95-100	95-100	60-100	0.20-0.63	0.19-0.21	7.4-8.4	None------	Moderate.	

TABLE 6.--ENGINEERING

[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 for

Soil series and map symbol	Suitability as a source of--				Soil features affecting--	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and levees
Apishapa: Aa, Ac.	Poor: high clay content.	Unsuitable to a depth of 55 inches; fair from 55 inches, with screening and washing.	Unsuitable----	Poor: high shrink-swell potential.	Depth to water table ranges from $3\frac{1}{2}$ to 6 feet; occasional flooding.	High shrink-swell potential; cracks when dry.
Baca: BcB-----	Good-----------	Unsuitable----	Unsuitable----	Fair: poorly graded fine material; with little coarse material.	Gently sloping uplands; moderately erodible embankments.	Fair stability.
Bankard: Bk---	Poor: low fertility; erodible.	Good with screening.	Poor: poorly graded fine gravel; little coarse gravel.	Good----------	Sandy soils along streams; frequent flooding.	Sandy materials; rapid permeability when packed.
Bloom: Bm-----	Poor: moderate salinity.	Unsuitable----	Unsuitable----	Fair: poorly graded fine material.	Poorly drained; nearly level.	Fair stability.
Cadoma: CaD---	Poor: high clay content.	Unsuitable----	Unsuitable----	Poor: poorly graded clay material containing shale; high shrink-swell potential.	Sloping uplands; moderate frost heave hazard; high gully erosion hazard.	Cracking hazard.
Cascajo and Gravelly land: Cg.	Unsuitable----	Fair; screening yields coarse sand.	Good----------	Good----------	Hilly, gravelly soils with outcrops of shale.	Good stability.
Dwyer: Dw-----	Poor: erodible; low fertility.	Fair: poorly graded fine sands with fines mixed in.	Unsuitable----	Good if soil binder is added.	Sandy, undulating upland soils; highly erodible.	Poor stability; sandy.

more kinds of soil. The soils in such mapping units may have different properties and limitations, and for referring to other series that appear in the first column of this table]

Soil features affecting--Continued				Soil limitations for--	
Farm ponds		Agricultural drainage	Irrigation	Septic tank filter field	Homesites
Reservoir area	Embankment				
Wet sand at depth of 3½ to 6 feet.	Poor compaction; fair stability.	Clayey texture and slow permeability; lacks adequate drainage outlets.	Difficult to work; poor aeration.	Severe: slow permeability; water table at depth of 3½ to 6 feet.	Severe: occasional flooding; high shrink-swell potential.
Moderate seepage-	Fair compaction and stability.	(2/)------------	(2/)------------	Moderate: moderately slow permeability.	Slight.
Too porous to hold water; has water table associated with stream level.	Poor to fair compaction; rapid permeability.	Frequent flooding; seasonal water table rises to about 4 feet from surface.	Low water-holding capacity.	Severe: frequent flooding.	Severe: frequent flooding.
Moderate seepage; high water table.	Fair stability---	Lacks adequate drainage outlet.	High water table-	Severe: depth to water table normally ranges from 6 inches to 3 feet.	Severe: wetness.
Slopes limit storage.	Poor to fair stability and compaction; cracks when dry.	(2/)------------	(2/)------------	Severe: slow permeability.	Severe: high shrink-swell potential; frost heaving; strongly alkaline.
Rapid seepage----	Rapid permeability when compacted.	(2/)------------	(2/)------------	Severe: very rapid permeability; contamination hazard.	Slight.
Materials too porous to hold water.	Poor stability; poor resistance to piping; moderate to rapid permeability when compacted.	(2/)------------	(2/)------------	Slight----------	Moderate: wind erosion hazard.

Soil series and map symbol	Suitability as a source of-- Topsoil	Sand	Gravel	Road fill	Soil features affecting-- Highway location	Dikes and levees
*Glenberg: GbA, GkA. For interpretation of Bankard component of GkA, see Bankard series.	Poor: erodible; low fertility.	Good below depth of 3 feet, with screening and washing.	Poor: poorly graded fine gravel below depth of 3 feet.	Good----------	Nearly level terraces; occasionally flooded.	Moderately sandy materials; rapid permeability when packed.
*Harvey: HaB, HsB. For interpretation of Stoneham component of HsB, see Stoneham series.	Fair to poor: low content of organic matter; moderate salinity in wet phases.	Unsuitable----	Unsuitable----	Poor to a depth of 16 inches; poorly graded fines; fair below depth of 16 inches; small amount of coarse material.	Gently sloping uplands; highly erodible on embankments.	Fair stability.
Haverson: HvB--	Fair: low fertility.	Unsuitable----	Unsuitable----	Fair: silts with small amount of coarse material.	Silty soils on nearly level terraces; occasional flooding.	Fair stability.
*Kim: KmC--------- For Wiley part, see Wiley series.	Fair: low content of organic matter.	Unsuitable----	Unsuitable----	Poor: small amount of coarse material and clay.	Sloping uplands; few sandstone cobbles; highly erodible on embankments.	Fair stability.
*Kornman: KnA, KnB, KnC. For Neesopah part, see Neesopah series.	Good to depth of 13 inches; fair below depth of 13 inches; low fertility; erodible.	Fair in subsoil, with screening and washing.	Unsuitable----	Good----------	Nearly level uplands and terraces; embankments moderately erodible.	Good stability.
Las Animas: Lm--	Poor: moderate salinity; low fertility; highly erodible.	Good, with washing and screening.	Poor: poorly graded fine gravel.	Good----------	Frequently flooded terraces; high water table.	Sandy material rapidly permeable when compacted.
Limon: LnB, LoB-	Poor: high clay content.	Unsuitable----	Unsuitable----	Poor: high shrink-swell potential.	Nearly level terraces; flooding hazard; high plasticity.	High shrink-swell potential; cracks when dry.

Soil features affecting--Continued				Soil limitations for--	
Farm ponds		Agricultural drainage	Irrigation	Septic tank filter field	Homesites
Reservoir area	Embankment				
Rapid seepage----	Fair stability; rapid permeability.	Occasional flooding.	Droughty; low water-holding capacity.	Moderate: occasional flooding.	Severe: occasional flooding.
Moderate seepage-	Fair stability and compaction.	Banks of drainage ditches unstable.	Moderate salinity in wet phases.	Slight: wet phases have severe limitation.	Slight: wet phases have severe limitations.
Moderate seepage-	Fair stability and compaction; poor resistance to piping.	(2/)------------	(2/)------------	Moderate: medium to moderately slow permeability.	Severe: occasional flooding.
Moderate seepage-	Fair stability and compaction; moderate permeability when compacted.	(2/)------------	(2/)------------	Severe: sandstone at depths ranging from 20 inches to several feet.	Slight.
Moderate to rapid seepage.	Good stability and compaction.	Banks of drainage ditches unstable.	Subsoil has low water-holding capacity.	Slight----------	Slight.
Sandy substratum; depth to water table ranges from 6 inches to 3 feet.	Fair stability; rapid permeability when compacted.	Lacks adequate drainage outlet.	Frequent flooding; wetness and salinity.	Severe: high water table.	Severe: wetness and frequent flooding.
Underlying material may have layers of moderate permeability or thin layers of gypsum.	Poor stability and compaction; poor resistance to piping in places.	Clayey texture and slow permeability; nearly level.	Slow intake and permeability.	Severe: slow permeability.	Severe: high shrink-swell potential; frequent flooding.

