SOIL SURVEY OF

Custer County, Oklahoma

United States Department of Agriculture
Soil Conservation Service

In cooperation with
Oklahoma Agricultural Experiment Station

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

Major fieldwork for this soil survey was completed in the period 1961-72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the Oklahoma Agricultural Experiment Station. It is part of the technical assistance furnished to the Custer County and the Deer Creek Conservation Districts.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; 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 Custer County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

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

Finding and Using Information

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

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

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

Foresters and others can refer to the section "Tree Plantings," where the soils of the county are grouped according to their suitability for trees.

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

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

Community planners and others can read about soil properties that affect the choice of sites for dwellings, for industrial buildings, and for recreational areas in the sections "Engineering Uses of the Soils," and "Recreational Development."

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

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

Newcomers in Custer 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 Facts About the County."

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SOIL SURVEY OF CUSTER COUNTY, OKLAHOMA

BY ODOS G. HENSON, SOIL CONSERVATION SERVICE

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

CUSTER COUNTY is in the west-central part of Oklahoma (fig. 1). Arapaho is the county seat. The county has an area of 640,640 acres, or 1,001 square miles. It lies within Central Rolling Red Plains physiographic region.

Farming is the principal source of income. About 50 percent of the county is rangeland. The rest is cropland used mainly for growing small grain, cotton, grain sorghum, and alfalfa.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Custer County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

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

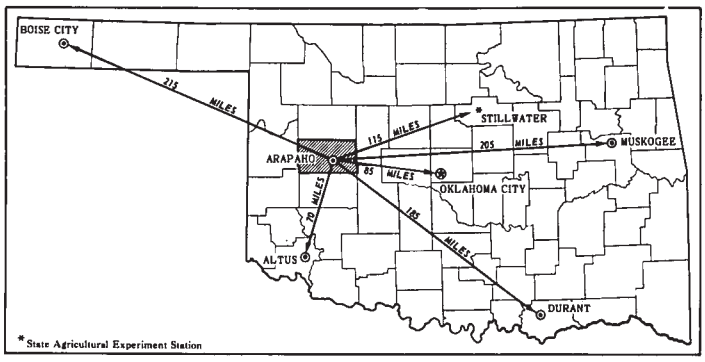

Figure 1.—Location of Custer County in Oklahoma.

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

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Carey silt loam, 1 to 3 percent slopes, is one of several phases within the Carey series.

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

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 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. Two such kinds of mapping units are shown on the soil map of Custer County: soil complexes and undifferentiated groups.

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

tions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Dill-Quinlan complex, 1 to 3 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. If there are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils, joined by "and." Cordell soils and Rock outcrop, 2 to 15 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rock outcrop is a land type that was mapped in an undifferentiated group with Cordell soils and Rock outcrop, 2 to 15 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 kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

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

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

General Soil Map

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

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

The soil associations in Custer County are discussed in the following pages.

The terms for texture used in the title for several of the associations apply to the texture of the surface layer unless otherwise indicated. For example, in the title of association 2, the word "loamy" refers to the texture of the surface layer.

Not all soil names identified on the general soil map of Custer County are the same as those in Roger Mills, Dewey, Blaine, and Caddo Counties. Most of the differences in names result from refinements in the system of soil classification.

1. Shellabarger-Pratt association

Deep, very gently sloping to strongly sloping, well-drained loamy or sandy soils that have a loamy or sandy subsoil over loamy or sandy sediment; on uplands

This association occupies about 20,000 acres, or 3 percent of the total land area of the county. About 50 percent of this association is Shellabarger soils, and 45 percent is Pratt soils. The remaining 5 percent is mainly Tivoli, Pond Creek, and Minco soils.

Shellabarger soils are very gently sloping and gently sloping. They have a loamy subsoil over loamy or sandy sediment. They are mainly on crests and side slopes.

Pratt soils are very gently sloping to strongly sloping. They have a sandy subsoil over sandy sediment. They are mainly on crests and side slopes and in valleys of uneven low dune topography.

About 70 percent of this association is cultivated, and the rest is used mainly as range. Commonly grown crops are grain sorghum, small grain, cotton, tame pasture, and alfalfa.

The chief concerns of management are maintaining soil structure and fertility and keeping erosion within allowable limits. The soils respond favorably to good management.

2. Cordell association

Shallow, very gently sloping to moderately steep, somewhat excessively drained loamy soils that have a loamy subsoil over hard siltstone; on uplands

This association occupies about 30,000 acres or 5 percent of the total land area of the county. About 52 percent of the association is Cordell soils. About 28 percent is soils that are similar to Cordell soils, but they are less than 10 inches thick or are thicker than 20 inches to bedrock. The remaining 20 percent is Rock outcrop and a trace of Quinlan soils.

Cordell soils are on crests, on side slopes, and in valleys. Most of this association is used as range.

The chief concern of management is keeping grasses growing vigorously.

3. *Woodward-Quinlan association*

Moderately deep and shallow, very gently sloping to strongly sloping, well-drained loamy soils that have a loamy subsoil over sandstone; on uplands

This association occupies about 243,640 acres, or 38 percent of the total land area of the county. About 56 percent of the association is Woodward soils, and 31 percent is Quinlan soils. The remaining 13 percent is mainly Carey, Clairemont, Devol, Dill, Hardeman, St. Paul, Yahola, and other soils similar to Woodward and Quinlan soils.

About 78 percent of this association is used as range, and the rest is used mainly for small grain, grain sorghum, tame pasture, and cotton.

The chief concerns of management are keeping grasses growing vigorously, maintaining soil structure and fertility, and keeping erosion within allowable limits.

4. *Carey-St. Paul association*

Deep, nearly level to sloping, well-drained loamy soils that have a loamy subsoil over loamy sediment, sandstone, or shale; on uplands

This association occupies about 205,000 acres, or 32 percent of the total land area of the county. About 45 percent of this association is Carey soils, and 45 percent is St. Paul soils. The remaining 10 percent is mainly Clairemont, Cornick, Dill, Quinlan, Woodward, and Yahola soils and Rock outcrop.

Carey soils are very gently sloping to sloping. They have a loamy subsoil over sandstone or loamy sediment. They are mainly on crests and side slopes.

About 75 percent of this association is cultivated or is in tame pasture, and the rest is used as range. The main crops are small grain, grain sorghum, cotton, and alfalfa.

The chief concerns of management are maintaining soil structure and fertility and keeping erosion within allowable limits. The soils respond favorably to good management.

5. *Lucien-Rock outcrop-Cornick association*

Shallow and very shallow, very gently sloping to moderately steep, well-drained loamy soils that have a loamy subsoil over sandstone or gypsum and Rock outcrop; on uplands

This association occupies about 19,000 acres, or 3 percent of the total land area of the county. About 31 percent of this association is Lucien soils, 18 percent is Rock outcrop, and 9 percent is Cornick soils. The remaining 42 percent is soils that are similar to Lucien soils but are not so dark or are 20 to 40 inches thick to sandstone; soils that are similar to Cornick soils but have gypsum at a depth of more than 10 inches; and Grant, Minco, and Pond Creek soils.

Lucien soils are shallow and strongly sloping to moderately steep. They have a loamy subsoil over sandstone. They are mainly on crests and side slopes of drainageways.

Rock outcrop consists of sandstone and gypsum that are exposed at the surface. It is mainly on crests and side slopes.

Cornick soils are very shallow and very gently sloping to strongly sloping. They have a loamy subsoil over gypsum and are mainly on the upper and middle parts of the slopes.

Most of this association is used as range.

The chief concerns of management are keeping grasses growing vigorously.

6. *Pond Creek-Grant-Minco association*

Deep, nearly level to moderately steep, well-drained loamy soils that have a loamy subsoil over loamy sediment or sandstone; on uplands

This association occupies about 60,000 acres, or 9 percent of the total land area of the county. About 58 percent of this association is Pond Creek soils, 21 percent is Grant soils, and 18 percent is Minco soils. The remaining 3 percent is mainly Lucien, Pratt, and Shellabarger soils.

Pond Creek soils are nearly level and very gently sloping. They have a loamy subsoil over loamy sediment. They are mainly on broad crests and side slopes.

Grant soils are very gently sloping and gently sloping. They have a loamy subsoil over loamy sediment or sandstone. They are mainly on narrow crests and side slopes.

Minco soils are gently sloping to moderately steep. They have a loamy subsoil over loamy sediment. They are mainly on crests and side slopes.

About 80 percent of the association is cultivated or is in tame pasture, and the rest is used as range. The main crops are grain sorghum, cotton, and alfalfa.

The chief concerns of management are maintaining soil structure and fertility and keeping erosion within allowable limits. The soils respond favorably to good management.

7. *Clairemont-Dale association*

Deep, nearly level, well-drained loamy soils that have a loamy subsoil over loamy sediment; on flood plains

This association occupies about 63,000 acres, or 10 percent of the total land area of the county. About 45 percent of this association is Clairemont soils, and 35 percent is Dale soils. The remaining 20 percent is mainly Crisfield, Gracemore, and Yahola soils and Fluvents.

Clairemont soils are in lower areas on the flood plains adjacent to stream channels.

Dale soils are in higher areas on flood plains adjacent to uplands.

About 80 percent of this association is cultivated and is in tame pasture, and the rest is used as range. The main crops are grain, grain sorghum, and cotton.

The chief concerns of management are maintaining soil structure and fertility and keeping erosion within allowable limits. The soils respond favorably to good management.

Descriptions of the Soils

In this section the soils of Custer County are described in detail and their use and management are discussed. Each soil series is described in detail, and then, briefly, the mapping units in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

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

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Rock outcrop, for example, does not belong to a soil series, but, nevertheless, it is listed along with the soil series.

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

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

[1] United States Department of Agriculture. 1951. Soil Survey Manual. U.S. Dep. Agric. Handb. No. 18, 503 pp., illus.

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

Soil	Acres	Percent
Carey silt loam, 1 to 3 percent slopes	48,050	7.5
Carey silt loam, 3 to 5 percent slopes	47,715	7.4
Carey soils, 2 to 6 percent slopes, severely eroded	1,243	.2
Clairemont silt loam	25,055	3.9
Clairemont silt loam, saline	1,080	.2
Clairemont soils	1,727	.3
Cordell soils and Rock outcrop, 2 to 15 percent slopes	31,297	4.9
Cornick soils and Rock outcrop, 2 to 12 percent slopes	3,590	.6
Crisfield fine sandy loam	6,105	.9
Dale silt loam	22,195	3.5
Devol fine sandy loam, 3 to 5 percent slopes (W)	2,150	.3
Dill-Quinlan complex, 1 to 3 percent slopes	5,610	.9
Dill-Quinlan complex, 3 to 5 percent slopes	2,235	.3
Fluvents	435	.1
Gracemore loamy fine sand	1,060	.2
Grant loam, 1 to 3 percent slopes	5,240	.8
Grant loam, 3 to 5 percent slopes	7,860	1.2
Hardeman fine sandy loam, 5 to 8 percent slopes (W)	1,155	.2
Lucien soils and Rock outcrop, 8 to 20 percent slopes	14,519	2.3
Minco very fine sandy loam, 5 to 8 percent slopes	7,055	1.1
Minco very fine sandy loam, 8 to 20 percent slopes	1,570	.2
Minco loam, 1 to 3 percent slopes	1,125	.2
Minco loam, 3 to 5 percent slopes	2,563	.4
Pond Creek fine sandy loam, 0 to 2 percent slopes	10,605	1.6
Pond Creek silt loam, 0 to 1 percent slopes	16,055	2.5
Pond Creek silt loam, 1 to 3 percent slopes	8,355	1.3
Pratt loamy fine sand, 1 to 4 percent slopes (W)	3,152	.5
Pratt loamy fine sand, 4 to 8 percent slopes (W)	3,363	.5
Pratt and Tivoli soils, 8 to 12 percent slopes (W)	3,830	.6
Quinlan-Woodward complex, 3 to 5 percent slopes, eroded	5,567	.9
Quinlan-Woodward complex, 5 to 10 percent slopes, severely eroded	20,449	3.2
Shellabarger fine sandy loam, 1 to 3 percent slopes (W)	6,880	1.1
Shellabarger fine sandy loam, 3 to 5 percent slopes (W)	3,638	.6
St. Paul silt loam, 0 to 1 percent slopes	10,743	1.7
St. Paul silt loam, 1 to 3 percent slopes	58,100	9.1
St. Paul silt loam, 3 to 5 percent slopes	27,439	4.3
Woodward silt loam, 1 to 3 percent slopes	1,252	.2
Woodward silt loam, 3 to 5 percent slopes	5,470	.9
Woodward silt loam, 5 to 8 percent slopes	37,401	5.8
Woodward-Clairemont complex	7,169	1.1
Woodward-Quinlan complex, 3 to 5 percent slopes	35,245	5.5
Woodward-Quinlan complex, 5 to 12 percent slopes	129,658	20.2
Yahola fine sandy loam	5,315	.8
Water area	320	(1)
Total	640,640	100.0

[1] Less than 0.05 percent.

Carey Series

The Carey series consists of deep, well-drained, very gently sloping to sloping soils on uplands. The soils formed under a cover of native grasses in loamy sediment on material weathered from sandstone.

In a representative profile the surface layer is 11 inches of reddish-brown silt loam. The upper part of the subsoil, to a depth of 25 inches, is reddish-brown silt loam. The lower part of the subsoil, to a depth of 42 inches, is reddish-brown loam. The underlying material is weathered sandstone.

Permeability is moderate. Available water capacity is high.

Representative profile of Carey silt loam, 3 to 5 percent slopes, 900 feet east and 225 feet south of the northwest corner of sec. 27, T. 15 N., R. 19 W.:

A1—0 to 11 inches, reddish-brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) when moist; weak, fine, granular structure; friable; mildly alkaline; gradual, smooth boundary.

B2t—11 to 25 inches, reddish-brown (5YR 4/4) silt loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; friable; patchy clay films on faces of peds; mildly alkaline; gradual, wavy boundary.

B3—25 to 42 inches, reddish-brown (2.5YR 5/4) loam, dark reddish brown (2.5YR 3/4) when moist; weak, fine, granular structure; friable; calcareous; moderately alkaline; abrupt, wavy boundary.

C—42 to 48 inches, red (2.5YR 5/6) partly weathered sandstone; calcareous; moderately alkaline.

The A1 or Ap horizon is reddish brown or brown and is mildly alkaline or neutral. The B2t horizon is reddish-brown, red, or brown silt loam or silty clay loam. It is neutral to moderately alkaline. The B3 horizon is reddish-brown or red loam or silt loam. The C horizon is red, yellowish-red, or light reddish-brown loamy sediment or partly weathered sandstone. Sandstone is at a depth of 40 inches to more than 70 inches.

CaB—Carey silt loam, 1 to 3 percent slopes. This soil is very gently sloping.

Included with this soil in mapping are areas of St. Paul, Quinlan, and Woodward soils. St. Paul soils make up about 10 percent of the mapped areas, Quinlan soils about 4 percent, and Woodward soils about 2 percent. Also included are soils that are similar to Carey soils but are 30 to 40 inches thick over sandstone. These areas make up about 15 percent of the mapped areas.

Most of this soil is used for wheat. Some areas are used for other small grain, grain sorghum, cotton, alfalfa, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. If this soil is well managed, most of the adapted crops can be grown. Returning crop residue to the soil and supplying plant nutrients are good management practices. Terraces that have protected outlets, contour farming, and minimum tillage are needed if row crops are grown. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

CaC—Carey silt loam, 3 to 5 percent slopes. This soil is gently sloping. It has the profile described as representative for the series.

Included with this soil in mapping are areas of St. Paul, Quinlan, and Woodward soils. St. Paul soils make up about 10 percent of the mapped areas, Quinlan soils 8 percent, and Woodward soils 2 percent. Also included, and making up about 15 percent of the mapped areas, are soils that are similar to Carey soils but are 30 to 40 inches thick over sandstone.

Most of this soil is used for wheat. Some areas are used for other small grain, grain sorghum, cotton, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil fertility and structure. If this soil is used for row crops, terraces and contour farming are needed. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops. Returning large amounts of crop residue to the soil and supplying plant nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit IIIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

CbC3—Carey soils, 2 to 6 percent slopes, severely eroded. These soils are very gently sloping to sloping. They have profiles similar to those described as representative of the series, but their surface layer is silt loam or loam and is thinner, and it is mixed with the subsoil in most of the area.

Included with these soils in mapping are soils that are similar to the Carey soils, but the present surface layer is material from the subsoil, and there are uncrossable gullies. The uncrossable gullies are 5 to 30 feet wide and about 50 to 300 feet apart. These soils make up about 20 percent of the mapped areas. Also included are areas of St. Paul and Woodward soils. St. Paul soils make up 10 percent of the mapped areas, and Woodward soils 3 percent.

These soils are used mostly as range. They are not suited to cultivation.

The main concerns of management are controlling erosion and keeping grasses growing vigorously. Capability unit VIe-4; Eroded Prairie range site; pasture and hayland suitability group 8F; tree suitability group 8.

Clairemont Series

The Clairemont series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy sediment under a cover of native grasses.

In a representative profile the surface layer is 11 inches of reddish-brown silt loam. The underlying material, to a depth of 72 inches, is reddish-brown silt loam.

Permeability is moderate. Available water capacity is high.

Representative profile of Clairemont silt loam, 1,050 feet east and 75 feet south of the northwest corner of sec. 36, T. 14 N., R. 18 W.:

A1—0 to 11 inches, reddish-brown (5YR 4/4) silt loam, reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; friable; calcareous; moderately alkaline; clear, wavy boundary.

C1—11 to 16 inches, reddish-brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) when moist; moderate, medium, granular structure; friable; calcareous, moderately alkaline; clear, wavy boundary.

C2—16 to 72 inches, reddish-brown (5YR 4/4) silt loam, dark reddish brown (5YR 3/4) when moist; weak, medium, granular structure; friable; calcareous; moderately alkaline.

The A1 or Ap horizon is reddish-brown, yellowish-red, brown, or red silt loam or loam. The C horizon is reddish-brown, red, or brown silt loam or loam. In a few areas salinity is low or moderate in the upper part of the profile.

Cc—Clairemont silt loam. This soil has slopes of 0 to 1 percent. It has the profile described as representative of the series. It is subject to occasional flooding.

Included with this soil in mapping are soils that are similar to this Clairemont soil, but they are grayer in the uppermost 10 to 30 inches. These soils make up about 20 percent of the mapped areas. Also included are Yahola soils, which make up about 2 percent of the acreage.

Most of this soil is used for wheat, cotton (fig. 2), and alfalfa. Some areas are used for other small grain, grain sorghum, tame pasture grasses, and native grasses.

The main concerns of management are occasional flooding and maintaining soil structure and fertility. Most of the crops generally produce large amounts of residue and can be grown continuously if the crop residue is returned to the soil and plant nutrients are supplied. Capability unit IIw-1; Loamy Bottomland range site; pasture and hayland suitability group 2A; tree suitability group 3.

Ce—Clairemont silt loam, saline. This soil has slopes of 0 to 1 percent. It has a profile similar to the one described as representative of the series, but the upper 24 inches has low to moderate salinity and the water table is at a depth of 20 to 50 inches most of the year. It is subject to occasional flooding.

Included with this soil in mapping are soils similar to this Clairemont soil, but they lack salinity in the upper 24 inches and lack a ground water table at a depth of 20 to 50 inches most of the year. These soils make up about 5 percent of the mapped areas.

Most of this soil is used for wheat, cotton, and grain sorghum. Some areas are used for alfalfa, tame pasture grasses, and native grasses.

The main concerns of management are occasional flooding, salinity in the upper 24 inches, and maintaining soil structure and fertility. Some of the crops produce large amounts of residue and can be grown continuously if the crop residue is returned to the soil and plant nutrients are supplied. Capability unit IIIs-1; Subirrigated range site; pasture and hayland suitability group 2B; tree suitability group 1.

Cf—Clairemont soils. These soils have slopes of 0 to 1 percent. They are in narrow areas along stream

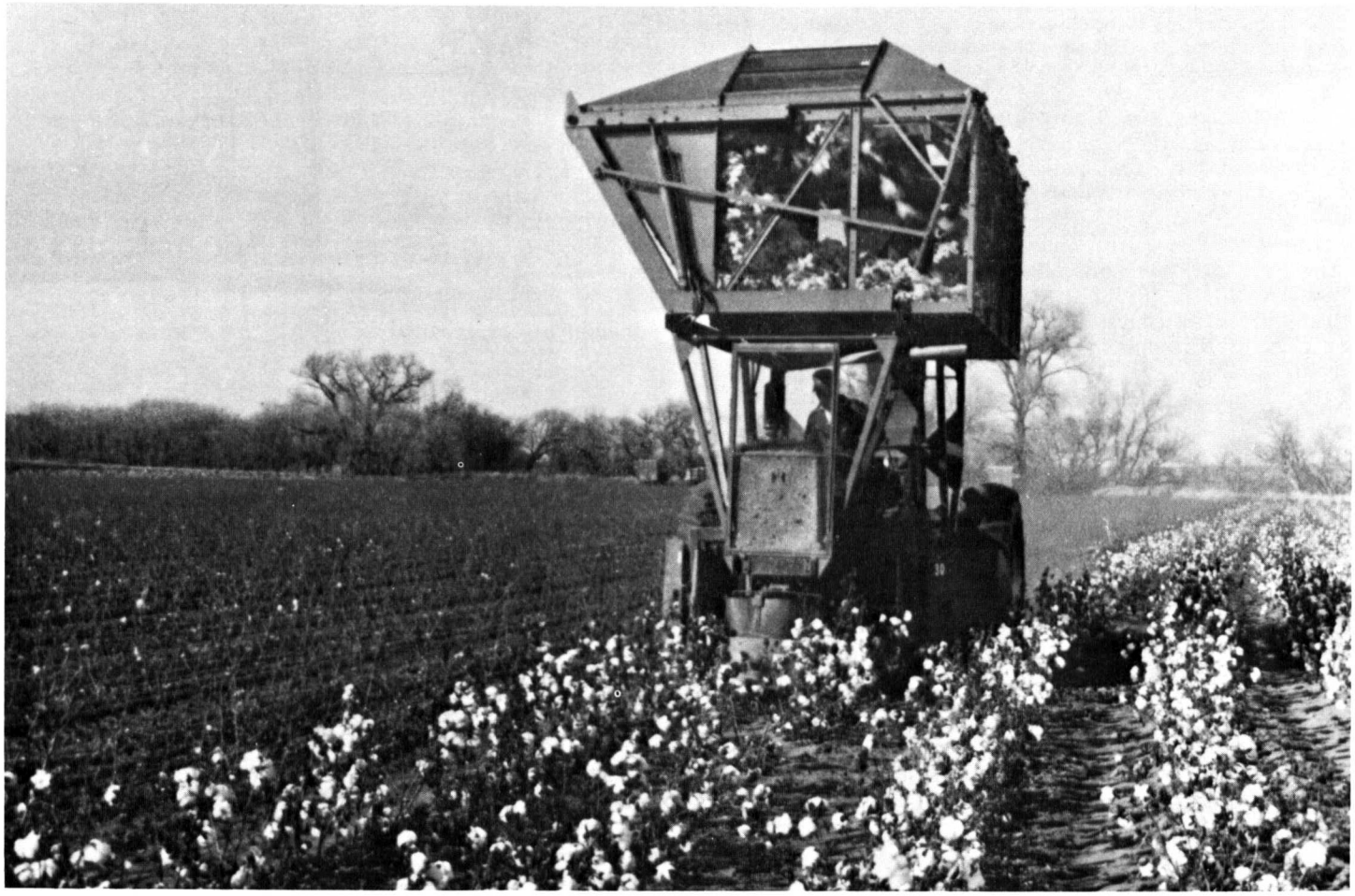

Figure 2.—**Harvesting cotton in an area of Clairemont silt loam.**

channels. Areas are about 150 to 500 feet wide. These soils have profiles similar to the one described as representative of the series, but their surface layer is silt loam or loam. They are subject to frequent flooding.

Included with these soils in mapping, and making up 5 percent of the mapped areas, are soils that are similar to Clairemont soils but are grayer in the upper 10 to 20 inches. Also included are Yahola soils, which make up about 5 percent of the acreage.

