

SOIL SURVEY OF

# Edwards County, Kansas



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

Issued September 1973

Major fieldwork for this soil survey was done in the period 1961-66. Soil names and descriptions were approved in 1967. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1966. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Edwards County Soil Conservation District, which was established in 1943.

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

## HOW TO USE THIS SOIL SURVEY

**T**HIS 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 and ranching, industry, and recreation.

### Locating Soils

All the soils of Edwards 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 windbreak group and range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil

map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

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

*Foresters and others* can refer to the section "Management of Windbreaks," 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 "Management for Fish and Wildlife."

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

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

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

*Newcomers* in Edwards 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 section "Additional Facts About the County."

Cover: A terraced, contour-farmed wheatfield on Harney silt loam, 1 to 3 percent slopes.

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# SOIL SURVEY OF EDWARDS COUNTY, KANSAS

By WILLIAM E. ROTH, SOIL CONSERVATION SERVICE

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

**E**DWARDS COUNTY is in the south-central part of Kansas (fig. 1). It occupies about 614 square miles, or 392,960 acres. Kinsley, the county seat, has a population of about 2,500.

Farming and ranching are the main enterprises in the county. Wheat, grain sorghum, and cattle are the main sources of income. The oil and natural gas industries are the most extensive nonfarm enterprises.

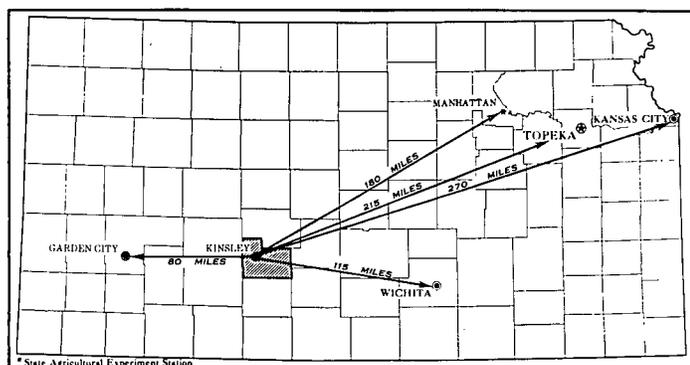


Figure 1.—Location of Edwards County in Kansas.

## How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Edwards 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.

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. Attica and Naron, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

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

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

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

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit, a soil complex, is shown on the soil map of Edwards County.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Attica-Carwile fine sandy loams is an example.

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

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

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

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present 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 Edwards 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 seven soil associations in Edwards County are described in the following pages. A soil in this county may be identified by a different name in a recently published soil survey of an adjacent county. Such differences in name result from changes in the concept of soil classification that have occurred since publication.

### 1. Harney association

*Deep, nearly level to gently sloping, well-drained, loamy soils on uplands*

This association is nearly level except along drainageways (fig. 2). It makes up about 18 percent of the county and is about 85 percent Harney soils. The rest is Holdrege, Tobin, Uly, and Ness soils, and areas of Breaks and Alluvial land.

Harney soils formed in windblown material. Their surface layer is silt loam about 10 inches thick. The subsoil is silty clay loam about 32 inches thick. The substratum is silt loam.

Holdrege and Uly soils have slopes of 1 to 6 percent. They are on uplands adjacent to the Arkansas River Valley. The nearly level Tobin soils are on flood plains. Ness soils are in shallow depressions that are ponded after heavy rainfall. Areas of Breaks and Alluvial land are on the sides and the narrow flood plains of intermittent drainageways.

This association is used mainly for wheat and sorghum. Soil blowing is a hazard in nearly level areas. Both soil blowing and water erosion are hazards in sloping areas.

### 2. Harney-Uly association

*Deep, gently sloping to sloping, well-drained, loamy soils on uplands*

This association is dominantly gently sloping to sloping and is cut by intermittent drainageways. It makes up about 6 percent of the county. It is about 67 percent Harney soils, 10 percent Uly soils, and about 23 percent Breaks and Alluvial land and Campus, Canlon, Tobin, and Holdrege soils. The Harney and Uly soils formed in silty windblown material.

Harney soils have a surface layer of silt loam about 10 inches thick. The subsoil is silty clay loam about 32 inches thick. The substratum is silt loam.

Uly soils have a surface layer of silt loam about 8 inches thick. The subsoil is silty clay loam about 22 inches thick. The substratum is silt loam.

Breaks and Alluvial land are on the sides and the narrow flood plains of intermittent drainageways. Campus and Canlon soils are along drainageways and have slopes of 6 to 15 percent. The nearly level Tobin soils are on flood plains. Holdrege soils have slopes of 1 to 6 percent and are on uplands adjacent to the Arkansas River Valley.

About 65 percent of this association is used for wheat and sorghum. About 35 percent is in native grass. Water erosion and soil blowing are the major hazards in cultivated areas.

### 3. Pratt-Tivoli association

*Deep, hummocky and dunny, well-drained and excessively drained, sandy soils on uplands*

This association is characterized by hummocky and dunny topography. It makes up about 13 percent of the county. It is about 60 percent Pratt soils and 40 percent Tivoli soils.

Pratt and Tivoli soils formed in windblown sand. Pratt soils are loamy fine sand to a depth of 60 inches. Tivoli soils are fine sand to a depth of 60 inches.

Practically all this association is in native grass. The soils are highly susceptible to blowing unless adequately protected.