Soil series and map symbol	Suitability as a source of--				Soil features affecting--	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and levees
Manvel: MaB---	Fair: low content of organic matter; highly erodible.	Unsuitable----	Unsuitable----	Poor: poorly graded silt with gypsum.	Gently sloping uplands; highly erodible on embankments.	Poor stability.
Manzanola: MbA, McB, Md2.	Good; fair for clay loam types because of clay content.	Unsuitable----	Unsuitable----	Poor to fair: silts and clays with small amount of coarse material; high shrink-swell potential in clay loam type.	Nearly level terraces; flooding hazard.	Good stability.
Minnequa: MeB, MnA, MnC.	Good from surface layer of irrigated areas; fair, nonirrigated; low content of organic matter.	Unsuitable----	Unsuitable----	Fair: small amount of clay and coarse material.	Gently sloping uplands; depth to bedrock ranges from 20 to 40 inches; highly erodible on embankments.	Poor stability.
Neesopah------	Good to depth of 0 to 12 inches; fair below depth of 12 inches; low fertility; erodible.	Poor: subsoil has poorly graded fine sands with excess of fines.	Unsuitable----	Fair: fine sands and silt with little coarse material.	Nearly level uplands; embankments moderately erodible.	Good stability.
Nepesta: NeB-	Good to depth of 10 inches; fair below depth of 10 inches; low fertility.	Unsuitable----	Unsuitable----	Fair: poorly graded sand-silt with small amount of coarse material.	Nearly level uplands; moderately erodible on embankments.	Fair stability.
Numa: NmA, NmB, NmC, NvD.	Good to depth of 14 inches; fair below depth of 14 inches; low fertility.	Unsuitable----	Unsuitable----	Fair: silts, with little coarse material (except gravel subsoil variant).	Nearly level to gently sloping uplands; highly erodible on embankments.	Moderate stability.

Soil features affecting--Continued				Soil limitations for--	
Farm ponds		Agricultural drainage	Irrigation	Septic tank filter field	Homesites
Reservoir area	Embankment				
Slow seepage; may have layers of gypsum in underlying material.	Poor stability and compaction; poor resistance to piping.	(2/)------------	(2/)-------------	Severe: slow permeability.	Slight.
Moderate to slow seepage.	Good stability and compaction; slow permeability when compacted.	Flooding hazard-	Moderately slow permeability and intake.	Moderate: moderately slow permeability.	Moderate: infrequent flooding; high shrink-swell potential in clay loam types.
Fractured bedrock or thin layers of gypsum underlie in places.	Poor stability and compaction; poor resistance to piping.	Depth to bedrock ranges from 20 to 40 inches; moderately corrosive to concrete; ditch banks unstable; materials may flow into, and plug, tile.	Salts accumulate-	Severe: bedrock at depths ranging from 20 to 40 inches.	Slight.
Moderate to rapid seepage.	Good stability and compaction; poor resistance to piping.	Banks of drainage ditches unstable.	Subsoil has moderately low water-holding capacity.	Slight-----------	Slight.
Moderate seepage-	Fair compaction and stability.	(1/)------------	Moderately slow permeability.	Slight-----------	Slight.
Moderate seepage-	Fair stability and compaction.	Banks of deep drainage ditches unstable.	Overirrigation causes seep spots on gently sloping areas.	Slight-----------	Slight.

Soil series and map symbol	Suitability as a source of-- Topsoil	Sand	Gravel	Road fill	Soil features affecting-- Highway location	Dikes and levees
Olney: OlB, OnA-	Fair: low fertility; good from surface layer of irrigated land.	Unsuitable----	Unsuitable----	Fair: poorly graded sand-silt, with little coarse material.	Nearly level uplands; moderately erodible on embankments.	Good stability.
Otero: OtC------	Poor: low fertility; erodible.	Unsuitable----	Unsuitable----	Good: fair in places because of poorly graded sand-silt.	Undulating uplands; highly erodible embankments.	Good stability.
Penrose: PeE----	Unsuitable---	Unsuitable----	Unsuitable; possible source of limestone for crushing.	Unsuitable without crushing.	Hilly; very shallow to limestone.	Shallow soil-
Rocky Ford: RfA, RfB-------	Good to depth of 18 inches; fair below depth of 18 inches; low content of organic matter; erodible.	Unsuitable----	Unsuitable----	Fair: silts with little coarse material.	Silty soils of nearly level to gently sloping terraces.	Moderate stability.
RgA, RgB-------	Good----------	Unsuitable----	Unsuitable----	Fair: silts and clays with little coarse material.	Nearly level to gently sloping terraces; flooding hazard in places.	Moderate stability.
RlA, RlB-------	Good to depth of 10 inches; fair between depth of 10 to 40 inches; low content of organic matter; erodible.	Unsuitable----	Unsuitable----	Fair: silts and clays with little coarse material.	Nearly level to gently sloping uplands; depth to bedrock ranges from 42 to 72 inches.	Moderate stability.

Soil features affecting--Continued				Soil limitations for--	
Farm ponds		Agricultural drainage	Irrigation	Septic tank filter field	Homesites
Reservoir area	Embankment				
Moderate seepage-	Fair stability, compaction, and resistance to piping.	(1/)------------	(1/)-------------	Slight-----------	Slight.
Moderate to rapid seepage.	Fair stability; moderate permeability when compacted; poor resistance to piping.	Substratum contains layers of sand and gravel in places.	Moderately rapid intake; droughty.	Slight-----------	Slight.
Shallow soil; rapid seepage.	A source of riprap material.	(2/)------------	(2/)-------------	Severe: very shallow to fractured bedrock.	Moderate: materials difficult to work.
Moderate seepage-	Poor stability and compaction; poor resistance to piping.	Banks of drainage ditches unstable.	(1/)-------------	Slight-----------	Slight.
Sandy substratum below 3 feet with water table.	Fair to good stability and compaction.	Lacks adequate drainage outlet in places.	Moderately slow intake and permeability; slight salinity.	Severe: depth to water table ranges from 3 to 6 feet.	Severe: wetness; occasional flooding.
Thin layers of gypsum in substratum in places.	Poor stability, compaction, and resistance to piping.	Depth to limestone ranges from 42 to 72 inches; moderately corrosive to concrete; ditchbanks unstable; material may flow into, and plug, tile.	Salts accumulate-	Severe: depth to limestone ranges from 42 to 72 inches.	Moderate: water table rises during irrigation season.

Soil series and map symbol	Suitability as a source of--				Soil features affecting--	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and levees
Rocky Ford--Continued. RmB----------	Fair to good to depth of 18 inches; poor below depth of 18 inches; low fertility; erodible.	Fair below depth of 24 inches; may need screening and washing.	Poor: poorly graded fine gravel.	Fair to good: top 18 inches has little coarse material.	Nearly level terraces; flooding hazard in places.	Moderate stability.
Samsil-Shale outcrop: Sc.	Unsuitable-----	Unsuitable----	Unsuitable----	Unsuitable-----	Unstable shale slopes; high frost heave hazard.	Shallow soil-
Shingle: SgC----------	Poor to depth of 12 inches; low fertility; highly erodible; unsuitable below depth of 12 inches.	Unsuitable----	Unsuitable----	Unsuitable-----	Shallow to soft, erodible shale.	Shallow soil-
ShC----------	Unsuitable; possible source of gypsum as a soil amendment.	Unsuitable----	Unsuitable----	Unsuitable-----	Gypsum, sandstone, and shale in successive layers from the surface.	Shallow soil-
Stoneham-------	Fair: low content of organic matter.	Unsuitable----	Unsuitable----	Fair: small amount of coarse material.	Gently sloping uplands; highly erodible on embankments.	Good stability.
Travessilla: TaC.	Unsuitable----	Unsuitable----	Unsuitable----	Unsuitable without crushing.	Bedrock at less than 20 inches; rock hinders hauling and grading.	Shallow soil-
Travessilla-Rock outcrop: Tr. Materials are too variable to classify.						

Soil features affecting--Continued				Soil limitations for--	
Farm ponds		Agricultural drainage	Irrigation	Septic tank filter field	Homesites
Reservoir area	Embankment				
Sandy substratum-	Fair to good stability; moderate permeability from 0 to 24 inches; poor stability, fair compaction, high permeability below depth of 24 inches.	Sand at depth of about 24 inches.	Low water-holding capacity.	Slight-----------	Slight: severe in places because of occasional flooding.
Shallow soil; slopes limit storage.	Poor stability and compaction; high compressibility.	(2/)-------------	(2/)-------------	Severe: very slow permeability.	Severe: unstable shale slopes.
Slopes limit storage.	Poor stability and compaction; high compressibility; poor resistance to piping.	Shale at depth of about 12 inches.	Slow intake and permeability; high water erosion hazard.	Severe: very slow permeability.	Severe: unstable shale slopes.
High seepage-----	Poor stability and compaction; high compressibility; poor resistance to piping.	(2/)-------------	(2/)-------------	Severe: very slowly permeable substratum.	Severe: unstable, erodible materials.
Moderate seepage-	Good stability and compaction.	(2/)-------------	(2/)-------------	Slight-----------	Slight.
Fractured bedrock at shallow depths.	A source of riprap materials.	(2/)-------------	(2/)-------------	Severe: shallow to fractured bedrock.	Severe: materials difficult to work.