Most areas of these soils are used as range or for tame pasture. They are not suited to cultivation.

The main concerns of management are frequent flooding, maintaining fertility, and keeping grasses growing vigorously. Capability unit Vw-1; Loamy Bottomland range site; pasture and hayland suitability group 2A; tree suitability group 3.

Cordell Series

The Cordell series consists of shallow, somewhat excessively drained, very gently sloping to moderately steep soils on uplands. These soils formed under a cover of native grasses in material weathered from hard siltstone.

In a representative profile the surface layer is 7 inches of reddish-brown silt loam. The subsoil, to a depth of 11 inches, is red very shaly silt loam over red, hard siltstone.

Permeability is moderately slow. Available water capacity is low.

Representative profile of a Cordell silt loam in an area of Cordell soils and Rock outcrop, 2 to 15 percent slopes, 150 feet west and 75 feet south of the northeast corner of sec. 2, T. 12 N., R. 20 W.:

A1—0 to 7 inches, reddish-brown (2.5YR 4/4) silt loam, dark reddish brown (2.5YR 3/4) when moist; moderate, medium, granular structure; friable; calcareous; moderately alkaline; clear, smooth boundary.

B2—7 to 11 inches, red (2.5YR 5/6) very shaly silt loam, red (2.5YR 4/6) when moist; weak, medium, granular structure; friable; few roots; 75 percent angular siltstone fragments less than 3 inches in diameter; calcareous; moderately alkaline; gradual, wavy boundary.

R—11 to 16 inches, red (2.5YR 5/6) hard siltstone, red (2.5YR 4/6) when moist; calcareous, moderately alkaline.

The A1 horizon is reddish-brown, red, or yellowish-red silt loam or silty clay loam. It is moderately alkaline or mildly alkaline. The B2 horizon is red, reddish-brown, or yellowish-red very shaly silt loam, very shaly silty clay loam, shaly silt loam, shaly silty clay loam, silt loam, or silty clay loam. Siltstone fragments less than 3 inches in diameter range from a trace to 75 percent of the volume. The R layer is red or reddish brown. The profile is 10 to 20 inches deep to bedrock.

CoE—Cordell soils and Rock outcrop, 2 to 15 percent slopes. This mapping unit consists of very gently sloping to moderately steep soils and siltstone Rock outcrop. About 50 percent of the mapping unit is Cordell soils, 20 percent Rock outcrop, and 30 percent other soils. The Cordell soils have a profile similar to the one described as representative of the series, but the surface layer is silty clay loam in places. Cordell soils and Rock outcrop occur together without regularity of pattern.

Included with this undifferentiated group in mapping are areas of soils that are similar to Cordell soils but are less than 10 inches thick or more than 20 inches thick over siltstone bedrock.

Most of this mapping unit is used as range. It is not suited to cultivation.

The main concerns of management are droughtiness and keeping grasses growing vigorously. Capability unit VIe-1; Red Shale range site; not assigned to a pasture and hayland suitability group; tree suitability group 7.

Cornick Series

The Cornick series consists of very shallow, well-drained, very gently sloping to strongly sloping soils on uplands. These soils formed under a cover of native grasses in material weathered from gypsum.

In a representative profile the surface layer is 7 inches of brown silt loam. The underlying material, to a depth of 18 inches, or more, is gypsum.

Permeability is moderate. Available water capacity is low.

Representative profile of Cornick silt loam, from an area of Cornick soils and Rock outcrop, 2 to 12 percent slopes, 450 feet west and 240 feet south of the northeast corner of sec. 25, T. 12 N., R 15 W.:

A1—0 to 7 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; moderate, medium, granular structure; very friable; calcareous; moderately alkaline; abrupt, wavy boundary.

C1—7 to 11 inches, pinkish-white (5YR 8/2) chalky gypsum, pinkish gray (5YR 7/2) when moist; common streaks and bodies of light reddish brown (5YR 6/4); mildly alkaline; abrupt, wavy boundary.

C2—11 to 18 inches, variegated white (5YR 8/1) and pale-red (10YR 6/3) gypsum; neutral.

The A1 horizon is brown or dark grayish-brown silt loam or loam. The C horizon is white, pinkish white, pink, or pale red. Gypsum is at a depth of 5 to 10 inches.

CrE—Cornick soils and Rock outcrop, 2 to 12 percent slopes. This undifferentiated group consists of very gently sloping to strongly sloping soils and gypsum Rock outcrop. About 45 percent of the mapping unit is Cornick soils, about 25 percent is Rock outcrop, and 30 percent is included soils. The Cornick soils have a profile similar to the one described as representative of the series, but the surface layer is loam in places. Cornick soils and Rock outcrop occur together without regularity of pattern.

Included with these soils in mapping are areas of soils that are similar to Cornick soils but are more than 10 inches deep to gypsum bedrock.

Most areas of this mapping unit are used as range. It is not suited to cultivation.

The main concerns of management are droughtiness and keeping grasses growing vigorously. Capability unit VIs-1; Gyp range site; not assigned to a pasture and hayland suitability group; tree suitability group 7.

Crisfield Series

The Crisfield series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy sediment under a cover of native grasses.

In a representative profile the surface layer is 15 inches of reddish-brown fine sandy loam. The subsoil, to a depth of 38 inches, is reddish-brown fine sandy loam. The underlying material, to a depth of 72 inches, is red fine sandy loam.

Permeability is moderately rapid. Available water capacity is high.

Representative profile of Crisfield fine sandy loam, 1,500 feet south and 75 feet west of the northeast corner of sec. 28, T. 14 N., R. 20 W.:

A1—0 to 15 inches, reddish-brown (5YR 4/3) fine sandy loam, dark reddish brown (5YR 3/3) when moist; weak, medium, granular structure; very friable; neutral; gradual, smooth boundary.

B2—15 to 38 inches, reddish-brown (2.5YR 4/4) fine sandy loam, dark reddish brown (2.5YR 3/4) when moist; weak, coarse, prismatic structure breaking to weak, medium, granular; very friable; neutral; gradual, wavy boundary.

C1—38 to 60 inches, red (2.5YR 4/6) fine sandy loam, dark red (2.5YR 3/6) when moist; single grained; very friable; calcareous; moderately alkaline; diffuse; smooth boundary.

C2—60 to 72 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) when moist; single grained; very friable; calcareous; moderately alkaline.

The A1 or Ap horizon is reddish brown, dark reddish gray, reddish gray, brown, or dark grayish brown. The B and C horizons are red, reddish brown, or yellowish red. The C horizon is mildly alkaline or moderately alkaline.

Cs—Crisfield fine sandy loam. This soil has slopes of 0 to 1 percent. It is protected from flooding.

Included with this soil in mapping are areas of soils that are similar to Crisfield soils, but the surface layer and subsoil are mildly alkaline or moderately alkaline. These soils make up about 10 percent of the mapped areas.

Most of this soil is used for cotton, grain sorghum, and small grain. Some areas are in alfalfa, tame pasture grasses, and native grasses.

The main concern of management is maintaining soil structure and fertility. Most of the crops produce large amounts of residue and can be grown continuously if the soil is well managed and most of the crop residue is returned to the soil. These measures, and the addition of plant nutrients, help to maintain content of organic matter and fertility, to retain structure, and to keep erosion within allowable limits. Capability unit I-1; Loamy Bottomland range site; pasture and hayland suitability group 2A; tree suitability group 2.

Dale Series

The Dale series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy sediment under a cover of native grasses and hardwood forest.

In a representative profile the surface layer is 24 inches of dark-brown silt loam. The subsoil, to a depth of 35 inches, is reddish-brown silt loam. The underlying material, to a depth of 66 inches, is red silt loam.

Permeability is moderate. Available water capacity is high.

Representative profile of Dale silt loam, 2,400 feet east and 450 feet south of the northwest corner of sec. 2, T. 13 N., R. 20 W.:

A1—0 to 24 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; friable; mildly alkaline; gradual, smooth boundary.

B2—24 to 35 inches, reddish-brown (5YR 4/4) silt loam, dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; friable; mildly alkaline; gradual, wavy boundary.

C—35 to 66 inches, red (2.5YR 4/6) silt loam, dark red (2.5YR 3/6) when moist; single grained; friable; few roots; calcareous; moderately alkaline.

The A1 or Ap horizon is mildly alkaline or neutral. The B2 horizon is mildly alkaline or moderately alkaline. The C horizon is red or reddish brown.

Da—Dale silt loam. This soil has slopes of 0 to 1 percent. It is protected from flooding.

Included with this soil in mapping are areas of Clairemont soils. These soils make up about 5 percent of the mapped areas. Also included are areas of a soil that is similar to this Dale soil, but it has a dark-brown surface layer less than 20 inches thick. This soil makes up about 5 percent of the mapped area.

Most of this soil is used for wheat, cotton, alfalfa, and grain sorghum. Some areas are in other small grain, tame pasture grasses, and native grasses.

The main concerns of management are maintaining soil structure and fertility. Most of the crops generally produce large amounts of residue and can be grown continuously if the crop residue is returned to the soil and plant nutrients are supplied. Capability unit I-1; Loamy Bottomland range site; pasture and hayland suitability group 2A; tree suitability group 3.

Devol Series

The Devol series consists of deep, well-drained, gently sloping soils on uplands. These soils formed in loamy and sandy sediment under a cover of native grasses.

In a representative profile the surface layer is 12 inches of reddish-brown fine sandy loam. The upper part of the subsoil, to a depth of 25 inches, is reddish-brown fine sandy loam. The lower part, to a depth of 40 inches, is red fine sandy loam. The underlying material, to a depth of 60 inches, is red loamy fine sand.

Permeability is moderately rapid. Available water capacity is high.

Representative profile of Devol fine sandy loam, 3 to 5 percent slopes, 2,250 feet north and 150 feet west of the southeast corner of sec. 29, T. 14 N., R. 20 W.:

A1—0 to 12 inches, reddish-brown (5YR 4/3) fine sandy loam, dark reddish brown (5YR 3/3) when moist; weak, fine, granular structure; very friable; mildly alkaline; gradual, smooth boundary.

B2t—12 to 25 inches, reddish-brown (2.5YR 4/4) fine sandy loam, dark reddish brown (2.5YR 3/4) when moist; weak, coarse, prismatic structure breaking to weak, fine, granular; friable; patchy clay films on faces of peds and coating grains; mildly alkaline; diffuse, wavy boundary.

B3—25 to 40 inches, red (2.5YR 4/6) fine sandy loam, dark red (2.5YR 3/6) when moist; weak, fine, granular structure; very friable; mildly alkaline; gradual, wavy boundary.

C—40 to 60 inches, red (2.5YR 5/6) loamy fine sand, red (2.5YR 4/6) when moist; single grained; loose; mildly alkaline.

The A1 or Ap horizon is reddish brown or brown. It is mildly alkaline or neutral. The B2t horizon is mildly alka-

line or neutral. The B3 horizon is red or reddish brown. It is mildly alkaline or moderately alkaline. The C horizon is red or reddish-brown loamy fine sand, fine sand, or fine sandy loam. It is mildly alkaline or moderately alkaline.

DeC—Devol fine sandy loam, 3 to 5 percent slopes (W). This soil is gently sloping. It has the profile described as representative of the series. There are some spots eroded by wind.

Included with this soil in mapping are spots of Woodward and Quinlan soils. Also included are areas of a soil that is similar to this Devol soil but has a moderately alkaline subsoil. This soil makes up about 5 percent of the mapped areas.

Most of this soil is used for small grain and grain sorghum. Some areas are in cotton, tame pasture grasses, and native grasses.

The main concerns of management are controlling wind and water erosion and maintaining soil structure and fertility. If this soil is used for row crops, terraces and contour farming are needed. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops. Returning large amounts of residue to the soil and adding plant nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit IIIe-2; Sandy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 5.

Dill Series

The Dill series consists of moderately deep, well-drained, very gently sloping to gently sloping soils on uplands. These soils formed in material weathered from sandstone under a cover of native grasses.

In a representative profile the surface layer is 12 inches of reddish-brown fine sandy loam. The subsoil, to a depth of 32 inches, is red fine sandy loam. The underlying material is red partly weathered sandstone.

Permeability is moderately rapid. Available water capacity is high.

Representative profile of Dill fine sandy loam, from an area of Dill-Quinlan complex, 1 to 3 percent slopes, 270 feet south and 45 feet east of the northwest corner of sec. 31, T. 12 N., R. 20 W.:

A1—0 to 12 inches, reddish-brown (2.5YR 4/4) fine sandy loam, dark reddish brown (2.5YR 3/4) when moist; weak, fine, granular structure; very friable; neutral; diffuse, smooth boundary.

B2—12 to 32 inches, red (2.5YR 4/6) fine sandy loam, dark red (2.5YR 3/6) when moist; weak, medium, granular structure; very friable; neutral; clear, wavy boundary.

C—32 to 40 inches, red (2.5YR 5/6) partly weathered sandstone, red (2.5YR 4/6) when moist; calcareous in crevices; mildly alkaline.

The A1 horizon is neutral or mildly alkaline. The B2 horizon is neutral or mildly alkaline. Sandstone is at a depth of 20 to 40 inches.

DfB—Dill-Quinlan complex, 1 to 3 percent slopes. These gently sloping soils are in such an intricate pattern that it is impractical to map each soil separately.

About 70 percent of this complex is Dill fine sandy loam, and 25 percent is Quinlan fine sandy loam. The Dill soil has the profile described as representative for the Dill series. The Quinlan soil has a profile similar to the one described as representative for the Quinlan series, but the profile is fine sandy loam throughout.

Included with these soils in mapping are areas of soils that are similar to Dill soils, but the upper 10 inches of the profile is a little grayer. These soils make up about 5 percent of the complex.

Most of this complex is in cotton, wheat, and grain sorghum (fig. 3). Other areas are in small grain, tame pasture, grasses, and native grasses.

The main concerns of management are controlling wind and water erosion and maintaining structure and fertility. If this complex is used for row crops, terracing and farming on the contour are needed. Where terraces are not used, a cropping system is needed that includes soil-maintaining crops. Returning crop residue to the soil and adding plant nutrients help to maintain the content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit IIIe-2; Dill part in Sandy Prairie range site, and Quinlan part in Shallow Prairie range site; Dill part in pasture and hayland suitability group 8A, Quinlan part not assigned to a pasture and hayland suitability group; tree suitability group 5.

DfC—Dill-Quinlan complex, 3 to 5 percent slopes. These gently sloping soils are in such an intricate pattern that it is impractical to map them separately.

About 58 percent of this complex is Dill fine sandy loam, and 40 percent is Quinlan fine sandy loam. The Dill soil has a profile similar to the one described as representative of the Quinlan series, but the profile is fine sandy loam.

Included with these soils in mapping are areas of a soil that is similar to this Dill soil but is slightly grayer in the upper 10 inches. This soil makes up about 2 percent of the complex.

Most of these soils are used for cotton, grain sorghum, and wheat. Some areas are in other small grain, tame pasture grasses, and native grasses.

The main concerns of management are controlling wind and water erosion and maintaining soil structure and fertility. Terraces and contour farming are needed. A cropping system is needed that includes soil-maintaining crops. Returning large amounts of crop residue to the soil and supplying plant nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit IVe-2; Dill part in Sandy Prairie range site, and Quinlan part in Shallow Prairie range site; Dill part in pasture and hayland suitability group 8A, Quinlan part not assigned to a pasture and hayland suitability group; tree suitability group 5.

Fluvents

Fluvents consists of deep, poorly drained, nearly level soils on flood plains. These soils formed in loamy and sandy sediment under a cover of native grasses and hardwood forest.

These soils are so variable that no one profile is representative of all the soils mapped as Fluvents. In one

Figure 3.—**Cover crop of wheat and cotton stubble in an area of Dill-Quinlan complex, 1 to 3 percent slopes.**

profile the surface layer is gray fine sandy loam in the upper 12 inches. The next 6 inches is light brownish-gray fine sandy loam over 4 inches of dark-gray fine sandy loam. The underlying material, to a depth of 60 inches, is brown and light brownish-gray loamy fine sand.

Permeability is moderately rapid to the water table. Available water capacity is moderate. The ground water table is at a depth of 12 to 36 inches most of the year.

A profile of Fluvents, 600 feet east and 75 feet south of the northwest corner of sec. 24, T. 15 N., R. 14 W.:

A11—0 to 12 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; friable; calcareous; moderately alkaline; clear, smooth boundary.

A12—12 to 18 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; common, fine, distinct, reddish-brown (5YR 4/4) mottles; weak, fine, granular structure; friable; calcareous; moderately alkaline; clear, wavy boundary.

A13—18 to 22 inches, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) when moist; common, fine, distinct, reddish-brown (5YR 4/4) mottles; weak, fine, granular structure; friable; water table at a depth of 20 inches; calcareous; moderately alkaline; clear, wavy boundary.

C1—22 to 30 inches, brown (10YR 5/3) loamy fine sand, brown (10YR 4/3) when moist; common, fine, distinct, brown (7.5YR 4/4) mottles; single grained; loose; calcareous; moderately alkaline; gradual, wavy boundary.

C2—30 to 60 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) when moist; single grained; loose; calcareous; moderately alkaline.

The A11 horizon is gray, dark-gray, dark grayish-brown, grayish-brown, or brown fine sandy loam, sandy loam, loamy fine sand, or silt loam. The C horizon is brown or light brownish-gray loamy fine sand, fine sandy loam, sandy loam, or silt loam.

Ff—Fluvents. These soils are deep and have slopes of 0 to 1 percent. They have a surface layer of fine sandy loam, sandy loam, loamy fine sand, or silt loam. They are subject to frequent flooding.

Included with these soils in mapping are areas of Gracemore and Yahola soils. Gracemore soils make up 5 percent of the mapped areas, and Yahola soils 4 percent.

Most areas of these soils are used for tame pasture. Some areas are used as range.

The main concerns of management are maintaining fertility and keeping grasses growing vigorously. Frequent flooding and a high water table are limitations to use. Capability unit Vw-2; subirrigated range site; pasture and hayland suitability group 2B; tree suitability group 1.

Gracemore Series

The Gracemore series consists of deep, somewhat poorly drained, nearly level soils on flood plains. These soils formed in sandy sediment under a cover of native grasses and hardwood forest.

In a representative profile the surface layer is 12 inches of brown loamy fine sand. The underlying material, to a depth of 72 inches, is brown fine sand.

Permeability is moderately rapid to the water table. Available water capacity is moderate. These soils have a water table at a depth of 20 to 40 inches most of the year.

Representative profile of Gracemore loamy fine sand, 2,640 feet east and 2,490 feet south of the northwest corner of sec. 23, T. 15 N., R. 14 W.:

A1—0 to 12 inches, brown (7.5YR 5/4) loamy fine sand, brown (7.5YR 4/4) when moist; weak, fine, granular structure; very friable; calcareous; moderately alkaline; clear, wavy boundary.

C—12 to 72 inches, brown (7.5YR 5/4) fine sand, brown (7.5YR 4/4) when moist; single grained; calcareous; moderately alkaline; very thin layers of fine sandy loam; water table at a depth of 34 inches.

The A1 horizon is brown, reddish brown, or yellowish brown. The C horizon is brown, reddish-brown, yellowish-brown, light yellowish-brown, or dark yellowish-brown fine sand or loamy fine sand.

Gm—Gracemore loamy fine sand. This soil has slopes of 0 to 1 percent. It is subject to occasional flooding.

Included in mapping are areas of a soil that is similar to this Gracemore soil, but it has a water table at a depth of 40 to 60 inches most of the year. This included soil makes up about 40 percent of the mapped areas. Also included are areas of Fluvents, which make up 5 percent of the mapped areas.

Most of this soil is used for small grain and tame pasture grasses. Some areas are in grain sorghum, cotton, alfalfa, and native grasses.

The main concerns of management are occasional flooding, maintaining fertility and keeping grasses growing vigorously. Most of the crops produce large amounts of residue and can be grown continuously if crop residue is returned to the soil and plant nutrients are supplied. Capability unit IIIw-1; Subirrigated range site; pasture and hayland suitability group 3B; tree suitability group 1.

Grant Series

The Grant series consists of deep, well-drained, very gently sloping to gently sloping soils on uplands. These soils formed in material weathered from sandstone or loamy sediment under a cover of native grasses.

In a representative profile the surface layer is 11 inches of reddish-brown loam. The upper part of the subsoil, to a depth of 36 inches, is reddish-brown loam. The lower part of the subsoil, to a depth of 48 inches, is red loam. The underlying material is red partly weathered sandstone.

Permeability is moderate. Available water capacity is high.

Representative profile of Grant loam, 1 to 3 percent slopes, 1,275 feet north and 150 feet west of the southeast corner of sec. 3, T. 14 N., R. 15 W.:

A1—0 to 11 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) when moist; weak, fine, granular structure; friable; slightly acid; gradual, smooth boundary.

B1—11 to 16 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) when moist; weak, coarse, prismatic structure breaking to moderate, medium, granular; friable; slightly acid; gradual, wavy boundary.

B2t—16 to 36 inches, reddish-brown (2.5YR 4/4) loam, dark reddish brown (2.5YR 3/4) when moist; weak, coarse, prismatic structure breaking to moderate, medium, granular; friable; thin clay films on faces of peds; neutral; gradual, wavy boundary.

B3—36 to 48 inches, red (2.5YR 4/6) loam, dark red (2.5YR 3/6) when moist; weak, fine, granular structure; friable; neutral; clear, wavy boundary.

C—48 to 54 inches, red (2.5YR 4/6) partly weathered sandstone; mildly alkaline.

The A1 or Ap horizon is reddish brown, dark reddish gray, or brown. It is slightly acid or neutral. The B2t horizon is loam or clay loam. It is neutral or mildly alkaline. The B3 horizon is neutral or mildly alkaline. Depth to sandstone is 40 inches to more than 72 inches.

GrB—Grant loam, 1 to 3 percent slopes. This soil is very gently sloping. It has the profile described as representative of the series.

Included with this soil in mapping are areas of a soil that is similar to this Grant soil, but it has sandstone at a depth of 30 to 40 inches. This soil makes up about 11 percent of the mapped areas. Also included are areas of Lucien and Pond Creek soils. Lucien soils make up about 5 percent of the mapped areas, and Pond Creek soils 2 percent.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, cotton, alfalfa, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. If this soil is well managed, most of the suited crops can be grown. Returning crop residue to the soil and adding plant nutrients are good management practices. Terracing with protected outlets, contour farming, and minimum tillage are needed if row crops are grown. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

GrC—Grant loam, 3 to 5 percent slopes. This soil is gently sloping.

Included with this soil in mapping are areas of a soil similar to this Grant soil, but it has sandstone at a depth of 30 to 40 inches. This soil makes up about 12 percent of the mapping areas. Also included are areas of Lucien soils, which make up about 3 percent.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, cotton, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil fertility and structure. If this soil is used for row crops, terraces and contour farming are needed. Where terraces are not used, a cropping system is needed that includes only soil-main-

taining crops. Returning large amounts of crop residue to the soil and supplying plant nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit IIIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

Hardeman Series

The Hardeman series consists of deep, well-drained, sloping soils on uplands. These soils formed in loamy sediment under a cover of native grasses.

In a representative profile the surface layer is 10 inches of reddish-brown fine sandy loam. The upper part of the subsoil, to a depth of 20 inches, is reddish-brown fine sandy loam. The lower part of the subsoil, to a depth of 42 inches, is red fine sandy loam. The underlying material, to a depth of 60 inches, is reddish-brown fine sandy loam.

Permeability is moderately rapid. Available water capacity is high.

Representative profile of Hardeman fine sandy loam, 5 to 8 percent slopes, 2,040 feet west and 120 feet south of the northeast corner of sec. 8, T. 13 N., R. 19 W.:

A1—0 to 10 inches, reddish-brown (5YR 4/3) fine sandy loam, dark reddish brown (5YR 3/3) when moist; weak, fine, granular structure; very friable; few pebbles; mildly alkaline; gradual, smooth boundary.

B2—10 to 20 inches, reddish-brown (2.5YR 4/4) fine sandy loam, dark reddish brown (2.5YR 3/4) when moist; weak, coarse, prismatic structure breaking to weak, fine, granular; friable; mildly alkaline; gradual, wavy boundary.

B3—20 to 42 inches, red (2.5YR 4/6) fine sandy loam, dark red (2.5YR 3/6) when moist; weak, fine, granular structure; very friable; calcareous; moderately alkaline; gradual, wavy boundary.

C—42 to 60 inches, reddish-brown (2.5YR 5/4) fine sandy loam, reddish brown (2.5YR 4/4) when moist; single grained; very friable; calcareous; moderately alkaline.

The A1 or Ap horizon is mildly alkaline or moderately alkaline. The B2 horizon is reddish brown or red. It is mildly alkaline or moderately alkaline. The B3 horizon is red or reddish brown.

HaD—Hardeman fine sandy loam, 5 to 8 percent slopes (W). This soil is sloping. It has spots eroded by wind.

Included with this soil in mapping are areas of a soil that is similar to this Hardeman soil, but it is not calcareous at a depth of 25 to 34 inches. This soil makes up about 20 percent of the mapped areas. Also included are areas of Woodward soils, spots of Quinlan soils, and wind-eroded spots of Hardeman soils. The Woodward soils make up about 2 percent of this mapping unit.

Most of this soil is used as range. Some areas are used for small grain, grain sorghum, and tame pasture grasses.

The main concern of range management is keeping grasses growing vigorously. The main concern of management of cultivated soils is controlling wind and water erosion and maintaining soil structure and fertility. Terraces and contour farming are needed. A cropping system is needed that includes soil-maintaining crops. Returning large amounts of crop residue to the soil and adding fertilizer help to maintain content of organic matter, to retain structure, and to increase the intake rate of water. Capability unit IVe-2; Sandy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 5.

Lucien Series

The Lucien series consists of shallow, well-drained, strongly sloping to moderately steep soils on uplands. These soils formed under a cover of native grasses in material weathered from sandstone.

In a representative profile the surface layer is 7 inches of reddish-brown very fine sandy loam. The subsoil, to a depth of 15 inches, is red very fine sandy loam. The underlying material is red partly weathered sandstone.

Permeability is moderately rapid. Available water capacity is moderate.

Representative profile of Lucien very fine sandy loam, in an area of Lucien soils and Rock outcrop, 8 to 20 percent slopes, 300 feet north and 75 feet east of the southwest corner of sec. 11, T. 14 N., R. 14 W.:

A1—0 to 7 inches, reddish-brown (5YR 4/3) very fine sandy loam, dark reddish brown (5YR 3/3) when moist; weak, medium, granular structure; very friable; slightly acid; gradual, smooth boundary.

B2—7 to 15 inches, red (2.5YR 4/6) very fine sandy loam, dark red (2.5YR 3/6) when moist; weak, medium, granular structure; very friable; slightly acid; clear, wavy boundary.

C—15 to 20 inches, red (2.5YR 5/6) partly weathered sandstone, red (2.5YR 4/6) when moist; neutral.

The A1 horizon is reddish-brown or brown very fine sandy loam or loam. It is slightly acid or neutral. The B2 horizon is red or reddish-brown very fine sandy loam or loam. It is slightly acid or neutral. The C horizon is red or reddish brown. The thickness of the profile over bedrock is 10 to 20 inches.

LrE—Lucien soils and Rock outcrop, 8 to 20 percent slopes. These strongly sloping to moderately steep soils and sandstone Rock outcrop occur together without regularity of pattern. About 40 percent of the mapping unit is Lucien soils, and about 20 percent is Rock outcrop. The Lucien soil that has the profile described as representative of the Lucien series is in this mapping unit. Some of the Lucien soils have a surface layer of loam.

Included with these soils in mapping are areas of a soil that is similar to these Lucien soils, but the surface layer is not so dark. This soil makes up about 25 percent of the mapping unit. Also included are areas of a soil that is similar to these Lucien soils, but it is 20 to 40 inches deep over sandstone. This soil makes up about 15 percent of the mapping unit.

Most of this undifferentiated group is used as range. The soils are not suited to cultivation.

The main concerns of management are droughtiness and keeping grasses growing vigorously. Capability unit VIe-7; Shallow Prairie range site; not assigned to a pasture and hayland suitability group; tree suitability group 7.

Minco Series

The Minco series consists of deep, well-drained, very gently sloping to moderately steep soils on uplands. These soils formed in loamy sediment under a cover of native grasses.

In a representative profile the surface layer is 10 inches of reddish-brown very fine sandy loam. The subsoil, to a depth of 27 inches, is reddish-brown very fine sandy loam. The underlying material, to a depth of 60 inches, is red very fine sandy loam.

Permeability is moderate. Available water capacity is high.

Representative profile of Minco very fine sandy loam, 5 to 8 percent slopes, 1,980 feet south and 750 feet west of the northeast corner of sec. 22, T. 13 N., R. 14 W.:

A1—0 to 10 inches, reddish-brown (5YR 4/3) very fine sandy loam, dark reddish brown (5YR 3/3) when moist; weak, medium, granular structure; very friable; slightly acid; gradual, smooth boundary.

B2—10 to 27 inches, reddish-brown (5YR 4/4) very fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak, medium granular structure; very friable; slightly acid; diffuse, wavy boundary.

C—27 to 60 inches, red (2.5YR 4/6) very fine sandy loam, dark red (2.5YR 3/6) when moist; single grained; very friable; neutral.

The A1 or Ap horizon is reddish-brown or brown very fine sandy loam or loam. It is slightly acid or neutral. The B2 horizon is reddish-brown or brown very fine sandy loam or loam. It is slightly acid to mildly alkaline. The C horizon is red, reddish-brown, or brown very fine sandy loam or loam. It is slightly acid to moderately alkaline.

McD—Minco very fine sandy loam, 5 to 8 percent slopes. This soil is sloping. It has the profile described as representative of the series.

Included with this soil in mapping are areas of a soil that is similar to this Minco soil but is 40 to 60 inches deep over bedrock. This soil makes up about 8 percent of the mapped areas. Also included are areas of a soil that is similar to this Minco soil but is calcareous at a depth of 25 to 36 inches. This soil makes up about 5 percent of the mapped areas.

Much of this soil is used for wheat. Some areas are used for other small grain, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. Returning crop residue to the soil and using plant nutrients are good management practices. Terracing with protected outlets, contour farming, and minimum tillage are needed. Capability unit IVe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

McE—Minco very fine sandy loam, 8 to 20 percent slopes. This soil is strongly sloping to moderately steep.

Included with this soil in mapping are areas of a soil that is similar to this Minco soil, but it is calcareous at a depth of 20 to 36 inches. This soil makes up about 15 percent of the mapped areas. Also included are areas of Lucien soils and spots of Rock outcrop. Lucien soils make up about 8 percent of the mapped areas. Also included are areas of a soil that is similar to this Minco soil, but it is 30 to 60 inches deep over bedrock. This soil makes up about 5 percent of the mapped areas.

This soil is used as range.

The main concern of management is keeping grasses growing vigorously. Capability unit VIe-2; Loamy Prairie range site; not assigned to a pasture and hayland suitability group; tree suitability group 6.

MdB—Minco loam, 1 to 3 percent slopes. This soil is very gently sloping. It has a profile similar to the one described as representative of the series, but the surface layer is loam and the combined thickness of the surface layer and subsoil is about 38 inches.

Included with this soil in mapping are areas of a soil that is similar to this Minco soil, but it is calcareous at a depth of 25 to 36 inches. This soil makes up about 15 percent of the mapped areas. Also included are areas of Pond Creek soils that make up about 4 percent of the mapped areas.

Most of this soil is used for wheat. Some areas are used for other small grain, grain sorghum, cotton, alfalfa, tame pasture grasses, or native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. If this soil is well managed, most of the suited crops can be grown. Returning crop residue to the soil and supplying plant nutrients are good management practices. Terraces with protected outlets, contour farming, and minimum tillage are needed if row crops are grown. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

MdC—Minco loam, 3 to 5 percent slopes. This soil is gently sloping.

Included with this soil in mapping are areas of a soil that is similar to this Minco soil, but it is calcareous at a depth of 25 to 36 inches. This soil makes up about 10 percent of the mapped area. Also included are areas of Pond Creek soils that make up about 2 percent of the mapped areas.

Most of this soil is used for wheat. Some areas are used for other small grain, grain sorghum, cotton, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil fertility and structure. If row crops are grown, terraces and contour farming are needed. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops. Returning large amounts of crop residue to the soil and supplying plant nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit IIIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

Pond Creek Series

The Pond Creek series consists of deep, well-drained, nearly level to very gently sloping soils on uplands. These soils formed in loamy sediment under a cover of native grasses.

In a representative profile the surface layer is 11

inches of dark grayish-brown silt loam. The upper part of the subsoil, to a depth of 25 inches, is dark-brown silt loam. The middle part, to a depth of 42 inches, is dark-brown silty clay loam. The lower part of the subsoil, to a depth of 72 inches, is brown silt loam.

Permeability is moderately slow. Available water capacity is high.

Representative profile of Pond Creek silt loam, 0 to 1 percent slopes, 1,050 feet south and 90 feet east of the northwest corner of sec. 31, T. 15 N., R. 14 W.:

A1—0 to 11 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; friable; slightly acid; gradual, smooth boundary.

B1—11 to 25 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; weak, coarse, prismatic structure breaking to moderate, medium, granular; friable; neutral; gradual, wavy boundary.

B2t—25 to 42 inches, dark-brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; firm; clay films on faces of peds; neutral; gradual, wavy boundary.

B31—42 to 54 inches, brown (10YR 5/3) silt loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; friable; few thin clay films on faces of peds; mildly alkaline; gradual, wavy boundary.

B32—54 to 72 inches, brown (10YR 5/3) silt loam, brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure; friable; common threads of mycelia carbonate; calcareous; moderately alkaline.

The A1 or Ap horizon is dark grayish-brown, dark-brown, brown, dark reddish-gray, or reddish-brown silt loam or fine sandy loam. It is slightly acid to neutral. The B1 horizon is dark-brown, brown, dark grayish-brown, dark reddish-gray, or reddish-brown silt loam, loam, clay loam, or silty clay loam. It is slightly acid to neutral. The B2t horizon is dark-brown, brown, dark grayish-brown, grayish-brown, or reddish-brown silty clay loam, clay loam, silt loam, or loam. It is slightly acid to neutral. The B3 horizon is brown, dark yellowish-brown, dark-brown, or reddish-brown silt loam, loam, clay loam, or silty clay loam. It is neutral to moderately alkaline. In some places there is a C horizon of brown, reddish-brown, or red silt loam, clay loam, or silty clay loam. This horizon is mildly alkaline or moderately alkaline.

PcA—Pond Creek fine sandy loam, 0 to 2 percent slopes. This soil is nearly level or very gently sloping.

Included with this soil in mapping are areas of Shellabarger soils that make up about 8 percent of the mapped areas.

Most of this soil is used for cotton, grain sorghum, and small grain. Some areas are in alfalfa, tame pasture grasses, and native grasses.

The main concern of management is maintaining soil structure and fertility. Returning large amounts of residue to the soil and supplying plant nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit I-2; Sandy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

PkA—Pond Creek silt loam, 0 to 1 percent slopes. This soil is nearly level. It has the profile described as representative of the series.

Included with this soil in mapping are areas of St. Paul soils that make up about 5 percent of the mapped area.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, cotton, alfalfa, tame pasture grasses, and native grasses.

The main concern of management is maintaining soil structure and fertility. Returning large amounts of residue to the soil and supplying plant nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit I-2; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

PkB—Pond Creek silt loam, 1 to 3 percent slopes. This soil is very gently sloping.

Included with this soil in mapping are areas of St. Paul and Minco soils. St. Paul soils make up about 8 percent of the mapped area, and Minco soils 2 percent.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, cotton, alfalfa, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. If this soil is well managed, most of the adapted crops can be grown. Returning crop residue to the soil and supplying plant nutrients are good management practices. Terraces with protected outlets, contour farming, and minimum tillage are needed if row crops are grown. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

Pratt Series

The Pratt series consists of deep, well-drained, very gently sloping to strongly sloping soils on uplands. These soils formed in sandy sediment under a cover of native grasses.

In a representative profile the surface layer is 11 inches of brown loamy fine sand. The subsoil, to a depth of 60 inches, is yellowish-red loamy fine sand.

Permeability is rapid. Available water capacity is moderate.

Representative profile of Pratt loamy fine sand, 4 to 8 percent slopes, 1,650 feet east and 180 feet north of the southwest corner of sec. 36, T. 13 N., R. 14 W.:

A1—0 to 11 inches, brown (7.5YR 5/3) loamy fine sand, dark brown (7.5YR 4/3) when moist; weak, medium, granular structure; very friable; neutral; gradual, smooth boundary.

B2t—11 to 42 inches, yellowish-red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6) when moist; weak, medium, granular structure; very friable; clay films on sand grains and bridging between sand grains; slightly acid; diffuse, smooth boundary.

B3—42 to 60 inches, yellowish-red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6) when moist; weak, coarse, prismatic structure; very friable; slightly acid.

The A1 or Ap horizon is brown or dark-brown loamy fine sand or fine sand. It is neutral or slightly acid. The B2t horizon is yellowish red, reddish brown, or brown. It is slightly acid or neutral. The B3 horizon is yellowish red, reddish brown, or brown.

PrB—Pratt loamy fine sand, 1 to 4 percent slopes (W). This soil is very gently sloping to gently sloping. It has spots eroded by wind.

Included with this soil in mapping are areas of Shellabarger soils that make up about 3 percent of the mapped area.

Most of this soil is used for grain sorghum and small grain. Some areas are in cotton, alfalfa, tame pasture grasses, and native grasses.

The main concerns of management are controlling wind erosion and maintaining soil structure and fertility. Returning large amounts of residue to the soil and supplying plant nutrients help to maintain soil structure and fertility and to control wind erosion. Delaying tillage in spring during the period of critical soil blowing also helps to control wind erosion. Capability unit IIIe-3; Deep Sand range site; pasture and hayland suitability group 9B; tree suitability group 4.

PrC—Pratt loamy fine sand, 4 to 8 percent slopes (W). This soil is gently sloping to sloping. It has the profile described as representative of the series. It also has spots eroded by wind.

Included with this soil in mapping are areas of Tivoli soils that make up about 5 percent of the mapped areas. Also included are areas of a soil that is similar to this Pratt soil but is 40 to 60 inches deep over bedrock. This soil makes up about 2 percent of the mapped areas.

Most of this soil is in grain sorghum, small grain, and native grasses. Some areas are used for tame pasture grasses.

The main concerns of management are controlling wind erosion and maintaining soil structure and fertility. Returning large amounts of residue to the soil and supplying plant nutrients help to maintain soil structure and fertility and to control wind erosion. Row direction, stripcropping at right angles to the prevailing winds, and delaying tillage in spring during the period of critical soil blowing also help to control wind erosion. Capability unit IVe-3; Deep Sand range site; pasture and hayland suitability group 9B; tree suitability group 4.

PtE—Pratt and Tivoli soils, 8 to 12 percent slopes (W). These strongly sloping soils occur together without regularity of pattern. They have spots eroded by wind. About 75 percent of this undifferentiated group is Pratt soils, and 20 percent is Tivoli soils. The Pratt soils have a profile similar to the one described as representative of the Pratt series, but the surface layer is fine sand or loamy fine sand in places. The Tivoli soils have a profile similar to the one described as representative of the Tivoli series, but the surface layer is fine sand in places.

Most of this mapping unit is used as range. The soils are also suited to tame pasture.

The main concern of management is keeping the grasses growing vigorously. Capability unit VIe-3; Deep Sand range site; pasture and hayland suitability group 9B; tree suitability group 4.

Quinlan Series

The Quinlan series consists of shallow, well-drained, very gently sloping to strongly sloping soils on uplands. These soils formed in material weathered from sandstone under a cover of native grasses.

In a representative profile the surface layer is 7 inches of reddish-brown silt loam. The subsoil, to a depth of 13 inches, is red silt loam. The underlying material is red partly weathered sandstone.

Permeability is moderately rapid to moderate. Available water capacity is moderate.

Representative profile of Quinlan silt loam in an area of Woodward-Quinlan complex, 5 to 12 percent slopes, 1,050 feet south and 30 feet east of the northwest corner of sec. 4, T. 14 N., R. 20 W.:

A1—0 to 7 inches, reddish-brown (2.5YR 4/4) silt loam, dark reddish brown (2.5YR 3/4) when moist; moderate, medium, granular structure; friable; calcareous; moderately alkaline; gradual, smooth boundary.

B2—7 to 13 inches, red (2.5YR 4/6) silt loam, dark red (2.5YR 3/6) when moist; moderate, medium, granular structure; friable; calcareous; moderately alkaline; gradual, wavy boundary.

C—13 to 20 inches, red (2.5YR 5/6) partly weathered sandstone, red (2.5YR 4/6) when moist; calcareous, moderately alkaline.

The A1 horizon is reddish-brown, red, or yellowish-red silt loam, loam, or fine sandy loam. It is mildly alkaline or moderately alkaline. The B2 horizon is red, reddish-brown, or yellowish-red silt loam or fine sandy loam. It is mildly alkaline or moderately alkaline. The C horizon is red, reddish brown, or yellowish red. Depth to bedrock is 10 to 20 inches.

QwC2—Quinlan-Woodward complex, 3 to 5 percent slopes, eroded. These gently sloping soils are in such an intricate pattern that it is impractical to map them separately. About 50 percent of the complex is Quinlan soils, and 40 percent is Woodward soils. Both soils have a profile similar to the ones described as representative of their respective series, but their surface layer has been thinned by erosion and is silt loam or loam in places.

Included with these soils in mapping is about 10 percent soils that are similar to Quinlan soils but are less than 10 inches thick to bedrock.

The soils in this complex are in small grain, grain sorghum, or native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. Returning crop residue to the soil and supplying plant nutrients are good management practices. Terracing, using protected outlets, contour farming, and minimum tillage are needed. Capability unit IVe-1; Quinlan part in Shallow Prairie range site, Woodward part in Loamy Prairie range site; Woodward part in pasture and hayland suitability group 8A, Quinlan part not assigned to a pasture and hayland suitability group; tree suitability group 7.

QwE3—Quinlan-Woodward complex, 5 to 10 percent slopes, severely eroded. These sloping to strongly sloping soils are in such an intricate pattern that it is impractical to map them separately. About 65 percent of the complex is Quinlan soils, and 25 percent is Woodward soils. Both soils have profiles similar to the ones described as representative of their respective series, but their surface layer has been thinned by erosion and is silt loam or loam in places.

Included with these soils in mapping is about 10 percent soils that are similar to Quinlan soils but are

less than 10 inches thick to bedrock. These soils have uncrossable gullies that are 50 to 300 feet apart and 5 to 15 feet wide.

The soils in this complex are used as range.

The main concerns of management are keeping grasses growing vigorously and controlling erosion. Capability unit VIe-4; Eroded Prairie range site; Quinlan part not assigned to a pasture and hayland suitability group, Woodward part in pasture and hayland suitability group 8F; tree suitability group 8.

Rock Outcrop

Rock outcrop consists of very gently sloping to moderately steep siltstone, gypsum, or sandstone outcrops. This land type is mapped only with Cordell, Cornick, and Lucien soils.

Shellabarger Series

The Shellabarger series consists of deep, well-drained, very gently sloping to gently sloping soils on uplands. These soils formed in loamy and sandy sediment under a cover of native grasses.

In a representative profile the surface layer is 11 inches of brown fine sandy loam. The upper part of the subsoil, to a depth of 32 inches, is reddish-brown fine sandy loam. The lower part of the subsoil, to a depth of 45 inches, is reddish-brown sandy clay loam. The underlying material, to a depth of 72 inches, is red fine sandy loam.

Permeability is moderate. Available water capacity is high.

Representative profile of Shellabarger fine sandy loam, 1 to 3 percent slopes, 675 feet north and 500 feet east of the southwest corner of sec. 14, T. 13 N., R. 14 W.:

A1—0 to 11 inches, brown (7.5YR 5/2) fine sandy loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; very friable; medium acid; gradual, smooth boundary.

B1—11 to 32 inches, reddish-brown (5YR 5/3) fine sandy loam, reddish brown (5YR 4/3) when moist; weak, coarse, prismatic structure breaking to moderate, medium, granular; friable; clay films on sand grains; slightly acid; gradual, wavy boundary.

B2t—32 to 45 inches, reddish-brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) when moist; weak, coarse, prismatic structure breaking to weak, medium, granular; friable; clay films on faces of peds; neutral; gradual, wavy boundary.

C—45 to 72 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) when moist; single grained; very friable; neutral.

The A1 or Ap horizon is brown, dark brown, reddish brown, or dark reddish gray. It is medium acid to slightly acid. The B1 horizon is slightly acid to neutral. The B2t horizon is reddish-brown or red sandy clay loam or fine sandy loam. It is neutral to slightly acid. The C horizon is red or yellowish-red fine sandy loam or loamy fine sand. It is neutral to mildly alkaline.

ShB—Shellabarger fine sandy loam, 1 to 3 percent slopes (W). This soil is very gently sloping. It has the profile described as representative of the series. It also has spots eroded by wind.

Included with this soil in mapping are areas of Pond Creek soils that make up about 10 percent of the mapped areas. Also included are areas of a soil that is similar to this Shellabarger soil, but it is 40 to 60 inches deep over sandstone. This soil makes up about 3 percent of the mapped areas.

Most of this soil is used for cotton, grain sorghum, and wheat. Some areas are in other small grain, alfalfa, tame pasture grasses, and native grasses.

The main concerns of management are controlling wind and water erosion and maintaining soil structure and fertility. Most crops that produce large amounts of residue can be grown continuously if crop residue is returned to the soil, plant nutrients are supplied, and other good management practices are used. Terraces with protected outlets, contour farming, and minimum tillage are needed if row crops are grown. Capability unit IIe-2; Sandy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

ShC—Shellabarger fine sandy loam, 3 to 5 percent slopes (W). This soil is gently sloping. It has spots eroded by wind.

Included with this soil in mapping are areas of a soil that is similar to this Shellabarger soil, but it is 40 to 60 inches deep over sandstone. This soil makes up about 3 percent of the mapped areas.

Most of this soil is used for cotton, grain sorghum, and wheat. Some areas are in other small grain, tame pasture grasses, and native grasses.

The main concerns of management are controlling wind and water erosion and maintaining soil structure and fertility. If crops are grown, terraces and contour farming are needed. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops. Returning large amounts of residue to the soil and supplying plant nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit IIIe-2; Sandy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

St. Paul Series

The St. Paul series consists of deep, well-drained, nearly level to gently sloping soils on uplands. The soils formed in loamy sediment or in material weathered from shale or sandstone.

In a representative profile the surface layer is 11 inches of dark-brown silt loam. The upper part of the subsoil, to a depth of 40 inches, is dark-brown silty clay loam. The lower part of the subsoil, to a depth of 52 inches, is reddish-brown silty clay loam. The underlying material, to a depth of 72 inches, is red silt loam (fig. 4).

Permeability is moderately slow. Available water capacity is high.

Representative profile of St. Paul silt loam, 1 to 3 percent slopes, 900 feet west and 60 feet north of the southeast corner of sec. 12, T. 15 N., R. 17 W.:

Ap—0 to 7 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A1—7 to 11 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; moderate, me-

Figure 4.—**Profile of a St. Paul silt loam.**

dium, granular structure; friable; neutral; gradual, smooth boundary.

B1—11 to 16 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.

B2t—16 to 40 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; firm; clay films on faces of peds; mildly alkaline; gradual, wavy boundary.

B3—40 to 52 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; weak, coarse, subangular blocky structure; firm; few clay films on faces of peds; calcareous; moderately alkaline; gradual, wavy boundary.

C—52 to 72 inches, red (2.5YR 4/6) silt loam, dark red (2.5YR 3/6) when moist; massive; friable; calcareous; moderately alkaline.

The A1 or Ap horizon is dark brown, brown, or dark grayish brown and is neutral or mildly alkaline. The B1 horizon is dark-brown, brown, or dark grayish-brown silty clay loam or silt loam. It is neutral to mildly alkaline. The B2t horizon is dark-brown, brown, dark reddish-gray, or reddish-brown silty clay loam or clay loam. It is mildly alkaline or moderately alkaline. The B3 horizon is reddish-brown, red, dark-brown, or brown silty clay loam or silt loam. It is moderately alkaline or mildly alkaline. The C horizon is red, reddish-brown, or light reddish-brown silt loam or silty clay loam.