Soil series and map symbol	Suitability as a source of--				Soil features affecting--	
	Topsoil	Sand	Gravel	Road fill	Highway location	Dikes and levees
Tyrone: TyB---	Poor: alkaline; low content of organic matter.	Unsuitable----	Unsuitable----	Poor: clayey material with gypsum; little coarse material.	Gently sloping uplands; high frost-heave hazard.	Moderate stability.
Vona: VdC-----	Fair: low fertility; high erodibility.	Unsuitable----	Unsuitable----	Fair: poorly graded silts and fine sands with little coarse material.	Gently undulating uplands; embankments highly erodible.	Good stability.
Wiley----------	Fair: low content of organic matter.	Unsuitable----	Unsuitable----	Poor: small amount of coarse material.	Gently sloping uplands; highly erodible on embankments; few small areas of sandstone outcrop.	Fair stability.

1/ All features favorable.

Soil features affecting--Continued				Soil limitations for--	
Farm ponds		Agricultural drainage	Irrigation	Septic tank filter field	Homesites
Reservoir area	Embankment				
Slow seepage-----	Fair stability and compaction; low permeability when compacted.	(2/)-------------	(2/)-------------	Severe: slow permeability.	Moderate: parent shale within 4 feet in places; saline-alkaline condition.
High seepage-----	Fair stability and compaction; moderate permeability; poor resistance to piping.	Gently undulating uplands; banks of deep drainage ditches unstable.	Moderately rapid intake rate; moderately low water-holding capacity.	Slight------------	Slight.
Slow seepage; depth to sandstone ranges from 3 to 6 feet.	Fair stability and compaction; slow permeability when compacted.	(2/)-------------	(2/)-------------	Severe: sandstone at depths ranging from 40 inches to 6 feet.	Slight.

2/ Practice not presently applicable on these soils.

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that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. Usually a long time is required for the development of distinct horizons.

The factors of soil genesis 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 Material[6/]

Parent material is the unconsolidated mass in which the soil profile develops. The soil parent material has an indefinite boundary with the overlying subsoil. It differs from subsoil in that it has been less modified by water, temperature, organisms, or plant roots. Parent soil material weathers from rocks of various geologic age and character (fig. 6).

In arid and semiarid climates the parent material gives the soil many of the characteristics that influence plant growth. Parent material also affects the rate of soil development. For instance, it is difficult for water to infiltrate clayey parent materials; consequently, clayey soils are very slow to develop in dry climates. Sands are easily penetrated by water, but develops slowly for another reason. The minerals that comprise sand are very inactive chemically and weather very slowly. Sandy parent material, therefore, invariably weathers to sandy soils.

The Niobrara formation of Upper Cretaceous age is the most extensive formation in Otero County. It is comprised of beds, 700 to 800 feet thick, chiefly of Smoky Hill marl and calcareous shale, but with a prominent limestone member (the Ft. Hayes limestone) 45 to 70 feet thick at the base. These beds are the parent rock for soils of the Manvel, Minnequa, Penrose, Shingle, and Tyrone series.

The Ft. Hayes limestone consists of white to cream-colored layers, 4 to 12 inches thick, separated by gray calcareous shale. The limestone weathers into rectangular blocks, which in turn weather to chips and fragments that occur in the profiles of Manvel, Minnequa, and Penrose soils. The Ft. Hayes limestone, because it is more resistant to erosion than beds above or below, forms prominent escarpments. One such escarpment occurs almost continuously along the southern edge of the Niobrara outcrop from the southwestern part of the county to the La Junta area. The soil is mostly Penrose channery loam.

Smoky Hill marl underlies much of Otero County. It consists of tan to yellow marl and calcareous shale, which have a characteristic yellowish-orange color in weathered exposures. It also contains a few thin beds of white limestone and bentonite. Smoky Hill marl is soft and rapidly weathered so that there is usually several feet of soil parent material over the raw marl. Soils developed in Niobrara parent material are strongly calcareous and have an alkaline subsoil that becomes more alkaline with depth.

Unconsolidated deposits of Quaternary age are widely distributed in Otero County and include (1) sandy and gravelly alluvium underlying stream terraces and high, level geomorphic surfaces; (2) silty and sandy eolian deposits; (3) residual soils on uplands; and (4) alluvium in stream flood plains. Within the Quaternary system it is possible to distinguish early and late Pleistocene and Recent age members.

Early Pleistocene alluvial deposits are a part of high, level geomorphic surfaces paralleling the valleys of the Arkansas and Apishapa Rivers. They are particularly extensive along the southern side of the Arkansas River. These surfaces occur on high mesas and terraces lying from 150 to 300 feet above the stream valley. The deposits underlying these surfaces consist mainly of river deposited sand and gravel.

Sandy and gravelly deposits of late Pleistocene age occur on the lower terraces along the Arkansas River. The surfaces of these terraces usually lie from 30 to 80 feet above the present stream channel. These terrace deposits are generally mantled with younger eolian and alluvial deposits, which are the parent material for a large part of the irrigated land. Along the Arkansas River, the maximum thickness of the Pleistocene valley fill is about 50 feet. It is a reservoir for ground water and is tapped by numerous irrigation wells. It is underlain by Smoky Hill marl.

Soils developing in Pleistocene alluvium include those of the Cascajo, Harvey, Numa, and Stoneham series. They are medium-textured to gravelly, well-drained, mildly alkaline soils having a prominent lime horizon.

Thin loesslike deposits, also considered to be late Peistocene, are thinly mantled parts of the uplands in northern and central Otero County. Loess is the parent material for Wiley and Baca soils.

Areas of wind-deposited sand occur throughout northern and western Otero County. In most instances these areas are adjacent to the important rivers. This medium-grained quartz sand is in most places moderately well rounded. Probably the sand accumulated in the stream valleys and then blew out on the nearby hills. The sand generally has a good cover of vegetation and is well stabilized. For these reasons, it seems likely that these deposits are also late Pleistocene, although some reworking by wind has occurred in Recent times. Dwyer, Olney, and Vona soils have developed in these eolian sands, which are intermixed with some silt and clay.

Deposits of Recent age include extensive areas of alluvial and colluvial deposits, plus some eolian sand mentioned above. From parent material of Recent age in Otero County nearly level soils having a wide range in texture have developed. Included are soils of the Apishapa, Bankard, Bloom, Haverson, Limon, and Rocky Ford series.

Dakota sandstone of Lower Cretaceous age crops out extensively along the Purgatoire River valley and in the Smith Creek canyon in the southeastern

[6/] Prepared with the help of ALEX D. ELKIN, geologist, Soil Conservation Service.

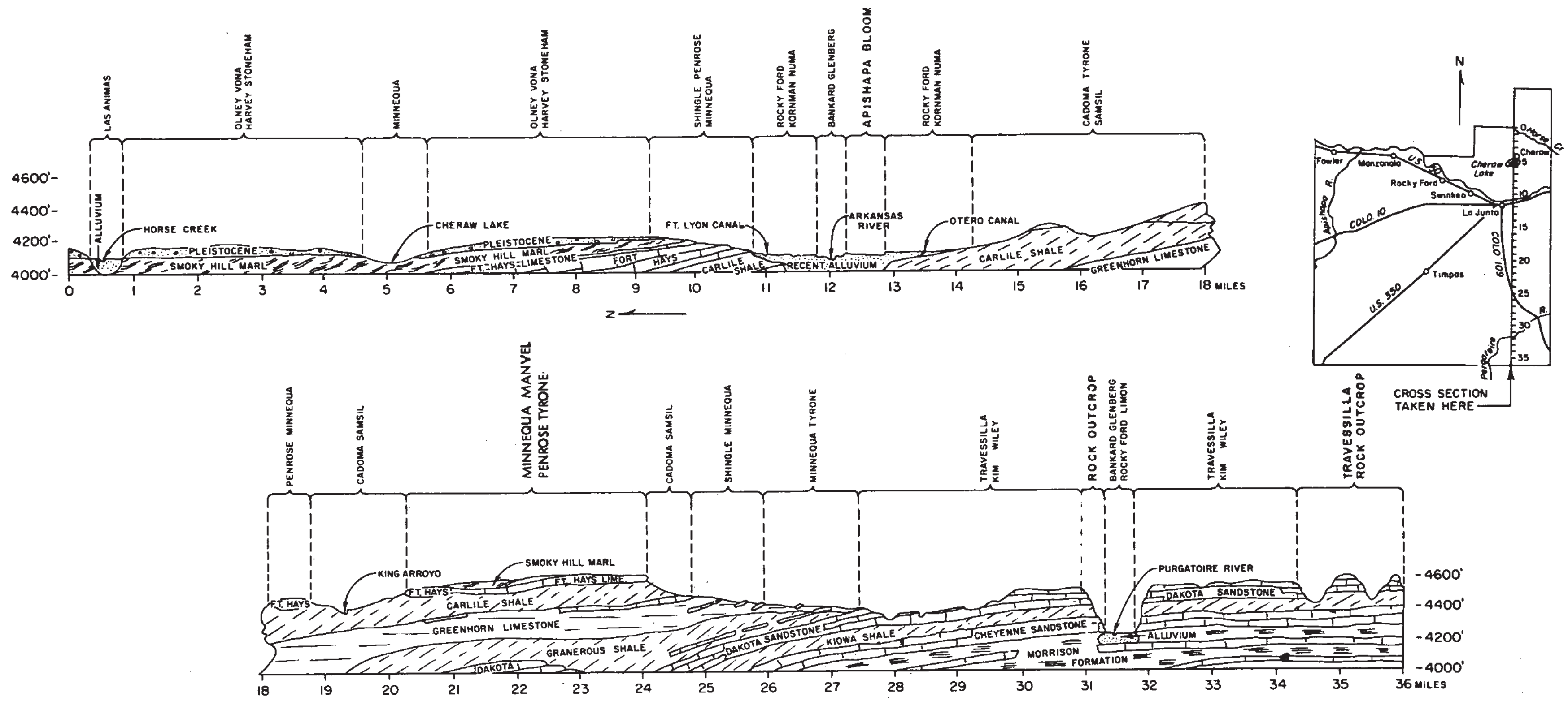

Figure 6.— Cross section of Otero County showing relief, drainage, and relation of soils to underlying geologic formations.

part of the county. It also crops out over limited areas of the Timpas Creek drainage basin in southwestern Otero County. The total thickness of the Dakota sandstone is variable, but probably does not exceed 150 feet. The Dakota sandstone consists of fine-grained, thin-bedded to massive sandstone containing layers of sandy shale. It is mainly buff and tan to light gray, but locally may be white, yellow, or light red. On weathered surfaces it is stained various shades of brown.

The Purgatoire formation, also of Lower Cretaceous age, underlies the Dakota. It includes the Cheyenne sandstone and Kiowa shale members. The Cheyenne sandstone, the lower member of the formation, is coarse-grained to fine-grained sandstone that is white to light-gray on fresh exposures, but weathers to cream, buff, and light tan. It crops out in prominent cliffs along canyon walls. It is somewhat lighter colored, less well cemented, more friable, and coarser grained than the Dakota. The total thickness is about 100 feet. Kiowa shale crops out on canyon walls in thin layers above the Cheyenne sandstone. It consists of dark-gray to black, calcareous, clayey shale containing sandy shale and thin beds of sandstone near the top. The Dakota and Purgatoire formations are the parent rock for soils of the Travessilla and Kim series.

Other geologic formations include Greenhorn limestone, Granerous shale, and Carlisle shale, all of Upper Cretaceous age. These formations crop out in places in a narrow belt extending from the southwestern corner of Otero County to the county line in the east-central part of the county. The Greenhorn and Granerous formations typically contain bands of bentonite. The bands, however, seldom exceed a few inches in thickness. It is possible that there are beds of bentonite up to 3 feet thick, but because of the colluvial mantle, none has been found.

The Morrison formation underlies the Purgatoire in the extreme southeastern part of the county. While of interest, it is not particularly important to soil formation in Otero County. It is a part of the Jurassic system, which also includes an unnamed unit containing alabaster gypsum. The latter is the parent material for small areas of Shingle loam, gypsum variant, 1 to 9 percent slopes, in the Smith Creek canyon in the southeastern part of the county.

Climate

Climate, one of the two active factors of soil formation, is responsible for variations in plant and animal life and for major soil differences. It affects the type of weathering of rocks and the removal and redeposition of materials by wind and water. It is responsible for percolation of water through the soil. The chemical nature of soils in arid and semiarid regions is vastly different than that of humid regions. Soils of arid regions are limy and contain various soluble salts. Soils of humid regions are more or less acid and deficient in lime because the salts have been leached. In humid regions, the effect of climate upon soil formation tends to obliterate the effects of parent material. In arid regions, the soils retain characteristics of the parent material.

The climate of Otero County is semiarid. The average annual rainfall is 12 inches, and the average annual temperature is 53° F. The winters are dry and mild; the summers, hot with very low humidity. The evaporation rate exceeds precipitation. Most of the precipitation comes late in spring and in summer as local thundershowers. With this type of rainfall there is considerable runoff. Soil formation, consequently, is exceedingly slow. The soils are high in lime and certain other salts.

Living Organisms

Living organisms are one of the two active factors of soil formation. They produce organic matter without which parent material would not become soil. The primary source of organic matter is the various associations of grass, trees, and other plants that grow on the soil. The leaves and stems furnish the raw material for organic matter. Putrifactive bacteria and fungi cause the decay of dead leaves and other plant remains and aid in incorporating it into the soil.

The plant associations of Otero County are of three kinds: (1) the short grass range which has inclusions of mid-tall grasses; (2) the juniper-grass association in the southeastern and southwestern parts of the county; and (3) the cultivated, high-yielding cropland of the irrigated section.

By far the most extensive plant association is the virtually treeless, short-grass range. The grasses are of a type that can remain dormant in periods of drought. Blue grama and galleta are typical. The above-ground growth varies widely from year to year, depending upon rainfall. Periods of drought during which growth is nearly terminated are common. Growth is interrupted by freezing temperatures in winter. The head of summer hastens decomposition of annual residues to such an extent that they are nearly gone before the next season's growth. The smaller leaflets and stems of dry plants are easily detached and blown about by wind. Most of the organic matter comes from the decay of roots.

The Juniper-grass association is on strongly sloping, moderately deep to very shallow soils. Juniper competes with grass by sapping moisture on shallow soils and shading the ground. The grasses, though sparse, include short and mid-tall varieties. Many kinds of drought-tolerant forbs grow in this association.

On range, the organic content of the upper 20 inches of the soil ranges from about 0.5 to 1.7 percent. Most of the organic matter is in the top 10 inches. The soil is too dry for earthworm activity, and bacterial action is limited. There is some rodent activity in the medium-textured to coarse-textured soils. Rodents are particularly active in overgrazed silty soils. Rodents mix soil horizons and bring parent material to the surface.

On the soils under irrigation, man has changed the soil climate. Earthworms and bacteria are active. Crop residue provides most of the raw material for organic matter. At times, water used for irrigation carries particles of topsoil eroded from the watershed. The particles settle on the fields and significantly thicken and enrich the surface layer with organic matter and plant nutrients. The content of organic matter is about 2 to 3 percent in the 12- to 18-inch surface layer of Nepesta, Numa, and Rocky Ford soils.

Relief

Relief affects runoff and drainage. Runoff is usually large from steep slopes and less on the nearly level ones.

The topography of Otero County, except for limestone escarpments and sandstone canyons and outcrops, is gently sloping to undulating. The county ranges in altitude from slightly more than 5,150 feet on a high mesa in the south-central part of the county to about 3,965 feet in the northeast where the Arkansas River leaves the county. The total relief therefore is nearly 1,200 feet. Runoff is not great, except on eroded areas, on overgrazed range, and on steep, very shallow soils.