StA—St. Paul silt loam, 0 to 1 percent slopes. This soil is nearly level.

Included with this soil in mapping are areas of Pond Creek and Carey soils. Pond Creek soils make up about 10 percent of the mapped areas, and Carey soils 3 percent.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, cotton, alfalfa, tame pasture grasses, and native grasses.

The main concern of management is maintaining soil structure and fertility. Most of the crops generally produce large amounts of residue and can be grown continuously if the crop residue is returned to the soil and plant nutrients are supplied. Capability unit IIc-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

StB—St. Paul silt loam, 1 to 3 percent slopes. This soil is very gently sloping.

Included with this soil in mapping are areas of Pond Creek and Carey soils. Pond Creek soils make up about 10 percent of the mapped areas, and Carey soils about 5 percent.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, cotton, alfalfa, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. If this soil is well managed, most of the adapted crops can be grown. Returning crop residue to the soil and supplying plant nutrients are good management practices. Terraces (fig. 5) that have protected outlets, contour farming, and minimum tillage are needed if row crops are grown. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

StC—St. Paul silt loam, 3 to 5 percent slopes. This soil is gently sloping.

Included with this soil in mapping are areas of Carey and Quinlan soils. Carey soils make up about 8 percent of the mapped areas, and Quinlan soils 2 percent.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, cotton, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil fertility and structure. If row crops are grown, terraces and contour farming are needed. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops (fig. 6). Returning large amounts of crop residue to the soil and supplying nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit IIIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

Tivoli Series

The Tivoli series consists of deep, excessively drained, strongly sloping soils on uplands. These soils formed in sandy sediment under a cover of native grasses.

In a representative profile the surface layer is 6 inches of brown loamy fine sand. The underlying material, to a depth of 72 inches, is light-brown fine sand.

Permeability is rapid. Available water capacity is low.

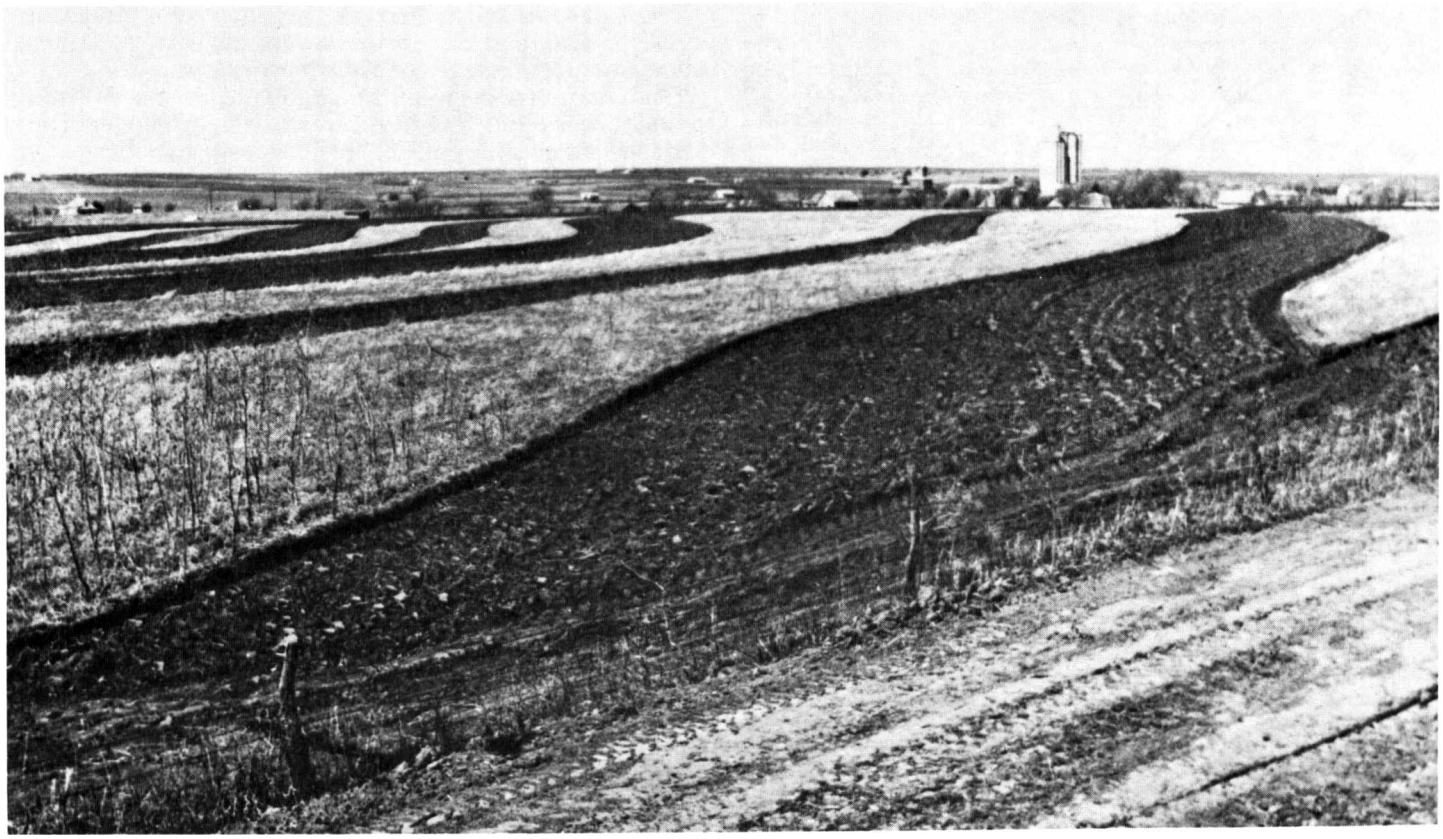

Figure 5.—Terrace maintenance in an area of St. Paul silt loam, 1 to 3 percent slopes.

Figure 6.—Stubble mulch tillage in an area of St. Paul silt loam, 3 to 5 percent slopes.

Representative profile of Tivoli loamy fine sand in an area of Pratt and Tivoli soils, 8 to 12 percent slopes (W), 1,575 feet south and 75 feet west of the northeast corner of sec. 10, T. 15 N., R. 14 W.:

A1—0 to 6 inches, brown (10YR 5/3) loamy fine sand, brown (10YR 4/3) when moist; single grained; very friable; neutral; gradual, wavy boundary.
C—6 to 72 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) when moist; single grained; loose; neutral.

The A1 horizon is brown, grayish-brown, light brownish-gray, or pale-brown loamy fine sand or fine sand. It is neutral to mildly alkaline. The C horizon is light brown, brown, strong brown, reddish yellow, reddish brown, or light reddish brown. It is neutral to mildly alkaline.

Tivoli soils in this survey area are mapped only in an undifferentiated group with Pratt soils.

Woodward Series

The Woodward series consists of moderately deep, well-drained, very gently sloping to strongly sloping soils on uplands. These soils formed in material weathered from sandstone under a cover of native grasses.

In a representative profile the surface layer is 10 inches of reddish-brown silt loam. The subsoil, to a depth of 30 inches, is red silt loam. The underlying material is red partly weathered sandstone.

Permeability is moderate. Available water capacity is high.

Representative profile of Woodward silt loam in an area of Woodward-Quinlan complex, 5 to 12 percent slopes, 1,080 feet south and 30 feet east of the northwest corner of sec. 4, T. 14 N., R. 20 W.:

A1—0 to 10 inches, reddish-brown (5YR 4/4) silt loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; friable; calcareous; moderately alkaline; gradual, smooth boundary.
B2—10 to 30 inches, red (2.5YR 4/6) silt loam, dark red (2.5YR 3/6) when moist; weak, medium, granular structure; friable; calcareous; moderately alkaline; gradual, wavy boundary.
C—30 to 40 inches, red (2.5YR 4/6) partly weathered sandstone, dark red (2.5YR 3/6) when moist; calcareous; moderately alkaline.

The A1 or Ap horizon is reddish-brown, brown, or red silt loam or loam. It is moderately alkaline to neutral. The B2 horizon is reddish-brown or red silt loam or loam. It is mildly alkaline or moderately alkaline. Depth to sandstone is 20 to 40 inches.

WoB—Woodward silt loam, 1 to 3 percent slopes. This soil is very gently sloping.

Included with this soil in mapping are areas of a soil that is similar to this Woodward soil, but it is 40 to 60 inches deep over sandstone. This soil makes up about 40 percent of the mapped areas. Also included are areas of Carey and Quinlan soils. Carey soils make up about 5 percent of the unit, and Quinlan soils 3 percent.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, cotton, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. If this soil is well managed, most of the suited crops can be grown. Returning crop residue to the soil and supplying plant nutrients are good management practices. Terraces with protected outlets, contour farming, and minimum tillage are needed if row crops are grown. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

WoC—Woodward silt loam, 3 to 5 percent slopes. This soil is gently sloping.

Included with this soil in mapping are areas of Quinlan, Minco, and Carey soils. Quinlan soils make up about 8 percent of the mapped areas, Minco soils 5 percent, and Carey soils 2 percent.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, cotton, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil fertility and structure. If row crops are grown, terraces with protected outlets (fig. 7) and contour farming are needed. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops. Returning large amounts of crop residue to the soil and supplying plant nutrients help to maintain content of organic matter and fertility, to retain structure, and to increase the intake rate of water. Capability unit IIIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

WoD—Woodward silt loam, 5 to 8 percent slopes. This soil is sloping.

Included with this soil in mapping are areas of Quinlan and Minco soils. Quinlan soils make up about 10 percent of the mapped areas, and Minco soils 8 percent.

Most of this soil is used for wheat. Some areas are in other small grain, grain sorghum, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. Returning crop residue to the soil and supplying plant nutrients are good management practices. Terraces with protected outlets, contour farming, and minimum tillage are needed. Capability unit IVe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 6.

Wt—Woodward-Clairemont complex. These soils are nearly level to strongly sloping. About 45 percent of the complex is Woodward soils that have slopes of 1 to 12 percent, and 25 percent is Clairemont soils that have slopes of 0 to 1 percent. The Woodward soils have a profile similar to the one described as representative for the Woodward series, but the surface layer is silt loam or loam. The Clairemont soils have a profile similar to the one described as representative for the Clairemont series. Woodward and Clairemont soils are in such an intricate pattern that it is impractical to map them separately. Clairemont soils are frequently flooded.

Included with these soils in mapping are areas of Quinlan, Carey, St. Paul, and Yahola soils. Quinlan soils make up about 10 percent of the mapped areas, and Carey, St. Paul, and Yahola soils each about 5 percent. Also included are areas of a soil that is similar

Figure 7.—Bermudagrass in an outlet in an area of Woodward silt loam, 3 to 5 percent slopes.

to the Clairemont soil, but it is grayer in the uppermost 10 inches. This soil makes up about 5 percent of the mapped areas. Spots of Rock outcrop are also included.

Most of this complex is used as range. Some areas are used for tame pasture.

The main concern of management is keeping the grasses growing vigorously. Capability unit VIe-5; Woodward soils in Loamy Prairie range site, Clairemont soils in Loamy Bottomland range site; Woodward soils in pasture and hayland suitability group 8A, Clairemont soils in 2A; tree suitability group 6.

WwC—Woodward-Quinlan complex, 3 to 5 percent slopes. These gently sloping soils are in such an intricate pattern that it is impractical to map them separately. About 50 percent of the complex is Woodward soils, and about 40 percent is Quinlan soils. Both soils have profiles similar to the ones described as representative of their respective series, but their surface layer is silt loam or loam.

Included with these soils in mapping are areas of a soil that is similar to the Woodward soils but is not calcareous at a depth of 25 to 34 inches. This soil makes up about 3 percent of the complex. Also included are areas of a soil that is similar to the Quinlan soils but is less than 10 inches deep over sandstone or is neutral at a depth of 10 to 20 inches. This soil makes up about 7 percent of the mapped areas.

Most of this complex is used for wheat. Some areas are in other small grain, grain sorghum, tame pasture grasses, and native grasses.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. Returning crop residue to the soil and supplying plant nutrients are good management practices. Terraces with protected outlets, contour farming, and minimum tillage are needed. Capability unit IVe-1; Woodward part in Loamy Prairie range site, Quinlan part in Shallow Prairie range site; Woodward part in pasture and hayland suitability group 8A, Quinlan part not assigned to a pasture and hayland suitability group; tree suitability group 7.

WwE—Woodward-Quinlan complex, 5 to 12 percent slopes. These sloping to strongly sloping soils are in such an intricate pattern that it is impractical to map them separately. About 50 percent of the complex is Woodward soils, and about 43 percent is Quinlan soils. Both soils have profiles similar to the ones described as representative of their respective series, but their surface layer is loam in places.

Included with Woodward and Quinlan soils in mapping is about 7 percent soils that are similar to Woodward soils but are 40 to 60 inches thick over sandstone. Also included are spots of Rock outcrop and of soils that are similar to Quinlan soils but are less than 10 inches thick over sandstone.

Most of this complex is used as range. The Woodward soils are also used for tame pasture.

The main concern of management is keeping the grasses growing vigorously. Capability unit VIe-6; Woodward part in Loamy Prairie range site, Quinlan part in Shallow Prairie range site; Woodward part in pasture and hayland suitability group 8A, Quinlan part not assigned to a pasture and hayland suitability group; tree suitability group 7.

Yahola Series

The Yahola series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy and sandy sediment under a cover of hardwood forest and native grass.

In a representative profile the surface layer is 28 inches of reddish-brown fine sandy loam. The underlying material, to a depth of 60 inches, is red fine sandy loam and reddish-brown loamy fine sand.

Permeability is moderately rapid. Available water capacity is high.

Representative profile of Yahola fine sandy loam, 450 feet north and 300 feet west of the southeast corner of sec. 2, T. 12 N., R. 19 W.:

A1—0 to 28 inches, reddish-brown (2.5YR 4/4) fine sandy loam, dark reddish brown (2.5YR 3/4) when moist; weak, fine, granular structure; very friable; calcareous; moderately alkaline; clear, wavy boundary.

C1—28 to 44 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) when moist; single grained; very friable; thin bedding planes of darker, more clayey sediment; calcareous; moderately alkaline; abrupt, wavy boundary.

C2—44 to 60 inches, reddish-brown (2.5YR 5/4) loamy fine sand, reddish brown (2.5YR 4/4) when moist; single grained; loose; thin bedding planes of fine sandy loam; calcareous; moderately alkaline.

The A1 or Ap horizon is reddish brown, red, dark brown, or brown. The C horizon is red, reddish-brown, yellowish-red, or brown loamy fine sand or fine sandy loam below a depth of 40 inches.

Yf—Yahola fine sandy loam. This soil is nearly level and has slopes of 0 to 1 percent. It is subject to occasional flooding.

Included with this soil in mapping are areas of a soil that is similar to this Yahola soil but has a ground water table at a depth of 40 to 60 inches most of the year. This soil makes up about 8 percent of the mapped areas. Also included are areas of Clairemont soils that make up about 5 percent of the mapped areas.

Most of this soil is used for wheat, cotton, and alfalfa. Some areas are in other small grain, grain sorghum, tame pasture grasses, and native grasses.

The main concerns of management are occasional flooding and maintaining soil structure and fertility. Most of the crops produce large amounts of residue and can be grown continuously if the crop residue is returned to the soil and plant nutrients are supplied. Capability unit IIw-1; Loamy Bottomland range site; pasture and hayland suitability group 2A; tree suitability group 2.

Use and Management of the Soils

This section explains the system of capability classification used by the Soil Conservation Service and gives estimated yields of principal crops grown in the county. This section also contains information about management of the soils for range, trees, wildlife habitat, and engineering.

Crops[2]

Cultivated soils in this county need management practices that conserve moisture, control erosion, maintain soil fertility and structure, supply organic matter, and preserve good tilth. Some of the management practices commonly needed in the county are discussed in the following paragraphs. For suggested combinations of practices for specific soils, see "Descriptions of the Soils."

The information in this section can be used with that in the descriptions of the mapping units to help the farmer and rancher select appropriate practices for specific soils. Most good management practices accomplish more than one purpose and can be used on nearly all of the cropland in the county.

Minimum tillage—If soils are to be cropped, they must be tilled to prepare a seedbed, to control weeds, and to provide a suitable place for the growth of plant roots. Excessive tillage breaks down the soil structure and speeds up the decomposition of organic matter. The soils then tend to puddle and crust at the surface, and they take in less water and air. Therefore, less moisture is stored for plant growth.

Minimum tillage is accomplished by—

1. Reducing the number of operations in preparing the seedbed, planting, and cultivating.
2. Using herbicides instead of cultivation for weed control.
3. Using a long-term cropping system that includes perennial grasses or legumes.

Crop residue management.—Crop residue helps to maintain soil structure, to maintain soil fertility, and to control erosion when crop residue is left on the surface or worked partly into the surface. Crop residue supplies organic matter that improves soil structure and soil tilth, reduces the hazard of erosion, and helps to prevent crusting. Such soil-maintaining crops as wheat produce large amounts of residue. This residue needs the addition of fertilizer to maintain soil fertility.

The increase in crop yields in recent years indicates that effective measures for controlling erosion have been applied. Suitable practices that help to control erosion are growing a winter cover crop, stripcropping, using a cropping system that includes returning crop residue to the soil, stubble mulching, terracing, farming on the contour, grassing waterways, and applying plant nutrients. Practices for the control of insects and plant diseases are also needed.

Tame pasture.—Tame pasture is an important source of forage for the livestock industry. Tame pasture combined with supplemental pasture and native range provide year-round grazing for livestock.

Bermudagrass is better suited to the deep soils on flood plains, such as Yahola fine sandy loam, than to other soils. Weeping lovegrass is well suited to the deep fine sandy loams of the county.

Where grazing management is applied, production can be maintained and erosion can be controlled.

Capability grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farm. These readers can make good use of the capability

[2] M. D. GAMBLE, conservation agronomist, Soil Conservation Service, assisted in preparing this section.

classification system, a grouping that shows, in a general way, the suitability of soils for most kinds of farming.

The grouping is based on limitations of soils when used for field crops, the risk of damage when they are farmed, and the way the soils 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 horticultural crops or other crops that require 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 for range, for forest trees, or for engineering.

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

The broadest groups, capability classes, are designated by Roman numerals I through VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage when they are used. The soils in other classes have progressively greater natural limitations. In class VIII are landforms so rough and soils so shallow or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclass indicates major kinds of limitations within the classes. The subclasses are indicated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example IIe. The letter *e* indicates that the main limitation is the risk of erosion unless good management practices are used; *w* indicates that water in or on the soil interferes with plant growth or cultivation; *s* indicates that the soil is limited mainly because it is droughty, shallow, saline, or stony; and *c* indicates that the chief limitation is climate that is too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w, s* and *c,* because the soils are subject to little or no erosion but have other limitations that confine their use largely to pasture, range, or wildlife habitat.

Subclasses are further divided into groups called capability units. These are groups of soils that are so much alike that they are suited to the same crops and pasture plants. They require about the same management and generally have similar productivity and response to management. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or IIIs-1.

The eight classes in the capability system and the subclasses and units in Custer County are described in the list that follows. The unit designation for each soil is given in the "Guide to Mapping Units." Information about management needs of a particular soil are given in the section "Descriptions of the Soils."

Class I. Soils that have few limitations that restrict their use (no subclasses).
- Unit I-1. Deep, nearly level, well-drained fine sandy loams and silt loams that have a loamy subsoil; on flood plains.
- Unit I-2. Deep, nearly level, well-drained fine sandy loams and silt loams that have a loamy subsoil; on uplands. A few areas are very gently sloping.

Class II. Soils that have moderate limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe. Soils that are subject to moderate erosion unless protected.
  - Unit IIe-1. Deep and moderately deep, very gently sloping, well-drained silt loams and loams that have a loamy subsoil; on uplands.
  - Unit IIe-2. Deep, very gently sloping, well-drained fine sandy loams that have a loamy subsoil; on uplands.
- Subclass IIw. Soils that are moderately limited because of excess water.
  - Unit IIw-1. Deep, nearly level, well drained fine sandy loams and silt loams that have loamy underlying material; on flood plains. A few areas have sandy underlying material below a depth of 40 inches.
- Subclass IIc. Soils that are moderately limited because climate is too dry.
  - Unit IIc-1. Deep, nearly level, well-drained silt loams that have a loamy subsoil; on uplands.

Class III. Soils that have severe limitations that reduce the choice of plants require special conservation practices, or both.
- Subclass IIIe. Soils that are subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe-1. Deep and moderately deep, gently sloping, well-drained loams and silt loams that have a loamy subsoil; on uplands.
  - Unit IIIe-2. Deep, moderately deep and shallow, very gently sloping and gently sloping, well-drained fine sandy loams that have a loamy subsoil; on uplands.
  - Unit IIIe-3. Deep, very gently sloping and gently sloping, well-drained loamy fine sands that have a sandy subsoil; on uplands.
- Subclass IIIw. Soils that are severely limited because of excess water.
  - Unit IIIw-1. Deep, nearly level, somewhat poorly drained loamy fine sands that have sandy underlying material; on flood plains.
- Subclass IIIs. Soils that are severely limited because of salinity.
  - Unit IIIs-1. Deep, nearly level, well-drained silt loams that have loamy underlying material; on flood plains.

Class IV. Soils that have very severe limitations that reduce the choice of plants or require very careful management, or both.
- Subclass IVe. Soils that are subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe-1. Deep, moderately deep and shallow, gently sloping and sloping, well-drained very fine sandy loams, loams, and silt loams that have a loamy subsoil; on uplands.
  - Unit IVe-2. Deep, moderately deep and shallow, gently sloping and sloping, well-drained fine sandy loams have a loamy subsoil; on uplands.
  - Unit IVe-3. Deep, gently sloping and sloping, well-drained loamy fine sands that have a sandy subsoil; on uplands.

Class V. Soils that are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.
- Subclass Vw. Soils that are too wet for cultivation; drainage or protection is not feasible.
  - Unit Vw-1. Deep, nearly level, well-drained silt loams and loams that have loamy underlying material; on flood plains.
  - Unit Vw-2. Deep, nearly level, poorly drained fine sandy loams, sandy loams, loamy fine sands, and silt loams that have loamy and sandy underlying material; on flood plains.

Class VI. Soils that have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, or wildlife habitat.
- Subclass VIe. Soils that are severely limited, chiefly by risk of erosion, unless protective cover is maintained.
  - Unit VIe-1. Shallow, very gently sloping to moderately steep, somewhat excessively drained silt loams and silty clay loams that have a loamy subsoil; on uplands.
  - Unit VIe-2. Deep, strongly sloping and moderately

steep, well-drained very fine sandy loams that have a loamy subsoil; on uplands.

Unit VIe-3. Deep, strongly sloping, well-drained and excessively drained loamy fine sands and fine sands that have a sandy subsoil; on uplands.

Unit VIe-4. Deep, moderately deep and shallow, very gently sloping to strongly sloping, well-drained silt loams and loams that are severely eroded and have a loamy subsoil; on uplands.

Unit VIe-5. Deep and moderately deep, nearly level to strongly sloping, well-drained silt loams and loams that have a loamy subsoil; on uplands and flood plains.

Unit VIe-6. Moderately deep and shallow, sloping and strongly sloping, well-drained silt loams and loams that have a loamy subsoil; on uplands.

Unit VIe-7. Shallow, strongly sloping and moderately steep, well-drained very fine sandy loams and loams that have a loamy subsoil; on uplands.

Subclass VIs. Soils that are severely limited because of droughtiness.

Unit VIs-1. Very shallow, very gently sloping to strongly sloping, well-drained silt loams and loams underlain by gypsum; on uplands.

Subclass VIs. Soils that are severely limited because of droughtiness.

Unit VIs-1. Very shallow, very gently sloping to strongly sloping, well-drained silt loams and loams underlain by gypsum; on uplands.

Class VII. (None in Custer County). Soils that have very severe limitations that make them unsuited to cultivation and restrict their use largely to range or wildlife habitat.