The Arkansas River occupies a broad, flat, moderately well drained flood plain that averages about a mile in width. The flood plain is bordered by well-drained, wide, or flat, terraces. Most of the Apishapa, Glenberg, Bankard, Bloom, and Las Animas soils are on the flood plain. Most of the Kornman, Numa, and Rocky Ford soils are on the terraces.

The area north of the river is characterized by broad, flat valleys, flanked by long, gentle slopes extending to nearly level drainage divides.

Immediately south of the Arkansas River are remnants of high, level, sandy and gravelly geomorphic surfaces which are 150 to 300 feet above adjacent stream valleys. This area merges to the south with gently undulating plains developed mainly from marl and limestone. Through it, the flood plains of tributaries of the Arkansas River average about one-half mile in width.

In the southern and southeastern parts of the county, rock outcrops, escarpments, and canyon walls having slopes that range from 1 to 65 percent cause a high rate of runoff. Parent material, in some places, is removed as fast as it accumulates. Most of the very shallow Penrose and Travessilla soils are located in such places.

Relief enhances soil genesis on most of the flood plains of Timpas Creek, Crooked Arroyo, and Tributaries of the Apishapa River. Most of the Manzanola soils are situated on the flood plains. These soils, developing in alluvium that presumably is among the most recent parent material, have well defined soil horizons. Runoff from slopes and overflow from the streams spread over the flood plains and readily percolate through the loamy parent material. This process encourages differentiation of soil horizons.

Time

The time required for a soil profile to develop can range from a few decades to thousands or even millions of years. It varies widely because of many combinations of living organisms, many kinds of rocks, many topographies, and many different ages of land surface.

Rather than describing a soil by age in years, it is more accurate to describe it as youthful or mature. Youthful soils resemble the parent material in which they developed. Mature soils have distinct soil horizons lying one above the other and parallel to the surface. The sequence of horizons makes up the soil profile.

The age of soils in Otero County ranges from youthful to mature. Most of the soils in Otero County are youthful. Youthful soils are not generally suitable for farming without irrigation. They reflect a droughty climate, and they are easily eroded. Among the youthful soils are those of the Harvey, Kornman, Manvel, Minnequa, Numa, Otero, and Rocky Ford series. Mature soils in Otero County are the Baca, Olney, Manzanola, and Vona. They each have a distinct sequence of soil horizons.

Processes of Soil Formation

Several processes were involved in the formation of soil horizons in the soils of Otero County. These processes are (1) accumulation of organic matter, (2) leaching of calcium carbonate, (3) translocation of silicate clay minerals, (4) accumulation of soluble salts, and (5) reduction of iron because of poor drainage.

Accumulation of organic matter in the upper profile has been important in the formation of an A horizon. Most of the organic matter has come from decay of plant roots and micro-organisms. The end product of decay in soil is humus.

Leaching of calcium carbonate is the most important factor of soil formation that takes place in the semiarid climate of Otero County. Most soils, except perhaps those with clay or sand parent materials, have a very pale brown to whitish zone of lime at a depth of about 20 inches. It has been left there by water that leached it from the horizons above. Soil scientists generally agree that the leaching of carbonates or other bases in soils usually precedes translocation of silicate clay minerals.

In some soils of Otero County, the translocation of clay minerals has contributed to horizon development. Olney and Baca soils have a B horizon in which the peds have distinct accumulations of clay (clay films) in pores and on ped surfaces. Vona, Tyrone, and Manzanola soils have less definite clay films. The clay is transferred from the surface layer by water and is redeposited in the B horizon.

Lack of good drainage causes accumulation of soluble salts and reduction of iron. Poorly drained soils are poorly aerated. This lack of oxygen results in the reduction and loss of iron. Yellowish-brown and dark-gray mottles indicate segregated iron. Such mottles can be seen in the subsoil of the Las Animas, Bloom, and Apishapa soils. Poorly drained soils also accumulate salts. As water evaporates from the surface, the salts that were in the water remain. During dry periods, salts are visible in places on the surface as a thin white crust.

Classification of the Soils

Soils are classified so that we may more easily remember their significant characteristics, assemble knowledge about them, see their relationships to one another and to the whole environment, understand their behavior and their response to management, and apply knowledge of their behavior within farms, ranches, or counties. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Two systems of classifying soils have been used in the United States. The older system was adopted in 1938 and revised later (6). The newer system was adopted for general use by the National Cooperative Soil Survey in 1965 (3, 5). In this survey the new system is used almost exclusively, but the placement of soils in the older system is also given (see table 7).

Under the current system, all soils are placed in six categories. Beginning with the most inclusive, the categories are the order, suborder, the great group, the subgroup, the family, and the series. The categories are defined in terms of observable or measurable properties of the soils. The properties are so chosen, however, that soils of similar mode of origin are grouped together.

In table 7 each soil series of the county is placed in its family, subgroup, and order of the new classification system and in its great soil group of the older system.

Following are brief descriptions of each of the six categories in the current system.

TABLE 7.--SOIL SERIES IN OTERO COUNTY CLASSIFIED IN HIGHER CATEGORIES

Series	Current classification			Great soil group, 1938 classification
	Family	Subgroup	Order	
Apishapa-----	Fine, montmorillonitic, calcareous, mesic.	Vertic Haplaquepts----	Inceptisols-	Alluvial soils.
Baca---------	Fine, montmorillonitic, mesic---------	Ustollic Haplargids---	Aridisols---	Brown soils.
Bankard------	Sandy, mixed, mesic-------------------	Ustic Torrifluvents---	Entisols----	Alluvial soils.
Bloom--------	Fine-silty, mixed, calcareous, mesic---	Typic Haplaquepts-----	Inceptisols-	Alluvial soils.
Cadoma-------	Fine, montmorillonitic, mesic---------	Ustollic Camborthids--	Aridisols---	Brown soils.
Cascajo------	Sandy, mixed, mesic-------------------	Ustollic Calciorthids-	Aridisols---	Calcisols.
Dwyer--------	Mixed, mesic--------------------------	Ustic Torripsamments--	Entisols----	Regosols.
Glenberg-----	Coarse-loamy, mixed, calcareous, mesic-	Ustic Torrifluvents---	Entisols----	Alluvial soils.
Harvey-------	Fine-loamy, mixed, mesic--------------	Ustollic Calciorthids-	Aridisols---	Calcisols.
Haverson-----	Fine-loamy, mixed, calcareous, mesic---	Ustic Torrifluvents---	Entisols----	Alluvial soils.
Kim----------	Fine-loamy, mixed, calcareous, mesic---	Ustic Torriorthents---	Entisols----	Regosols.
Kornman------	Coarse-loamy, mixed, calcareous, mesic-	Ustic Torrifluvents---	Entisols----	Alluvial soils.
Las Animas---	Coarse-loamy, mixed, calcareous, mesic-	Fluventic Haplaquepts-	Inceptisols-	Alluvial soils.
Limon--------	Fine, montmorillonitic, calcareous, mesic.	Ustic Torriorthents---	Entisols----	Alluvial soils.
Manvel-------	Fine-carbonatic, mesic----------------	Ustic Torriorthents---	Entisols----	Regosols.
Manzanola----	Fine, montmorillonitic, mesic---------	Ustollic Haplargids---	Aridisols---	Brown soils.
Minnequa-----	Fine-carbonatic, mesic----------------	Ustic Torriorthents---	Entisols----	Regosols.
Neesopah-----	Coarse-loamy, mixed, mesic------------	Ustollic Haplargids---	Aridisols---	Brown soils.
Nepesta------	Fine-silty, mixed, mesic--------------	Ustollic Haplargids---	Aridisols---	Brown soils.
Numa---------	Fine-loamy, mixed, mesic--------------	Ustollic Calciorthids-	Aridisols---	Calcisols.
Olney--------	Fine-loamy, mixed, mesic--------------	Ustollic Haplargids---	Aridisols---	Brown soils.
Otero--------	Coarse-loamy, mixed, calcareous, mesic-	Ustic Torriorthents---	Entisols----	Regosols.
Penrose------	Fine-carbonatic, mesic----------------	Lithic Ustic Torriorthents.	Entisols----	Lithosols.
Rocky Ford---	Fine-silty, mixed, calcareous, mesic---	Ustic Torriorthents---	Entisols----	Alluvial soils.
Samsil-------	Clayey, mixed, calcareous, mesic------	Ustic Torriorthents---	Entisols----	Lithosols.
Shingle------	Loamy, mixed, calcareous, mesic, shallow.	Ustic Torriorthents---	Entisols----	Lithosols.
Stoneham-----	Fine-loamy, mixed, mesic--------------	Ustollic Haplargids---	Aridisols---	Brown soils.
Travessilla--	Loamy, mixed, calcareous, mesic--------	Lithic Ustic Torriorthents.	Entisols----	Lithosols.
Tyrone-------	Fine-carbonatic, mesic----------------	Haplic Ustollic Natrargids.	Aridisols---	Solonetz soils.
Vona---------	Coarse-loamy, mixed, mesic------------	Ustollic Haplargids---	Aridisols---	Brown soils.
Wiley--------	Fine-silty, mixed, mesic--------------	Ustollic Haplargids---	Aridisols---	Brown soils.