Class VIII. (None in Custer County). Soils and landforms that have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

Predicted yields

Table 2 lists predicted yields of the principal crops

TABLE 2.—*Predicted average yields per acre of principal crops*

[Yields can be expected under a high level of management. Absence of data indicates that the crop is not suited to the soil or that it is commonly not grown on the soil]

Soil	Wheat (fall)	Grain sorghum	Cotton	Alfalfa (hay)	Improved bermudagrass
	Bu	*Bu*	*Lb of lint*	*Tons*	*AUM*[1]
Carey silt loam, 1 to 3 percent slopes	20	35	250	2.4	5.0
Carey silt loam, 3 to 5 percent slopes	20	30	200		4.5
Carey soils, 2 to 6 percent slopes, severely eroded					2.5
Clairemont silt loam	30	45	400	3.4	7.5
Clairemont silt loam, saline	20	30	300	2.2	8.0
Clairemont soils					8.0
Cordell soils and Rock outcrop, 2 to 15 percent slopes					
Cornick soils and Rock outcrop, 2 to 12 percent slopes					
Crisfield fine sandy loam	25	45	400	3.5	7.0
Dale silt loam	30	45	450	4.5	7.5
Devol fine sandy loam, 3 to 5 percent slopes (W)	20	30	250		5.0
Dill-Quinlan complex, 1 to 3 percent slopes	20	30	300		6.0
Dill-Quinlan complex, 3 to 5 percent slopes	15	25	250		5.0
Fluvents					6.0
Gracemore loamy fine sand	25	30	350	2.6	6.0
Grant loam, 1 to 3 percent slopes	25	40	350	2.6	6.0
Grant loam, 3 to 5 percent slopes	25	35	300		5.5
Hardeman fine sandy loam, 5 to 8 percent slopes (W)	15	20			4.5
Lucien soils and Rock outcrop, 8 to 20 percent slopes					
Minco very fine sandy loam, 5 to 8 percent slopes	20				5.5
Minco very fine sandy loam, 8 to 20 percent slopes					
Minco loam, 1 to 3 percent slopes	25	40	400	2.6	6.5
Minco loam, 3 to 5 percent slopes	25	35	350		6.0
Pond Creek fine sandy loam, 0 to 2 percent slopes	30	45	400	3.0	6.5
Pond Creek silt loam, 0 to 1 percent slopes	30	45	400	3.0	6.5
Pond Creek silt loam, 1 to 3 percent slopes	25	40	350	2.6	6.0
Pratt loamy fine sand, 1 to 4 percent slopes (W)	20	40	250	2.2	5.5
Pratt loamy fine sand, 4 to 8 percent slopes (W)	15	35			5.0
Pratt and Tivoli soils, 8 to 12 percent slopes (W)					3·5
Quinlan-Woodward complex, 3 to 5 percent slopes, eroded	15	25			
Quinlan-Woodward complex, 5 to 10 percent slopes, severely eroded					
Shellabarger fine sandy loam, 1 to 3 percent slopes (W)	25	40	400	2.6	6.5
Shellabarger fine sandy loam, 3 to 5 percent slopes (W)	25	35	350		6.0
St. Paul silt loam, 0 to 1 percent slopes	25	40	300	2.4	5.0
St. Paul silt loam, 1 to 3 percent slopes	20	35	250	2.2	5.0
St. Paul silt loam, 3 to 5 percent slopes	20	25	200		4.5
Woodward silt loam, 1 to 3 percent slopes	20	30	250		5.0
Woodward silt loam, 3 to 5 percent slopes	15	25	200		4.5
Woodward silt loam, 5 to 8 percent slopes	15	20			4.0
Woodward-Clairemont complex					5.5
Woodward-Quinlan complex, 3 to 5 percent slopes	15	20			4.0
Woodward-Quinlan complex, 5 to 12 percent slopes					3.5
Yahola fine sandy loam	25	45	400	3.2	7.5

[1] AUM stands for animal-unit-month, a term used to express the carrying capacity of pasture. It is the number of animal units carried per acre multiplied by the number of months a pasture can be grazed during a single grazing season without injury to the sod. An acre of pasture that provides 2 months of grazing for two cows has a carrying capacity of 4 animal-unit-months.

grown in the county. The predictions are based on estimates made by farmers, soil scientists, and others who have knowledge of yields in the county and on information taken from research data. The predicted yields are average yields per acre that can be expected by good commercial farmers at the level of management that tends to produce the highest economic returns.

Crops other than those shown in table 2 are grown in the county, but their predicted yields are not included, because their acreage is small or reliable data on yields are not available. Absence of a yield figure indicates the crop is not suited to the soil or is not commonly grown on it.

The predicted yields given in table 2 can be expected if the following management practices are used.

1. Rainfall is effectively used and conserved.
2. Crop residue is managed to maintain soil structure and soil tilth.
3. Minimum but timely tillage is used.
4. Insect, disease, and weed control measures are consistently used.
5. Plant nutrients are applied according to soil tests and crop needs.
6. Suited crop varieties are used at recommended seeding rates.

Pasture and Hayland[3]

This section provides general guidelines for managing soils for pasture and hay. Following this the soils are placed in six pasture and hayland suitability groups, and each group is described. The pasture and hayland suitability group of a specfic soil is given in the "Guide to Mapping Units" at the back of this survey, and detailed information about the management of the soils is given in the section "Descriptions of the Soils."

Pasture plants are grown on soils ranging in capability from Class I to Class VI, except on the shallow and very shallow soils. The chief, or basic, grasses are improved bermudagrass and weeping lovegrass. Improved varieties under good management produce more forage than common bermudagrass. Sudan and sorghum hybrids are used for temporary pasture in summer where perennial forage is in short supply. Fall-sown small grain such as wheat is used for fall, winter, and spring grazing (fig. 8).

Management and maintenance

Proper grazing helps to lengthen the life of most pastures. Applying moderate amounts of plant food that contains the needed elements provides for more vigorous plants and more palatable forage, which help to increase production and lengthen the lifespan of the pasture.

Pasture and hayland suitability groups

The soils in Custer County have been placed in pasture and hayland suitability groupings to assist farm-

[3] M. D. GAMBLE, conservation agronomist, Soil Conservation Service, helped to prepare this section.

Figure 8.—Cattle grazing wheat pasture in an area of Dale silt loam.

ers in selecting suitable forage plants for grazing livestock. These groups are described in the following pages. The soils of each group will grow similar pasture plants and require similar treatment and management. Forage production for one soil in the group is essentially the same as for other soils when management and treatment are the same for all soils.

Yields of pasture are given in table 2. Grazing data are estimated in terms of animal-unit months.

PASTURE AND HAYLAND SUITABILITY GROUP 2A

In this group are deep, well-drained soils that are loamy throughout. These soils are on flood plains. They are moderately permeable to moderately rapidly permeable. Unless protected, they are subject to flooding.

These soils are well suited to improved bermudagrass and improved weeping lovegrass.

PASTURE AND HAYLAND SUITABILITY GROUP 2B

In this group are deep, well-drained to poorly drained soils that are loamy or sandy throughout. These soils are on flood plains. They have a high water table most of the year and are subject to flooding. They are moderately permeable to moderately rapidly permeable above the water table.

These soils are suited to improved bermudagrass. Management includes controlling brush.

PASTURE AND HAYLAND SUITABILITY GROUP 3B

In this group are deep, somewhat poorly drained soils that are sandy throughout. These soils are on flood plains. They have a high water table most of the year and are subject to flooding. They are moderately rapidly permeable above the water table.

These soils are suited to improved bermudagrass and Karlow switchgrass. Management includes controlling brush.

PASTURE AND HAYLAND SUITABILITY GROUP 8A

In this group are deep and moderately deep, well-drained soils that are loamy throughout. These soils are on uplands. They are moderately permeable, moderately rapidly permeable, or moderately slowly permeable.

These soils are suited to improved bermudagrass and improved weeping lovegrass.

PASTURE AND HAYLAND SUITABILITY GROUP 8F

In this group are deep and moderately deep, well-drained soils that are loamy throughout. These soils are on uplands. They are severely eroded. Permeability is moderate.

These soils are better suited to improved weeping lovegrass than to most other uses.

PASTURE AND HAYLAND SUITABILITY GROUP 9B

In this group are deep, well-drained or excessively drained soils that are sandy throughout. These soils are on uplands. They are rapidly permeable.

These soils are better suited to improved weeping lovegrass than to most other uses.

Range[4]

This section contains information about the use of soils for range. Range consists of natural plant communities, mainly grasses, grasslike plants, forbs, and shrubs, that are sufficient in quantity and value to justify grazing use. About half of the soils in Custer County generally have sufficient native plant communities to provide yearlong range for livestock. During years of favorable moisture, forage sorghum and small grain pasture furnish supplemental range for livestock. During the dormant season of the range, protein feeds and hay are used as feed supplements.

Range sites and condition classes

Different kinds of soil vary in their capabilities to produce grass and other plants for grazing. Soils that produce about the same kinds and amounts of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of rangeland that differ in their ability to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation. Climax vegetation is the stabilized plant community; it reproduces itself and does not change as long as the environment remains unchanged. Throughout the prairie and the plains, the climax vegetation consists of the plants that were growing there when the region was first settled. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

Decreasers are plants in the climax or original plant community that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasers are plants in the climax plant community that increase in relative amount as the more desirable decreaser plants are reduced by close grazing. They are commonly shorter than decreasers and are generally less palatable to livestock.

Invaders are plants that cannot compete with plants in the climax plant community for moisture, nutrients, and light. Hence, invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in good condition if the percentage is 51 to 75; in fair condition if the percentage is 26 to 50; and in poor condition if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular range site. It expresses the

[4] ERNEST C. SNOOK and DAVID D. ANKLE, range conservationists, Soil Conservation Service, helped to prepare this section.

present kind and amount of vegetation in relation to the climax plant community for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

An important objective of good range management is to keep rangeland in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The problem is recognizing important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of the range sites

In the following pages, range sites of Custer County are described and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential annual yield of air-dry herbage for each site when it is in excellent condition. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey.

DEEP SAND RANGE SITE

This site consists of deep, very gently sloping to strongly sloping, sandy soils that have a sandy subsoil. The soils are on uplands.

If this site is in excellent condition (fig. 9), the approximate composition of the major plants is little bluestem, 25 percent; sand bluestem, 20 percent; indiangrass, 10 percent; switchgrass, 5 percent; other grasses, 20 percent; legumes, 5 percent; forbs, 5 percent; and shrubs 10 percent.

Continuous heavy grazing results in a decrease in such plants as sand bluestem, little bluestem, indiangrass, switchgrass, Illinois bundleflower, and sand lovegrass. Such plants as sand paspalum, tall dropseed, sand sagebrush, skunkbrush, Texas bluegrass, bigtop dalea, queens-delight, and sand plum then increase. If overgrazing is prolonged, sandbur, sand dropseed, red lovegrass, deer vetch, wild buckwheat, camphorweed, locust, and coralberry make up a substantial part of the annual production, and total production is greatly reduced.

Suitable range management practices include proper grazing, deferred grazing, planned grazing systems, range seeding, fencing, developing stockwater sources, and controlling brush and weeds.

On this site the total annual production of air-dry herbage is about 3,600 pounds per acre when growing conditions are favorable and about 1,800 pounds when growing conditions are unfavorable.

ERODED PRAIRIE RANGE SITE

This site consists of deep, moderately deep and shallow, very gently sloping to strongly sloping, severely eroded loamy soils that have a loamy subsoil. The soils are on uplands.

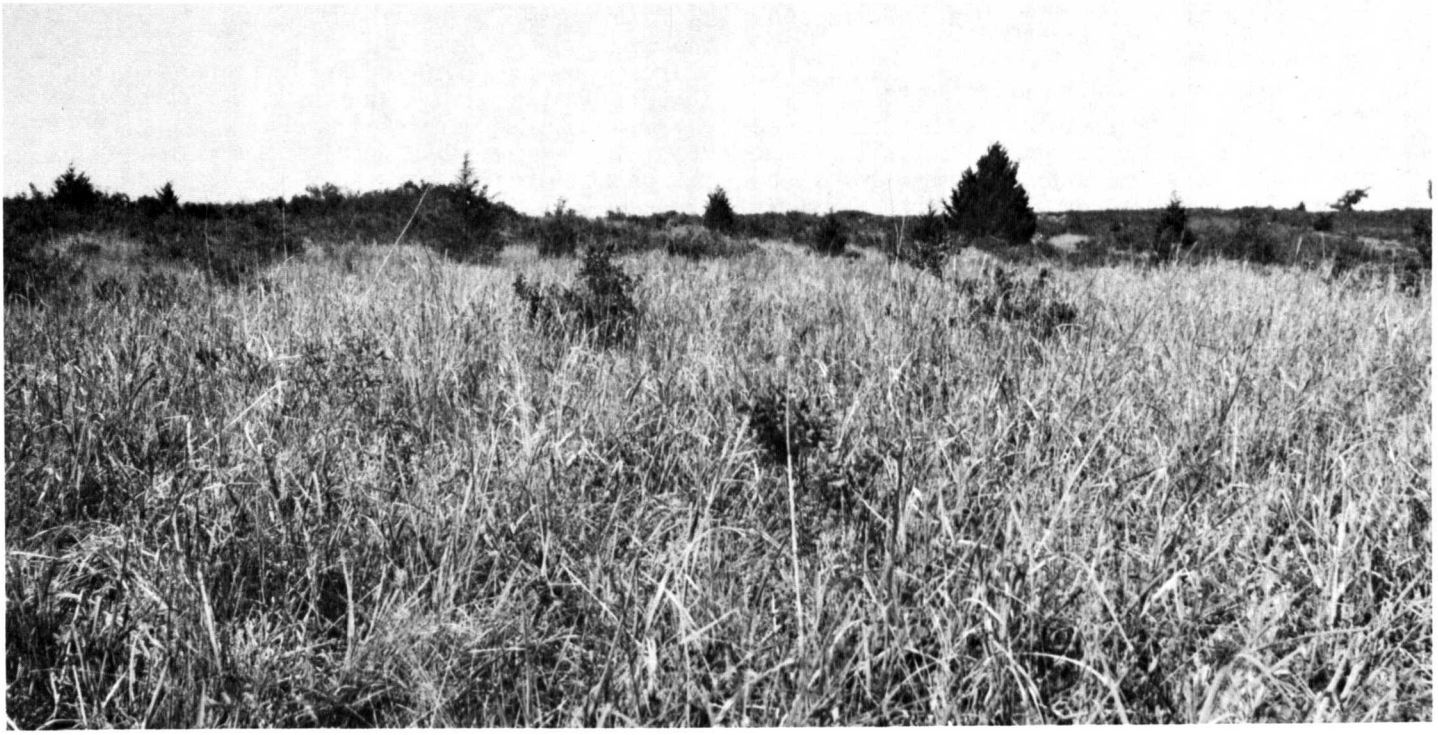

Figure 9.—**Deep Sand range site in an area of Pratt loamy fine sand, 1 to 4 percent slopes. This site is in excellent condition.**

If this site is in excellent condition, the approximate composition of the major plants is little bluestem, 35 percent; side-oats grama, 20 percent; sand bluestem, 15 percent; blue grama, 10 percent; buffalograss, 5 percent; other grasses, 10 percent; and forbs, 5 percent.

Continuous heavy grazing results in a decrease in such plants as little bluestem, side-oats grama, and sand bluestem. Such plants as tall dropseed, blue grama, dotted gayfeather, sumac, and sand plum then increase. If overgrazing is prolonged, silver bluestem, annual bromes, three-awns, showy partridgepea, common broomweed, ragweed, and yarrow make up a substantial part of the annual production, and total production is reduced.

Suitable range management practices include proper grazing, range seeding, deferred grazing, planned grazing systems, developing stockwater sources, fencing, and controlling brush and weeds.

On this site the total annual production of air-dry herbage is about 1,800 pounds per acre when growing conditions are favorable and about 800 when growing conditions are unfavorable.

GYP RANGE SITE

This site consists of very shallow, very gently sloping to strongly sloping, loamy soils that are underlain by gypsum. The soils are on uplands.

If this site is in excellent condition (fig. 10), the approximate composition of the major plants is little bluestem, 40 percent; side-oats grama, 20 percent; blue grama, 10 percent; sand dropseed, 5 percent; other grasses, 15 percent; and forbs, 10 percent.

Continuous heavy grazing results in a decrease in such plants as side-oats grama. Such plants as blue grama, sand dropseed, hairy grama, hairy goldaster, and hairy tridens then increase. If overgrazing is prolonged, sand dropseed and gypweed make up a substantial part of the annual production and total production is reduced.

Suitable range management practices include proper grazing, deferred grazing, planned grazing systems, fencing, stock-water development, range seeding, and controlling brush and weeds.

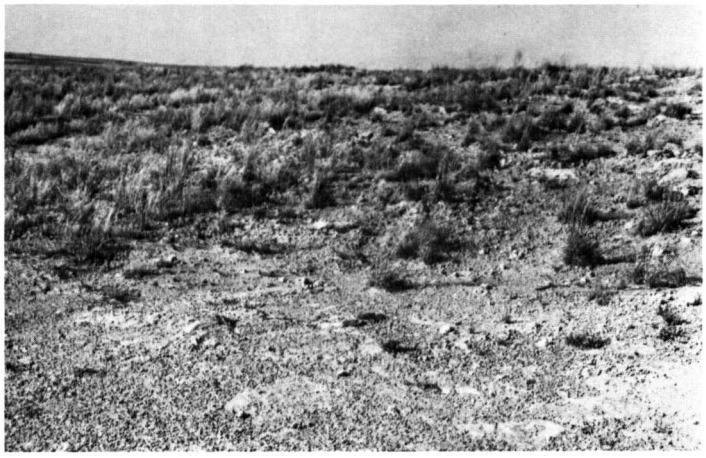

Figure 10.—Gyp range site in an area of Cornick soils and Rock outcrop, 2 to 12 percent slopes. This site is in excellent condition.

On this site the total annual production of air-dry herbage is about 1,800 pounds per acre when growing conditions are favorable and about 1,000 pounds when growing conditions are unfavorable.

LOAMY BOTTOMLAND RANGE SITE

This site consists of deep, nearly level, loamy soils that have a loamy subsoil. The soils are on flood plains.

If this site is in excellent condition, the approximate composition of the major plants is big bluestem, 25 percent; indiangrass, 15 percent; switchgrass, 15 percent; little bluestem, 10 percent; eastern gamagrass, 5 percent; tall dropseed, 5 percent; other grasses, 10 percent; forbs, 10 percent; and trees, 5 percent.

Continuous heavy grazing results in a decrease in such plants as big bluestem, indiangrass, switchgrass, eastern gamagrass, little bluestem, and compassplant. Such plants as beaked panicum, tall dropseed, heath aster, sedges, and woody plants such as elms, pecan black walnut, and greenbrier then increase. If overgrazing is prolonged, annual bromes, silver bluestem, three-awns, ragweeds, ironweed, and white snakeroot make up a substantial part of the annual production, and total production is greatly reduced.

Suitable range management practices include proper grazing, deferred grazing, planned grazing systems, stock-water development, cross fencing, fencing, controlling brush and weeds, and range seeding.

On this site the total annual production of air-dry herbage is about 7,000 pounds per acre when growing conditions are favorable and about 4,000 pounds when growing conditions are unfavorable.

LOAMY PRAIRIE RANGE SITE

This site consists of deep and moderately deep, nearly level to moderately steep, loamy soils that have a loamy subsoil. The soils are on uplands.

If this site is in excellent condition, the approximate composition of the major plants is little bluestem, 25 percent; big bluestem and sand bluestem, 20 percent; switchgrass, 10 percent; indiangrass, 10 percent; Canada wildrye, 5 percent; tall dropseed, 5 percent; side-oats grama, 5 percent, blue grama, 5 percent; legumes, 5 percent; forbs, 8 percent; and shrubs, 2 percent.

Continuous heavy grazing results in a decrease in such plants as little bluestem, big bluestem, sand bluestem, switchgrass, indiangrass, Canada wildrye, Virginia wildrye, and perennial lespedeza. Such plants as tall dropseed, side-oats grama, blue grama, dotted gayfeather, sumac, and sand plum then increase. If overgrazing is prolonged, silver bluestem, annual bromes, three-awns, showy partridgepea, common broomweed, ragweed, and yarrow make up a substantial part of the annual production, and total production is greatly reduced.

Suitable range management practices include proper grazing, deferred grazing, planned grazing systems, stock-water development, fencing, controlling brush and weeds, and range seeding.

On this site the total annual production of air-dry

herbage is about 4,200 pounds per acre when growing conditions are favorable and about 1,800 pounds when growing conditions are unfavorable.

RED SHALE RANGE SITE

This site consists of shallow, very gently sloping to moderately steep, loamy soils that have a loamy subsoil. The soils are on uplands.

If this site is in excellent condition, the approximate composition of the major plants is side-oats grama, 25 percent; little bluestem, 20 percent; hairy grama, 15 percent; blue grama, 15 percent; buffalograss, 5 percent; other grasses, 5 percent; legumes, 5 percent; forbs, 5 percent; and shrubs, 5 percent.

Continuous heavy grazing results in a decrease in such plants as side-oats grama, little bluestem, wild alfalfa, and prairie clovers. Such plants as hairy grama, blue grama, buffalograss, and skunkbush then increase. If overgrazing is prolonged, three-awns, ragweeds, silver bluestem, and hairy tridens make up a substantial part of the annual production, and total production is reduced.

Suitable range management practices include proper grazing, deferred grazing, planned grazing systems, stock-water development, fencing, controlling weeds, and range seeding.

On this site the total annual production of air-dry herbage is about 1,300 pounds per acre when growing conditions are favorable and about 600 pounds when growing conditions are unfavorable.

SANDY PRAIRIE RANGE SITE

This site consists of deep and moderately deep, nearly level to sloping, loamy soils that have a loamy subsoil. The soils are on uplands.

If this site is in excellent condition, the approximate composition of the major plants is little bluestem, 30 percent; sand bluestem, 15 percent; indiangrass, 10 percent; Canada wildrye, 5 percent; Scribner panicum, 5 percent; side-oats grama, 5 percent; blue grama, 5 percent; other grasses, 10 percent; legumes, 5 percent; forbs, 5 percent; and trees, 5 percent.

Continuous heavy grazing results in a decrease in such plants as little bluestem, sand bluestem, Canada wildrye, indiangrass, prairie clovers, and halfshrub sundrop. Such plants as Scribner panicum, sand paspalum, side-oats grama, yucca, sumac, skunkbush, and coralberry then increase. If overgrazing is prolonged, sand dropseed, stinkgrass, windmillgrass, sandbur, croton, nightshades, oak, and western soapberry make up a substantial part of the annual production, and total production is greatly reduced.

Suitable range management practices include proper grazing, deferred grazing, planned grazing systems, stock-water development, fencing, controlling brush and weeds, and range seeding.

On this site the total annual production of air-dry herbage is about 4,000 pounds per acre when growing conditions are favorable and about 2,000 pounds when growing conditions are unfavorable.

Figure 11.—**Shallow Prairie range site in an area of Lucien soils and Rock outcrop, 8 to 20 percent slopes. This site is in excellent condition.**

SHALLOW PRAIRIE RANGE SITE

This site consists of shallow, very gently sloping to moderately steep, loamy soils that have a loamy subsoil. The soils are on uplands.

If this site is in excellent condition (fig. 11), the approximate composition of the major plants is little bluestem, 30 percent; switchgrass, 10 percent; big bluestem and sand bluestem, 15 percent; indiangrass, 10 percent; tall dropseed, 5 percent; side-oats grama, 5 percent; Scribner panicum, 5 percent; other grasses, 5 percent; legumes, 5 percent; forbs, 5 percent; and shrubs, 5 percent.

Continuous heavy grazing results in a decrease in such plants as little bluestem, big bluestem, sand bluestem, indiangrass, switchgrass, and perennial sunflowers. Such plants as side-oats grama, hairy grama, Scribner panicum, tall dropseed, dotted gayfeather, sumacs, coralberry, and blackberry then increase. If overgrazing is prolonged, three-awns, ragweeds, common yarrow, bitter sneezeweed, and persimmon make up a substantial part of the annual production, and total production is reduced.

Suitable range management practices include proper grazing, planned grazing systems, stock-water development, range seeding, and controlling brush and weeds.

On this site the total annual production of air-dry herbage is about 2,500 pounds per acre when growing conditions are favorable and about 1,300 pounds when growing conditions are unfavorable.

SUBIRRIGATED RANGE SITE

This site consists of deep, nearly level, loamy and sandy soils that are underlain by loamy or sandy sediment. The soils are on flood plains and have a high water table. Saline soils occur in some areas.

If this site is in excellent condition, the approximate composition of the major plants is switchgrass, 25 percent; sand bluestem, 20 percent; indiangrass, 10 percent; Canada wildrye, 5 percent; Scribner panicum, 5 percent; other grasses, 25 percent; forbs, 5 percent; and trees, 5 percent.

Continuous heavy grazing results in a decrease in such plants as switchgrass, sand bluestem, indiangrass, eastern gamagrass, wildrye, common reedgrass, and Maximillan sunflower. Such plants as alkali sacaton, inland saltgrass, tall dropseed, silver bluestem, cottonwood, and willow then increase. If overgrazing is prolonged, johnsongrass, annual bromes, tall dropseed, inland saltgrass, silver bluestem, ragweeds, and ironweeds make up a substantial part of the annual production, and total production is greatly reduced.

Suitable range management practices include proper grazing, deferred grazing, planned grazing systems, range seeding, stock-water development, controlling brush and weeds, and cross fencing.

On this site the total annual production of air-dry herbage is about 9,000 pounds per acre when growing conditions are favorable and about 6,000 pounds when growing conditions are unfavorable.

Tree Plantings[5]

This section gives information on the suitability of the soils of Custer County for tree plantings. Natural stands occur mostly on narrow banks along the rivers and their tributaries. Some of the trees and shrubs native to this county are American elm, American plum, black locust, blackjack oak, black walnut, black willow, bur oak, eastern cottonwood, eastern redcedar, green ash, hackberry, honeylocust, pecan, post oak, sandbar willow, Shumard oak, tamarisk, and white mulberry. Some of the trees and shrubs preferred for planting are introduced from other areas.

Except for their uses in watershed areas, as wildlife habitat, and in esthetic landscapes, natural stands have only limited commercial value. Early settlers planted trees for protection, shade, and fence-posts. Through the years, landowners continued to plant trees to protect their buildings, livestock, and soil. Farmstead windbreaks, if properly designed and located, can help to control drifting snow and to keep snow out of farmyards. Field windbreaks are effective in helping to control soil blowing on cropland, especially on sandy soils.

Belts of trees and shrubs are useful in screening unsightly areas. Properly planned trees and shrubs screen and reduce noise.

Preparation and planting

Preparation for tree planting can be the same as for ordinary field crops on most soils. Many of the species used are native to the county, but they are not growing naturally on many soils where trees are needed. In soils that are not sandy, the soil can be prepared far enough in advance so that it will have time to settle. Alfalfa and grass sod should be summer fallowed at least 1 year before planting, and cropland should be fall plowed. Sandy soils can be planted without any advance preparation, or a cover can be planted. Cover crops protect the sod before and after planting and protect the young seedlings.

Trees and shrubs should be planted late in winter or early in spring. The seedlings should be protected from drying out while being planted, and the soil should be packed so that it is firm around the roots.

Young trees need special care. Weeds need to be controlled, and trees should be protected from livestock and fire. Additional information on design and treatment of tree plantings is available from the Soil Conservation Service, State Forester, and Extension Service.

Descriptions of tree suitability groups

The soils of Custer County that have similar characteristics affecting tree growth have been placed in tree suitability groups. Tree suitability groups and the names of trees and shrubs that are suitable for plant-

[5] NORMAN E. SMOLA, forester, Soil Conservation Service, helped to prepare this section.

ing in each group are listed in the following paragraphs. For the tree suitability group of a specific soil, refer to the "Guide to Mapping Units."

TREE SUITABILITY GROUP 1

This group consists mainly of deep, poorly drained or somewhat poorly drained soils that have a high water table most of the year and are on flood plains. A few well-drained soils are included. The texture of the surface layer is moderately coarse, medium, or coarse, and that of the subsurface layer is moderately fine, medium, moderately coarse, or coarse. These soils are nearly level.

The soils in this group are suited to trees and shrubs that tolerate wetness and flooding. Among trees and shrubs suitable for planting are American plum, black locust, bur oak, eastern cottonwood, eastern redcedar, green ash, hackberry, loblolly pine, northern catalpa, Osage-orange, sandbar willow, and sycamore. Estimated height of eastern cottonwood at 20 years of age is 75 feet.

TREE SUITABILITY GROUP 2

This group consists mainly of deep, well-drained soils that are moderately coarse textured throughout and occur on flood plains. These soils are nearly level.

The soils in this group are suited to trees and shrubs that tolerate flooding. Among trees and shrubs suitable for planting are American plum, Austrian pine, autumn-olive, black locust, eastern cottonwood, eastern redcedar, honeylocust, loblolly pine, northern catalpa, oriental arborvitae, Osage-orange, ponderosa pine, Scotch pine, short-leaf pine, and sycamore. Estimated height of eastern cottonwood at 20 years of age is 55 feet and of eastern redcedar is 25 feet.

TREE SUITABILITY GROUP 3

This group consists mainly of deep, well-drained soils that have a medium-textured surface layer and a medium-textured or moderately fine textured subsoil. These soils are on flood plains. They are nearly level.

The soils in this group are suited to trees and shrubs that tolerate flooding. Among trees and shrubs suitable for planting are American plum, Austrian pine, autumn-olive, black locust, bur oak, black walnut, eastern cottonwood, eastern redcedar, green ash, hackberry, honeylocust, loblolly pine, northern catalpa, oriental arborvitae, Osage-orange, pecan, ponderosa pine, Scotch pine, shortleaf pine, and sycamore. Estimated height of eastern cottonwood at 20 years of age is 65 feet and of green ash is 45 feet.

TREE SUITABILITY GROUP 4

This group consists of typically deep, well-drained soils that are coarse-textured throughout. These soils are on uplands. They are very gently sloping to strongly sloping. A few excessively drained soils are included.

The soils in this group are suited to trees and shrubs if blowing is prevented by maintaining strips of plant cover between tree rows. Cultivation should be restricted to the tree rows. Among trees and shrubs suitable for planting are American plum, eastern redcedar, Osage-orange, oriental arborvitae, ponderosa pine, and Scotch pine. Estimated height of eastern redcedar at 20 years of age is 18 feet.

TREE SUITABILITY GROUP 5

This group consists mainly of deep or moderately deep, well-drained soils that are moderately coarse textured throughout. These soils are on uplands. They are very gently sloping to sloping. Shallow soils occur in some areas.

The soils in this group are suited to trees and shrubs if weeds and grasses are controlled. Among trees and shrubs suitable for planting are American plum, Austrian pine, autumn-olive, black locust, eastern cottonwood, eastern redcedar, loblolly pine, northern catalpa, oriental arborvitae, Osage-orange, ponderosa pine, Scotch pine, and shortleaf pine. Estimated height of eastern cottonwood at 20 years of age is 45 feet and of eastern redcedar is 20 feet.

TREE SUITABILITY GROUP 6

This group consists mainly of deep or moderately deep, well-drained soils that have a medium-textured surface layer and a medium-textured or moderately fine textured subsoil. These soils are on uplands. They are nearly level to moderately steep. Also in this group are some areas of soils that have a moderately coarse textured surface layer and small areas of soils on flood plains.

The soils in this group are suited to trees and shrubs if weeds and grasses are controlled. Among trees and shrubs suitable for planting are American plum, Austrian pine, autumn-olive, black locust, bur oak, eastern cottonwood, eastern redcedar, hackberry, honeylocust, loblolly pine, northern catalpa, oriental arborvitae, Osage-orange, ponderosa pine, Scotch pine, and shortleaf pine. Estimated height of eastern cottonwood at 20 years of age is 55 feet and of eastern redcedar is 25 feet.

TREE SUITABILITY GROUP 7

This group consists mainly of shallow or very shallow, well-drained or somewhat excessively drained soils that are medium-textured or moderately fine textured throughout. These soils are on uplands. They are very gently sloping to moderately steep. Some moderately deep soils are included.

The soils in this group are suited to a few trees. Trees planted on these soils suffer from a shortage of moisture. Among trees suitable for planting are black locust, eastern redcedar, one-seed juniper, and Osage-orange. Estimated height of eastern redcedar at 20 years of age is 13 feet.

TREE SUITABILITY GROUP 8

This group consists mainly of deep, moderately deep, or shallow, severely eroded, well-drained soils that have a medium-textured surface layer and a medium-textured or moderately fine textured subsoil. These soils are on uplands. They are very gently sloping to strongly sloping.

The soils in this group are suited to a few species of trees. Planting trees and shrubs on these soils is not recommended, however, because of the severe hazard of erosion.

Wildlife Habitat[6]

This section gives information on the suitability of the soils of Custer County for wildlife habitat. Soil directly influences the kind and amount of vegetation and the amount of water available, and in this way influences the kind of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are (1) thickness of soil useful to crops, (2) surface texture, (3) available water capacity, (4) wetness, (5) flood hazard, (6) slope, and (7) permeability of the soil to air and water.

In table 3 soils of this survey area are rated for producing six elements of wildlife habitat and for three groups, or kinds, of wildlife.

The ratings indicate relative suitability for various elements. A rating of *good* means that the elements of wildlife habitat and kinds of habitat generally are easily created, improved, and maintained. Few or no limitations affect management in this category, and satisfactory results are expected when the soil is used for the prescribed purposes. A rating of *fair* means the elements of wildlife habitat and kinds of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention may be required for satisfactory results.

A rating of *poor* means that the limitations for the designated use are severe. Habitats can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that use of the soil for elements of wildlife habitat are very severe and that unsatisfactory results are to be expected. It is impractical to create, improve or maintain habitats on soils in this category. The ratings take into account mainly the characteristics of the soils and closely related natural factors of the environment. They do not take into account climate, present use of soils, or present distribution of wildlife and people. For this reason selection of a site for development as a habitat for wildlife requires inspection at the site.

Grain and seed crops are annual grain-producing plants, such as wheat, sorghum, millet, and soybeans.

Domestic grasses and legumes are domestic grasses and legumes that are established by planting. They provide food and cover for wildlife. Grasses include bermudagrass and weeping lovegrass. Legumes include alfalfa, clovers, peas, and lespedezas.

Wild herbaceous plants consist of native grasses, forbs, legumes, and weeds that provide food and cover for wildlife. Grasses include bluestem, switchgrass, other panicums, foxtail, wildryes, wild buckwheats, and annual bromes. Legumes include lespedezas, wild beans, Illinois bundleflower, tickclovers, and scurfpeas. Forbs and weeds include croton, sunflower, ragweed, pigweed, pokeweed, nightshades, Queens-delight, blacksamson, and prickly poppy.

Shrubs consist of shrubs, conifer plants, and woody vines that provide wildlife food in the form of fruits, nuts, buds, catkins, or browse. Such plants commonly grow in their natural environment, but they may be

[6] JEROME F. SYKORA, biologist, Soil Conservation Service, helped to prepare this section.

TABLE 3.—*Suitability for elements of wildlife habitat and kinds of wildlife*

Soil series and map symbol	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland	Wetland	Rangeland
Carey: CaB, CaC, CbC3	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Very poor.	Fair.
Clairemont:									
Cc	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.
Ce	Fair	Good	Poor	Good	Very poor.	Very poor.	Fair	Very poor.	Fair.
Cf	Poor	Fair	Fair	Good	Very poor.	Very poor.	Fair	Very poor.	Fair.
Cordell: CoE Rock outcrop part not rated.	Poor	Fair	Fair	Poor	Very poor.	Very poor.	Fair	Very poor.	Poor.
Cornick: CrE Rock outcrop part not rated.	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
Crisfield: Cs	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.
Dale: Da	Good	Good	Fair	Good	Poor	Very poor.	Good	Very poor.	Fair.

TABLE 3.—*Suitability for elements of wildlife habitat and kinds of wildlife*—Continued

Soil series and map symbol	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Open-land	Wetland	Range-land
Devol: DeC	Good	Good	Good	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Dill: DfB, DfC For Quinlan parts, see Quinlan series.	Fair	Good	Good	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Fluvents: Ff	Poor	Fair	Fair	Fair	Good	Good	Fair	Fair	Fair.
Gracemore: Gm	Fair	Fair	Good	Fair	Fair	Poor	Fair	Poor	Fair.
Grant: GrB, GrC	Good	Good	Good	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Hardeman: HaD	Good	Good	Good	Good	Very poor.	Very poor.	Good	Very poor.	Good.
Lucien: LrE Rock outcrop part not rated.	Poor	Fair	Fair	Fair	Poor	Very poor.	Fair	Very poor.	Fair.
Minco:									
McD	Fair	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.
McE	Fair	Good	Good	Fair	Very poor.	Very poor.	Good	Very poor.	Fair.
MdB, MdC	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.
Pond Creek: PcA, PkA, PkB	Good	Good	Fair	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Pratt:									
PrB, PrC	Fair	Fair	Good	Fair	Poor	Very poor.	Fair	Very poor.	Fair.
PtE For Tivoli part, see Tivoli series.	Fair	Fair	Good	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
Quinlan: QwC2, QwE3 For Woodward parts, see Woodward series.	Poor	Poor	Fair	Poor	Poor	Very poor.	Poor	Very poor.	Poor.
Shellabarger: ShB, ShC	Good	Good	Good	Fair	Poor	Very poor.	Good	Very poor.	Fair.
St. Paul: StA, StB, StC	Good	Good	Fair	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Tivoli Mapped only with Pratt soils.	Poor	Poor	Fair	Poor	Very poor.	Very poor.	Poor	Very poor.	Poor.
Woodward:									
WoB, WoC, WoD, WwC For Quinlan part of WwC, see Quinlan series.	Fair	Good	Good	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Wt, WwE For Clairemont part of Wt and Quinlan part of WwE, see their respective series.	Fair	Good	Good	Fair	Very poor.	Very poor.	Good	Very poor.	Fair.
Yahola: Yf	Good	Good	Good	Good	Poor	Very. poor.	Good	Very poor.	Good.

planted. Typical species in this category are American plum, chittomwood, skunkbush, sumac, greenbrier, roughleaf dogwood, poison-ivy, and redcedar.

Wetland plants are herbaceous plants that grow wild on moist and wet sites. They furnish food and cover mostly for wetland wildlife. Typical examples of plants are smartweed, wild millet, rushes, barnyardgrass, and sedges.

Shallow-water areas are impoundments or excavations for controlling water, generally not more than 5 feet deep, to create habitats that are suitable for waterfowl. Some are designed to be drained, planted, and then flooded; others are permanent impoundments that grow submerged aquatics.

Open-land wildlife consists of birds and mammals that normally live in meadows, pastures, and open areas where grasses, herbs, and shrubby plants grow. Quail, doves, meadowlarks, field sparrows, rabbits, and foxes are examples of open-land wildlife.

Wetland wildlife consists of birds and mammals that normally live in wet areas, marshes, and swamps. Ducks, geese, rails, shore birds, herons, minks, beaver, and muskrats are examples of wetland wildlife.

Rangeland wildlife consists of birds and mammals of natural rangelands. Examples are antelope, whitetail deer, prairie chicken, chukar, quail, meadowlark, dove, turkey, and squirrel, which are present along the timbered drainageways.

Recreational Development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 4 the soils are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails.

In table 4 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable, and limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intensive maintenance, or a combination of these is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

TABLE 4.—*Soil ratings for recreational development*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Soil series and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Carey: CaB, CaC, CbC3	Slight	Slight	Moderate: slope	Slight.
Clairemont:				
Cc, Ce	Severe: floods	Moderate: floods	Severe: floods	Slight.
Cf	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
Cordell: CoE Rock outcrop part too variable to rate.	Moderate: percs slowly.	Moderate: too clayey	Severe: depth to rock	Moderate: too clayey.
Cornick: CrE Rock outcrop part too variable to rate.	Severe: rock outcrop	Moderate: dusty	Severe: depth to rock	Moderate: dusty.
Crisfield: Cs	Slight	Slight	Slight	Slight.
Dale: Da	Slight	Slight	Slight	Slight.
Devol: DeC	Slight	Slight	Moderate: slope	Slight.
*Dill: DfB, DfC For Quinlan part of DfB, see Quinlan series.	Slight	Slight	Moderate: slope	Slight.
Fluvents: Ff	Severe: floods	Severe: floods, wet	Severe: floods, wet	Severe: floods, wet.
Gracemore: Gm	Severe: floods	Moderate: floods, wet	Moderate: floods, wet	Moderate: floods, wet.
Grant: GrB, GrC	Slight	Slight	Moderate: slope	Slight.
Hardeman: HaD	Slight	Slight	Severe: slope	Slight.
Lucien: LrE Rock outcrop part too variable to rate.	Moderate: slope	Moderate: slope	Severe: depth to rock	Slight.

TABLE 4.—*Soil ratings for recreational development*—Continued

Soil series and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Minco:				
McD	Slight	Slight	Severe: slope	Slight.
McE	Moderate: slope	Moderate: slope	Severe: slope	Slight.
MdB, MdC	Slight	Slight	Moderate: slope	Slight.
Pond Creek: PcA, PkA, PkB	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
*Pratt				
PrB, PrC	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy, slope.	Moderate: too sandy.
PtE	Moderate: too sandy	Moderate: too sandy	Severe: slope	Moderate: too sandy.
For Tivoli part, see Tivoli series.				
*Quinlan:				
QwC2	Slight	Slight	Severe: depth to rock	Slight.
For Woodward part, see Woodward series.				
QwE3	Moderate: slope	Moderate: slope	Severe: depth to rock, slope.	Slight.
For Woodward part, see Woodward series.				
Shellabarger: ShB, ShC	Slight	Slight	Moderate: slope	Slight.
St. Paul:				
StA	Slight	Slight	Slight	Slight.
StB, StC	Slight	Slight	Moderate: slope	Slight.
Tivoli	Severe: too sandy, dusty.	Severe: too sandy, dusty.	Severe: too sandy, dusty.	Severe: too sandy, dusty.
Mapped only with Pratt soils.				
*Woodward:				
WoB, WoC, WwC	Slight	Slight	Moderate	Slight.
For Quinlan part of WwC and WwE, see Quinlan series.				
WoD	Slight	Slight	Severe: slope	Slight.
Wt, WwE	Moderate: slope	Moderate: slope	Severe: slope	Slight.
For Clairemont part of Wt, see Clairemont series.				
Yahola: Yf	Severe: floods	Moderate: floods	Moderate: floods	Slight.

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stoniness that greatly increases cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross country travel by foot or horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Engineering Uses of the Soils[7]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

[7] WILLIAM E. HARDESTY, civil engineer, Soil Conservation Service, helped to prepare this section.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5, 6, and 7, which show, respectively, several estimated soil properties significant to engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 5, 6, and 7, and it also can be used to make other useful maps.

This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have a different meaning in soil science than in engineering. The Glossary defines many of these terms as they commonly are used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system,[8] used by the SCS engineers, Department of Defense, and others, and the AASHTO system, adopted by the American Association of State Highway and Transportation Officials.[9]

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 7; the estimated classification, without group index numbers, is given in table 5 for all soils mapped in the survey area.

Soil properties significant to engineering

Several estimated soil properties significant in engineering are given in table 5. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 5.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Depth to seasonal high water table is distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 5 in the standard terms used by the United States Department of Agriculture (USDA). These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand."

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semi-solid to a plastic state. If the moisture content is further increased, the material changes from a plas-

[8] United States Department of Defense. Unified soil classification system for roads, airfields, embankments and foundations. MIL-STD-619B, 30 pp., illus., 1968.

[9] American Association of State Highway [and Transportation] Officials. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus., 1970.

TABLE 5.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. the instructions for referring to other series that appear in the first column

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	In	*In*	*In*			
Carey: CaB, CaC, CbC3	40–>70	>72	0–11	Silt loam, loam	ML, CL–ML	A–4
			11–25	Silt loam, silty clay loam	CL, ML, CL–ML	A–4, A–6
			25–42	Loam, silt loam	ML, CL–ML	A–4
			42	Sandstone (rippable), loamy sediment.		
Clairemont:						
Cc, Cf	>60	>72	0–11	Silt loam	CL–ML, CL	A–4, A–6
			11–72	Silt loam, loam	CL–ML, CL	A–4, A–6
Ce[1]	>60	20–50	0–15	Silt loam	CL–ML, CL	A–4, A–6
			15–60	Silt loam, loam	CL–ML, CL	A–4, A–6
Cordell: CoE	10–20	>72	0–7	Silt loam, silty clay loam	CL	A–4, A–6
Rock outcrop part not rated.			7–11	Very shaly silt loam, very shaly silty clay loam, shaly silt loam, shaly silty clay loam, silt loam, silty clay loam.	CL, SC, GC, GM–GC, CL–ML, SP, GC–GP, SM–SC	A–2, A–4, A–1, A–6
			11	Siltstone (hard).		
Cornick: CrE	5–10	>72	0–7	Silt loam, loam	CL, ML, CL–ML	A–4, A–6
Rock outcrop part not rated.			7	Gypsum (rippable).		
Crisfield: Cs	>60	>72	0–72	Fine sandy loam	SM, CL–ML, ML, SM–SC	A–4
Dale: Da	>60	>72	0–66	Silt loam	CL, ML	A–4, A–6
Devol: DeC	>60	>72	0–40	Fine sandy loam	SM, ML, SM–SC, CL–ML	A–4
			40–60	Loamy fine sand, fine sand, fine sandy loam.	SM	A–2, A–4
*Dill: DfB, DfC	20–40	>72	0–32	Fine sandy loam	SM, ML, CL–ML, SC–SM	A–4
For Quinlan part, see Quinlan series.			32	Sandstone (rippable).		
Fluvents: Ff	>60	12–36	0–60	Fine sandy loam, sandy loam, loamy fine sand, silt loam.	SM, ML, SC, CL, CL–ML, SM–SC	A–2, A–4
Gracemore: Gm	>60	20–40	0–12	Loamy fine sand	SM	A–2
			12–72	Fine sand, loamy fine sand	SM, SP–SM	A–2, A–3
Grant: GrB, GrC	40–72	>72	0–16	Loam	ML, CL, CL–ML	A–4
			16–36	Loam, clay loam	CL, ML	A–6, A–4
			36–48	Loam	CL, ML	A–4, A–6
			48	Sandstone (rippable), loamy sediment.		
Hardeman: HaD	>60	>72	0–60	Fine sandy loam	SM, ML, SM–SC, CL–ML	A–4
Lucien: LrE	10–20	>72	0–15	Very fine sandy loam, loam	CL, ML	A–4
Rock outcrop part not rated.			15	Sandstone (rippable).		
Minco: McD, McE, MdB, MdC	>60	>72	0–60	Very fine sandy loam, loam	ML, CL, CL–ML	A–4
Pond Creek: PcA, PkA, PkB	>60	>72	0–11	Silt loam, fine sandy loam	ML, CL, SM, SC, CL–ML, SM–SC	A–4, A–6
			11–72	Silty clay loam, clay loam, silt loam, loam.	CL, ML	A–4, A–6, A–7