ORDER.--Ten soil orders are recognized in the classification system; three of these orders are recognized in Otero County. They are Entisols, Inceptisols, and Aridisols. The orders are primarily broad climatic groupings. Entisols are exceptions; they include soils in many different climates.

Entisols are young soils; they are without genetic horizons or have only the beginning of such horizons. In Otero County, this order includes soils previously classified as Alluvial soils, Regosols, or Lithosols.

Inceptisols are soils with one or more horizons which are thought to form rather quickly. In Otero County, this order includes soils formerly classified as poorly drained Alluvial soils.

Aridisols are soils with a light-colored surface layer and a zone of translocated carbonates in the subsoil. They may or may not have clay-enriched B horizons. They are so named because they occur in semiarid and arid climates. In Otero County, this order includes soils that were formerly classified as Brown soils, Solonetz soils, or Calcisols.

SUBORDER.--Each order is divided into suborders, primarily on the basis of those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders have a narrower climatic range than the orders. The soil properties used to separate suborders are mainly those that reflect differences resulting from climate, vegetation, or the presence or absence of waterlogging, or differences in parent material.

GREAT GROUP.--Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequences of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with growth of roots or movement of water. The features used are soil temperature, and major differences in chemical composition (mainly calcium, sodium, magnesium, and potassium).

SUBGROUP.--Great groups are divided into subgroups, one representing the central (typic) segment of the group, and others, 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 separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

All of the soils in Otero County are mesic, as compared to frigid or thermic. These terms refer to soil temperature classes. Mesic soils are those soils with 9° F. or more difference (at a depth of 20 inches) between mean summer (June, July, and August) and mean winter (December, January, and February) temperatures, and with a mean annual temperature (at a depth of 20 inches) between 47° and 59°. Frigid soils have lower mean annual temperatures than mesic soils; thermic soils have warmer mean annual temperatures than mesic soils. Over a large part of the United States, the mean annual soil temperature at a 20-inch depth is about 2 degrees warmer than the mean annual air temperature. Table 8 gives the measure of temperatures of some soils in 1965-1966.

SERIES.--The series is a group of soils that, except for the texture of the surface layer, have major horizons that are similar in important characteristics and in arrangement in the profile. They are given the name of a geographic location near the place where that series was first observed and mapped. An example is the Rocky Ford series.

TABLE 8.--SOIL TEMPERATURES

[Data for temperatures measured at 20-inch depth on the 15th day of the month, 1965-1966]

Soil	June	July	August	Average summer temperature	December	January	February	Average winter temperature	Average annual temperature
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Apishapa clay (irrigated)	64	73	72	70	44	40	39	41	55
Dwyer loamy sand	70	78	80	76	43	40	34	39	58
Glenberg loamy fine sand (wooded)	65	72	72	70	43	38	36	39	55
Limon silty clay (irrigated)	63	72	73	69	42	39	35	39	54
Manvel silt loam	75	75	72	72	42	38	33	38	55
Manzanola loam	66	76	75	72	44	38	36	39	56
Minnequa loam	67	75	75	72	42	38	35	38	55
Neesopah loam (irrigated)	68	76	75	73	42	36	34	37	55
Numa clay loam (irrigated)	66	74	74	71	42	36	34	37	54
Olney sandy loam	68	80	80	76	43	38	37	39	58

TABLE 8.--SOIL TEMPERATURES--Continued

Soil	June	July	August	Average summer temper-ature	December	January	February	Average winter temper-ature	Average annual temper-ature
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Rocky Ford silty clay loam (irrigated).	66	74	70	70	41	38	35	38	54
Rocky Ford silty clay loam, wet (irrigated).	64	72	68	68	42	40	36	39	54
Tyrone silty clay loam-----------	67	76	76	73	44	39	36	40	57
Vona sandy loam------------------	69	77	80	75	44	40	35	40	58
Wiley loam-----------------------	68	75	76	73	44	39	36	40	56

GENERAL NATURE OF THE COUNTY

In this section the physiography, relief, and drainage, climate, and farming and industry of Otero County are discussed.

Physiography, Relief, and Drainage

Otero County lies entirely within the physiographic province of the Great Plains. For the most part, the relief of the land area is gently undulating. The southern part of the county merges irregularly with a region of excessive relief comprised of nearly level mesas and steeply sloping escarpments and canyon walls. The elevation ranges from about 3,965 feet in the northeast where the Arkansas River leaves the county to slightly more than 5,150 feet on a high mesa in the south-central part of the county. The total relief, therefore, is nearly 1,200 feet.

Otero County is drained by the Arkansas River and its tributaries. The Arkansas River flows eastward along the north county line in northwestern Otero County and then across the middle of the northeastern quarter of the county.

Major tributaries of the Arkansas River in Otero County are the Apishapa River, Timpas Creek, Crooked Arroyo, Anderson Arroyo, and King Arroyo. All of these streams flow northward or northeastward and drain into the Arkansas River within the county. The southeastern part of the county is drained by the Purgatoire River and its tributaries, the largest of which is Smith Creek. The Purgatoire River enters the Arkansas River east of this area in Bent County.

A small area in the northeastern corner of Otero County is drained by Horse Creek and its tributaries. Between Horse Creek and the Arkansas River, there is a small area with no well-defined stream pattern, and much of the surface drainage here is into small enclosed basins.

The Arkansas, Apishapa, and Purgatoire Rivers have a continuous flow of water, which generally is smallest during fall and winter. Timpas Creek, Crooked Arroyo, and Horse Creek are among those tributary streams that have a small, continuous flow originating from subsurface return of irrigation waters in their lower reaches. Most of the other tributary streams are intermittent. Few contain running water other than during the summer months, when runoff from thunderstorms can fill their channel for a short period.

Climate [7/]

The semiarid climate of Otero County is typical of the high plains, modified by the effects of the mountains to the west. Meager and variable precipitation from year to year, abundant sunshine, low humidity, wide temperature ranges, and considerable wind movement are characteristic.

The weather of the area is influenced by air movement from four main sources. The most common source is dry and usually relatively warm air from the southwest. During winter, invasions of cold air from the north bring occasional blizzards and sharp drops in temperature for periods extending 3 to 5 days. Except for such cold spells, winter weather is generally open and relatively mild. After crossing the Rocky Mountains, Pacific maritime air from the west brings little moisture to the area. It is frequently associated with storms to the north and with high winds late in winter and in spring. Air from the Gulf of Mexico in spring, summer, and fall brings warm temperatures and higher humidity. It is the principle source of moisture for the thundershower activity, which is responsible for precipitation during the growing season.

Temperature and precipitation for Otero County are summarized in table 9. The probabilities of the last freezing temperature in spring and the first in the fall are given in table 10.

[7/] Prepared by J. W. BERRY, climatologist for Colorado, National Weather Bureau Service, U.S. Department of Commerce.