significant to engineering

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully of this table. The symbol < means less than; the symbol > means more than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*			
	100	96–100	60–90	20–30	3–7	0.6–2.0	0.16–0.20	6.6–7.8	Low	Low	Low.
	100	96–100	80–95	25–40	5–15	0.6–2.0	0.16–0.20	6.6–8.4	Low	Moderate	Low.
	100	96–100	75–85	20–30	3–7	0.6–2.0	0.15–0.19	7.9–8.4	Low	Low	Low.
	100	96–100	85–95	25–37	7–13	0.6–2.0	0.16–0.20	7.9–8.4	Low	Low	Low.
	100	96–100	85–95	25–40	7–20	0.6–2.0	0.16–0.20	7.9–8.4	Low	Moderate	Low.
	100	96–100	85–95	25–37	7–13	0.6–2.0	0.11–0.14	7.9–8.4	Low	Very high	Moderate.
	100	96–100	85–95	25–40	7–20	0.6–2.0	0.11–0.14	7.9–8.4	Moderate	Very high	Moderate.
90–100	83–100	80–95	65–90	20–40	8–20	0.2–0.6	0.16–0.20	7.9–8.4	Moderate	Low	Low.
15–100	5–100	5–95	5–90	20–40	5–20	0.2–0.6	0.08–0.20	7.9–8.4	Moderate	Low	Low.
	100	90–100	70–90	22–37	2–14	0.6–2.0	0.18–0.22	7.9–8.4	Low	High	Moderate.
	100	85–95	40–55	15–25	1–5	2.0–6.0	0.15–0.17	6.6–8.4	Low	Low	Low.
	100	96–100	80–95	30–37	8–13	0.6–2.0	0.18–0.22	6.6–8.4	Low	Moderate	Low.
98–100	98–100	70–100	36–60	<26	[2]NP–6	2.0–6.0	0.11–0.15	6.6–8.4	Low	Low	Low.
98–100	98–100	50–100	15–50	<26	NP–3	2.0–6.0	0.08–0.12	7.4–8.4	Low	Low	Low.
98–100	95–100	90–100	36–60	<26	NP–6	2.0–6.0	0.11–0.15	6.6–7.8	Low	Low	Low.
100	98–100	90–100	15–80	<30	NP–10	2.0–6.0	0.08–0.16	7.9–8.4	Low	High	Low.
100	98–100	90–100	15–35	NP	NP	2.0–6.0	0.07–0.11	7.9–8.4	Low	Low	Low.
100	98–100	82–100	5–35	NP	NP	2.0–6.0	0.05–0.11	7.9–8.4	Low	Low	Low.
	100	90–100	70–90	20–30	1–10	0.6–2.0	0.15–0.19	6.1–7.3	Low	Low	Low.
	100	90–100	70–90	30–40	8–18	0.6–2.0	0.15–0.19	6.6–7.8	Moderate	Low	Low.
	100	90–100	65–85	30–37	8–14	0.6–2.0	0.15–0.19	6.6–7.8	Low	Low	Low.
100	90–100	70–100	40–60	<30	NP–7	2.0–6.0	0.11–0.15	7.4–8.4	Low	Low	Low.
98–100	95–100	94–100	51–85	<30	NP–10	2.0–6.0	0.15–0.19	6.1–7.3	Low	Low	Low.
100	98–100	94–100	51–85	<30	NP–10	0.6–2.0	0.15–0.19	6.1–8.4	Low	Low	Low.
100	98–100	94–100	36–97	<37	NP–14	0.6–6.0	0.14–0.18	6.1–7.3	Low	Low	Low.
	100	96–100	65–98	30–43	8–10	0.2–0.6	0.16–0.20	6.1–8.4	Moderate	Moderate	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	In	*In*	*In*			
*Pratt: PrB, PrC, PtE. For Tivoli part of PtE, see Tivoli series.	>60	>72	0–11	Loamy fine sand, fine sand	SM, SP–SM	A–2, A–3
			11–60	Loamy fine sand	SM	A–2
*Quinlan: QwC2, QwE3. For Woodward part, see Woodward series.	10–20	>72	0–13	Silt loam, loam, fine sandy loam.	ML, CL, CL–ML	A–4, A–6
			13	Sandstone (rippable).		
Shellabarger: ShB, ShC	>60	>72	0–32	Fine sandy loam	SM, ML, SC, CL, CL–ML, SM–SC	A–4
			32–45	Sandy clay loam, fine sandy loam.	CL, SC	A–4, A–6
			45–72	Fine sandy loam, loamy fine sand.	SM–SC, SC, SM	A–2, A–4
St. Paul: StA, StB, StC	>60	>72	0–11	Silt loam	ML, CL, CL–ML	A–4, A–6
			11–16	Silty clay loam, silt loam	CL	A–4, A–6
			16–40	Silty clay loam, clay loam	CL	A–6, A–7
			40–72	Silty clay loam, silt loam	CL, CH	A–4, A–6, A–7
Tivoli. Mapped only with Pratt soils.	>60	>72	0–6	Loamy fine sand, fine sand	SM, SP–SM	A–2, A–3
			6–72	Fine sand	SM, SP–SM	A–2, A–3
Woodward: WoB, WoC, WoD, Wt, WwC, WwE. For Clairemont part of Wt, see Clairemont series. For Quinlan part of WwC and WwE, see Quinlan series.	20–40	>72	0–30	Silt loam, loam	ML, CL, CL–ML	A–4
			30	Sandstone (rippable).		
Yahola: Yf	>60	>72	0–44	Fine sandy loam	SM, ML, SC, CL, CL–ML, SM–SC	A–4
			44–60	Loamy fine sand, fine sandy loam.	SM, ML, SC, CL, CL–ML, SM–SC	A–2, A–4

[1] This Clairemont soil has moderate or low salinity to a depth of 24 inches.

tic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5, but in table 7 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.075 mm)							Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*			
100	98–100	82–100	5–35	NP	NP	6.0–20	0.05–0.11	6.1–7.3	Low	Low	Low.
100	98–100	90–100	15–35	NP	NP	6.0–20	0.07–0.11	6.1–7.3	Low	Low	Low.
100	95–100	90–100	55–97	<37	NP–14	0.6–6.0	0.15–0.19	7.4–8.4	Low	Low	Low.
100	98–100	94–100	36–60	<30	NP–10	0.6–2.0	0.11–0.15	5.6–7.3	Low	Low	Low.
100	95–100	70–90	36–65	25–37	8–16	0.6–2.0	0.13–0.17	6.1–7.3	Low	Low	Low.
100	95–100	50–80	20–40	<30	NP–10	0.6–2.0	0.09–0.15	6.6–7.8	Low	Low	Low.
	100	95–100	80–98	21–35	2–13	0.6–2.0	0.17–0.21	6.6–7.8	Low	Low	Low.
	100	95–100	80–98	27–40	8–18	0.6–2.0	0.17–0.21	6.6–7.8	Moderate	Moderate	Low.
	100	95–100	80–98	33–43	12–20	0.2–.06	0.17–0.21	7.4–8.4	Moderate	Moderate	Low.
	100	95–100	80–98	27–55	8–30	0.2–2.0	0.17–0.21	7.4–8.4	Moderate	Moderate	Low.
100	98–100	80–100	5–35	NP	NP	6.0–20	0.05–0.11	6.6–7.8	Low	Low	Low.
100	98–100	80–98	5–20	NP	NP	6.0–20	0.05–0.08	6.6–7.8	Low	Low	Low.
	100	96–100	65–85	22–31	3–10	0.6–2.0	0.16–0.20	6.6–8.4	Low	Low	Low.
100	95–100	90–100	36–60	<30	NP–10	2.0–6.0	0.12–0.16	7.9–8.4	Low	Low	Low.
100	95–100	90–100	15–60	<30	NP–10	2.0–6.0	0.07–0.14	7.9–8.4	Low	Low	Low.

[2] NP means nonplastic.

installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations of soils

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Custer County. In table 6, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for drainage of crops and pasture, irrigation, and terraces and diversions. For these particular uses, table 6 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means that soil properties are generally favorable for the rated use, or, in other words, that limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance. For some uses, the rating of severe is divided to obtain ratings of severe and very severe. *Very severe* means one or more soil properties are so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly is not practical for the rated use.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 6.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the

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 more kinds of soil. fully the instructions for referring to other series that appear in the first column of this table. Floods,

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill[1] (trench)	Local roads and streets
Carey:						
CaB, CaC	Slight	Moderate: seepage; depth to rock.	Slight	Moderate: low strength.	Slight	Moderate: low strength.
CbC3	Slight	Moderate: seepage; depth to rock.	Slight	Moderate: low strength.	Slight	Moderate: low strength.
Clairemont:						
Cc, Cf	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods
Ce	Severe: floods; wet.	Severe: floods; wet.	Severe: floods	Severe: floods; wet.	Severe: floods; wet.	Severe: floods
Cordell: CoE Rock outcrop part not rated.	Severe: seepage; depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Cornick: CrE Rock outcrop part not rated.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.
Crisfield: Cs[2]	Slight	Severe: seepage	Slight	Slight	Severe: seepage	Slight
Dale: Da[2]	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Moderate: low strength.
Devol: DeC	Slight	Severe: seepage	Slight	Slight	Severe: seepage	Slight
*Dill: DfB, DfC For Quinlan part, see Quinlan series.	Severe: depth to rock.	Severe: seepage; depth to rock.	Moderate: depth to rock.	Slight	Severe: seepage	Slight
Fluvents: Ff	Severe: floods; wet.	Severe: floods; wet.	Severe: floods; wet.	Severe: floods; wet.	Severe: floods; wet.	Severe: floods
Gracemore: Gm	Severe: wet; floods.	Severe: wet; floods.	Severe: wet; cutbanks cave; floods.	Severe: wet; floods.	Severe: floods; wet.	Moderate: floods.
Grant: GrB, GrC	Moderate: depth to rock.	Moderate: seepage; depth to rock.	Slight	Moderate: low strength; shrink-swell.	Moderate: depth to rock; too clayey.	Severe: low strength.
Hardeman: HaD	Slight	Severe: seepage	Slight	Slight	Severe: seepage	Moderate: low strength.
Lucien: LrE Rock outcrop part not rated.	Severe: depth to rock.	Severe: seepage; depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Severe: seepage; depth to rock.	Moderate: depth to rock.
Minco:						
McD, MdB, MdC	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Moderate: low strength.
McE	Moderate: slope	Severe: slope	Moderate: slope	Moderate: low strength.	Slight	Moderate: low strength.

interpretations

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care- seepage, and other computer-adapted terms that describe restrictive soil features are explained in the Glossary]

Suitability as a source of—			Degree and kind of limitation for—		Soil features affecting—		
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Fair: low strength.	Unsuited: excess fines.	Fair: thin layer.	Moderate: seepage.	Moderate: piping; low strength; seepage.	Not needed	Slope	Favorable.
Fair: low strength.	Unsuited: excess fines.	Fair: thin layer.	Moderate: seepage.	Moderate: piping; low strength; seepage.	Not needed	Erodes: easily; slope.	Erodes easily.
Fair: low strength.	Unsuited: excess fines.	Fair: thin layer.	Moderate: seepage.	Moderate: low strength; piping; seepage.	Floods	Floods	Floods.
Fair: low strength.	Unsuited: excess fines.	Fair: thin layer; excess salt.	Moderate: seepage.	Moderate: low strength; piping; seepage.	Floods; excess salt; wet.	Excess salt; floods.	Floods.
Poor: thin layer.	Unsuited: excess fines.	Fair: thin layer; small stones; too clayey.	Severe: depth to rock.	Severe: thin layer.	Not needed	Droughty; rooting depth.	Depth to rock; rooting depth.
Poor: thin layer.	Unsuited: excess fines.	Poor: thin layer.	Severe: depth to rock.	Severe: thin layer.	Not needed	Droughty: rooting depth.	Depth to rock; rooting depth.
Good	Poor for sand: excess fines. Unsuited for gravel: excess fines.	Good	Severe: seepage.	Moderate: low strength; seepage; piping.	Not needed	Seepage	Erodes easily.
Fair: low strength.	Unsuited: excess fines.	Good	Moderate: seepage.	Moderate: low strength; piping.	Not needed	Favorable	Favorable.
Good	Poor for sand: excess fines. Unsuited for gravel: excess fines.	Good	Severe: seepage.	Moderate: low strength; piping.	Not needed	Seepage	Erodes easily.
Fair: thin layer.	Unsuited: excess fines.	Good	Severe: seepage.	Moderate: thin layer; low strength; piping.	Not needed	Seepage	Erodes easily; depth to rock.
Fair: low strength.	Unsuited: excess fines.	Poor: wet	Severe: seepage.	Moderate: low strength; piping.	Wet; floods	Wet; floods	Floods.
Fair: low strength; wet.	Poor for sand: excess fines. Unsuited for gravel: excess fines.	Poor: too sandy.	Severe: seepage.	Moderate: low strength; piping.	Wet; floods; cutbanks cave.	Wet; seepage	Not needed.
Poor: low strength.	Unsuited: excess fines.	Fair: thin layer.	Moderate: seepage.	Moderate: low strength; piping.	Not needed	Slope; erodes easily.	Slope; erodes easily.
Fair: low strength.	Poor: excess fines.	Good	Severe: seepage.	Moderate: low strength; piping.	Not needed	Slope; seepage	Slope.
Fair: low strength.	Unsuited: excess fines.	Fair: thin layer.	Severe: depth to rock; seepage.	Severe: thin layer.	Not needed	Rooting depth; slope; droughty.	Depth to rock; slope; rooting depth.
Fair: low strength.	Unsuited: excess fines.	Good	Moderate: seepage.	Moderate: low strength; piping.	Not needed	Slope	Slope.
Fair: low strength.	Unsuited: excess fines.	Fair: slope	Moderate: seepage.	Moderate: low strength; piping.	Not needed	Slope; erodes easily.	Slope.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings basements without	Sanitary landfill[1] (trench)	Local roads and streets
Pond Creek: PcA, PkA, PkB.	Severe: percs slowly.	Slight	Moderate: too clayey.	Moderate: low strength; shrink-swell.	Moderate: too clayey.	Severe: low strength.
*Pratt: PrB, PrC	Slight	Severe: seepage	Moderate: cutbanks cave.	Slight	Severe: seepage	Slight
PtE For Tivoli part, see Tivoli series.	Moderate: slope	Severe: seepage	Moderate: cutbanks cave.	Moderate: slope	Severe: seepage	Moderate: slope.
*Quinlan: QwC2, QwE3 For Woodward part, see Woodward series.	Severe: depth to rock.	Severe: depth to rock; seepage.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: low strength; depth to rock.
Shellabarger: ShB, ShC	Slight	Moderate: seepage.	Slight	Slight	Slight	Moderate: low strength.
St. Paul: StA	Moderate: percs slowly.	Slight	Moderate: too clayey.	Moderate: low strength; shrink-swell.	Moderate: too clayey.	Severe: low strength.
StB, StC	Moderate: percs slowly.	Moderate: slope	Moderate: too clayey.	Moderate: low strength; shrink-swell.	Moderate: too clayey.	Severe: low strength.
Tivoli Mapped only with Pratt soils.	Moderate: slope	Severe: seepage	Severe: cutbanks cave.	Moderate: slope	Severe: seepage	Moderate: slope.
*Woodward: WoB, WoC, WoD, WwC For Quinlan part of WwC, see Quinlan series.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: low strength.	Moderate: depth to rock.	Moderate: low strength.
Wt, WwE For Clairemont part of Wt, see Clairemont series. For Quinlan part of WwE, see Quinlan series.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: low strength.	Moderate: depth to rock.	Moderate: low strength.
Yahola: Yf	Severe: floods	Severe: floods; seepage.	Severe: floods	Severe: floods	Severe: floods; seepage.	Moderate: floods; low strength.

[1] Onsite deep studies of the underlying strata, water table, and hazards of aquifer pollution and drainage into ground water need to be made for landfill deeper than 5 or 6 feet.

system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor, and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are con-

interpretations—Continued

Suitability as a source of—			Degree and kind of limitation for—		Soil features affecting—		
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: low strength.	Unsuited: excess fines.	Fair: thin layer.	Moderate: seepage.	Moderate: low strength; piping.	Not needed.	Favorable.	Slope.
Good.	Poor for sand: excess fines. Unsuited for gravel: excess fines.	Poor: too sandy.	Severe: seepage.	Moderate: low strength; piping.	Not needed.	Seepage; complex slope.	Complex slope; erodes easily.
Good.	Poor for sand: excess fines. Unsuited for gravel: excess fines.	Poor: too sandy.	Severe: seepage.	Moderate: low strength; piping.	Not needed.	Seepage; complex slope.	Complex slope; erodes easily.
Fair: thin layer.	Unsuited: excess fines.	Fair: thin layer.	Severe: depth to rock.	Severe: thin layer.	Not needed.	Rooting depth; slope; droughty.	Depth to rock; rooting depth.
Fair: low strength.	Poor for sand: excess fines. Unsuited for gravel: excess fines.	Fair: thin layer.	Severe: seepage.	Moderate: low strength; piping.	Not needed.	Slope.	Slope.
Poor: low strength.	Unsuited: excess fines.	Fair: thin layer.	Moderate: seepage.	Moderate: low strength; piping.	Not needed.	Favorable.	Slope.
Poor: low strength.	Unsuited: excess fines.	Fair: thin layer.	Moderate: seepage.	Moderate: low strength; piping.	Not needed.	Slope.	Slope.
Good.	Poor for sand: excess fines. Unsuited for gravel: excess fines.	Poor: too sandy.	Severe: seepage.	Severe: low strength; seepage.	Not needed.	Complex slope; droughty; seepage.	Complex slope; seepage.
Fair: low strength.	Unsuited: excess fines.	Good.	Severe: depth to rock.	Moderate: thin layer; low strength; piping.	Not needed.	Slope.	Slope.
Fair: low strength.	Unsuited: excess fines.	Fair: slope.	Severe: depth to rock.	Moderate: thin layer; low strength; piping.	Not needed.	Slope.	Slope.
Fair: low strength.	Poor for sand: excess fines. Unsuited for gravel: excess fines.	Good.	Severe: seepage.	Moderate: low strength; piping; seepage.	Not needed.	Floods.	Floods.

[2] Ratings are for areas protected from flooding.

sidered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic-matter content and slope, and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewerlines, phone and power transmission lines, basements, open ditches, and

TABLE 7.—*Engineering test data*

[Tests performed by Oklahoma State Department of Highways, Materials Division in accordance with standard procedures of the American Association of State Highway and Transportation Officials (AASHTO)]

Soil name and location	Parent material	Report no.	Depth	Shrinkage		Volume change from field moisture equivalent	Mechanical analysis[1]						Liquid limit	Plasticity index	Classification	
				Limit	Ratio		Percentage passing sieve—			Percentage smaller than—					AASHTO[2]	Unified[3]
							No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.005 mm	0.002 mm				
			In	*Pct*		*Pct*							*Pct*			
Cornick soils:																
In an area of Cornick soils and Rock outcrop, 2 to 12 percent slopes; about 1,350 feet south and 310 feet west of northeast corner of sec. 32, T. 12 N., R. 15 W; west side of road. (Modal)	Gypsum	515–456	0–7	21	1.82	12	100	99	85	65	17	15	30	11	A–6(8)	CL
Dale silt loam:																
About 450 feet south and 2,550 feet east of the northwest corner of sec. 2, T. 13 N., R. 20 W. (Modal)	Loamy sediment	515–456	0–10	16	1.78	16	.....	100	91	83	22	18	28	11	A–6(9)	CL
			10–24	16	1.82	16	100	99	94	81	24	19	30	10	A–4(9)	CL
			30–60	16	1.82	20	.....	100	90	78	22	18	29	11	A–6(9)	CL
Dill fine sandy loam:																
In an area of Dill-Quinlan complex, 1 to 3 percent slopes; about 150 feet west and 2,600 feet north of the southeast corner of sec. 30, T. 12 N., R. 20 W. (Modal)	Sandstone	515–456	0–10	[4]NP	NP	NP	100	99	43	24	10	8	NP	NP	A–4(0)	SM
			10–34	NP	NP	NP	.....	100	44	26	11	10	NP	NP	A–4(0)	SM
			34–42	NP	NP	NP	.....	100	43	26	10	7	NP	NP	A–4(0)	SM
Pond Creek silt loam:																
About 2,500 feet south and 60 feet west of the northeast corner of sec. 4, T. 14 N., R. 14 W. (Modal)	Loamy sediment	515–456	0–12	16	1.74	12	.....	100	79	63	13	9	25	7	A–4(3)	CL–ML
			12–30	16	1.79	20	.....	100	86	70	18	14	32	12	A–6(9)	CL
			30–48	13	1.89	28	.....	100	84	72	25	21	33	15	A–6(11)	CL
			48–60	13	1.90	31	100	99	76	70	38	35	35	17	A–6(11)	CL
Quinlan silt loam:																
In an area of Woodward-Quinlan complex, 3 to 5 percent slopes; about 1,050 feet north and 60 feet west of the southeast corner of sec. 16, T. 13 N., R. 17 W. (Modal)	Sandstone	515–456	0–8	15	1.85	16	100	98	80	68	23	13	26	7	A–4(4)	CL–ML
			8–16	15	1.85	18	100	97	76	63	25	17	30	11	A–6(7)	CL
Yahola fine sandy loam:																
About 600 feet north and 60 feet west of the southeast corner of sec. 2, T. 12 N., R. 19 W. (Modal)	Loamy sediment	515–456	0–16	13	1.91	8	100	97	53	45	15	10	20	7	A–4(1)	SM–SC
			45–60	NP	NP	NP	100	97	34	24	7	4	NP	NP	A–2–4(0)	SM

[1] Mechanical analysis according to AASHTO Designation T 88-70 (See footnote 9, p. 35.) Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

[2] Based on AASHTO Designation M 146-66 (See footnote 9, page 35.)

[3] Based on Unified soil classification system (See footnote 8, page 35.)

[4] NP means nonplastic.

cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings without basements, as rated in table 6, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated the ratings in table 6 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Local roads and streets, as rated in table 6, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 6 provide guidance about where to look for probable sources. A soil rated as *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among factors that are unfavorable.

Drainage for crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope, stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Soil test data

Table 7 contains engineering test data for some of the major soil series in Custer County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material, as has been explained for table 5.

Shrinkage limit is the percentage of moisture at which shrinkage of the soil material stops.

Shrinkage ratio is the relationship between the change in the volume of the soil material and the water content of the soil material when at the shrinkage limit. The change in volume is expressed as a percentage of the air-dry volume of the soil material, and the water content is expressed as a percentage of the weight of the soil material when overdry.

Linear shrinkage is the decrease in one dimension, expressed as a percentage of the original dimension, of the soil mass when the moisture content is reduced from the given value to the shrinkage limit.

Formation and Classification of the Soils

This section lists the major factors of soil formation as they relate to the soils of Custer County, the processes of soil formation, and the system of classifying soils into categories broader than the series.

Factors of Soil Formation

Soil is the product of five major factors of soil formation—parent material, climate, plants and animals, relief, and time. If a factor, such as vegetation, differs in one area from the same factor in another area, but the other four factors are the same, the soil formed in one area differs from that formed in the other area.

Parent material

Parent material is the unconsolidated material from which soil is formed. It influences the rate of soil formation, the chemical, physical, and mineralogical composition; and the color of the soil.

Soils of the uplands of Custer County formed in material weathered from sandstone, shale, siltstone, gypsum, loamy sediment, and sandy sediment. Soils of the Woodward and Quinlan series are examples of soils that formed in material weathered from sandstone. The St. Paul soils are examples of soils that formed in material weathered from shale. The Cordell soils are examples of soils that formed in material weathered from siltstone. The Cornick soils are examples of soils that formed in material weathered from gypsum. Soils of the Pond Creek series are examples of soils that formed in material weathered from loamy sediment. The Pratt soils are examples of soils that formed in material weathered from sandy sediment.

Soils of the flood plains of Custer County formed in material weathered from loamy sediment and sandy sediment. Soils of the Clairemont series are examples of soils that formed in material weathered from loamy sediment. The Gracemore soils are examples of soils that formed in material weathered from sandy sediment.

Climate

Custer County has a dry-subhumid climate. The climate is fairly uniform throughout the county, and differences among the soils cannot be attributed to differences in climate. The average annual rainfall is about 28 inches. About 32 percent of the rainfall is received in spring, about 33 percent in summer, about 24 percent in fall, and about 11 percent in winter. Basic elements are not depleted by leaching. For a more complete description of the climate, refer to the section "Climate."

Plants and animals

Plants, burrowing animals, insects, and soil microorganisms have a direct influence on the formation of the soils. Most of the soils have developed under a cover of native grasses. The fibrous roots of these grasses promote granular structure, furnish organic matter, and retain large amounts of plant nutrients. Many kinds of micro-organisms influence soil formation by changing organic matter into stable humus and by transforming parent material into soil. Burrowing animals, insects, and earthworms influence soil formation by mixing the organic and mineral parts of the soil.