TABLE 9.--TEMPERATURE AND PRECIPITATION, OTERO COUNTY, COLORADO

[All data from Rocky Ford in Otero County]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with--		Average total	Two years in 10 will have--		Days with snow cover	Average depth of snow on days with snow cover
			Maximum temperature equal to or higher than--	Minimum temperature equal to or lower than--		Less than--	More than--		
	°F.	°F.	°F.	°F.	In.	In.	In.	No.	In.
January---	46	14	64	-6	0.43	0.1	0.9	7	3
February--	51	19	69	1	.35	.1	.9	5	4
March-----	58	25	75	7	.72	.2	1.1	3	5
April-----	69	36	84	23	1.45	.5	1.7	1	2
May-------	77	46	91	35	2.02	.7	2.9	0	---
June------	89	55	100	46	1.26	.3	2.1	0	---
July------	94	60	101	54	1.74	.7	2.7	0	---
August----	91	59	99	51	1.70	.9	2.1	0	---
September-	84	49	96	38	1.07	.2	1.9	0	---
October---	73	36	86	25	.79	.1	1.4	(1/)	1
November--	57	23	73	9	.46	.1	.6	3	5
December--	49	17	66	1	.32	.1	.5	4	3
Year----	70	37	2/ 103	3/ -15	12.31	8.0	16.0	23	4

1/ Less than one-half day.
2/ Average highest annual maximum.
3/ Average lowest annual minimum.

TABLE 10.--PROBABILITY OF LAST FREEZING TEMPERATURES IN SPRING AND FIRST IN FALL

[All data from Rocky Ford in Otero County]

Probability	Dates for given probability and temperature				
	16° F.	20° F.	24° F.	28° F.	32° F.
Spring:					
1 year in 10 later than-----	April 7	April 14	April 24	April 30	May 12
2 years in 10 later than----	April 3	April 9	April 19	April 26	May 7
5 years in 10 later than----	March 24	March 30	April 10	April 16	April 28
Fall:					
1 year in 10 earlier than---	October 31	October 23	October 15	October 4	September 21
2 years in 10 earlier than--	November 4	October 28	October 19	October 8	September 26
5 years in 10 earlier than--	November 12	November 5	October 27	October 17	October 4
Average number of days between last spring and first fall occurrence.	223	219	200	183	160

Temperature.--During the winter, temperatures rise above freezing on most days. Night temperatures fall below freezing usually from late in October to early in April. The average date of the last 32° F. freezing temperature in spring is April 28; the first in fall is October 4. The average number of freeze-free days is 160. Temperatures of zero or below occur every winter, but only on a relatively few days, or an average of 9 days for the year. Summer maximum temperatures frequently reach 100° or more from late in June through August, but in about one summer in ten, the highest temperature reached is less than 100°.

Precipitation.--Over a period of 30 years, the annual precipitation has varied a great deal from year to year. The 30-year average at Rocky Ford for the period ending with 1940 was 11.31 inches; for the period ending with 1920, it was 12.72 inches. Yearly totals range from more than 22 inches to less than 6 inches. About 1 year in 10 has a total of 18 inches or more, and about 1 year in 12 has less than 7 inches. About 1 year in 25 has 20 inches or more.

Monthly precipitation shows wide variation from year to year. May, the wettest month of the year has had on the average less than 0.7 inch in 1 year out of 5, and more than 3 inches in 1 year out of 6. About 40 percent of the annual precipitation falls in the period April through June, and about 75 percent in the period April through September. Most of this precipitation comes from thunderstorms, which vary a great deal in amounts of rainfall or hail. Some hail storms are severe and damaging, but these are fewer than in other high plain areas of Colorado. Tornadoes, which occur in the area at times, are generally smaller, less damaging, and less frequent than in areas farther east. The low amount of precipitation limits agricultural activity to stock raising, except in extensively irrigated areas where intensive farming is favored by the relatively long growing season and warm summer temperatures.

Farming and Industry

The Homestead Act of the 1870's brought an influx of settlers to Otero County. La Junta, the county seat, was first settled by cattle and sheep ranchers. During the same period, George Washington Swink, founder of the town of Rocky Ford, became interested in farming and irrigation. He grew, improved, and marketed cantaloups and watermelons, for which the area is now well known. In the 1880's, the Federal Government granted land to the State of Colorado. The State, in turn, sold tracts to irrigation companies, in consideration that they build canals for irrigation projects. This offer attracted promoters and developers who built the irrigation canals that are in use at the present time.

Although many kinds of irrigated crops are grown in Otero County, the trend in the last few years has been toward producing more feed crops. The acreages of alfalfa, corn, and sorghum have increased nearly every year. This increase is the result of increasing costs of production, shortage of irrigation water, and the increased demand for feed crops. The acreage of vegetable crops remains fairly constant. Acreages of the main crops were reported in the 1964 United States Census of Agriculture as follows:

	Acres
Alfalfa	19,880
Corn	12,554
Grain sorghum	5,150
Sugar beets	3,288
Barley	1,137
Winter wheat	2,989
Oats	1,220
Onions	1,507
Pinto beans	1,291
Cantaloups	1,282
Potatoes	565
Tomatoes	925

There are eight irrigation canals and 400 to 500 pumps serving the irrigated farming areas of Otero County. Many of the pumps are used to supplement ditchwater. Even with irrigation water, most crops grown lack adequate water for maximum production. All of the canals normally experience shortages early and late in the growing season.

Dryland farming is no longer attempted in Otero County because of the hazards of dryfarming in the prevailing climate.

In recent years, the trend in the number of cattle has been upward. This trend results mostly from an increase in livestock feeding. Most ranches are cow-calf enterprises. The most popular breed is the Hereford, although the Aberdeen Angus breed is rising in popularity. The 1964 U.S. Census of Agriculture reported 59,997 cattle and calves and 12,154 hogs and pigs on farms in the county.

Most of the industry in the county, with the exception of the railroad and a brass fitting factory, is linked directly with farming. There are two small meat packing plants, a turkey processing plant, a wool processing plant, two canneries, and a food freezing plant. All the sugar beets grown in the county are processed at the sugar refining factory in Rocky Ford. Several seed houses contract, harvest, clean, and distribute melon, zinnia, and vegetable seeds. Local machine and equipment shops have been instrumental in developing and producing new machinery used in farming and processing agricultural products. Several alfalfa dehydrating mills are in operation, and alfalfa pellets produced are shipped nationwide.

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GLOSSARY

AC soil. A soil that has an A and a C horizon but no B horizon. Commonly such soils are immature, as those developing from alluvium or those on steep, rocky slopes.

Aggregate. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited on land by streams.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Channery soil. A soil that contains thin, flat fragments of sandstone, limestone, or schist, as much as 6 inches in length along the longer axis. A single piece is called a fragment.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

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; soil does not hold together in a mass.

Friable.--When moist, soil crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed into a lump.

Firm.--When moist, soil crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.--When wet, soil is readily deformed by moderate pressure but can be pressed into a lump; forms a wire when rolled between thumb and forefinger.

Sticky.--When wet, soil adheres to other material; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard.--When dry, soil is moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.--When dry, soil breaks into powder or individual grains under very slight pressure.

Cover crop. A close-growing crop that is grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown primarily between trees and vines in orchards and vineyards.

Deferred grazing (range). The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Drainage classes (natural). Refers to frequency and duration of saturation or partial saturation during development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and in Podzolic soils commonly have mottlings below a depth of 6 to 16 inches, in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light-gray, with or without mottling, in the deeper parts of the profile.

Dryfarming. Production of crops that require some tillage in a subhumid or semiarid region, without irrigation. Usually involves use of periods of fallow, during which time enough moisture accumulates in the soil to allow production of a cultivated crop.

Eolian soil material. Soil parent material accumulated through wind action; commonly refers to sandy material in dunes.

Friability. Term for the ease with which soil crumbles. A friable soil is one that crumbles easily.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes and that differs in one or more ways from adjacent horizons in the same profile.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the height of the water table, either permanent or perched. Relative terms for expressing internal drainage are none, very slow, slow, medium, rapid, and very rapid.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance--few, common, and many; size--fine, medium, and coarse; and contrast--faint, distinct, and prominent. The size measurements are these; fine, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; medium, ranging from 5 to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and coarse, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Nurse crop. A companion crop grown to protect some other crop sown with it; for example, a small grain is sometimes seeded as a nurse crop with clover.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. 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 type, 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 management.

Plowsole. A compacted layer formed in the soil immediately below the plowed layer.