Relief

Relief affects the formation of soils through its influence on moisture, drainage, erosion, temperature of the soil, and plant cover. In Custer County relief is determined largely by the resistence of underlying formations to weathering and geological erosion. About 10 percent of the acreage is nearly level soils on flood plains, and about 90 percent is nearly level to moderately steep soils on uplands.

Carey and Quinlan soils formed in similar parent material, but their development has been controlled to a large extent by relief. The deep Carey soils are typically less sloping than the shallow Quinlan soils.

Time

Time as a factor in soil formation cannot be measured strictly in years. The length of time needed for the development of genetic horizons depends on the intensity and the interactions of soil-forming factors in promoting the losses, gains, transfers, or transformations of soil constituents that are necessary for forming soil horizons. Soils with no definite genetic horizons are young or immature. Mature or older soils have approached equilibrium with their environment and tend to have well-defined horizons.

The soils of Custer County range from young to old.

Some of the older, more mature soils are Pond Creek soils on uplands. The Woodward soils are younger, but they have well-expressed soil horizons. The Cornick soils are considered young soils. They have had sufficient time to develop well-expressed horizons, but geologic erosion has taken away soil material almost as fast as it has formed. The Clairemont and Yahola soils are on flood plains and have been developing for such a short time they have little horizon development.

Processes of Soil Formation

Several processes were involved in the formation of soils in Custer County. These processes are the accumulation of organic matter, the leaching of calcium carbonates, the reduction and transfer of iron, and the translocation of silicate clay minerals. The results of these processes are not evident to the same degree in all the soils of the county.

Most of the older soils in the county have three major horizons. Some of the properties in which the major horizons differ are color, texture, structure, consistence, reaction, organic-matter content, and thickness. Subdivisions of the major horizons are based on minor differences.

The A horizon is the surface layer. The B horizon is the mineral horizon below the A horizon, generally called the subsoil. In the older soils of the county, such as those of the Pond Creek series, the B horizon has the maximum accumulation of silicate clay. The younger soils of the county, such as those of the Yahola series, do not have a B horizon. The C horizon is material weathered from rock, soft rock, loamy sediment, or sandy sediment. It has been affected by soil forming processes and may have been modified by reduction of iron or accumulation of calcium carbonate.

The R layer is consolidated hard rock.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965.[10] Because this system is under continual study, readers interested in developments of the current system should search the latest literature available.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 8, the soil series of Custer County

[10] United States Department of Agriculture, Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. 1960. [Supplements issued in March 1967 and in September 1968]

TABLE 8.—*Classification of soil series*

Series	Family	Subgroup	Order
Carey	Fine-silty, mixed, thermic	Typic Argiustolls	Mollisols.
Clairemont	Fine-silty, mixed (calcareous), thermic	Typic Ustifluvents	Entisols.
Cordell	Loamy, mixed, thermic	Lithic Ustochrepts	Inceptisols.
Cornick	Loamy, mixed, thermic, shallow	Entic Haplustolls	Mollisols.
Crisfield	Coarse-loamy, mixed, thermic	Udic Haplustolls	Mollisols.
Dale	Fine-silty, mixed, thermic	Pachic Haplustolls	Mollisols.
Devol	Coarse-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Dill	Coarse-loamy, mixed, thermic	Udic Ustochrepts	Inceptisols.
Fluvents[1]	Unclassified	Unclassified	Entisols.
Gracemore	Sandy, mixed, thermic	Aquic Udifluvents	Entisols.
Grant	Fine-silty, mixed, thermic	Udic Argiustolls	Mollisols.
Hardeman	Coarse-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Lucien	Loamy, mixed, thermic, shallow	Typic Haplustolls	Mollisols.
Minco	Coarse-silty, mixed, thermic	Udic Haplustolls	Mollisols.
Pond Creek	Fine-silty, mixed, thermic	Pachic Argiustolls	Mollisols.
Pratt	Sandy, mixed, thermic	Psammentic Haplustalfs	Alfisols.
Quinlan	Loamy, mixed, thermic, shallow	Typic Ustochrepts	Inceptisols.
Shellabarger	Fine-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
St. Paul	Fine-silty, mixed, thermic	Pachic Argiustolls	Mollisols.
Tivoli	Mixed, thermic	Typic Ustipsamments	Entisols.
Woodward	Coarse-silty, mixed, thermic	Typic Ustochrepts	Inceptisols.
Yahola	Coarse-loamy, mixed (calcareous), thermic	Typic Ustifluvents	Entisols.

[1] Fluvents are not classed as a series.

are placed in categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Ent-i-sol).

SUBORDER: Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order.

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, or movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder.

SUBGROUP: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the 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 of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group.

FAMILY: Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae (see table 8).

SERIES: The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in the arrangement in the profile.

General Facts About the County

Additional information about the soil survey area is given in this section. It will be most useful to people not familiar with Custer County. It describes the relief and drainage, settlement and development, natural resources, transportation and industry, farming, and climate.

Relief and Drainage

The county is drained by the Washita and South Canadian Rivers and their tributaries. The topography ranges from the nearly level flood plains of the rivers and their tributaries to steep uplands. The general slope is toward the southeast. The major tributaries of the Washita River are Quartermaster Creek, Panther Creek, Oak Creek, Turkey Creek, Barnitz Creek, Beaver Creek, and Bear Creek. The major tributaries of the South Canadian River are Deer Creek and Horse Creek.

Settlement and Development

Custer County was once used by migratory bands of Indians as they moved with roving herds of buffalo. The buffalo herds provided their food, clothing, and shelter. The county was a part of the Louisiana Purchase. Cheyenne and Arapaho Indians were brought here in 1869.

The Great Western Trail crosses the west side of the county. This cattle trail was used to drive cattle herds from south of Vernon, Texas, to market at Dodge City, Kansas, in the late 1860's, the 1870's, and the 1880's. The Texas drovers, finding excellent grazing on the Cheyenne and Arapaho land, leased much of it from the Indians in 1883.

The Cheyenne and Arapaho lands were opened for settlement by run on April 19, 1892. Many claims in Custer County were made by wheat and corn farmers from Kansas. The town of Clinton was founded in 1903, when the Frisco Railway was extended to the site. It was named for Federal Judge Clinton F. Irwin. Custer County, organized in 1908, was named for General George A. Custer.

Natural Resources

The major natural resources of the county include farmland, natural gas and oil, water, and gypsum.

There is extensive production of gas and oil in the northern and central parts of the county. Many gravel deposits are located near the Washita River and Deer Creek. Beds of volcanic ash as much as 12 feet deep are near Custer City. A limited amount has been quarried. About 24 square miles of gypsum beds averaging about 36 feet in thickness are in the southeastern part of the county. In the same area there is about 10 square miles of anhydrite that averages about 20 feet in thickness and underlies the gypsum at a depth of about 40 feet. There is no commercial production of either gypsum or anhydrite in the county at present.

There is an adequate supply of water for livestock and domestic uses in the county, and in some places there is enough for irrigation. The two major water-bearing formations are the Rush Springs Sandstone,

in the eastern part of the county,[11] and the Washita River flood plain. Irrigation wells in the Rush Springs Sandstone generally produce 300 to 800 gallons per minute of good-quality water from a depth of 200 to 400 feet. On the Washita River flood plain the production is up to 1,000 gallons per minute and is generally from a depth of less than 100 feet. In other parts of the county ground water is commonly of adequate quantity for livestock and domestic uses but generally is not sufficient for irrigation. It normally is of poorer quality than that in the Rush Springs Sandstone because it contains dissolved gypsum.

Water from Foss Reservoir is used by several towns in the area for household use, industry, irrigation, and recreation. More than 150 flood detention reservoirs in the county control flooding and furnish livestock water, irrigation water, and water for recreation. Farm ponds and wells are the major source of livestock water.

Transportation and Industry

Highways serving the county are Interstate 40, U.S. Highway 183, and State Highways 33, 34, 44, 47, 54, and 73. Numerous railways are also located in the county. Airports are near Clinton and Weatherford.

Among the various industries in Custer County are a brick plant, a cottonseed oil mill, a dry goods manufacturing plant, a paper products manufacturing plant, an insulation materials plant, a wrought-iron products plant, a hayloader manufacturing plant, an automotive carpet manufacturing plant, earthmoving construction companies, and grain elevators.

Farming

Farming is the principal source of income in Custer County. About half of the acreage is rangeland, and the rest is cropland. Wheat ranks first in crop income, cotton second, grain sorghum third, barley fourth, oats fifth, and alfalfa sixth.

Small grain is grown mainly on loamy soils on uplands. Small grain is generally seeded between October 1 and October 15 if it is to be used only for producing grain; if it is to be used for pasture, the planting dates are generally between September 1 and September 15. Wheat is generally harvested between June 1 and June 10.

Cotton is grown mostly on moderately sandy soils on uplands and on bottom lands. It is generally planted from May 1 to June 15 and harvested between November 1 and January 1.

Grain sorghum is grown mainly on the Dill-Quinlan fine sandy loams in the southwestern part of the county. It is generally planted on May 1 to June 15 and harvested in October and November.

Alfalfa is grown mostly on soils on bottom lands. Some of it is irrigated. It is generally seeded in September. The average life of a stand is 4 to 6 years.

There has been a gradual increase in the quality and quantity of beef cattle in the past 30 years. Much of the wheat in the county is grazed by stocker calves from about November 1 to March 15, which are then shipped to market as feeder calves. The wheat crop is later harvested for grain. Some wheat is grazed out.

Cow-calf operations are generally maintained on native grass rangeland or bermudagrass pastures.

Hereford and Angus are the dominant breeds of beef cattle, and they are both purebred and Hereford-Angus crossbreed. Protein supplement is fed in winter unless the cattle are grazed on small grain pastures.

The number of hogs, sheep, dairy cattle, and poultry has been decreasing for several years.[12]

Farms are increasing in size. Acreage in crops is increasing on bottom lands and decreasing on uplands where shallow, sloping soils are being reseeded to native grasses.

Climate[13]

Custer County has dry-subhumid climate and is subject to drought. Nearly 80 percent of the normal annual precipitation comes during the frost-free season. A large percentage of the precipitation is from thunderstorms, which frequently produce high-intensity rainfall. Thunderstorms occur on an average of 50 days in a normal 205-day crop season. There are normally 32 days during the frost-free season that have rainfall of 0.10 inch or more, 23 days of 0.25 inch or more, 15 days of 0.5 inch or more, 7 days of 1 inch or more, and about 2 days of 2 inches or more. Since 1935, the greatest 24-hour rainfall at Clinton was 7.05 inches on May 17, 1951. An estimated 24-hour rainfall of 5.70 inches will occur on an average of once every 10 years, and 6.60 inches once every 25 years. An estimated 1-hour rainfall of 2.80 inches will occur once every 10 years, and 3.30 inches once every 25 years. The estimated return period of a 15-minute duration rainfall of 1.60 inches is 10 years and of 1.88 inches is 25 years.

The normal seasonal snowfall in Custer County is about 11 inches. About 4 days in an average year have snowfall of 1 inch or more, and about 8 days have a snow cover of 1 inch or more. Since 1936, the greatest seasonal snowfall at Clinton was 30.0 inches in 1947-48.

Temperatures of 90° F or higher occur frequently from May through September, and occasionally from March through October. Temperatures of 100° or higher are experienced about 22 days each year, mainly in July and August. The highest temperature of record at Clinton was 115° on August 12, 1936, and earlier dates. Average temperature and precipitation are listed in table 9.

Winter is frequently mild and occasionally cold. Minimum temperatures of 32° or less occur on 96 days of a normal year, and there are 7 days of a normal year when temperatures remain at 32° or below throughout the day. On only 22 days in the past 30 years has a temperature of 0° or less been observed at Clinton. The lowest temperature of record at Clinton was −14° on January 4, 1947.

The average date of the last spring freeze at Clinton

[11] Hugh D. Miser. Geologic map of Oklahoma. U.S. Geol. Survey, 1954.

[12] U.S. Department of Commerce. Census of agriculture. vol. 1, pt. 36, sec. 2, pp. 161-168. 1969.

[13] By BILLY R. CURRY, climatologist for Oklahoma, National Weather Service, U.S. Department of Commerce.

TABLE 9.—*Temperature and precipitation*

Month	Temperature[1]				Precipitation[2]				
	Average daily maximum	Average daily minimum	Average monthly highest maximum	Average monthly lowest minimum	Average total	One year in 10 will have—		Days with snow cover 1 inch or more	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	50	24	73	4	0.8	([3])	1.9	3	2
February	55	29	75	11	1.1	0.1	2.3	2	2
March	63	35	85	16	1.5	.3	3.1	1	4
April	74	47	90	30	2.7	.6	5.5	0	0
May	82	56	96	40	4.8	.9	10.2	0	0
June	91	66	101	53	3.8	.8	7.8	0	0
July	96	69	105	59	2.5	.7	4.8	0	0
August	95	68	105	57	3.0	.6	6.3	0	0
September	87	60	100	44	2.7	.3	6.3	0	0
October	76	48	91	31	2.7	.2	5.9	0	0
November	62	35	80	19	1.3	([3])	3.5	0	0
December	52	27	72	10	1.0	.1	2.3	2	1
Year	74	47	[4]107	[5]2	27.8	17.9	38.7	8	2

[1] Period of record 1942-71.
[2] Period of record 1941-70.
[3] Trace.
[4] Average annual highest temperature.
[5] Average annual lowest temperature.

is April 8, and the average date of the first fall freeze is October 30. Freezing temperatures have occurred as late as May 3 and as early as October 7. Probability of last freezing temperature in spring and first in fall are listed in table 10.

The prevailing wind direction across Custer County is southerly, although northerly and southerly winds occur with about equal frequency from November through March. The average monthly windspeed ranges from 9 miles per hour in July and August to 15 miles per hour in May. Strong, gusty winds occur during thunderstorms and occur when low-pressure systems migrate from west to east in winter and spring.

The average monthly relative humidity at 6 a.m. is 75 to 85 percent throughout the year. The average monthly relative humidity at 6 p.m. ranges from about 40 percent in March, April, and July to 60 percent in December. An average of 150 clear days, 105 partly cloudy days, and 110 cloudy days each year provide Custer County with about 70 percent of the year's total possible sunshine. Sunshine is more abundant in summer and fall.

Custer County is susceptible to the occurrence of severe storms. These storms occur more frequently on hot afternoons in spring, but they have occurred in every month of the year and at every hour of the day. Hailstorms occur an average of 5 days during the year, although not all of the hailstorms are so intense that they cause damage to crops and property.

TABLE 10.—*Probability of last freezing temperatures in spring and first in fall*

[All data from Clinton. Period of record 1921-68]

Probability	Dates for given probability and temperature				
	16° F	20° F	24° F	28° F	32° F
Spring:					
1 year in 10 later than	March 12	March 28	April 6	April 13	April 22
2 years in 10 later than	March 13	March 22	March 31	April 8	April 17
5 years in 10 later than	February 26	March 10	March 20	March 30	April 8
Fall:					
1 year in 10 earlier than	November 21	November 6	October 27	October 24	October 16
2 years in 10 earlier than	November 27	November 12	November 2	October 28	October 20
5 years in 10 earlier than	December 12	November 26	November 15	November 8	October 30

Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expresed as inches of water per inch of soil.

Argillic horizon. An illuvial horizon in which layer-lattice silicate clay has significantly accumulated.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change.

Complex slope. Short and irregular slopes. Planning and construction of terraces, diversions, and other water-control measures are difficult.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented 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 when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Cutbanks cave. Walls of cuts are not stable. The soil sloughs easily.

Depth to rock. Bedrock is so near the surface that it affects specified use of the soil.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the 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 available water 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 mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

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.

Deferred grazing. 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.

Excess fines. The soil contains too much silt and clay for use as gravel or sand in construction.

Excess salt. The amount of soluble salt in the soil is so high that it restricts the growth of most plants.

Fallow. Cropland left idle in order to restore productivity mainly through accumulation of water, nutrients, or both. Summer fallow is a common stage before cereal grain in regions of limited rainfall. The soil is tilled for at least one growing season to control weeds, to aid decomposition of plant residues, and to encourage the storage of moisture for the succeeding grain crop.

Favorable. Features of the soil are favorable for the intended use.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rains. The distinction between gully and rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by normal tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage. V-shaped gullies result if the material is more difficult to erode with depth; whereas U-shaped gullies result if the lower material is more easily eroded than that above it.

Gypsum. Calcium sulphate.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed

to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Low strength. The soil has inadequate strength to support loads.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Parent material. Disintegrated and partly weathered rock 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.

Percs slowly. Water moves through the soil slowly, affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Piping. The soil is susceptible to the formation of tunnels or pipelike cavities by moving water.

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth. A layer that greatly restricts the downward rooting of plants occurs at a shallow depth.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Seepage. Water moves through the soil so quickly that it affects the specified use.

Shrink-swell. The soil expands on wetting and shrinks on drying, which may cause damage to roads, dams, building foundations, or other structures.

Silica. Silica is a combination of silicon and oxygen. The mineral form is called quartz.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slope, soil. The difference in elevation for each 100 feet horizontal. It is expressed as follows in this survey: nearly level, 0 to 1 percent; very gently sloping, 1 to 3 percent; gently sloping, 3 to 5 percent; sloping, 5 to 8 percent; strongly sloping, 8 to 12 percent; and moderately steep, 12 to 20 percent.

Small stones. Rock fragments that are less than 10 inches across may affect the specified use.

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* (0.5 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). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (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 material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (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 solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

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 surface 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.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt 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."

Thin layer. Suitable soil material is not thick enough for use as borrow material or topsoil.

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 till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Well-graded soil. A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

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.

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and the soil series to which the mapping unit belongs. The capability classification system is described on pages 21 to 23. In referring to a pasture and hayland suitability group, a range site, or a tree suitability group read the introduction to the section it is in for general information about its management. Pasture and hayland suitability groups are described on page 25. Tree suitability groups are described on page 30.

Map symbol	Mapping unit	Page	Capability unit	Range site		Pasture and hayland suitability group	Tree suitability group
			Symbol	Name	Page	Symbol	Number
CaB	Carey silt loam, 1 to 3 percent slopes	5	IIe-1	Loamy Prairie	27	8A	6
CaC	Carey silt loam, 3 to 5 percent slopes	5	IIIe-1	Loamy Prairie	27	8A	6
CbC3	Carey soils, 2 to 6 percent slopes, severely eroded	5	VIe-4	Eroded Prairie	26	8F	8
Cc	Clairemont silt loam	6	IIw-1	Loamy Bottomland	27	2A	3
Ce	Clairemont silt loam, saline	6	IIIs-1	Subirrigated	29	2B	1
Cf	Clairemont soils	6	Vw-1	Loamy Bottomland	27	2A	3
CoE	Cordell soils and Rock outcrop, 2 to 15 percent slopes	7	VIe-1	Red Shale	28	------	7
CrE	Cornick soils and Rock outcrop, 2 to 12 percent slopes	7	VIs-1	Gyp	27	------	7
Cs	Crisfield fine sandy loam	8	I-1	Loamy Bottomland	27	2A	2
Da	Dale silt loam	8	I-1	Loamy Bottomland	27	2A	3
DeC	Devol fine sandy loam, 3 to 5 percent slopes (W) 1/	9	IIIe-2	Sandy Prairie	28	8A	5
DfB	Dill-Quinlan complex, 1 to 3 percent slopes	9	IIIe-2	----------	----	------	5
	Dill part	----	------	Sandy Prairie	28	8A	------
	Quinlan part	----	------	Shallow Prairie	29	------	------
DfC	Dill-Quinlan complex, 3 to 5 percent slopes	9	IVe-2	----------	----	------	5
	Dill part	----	------	Sandy Prairie	28	8A	------
	Quinlan part	----	------	Shallow Prairie	29	------	------
Ff	Fluvents	10	Vw-2	Subirrigated	29	2B	1
Gm	Gracemore loamy fine sand	11	IIIw-1	Subirrigated	29	3B	1
GrB	Grant loam, 1 to 3 percent slopes	11	IIe-1	Loamy Prairie	27	8A	6
GrC	Grant loam, 3 to 5 percent slopes	11	IIIe-1	Loamy Prairie	27	8A	6
HaD	Hardeman fine sandy loam, 5 to 8 percent slopes (W) 1/	12	IVe-2	Sandy Prairie	28	8A	5
LrE	Lucien soils and Rock outcrop, 8 to 20 percent slopes	12	VIe-7	Shallow Prairie	29	------	7
McD	Minco very fine sandy loam, 5 to 8 percent slopes	13	IVe-1	Loamy Prairie	27	8A	6
McE	Minco very fine sandy loam, 8 to 20 percent slopes	13	VIe-2	Loamy Prairie	27	------	6
MdB	Minco loam, 1 to 3 percent slopes	13	IIe-1	Loamy Prairie	27	8A	6
MdC	Minco loam, 3 to 5 percent slopes	13	IIIe-1	Loamy Prairie	27	8A	6
PcA	Pond Creek fine sandy loam, 0 to 2 percent slopes	14	I-2	Sandy Prairie	28	8A	6
PkA	Pond Creek silt loam, 0 to 1 percent slopes	14	I-2	Loamy Prairie	27	8A	6
PkB	Pond Creek silt loam, 1 to 3 percent slopes	14	IIe-1	Loamy Prairie	27	8A	6
PrB	Pratt loamy fine sand, 1 to 4 percent slopes (W) 1/	14	IIIe-3	Deep Sand	26	9B	4
PrC	Pratt loamy fine sand, 4 to 8 percent slopes (W) 1/	15	IVe-3	Deep Sand	26	9B	4
PtE	Pratt and Tivoli soils, 8 to 12 percent slopes (W) 1/	15	VIe-3	Deep Sand	26	9B	4

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit	Range site		Pasture and hayland suitability group	Tree suitability group
			Symbol	Name	Page	Symbol	Number
QwC2	Quinlan-Woodward complex, 3 to 5 percent slopes, eroded	15	IVe-1	----------	----	------	7
	Quinlan part	----	------	Shallow Prairie	29	------	------
	Woodward part	----	------	Loamy Prairie	27	8A	------
QwE3	Quinlan-Woodward complex, 5 to 10 percent slopes, severely eroded	15	VIe-4	Eroded Prairie	26	------	8
	Quinlan part	----	------	----------	----	------	------
	Woodward part	----	------	----------	----	8F	------
ShB	Shellabarger fine sandy loam, 1 to 3 percent slopes (W) 1/	16	IIe-2	Sandy Prairie	28	8A	6
ShC	Shellabarger fine sandy loam, 3 to 5 percent slopes (W) 1/	16	IIIe-2	Sandy Prairie	28	8A	6
StA	St. Paul silt loam, 0 to 1 percent slopes	17	IIc-1	Loamy Prairie	27	8A	6
StB	St. Paul silt loam, 1 to 3 percent slopes	17	IIe-1	Loamy Prairie	27	8A	6
StC	St. Paul silt loam, 3 to 5 percent slopes	17	IIIe-1	Loamy Prairie	27	8A	6
WoB	Woodward silt loam, 1 to 3 percent slopes	19	IIe-1	Loamy Prairie	27	8A	6
WoC	Woodward silt loam, 3 to 5 percent slopes	19	IIIe-1	Loamy Prairie	27	8A	6
WoD	Woodward silt loam, 5 to 8 percent slopes	19	IVe-1	Loamy Prairie	27	8A	6
Wt	Woodward-Clairemont complex	19	VIe-5	----------	----	------	6
	Woodward part	----	------	Loamy Prairie	27	8A	------
	Clairemont part	----	------	Loamy Bottomland	27	2A	------
WwC	Woodward-Quinlan complex, 3 to 5 percent slopes	20	IVe-1	----------	----	------	7
	Woodward part	----	------	Loamy Prairie	27	8A	------
	Quinlan part	----	------	Shallow Prairie	29	------	------
WwE	Woodward-Quinlan complex, 5 to 12 percent slopes	20	VIe-6	----------	----	------	7
	Woodward part	----	------	Loamy Prairie	27	8A	------
	Quinlan part	----	------	Shallow Prairie	29	------	------
Yf	Yahola fine sandy loam	21	IIw-1	Loamy Bottomland	27	2A	2

1/ (W) indicates signs of wind erosion.

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