Poorly graded soil (engineering). A soil material consisting mainly of particles nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

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. The degrees of acidity or alkalinity and their pH values 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

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill normally is a few inches in depth and width and is not large enough to be an obstacle to farm machinery.

Saline soil. A soil that contains soluble salts in amounts that impair growth of crop plants but that does not contain excess exchangeable sodium.

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 textural class called silt is 80 percent or more silt and less than 12 percent clay.

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated affect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: Very coarse sand (2.0 to 1.0 millimeter); coarse sand (1.0 to 0.5 millimeter); medium sand (0.05 to 0.25 millimeter); fine sand (0.25 to 0.10 millimeter); very fine sand (0.10 to 0.05 millimeter); silt (0.05 to 0.002 millimeter); and clay (less than 0.002 millimeter).

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 parent material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stripcropping. Growing crops in a systematic arrangement of strips, or bands, to serve as vegetative barriers to wind and water erosion.

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 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 profile below plow depth.

Subsoiling. The tillage of the soil below the normal plow depth, usually to shatter a hardpan or claypan.

Substratum. Any layer lying beneath the solum, or true soil, and above solid rock.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting of winter grain.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and can include part of B horizon; has no depth limit.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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 as follows: 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."

Tile drain. Concrete or pottery pipe placed at suitable spacing and depth in the soil or subsoil to provide water outlets from the soil.

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to til.

Topsoil. A presumed fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents. These changes result in more or less complete disintegration and decomposition of the rock.

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere. At wilting point the percentage of water available to plants approximates the minimum content of moisture in the soil at a depth below that affected by surface evaporation.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit 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 is given in tables as follows:

Acreage and extent, table 1, page 5.
Predicted yields, table 2, page 38.
Engineering uses of soils, tables 5 and 6, pages 52 through 71.

Map symbol	Mapping unit	Page	Capability unit: Irrigated Symbol	Irrigated Page	Capability unit: Nonirrigated Symbol	Nonirrigated Page	Range site Name	Range site Page
Aa	Apishapa loamy sand	7	IIIew-4	34	VIw-1	41	Salt Meadow	45
Ac	Apishapa clay	7	IIIs-1	35	VIw-1	41	Salt Meadow	45
BcB	Baca loam, 1 to 5 percent slopes	8	-------	--	VIe-1	37	Loamy Plains	43
Bk	Bankard sand	8	IVs-8	36	VIe-6	40	------------	--
Bm	Bloom loam	9	IIIw-1	35	VIw-1	41	Salt Meadow	45
CaD	Cadoma clay, 2 to 12 percent slopes	9	-------	--	VIe-2	40	Alkaline Plains	44
Cg	Cascajo soils and Gravelly land	10	-------	--	VIIs-2	41	Gravel Breaks	46
Dw	Dwyer loamy sand	11	-------	--	VIe-5	40	Deep Sands	44
GbA	Glenberg loamy fine sand, 0 to 1 percent slopes	12	IIIe-9	34	VIe-6	40	Sandy Bottomland	45
GkA	Glenberg-Bankard sandy loams, 0 to 1 percent slopes	12	IVs-7	36	VIe-6	40	Sandy Bottomland	45
HaB	Harvey loam, wet, 0 to 3 percent slopes	12	IIew-1	33	VIw-1	41	Salt Meadow	45
HsB	Harvey-Stoneham loams, 0 to 3 percent slopes	13	-------	--	VIe-1	37	Loamy Plains	43
HvB	Haverson loam, 0 to 3 percent slopes	13	-------	--	VIe-4	40	Saline Overflow	45
KmC	Kim and Wiley loams, 1 to 9 percent slopes	14	-------	--	VIe-1	37	Loamy Plains	43
KnA	Kornman and Neesopah loams, 0 to 1 percent slopes	15	IIs-1	33	------	--	------------	--
KnB	Kornman and Neesopah loams, 1 to 3 percent slopes	15	IIe-1	32	------	--	------------	--
KnC	Kornman and Neesopah loams, 3 to 5 percent slopes	15	IIIe-2	34	------	--	------------	--
Lm	Las Animas soils	16	IVw-2	36	VIw-1	41	Salt Meadow	45
LnB	Limon silty clay loam, 0 to 3 percent slopes	16	IIs-1	33	------	--	------------	--
LoB	Limon silty clay, 0 to 3 percent slopes	17	IIIs-1	35	VIs-1	41	Salt Flat	44
MaB	Manvel silt loam, 0 to 3 percent slopes	17	--------	--	VIe-1	37	Loamy Plains	43
MbA	Manzanola loam, 0 to 1 percent slopes	18	--------	--	VIe-4	40	Saline Overflow	45
McB	Manzanola clay loam, 1 to 3 percent slopes	18	--------	--	VIe-1	37	Loamy Plains	43
Md2	Manzanola soils, eroded	18	--------	--	VIs-1	41	Salt Flat	44
MeB	Minnequa loam, 1 to 3 percent slopes	19	--------	--	VIe-1	37	Loamy Plains	43
MnA	Minnequa silty clay loam, 0 to 1 percent slopes	19	IIIs-1	35	------	--	------------	--
MnC	Minnequa silty clay loam, 1 to 5 percent slopes	19	IIIe-1	33	------	--	------------	--
NeB	Nepesta clay loam, 0 to 3 percent slopes	21	IIs-1	33	------	--	------------	--
NmA	Numa clay loam, 0 to 1 percent slopes	22	IIs-1	33	------	--	------------	--
NmB	Numa clay loam, 1 to 3 percent slopes	22	IIe-1	32	------	--	------------	--
NmC	Numa clay loam, 3 to 5 percent slopes	22	IIIe-2	34	------	--	------------	--
NvD	Numa loam, gravel subsoil variant, 5 to 9 percent slopes	22	IVe-1	35	------	--	------------	--
OlB	Olney sandy loam, 0 to 3 percent slopes	23	--------	--	VIe-3	40	Sandy Plains	43
OnA	Olney sandy clay loam, 0 to 1 percent slopes	23	I-1	32	------	--	------------	--
OtC	Otero sandy loam, 1 to 5 percent slopes	24	IIIe-8	34	VIe-3	40	Sandy Plains	43
PeE	Penrose channery loam, 1 to 25 percent slopes	24	--------	--	VIIs-3	42	Limestone Breaks	46
RfA	Rocky Ford silty clay loam, 0 to 1 percent slopes	25	IIs-1	33	------	--	------------	--
RfB	Rocky Ford silty clay loam, 1 to 3 percent slopes	25	IIe-1	32	------	--	------------	--
RgA	Rocky Ford silty clay loam, wet, 0 to 1 percent slopes	25	IIws-1	33	------	--	------------	--
RgB	Rocky Ford silty clay loam, wet, 1 to 3 percent slopes	25	IIew-1	33	------	--	------------	--
RlA	Rocky Ford silty clay loam, limestone substratum, 0 to 1 percent slopes	26	IIIs-1	35	------	--	------------	--
RlB	Rocky Ford silty clay loam, limestone substratum, 1 to 3 percent slopes	26	IIIe-1	33	------	--	------------	--
RmB	Rocky Ford loam, sand subsoil variant, 0 to 3 percent slopes	26	IIIs-2	35	------	--	------------	--
Sc	Samsil-Shale outcrop complex	26	--------	--	VIIs-1	41	Shaly Plains	44
SgC	Shingle loam, 1 to 9 percent slopes	27	VIe-1	36	VIIs-1	41	Shaly Plains	44
ShC	Shingle loam, gypsum variant, 1 to 9 percent slopes	27	--------	--	VIIs-1	41	Shaly Plains	44
TaC	Travessilla sandy loam, 1 to 9 percent slopes	28	--------	--	VIIs-4	42	Sandstone Breaks	45
Tr	Travessilla-Rock outcrop complex	28	--------	--	VIIs-4	42	Sandstone Breaks	45
TyB	Tyrone silty clay loam, 0 to 3 percent slopes	29	--------	--	VIe-2	40	Alkaline Plains	44
VdC	Vona sandy loam, 1 to 5 percent slopes	30	IIIe-8	34	VIe-3	40	Sandy Plains	43

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