### 4. Attica-Pratt-Carville association

*Deep, nearly level to undulating, well-drained and somewhat poorly drained, loamy and sandy soils on uplands*

This association is dominantly undulating but includes nearly level to slightly depressional areas (fig. 3). It

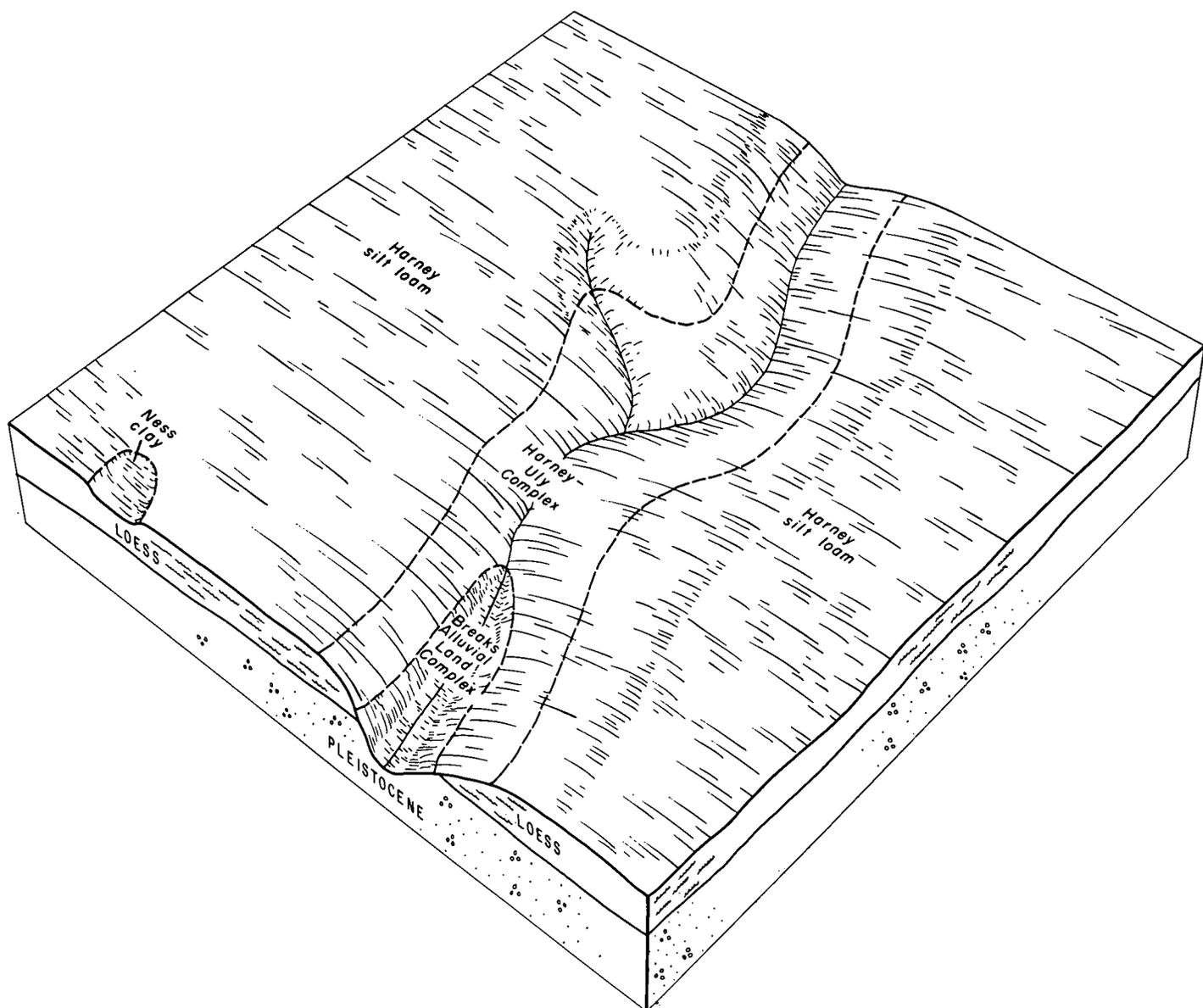


Figure 2.—Typical pattern of soils in association 1.

makes up about 23 percent of the county. It is about 49 percent Attica soils, 35 percent Pratt soils, 9 percent Carwile soils, and about 7 percent Naron, Brazos, and Plevna soils. The Attica, Pratt, and Carwile soils formed in wind-blown sand or old alluvium.

Attica soils have a surface layer of fine sandy loam about 11 inches thick. The subsoil is fine sandy loam about 19 inches thick. The substratum is loamy fine sand.

Pratt soils are loamy fine sand to a depth of 60 inches. The surface layer is about 13 inches thick, and the subsoil about 17 inches thick.

Carwile soils have a surface layer of fine sandy loam about 11 inches thick. The subsoil is light sandy clay loam in the upper 6 inches and clay in the lower 25 inches. The substratum is clay loam.

Naron soils are on uplands and have slopes of 0 to 3 percent. Brazos soils are on uplands and have slopes of 0 to 1 percent. Plevna soils are in concave areas on lowlands and in depressions on uplands.

This association is used mainly for wheat and sorghum. Soil blowing is the major hazard. Slow surface drainage is a hazard in low areas.

##### 5. *Farnum-Lubbock association*

*Deep, nearly level, well-drained, loamy soils on uplands*

This association is dominantly nearly level but is gently sloping in some areas. It makes up about 11 percent of the county. It is about 55 percent Farnum soils, 24 percent Lubbock soils, and about 21 percent Tabler, Carwile, Ness,

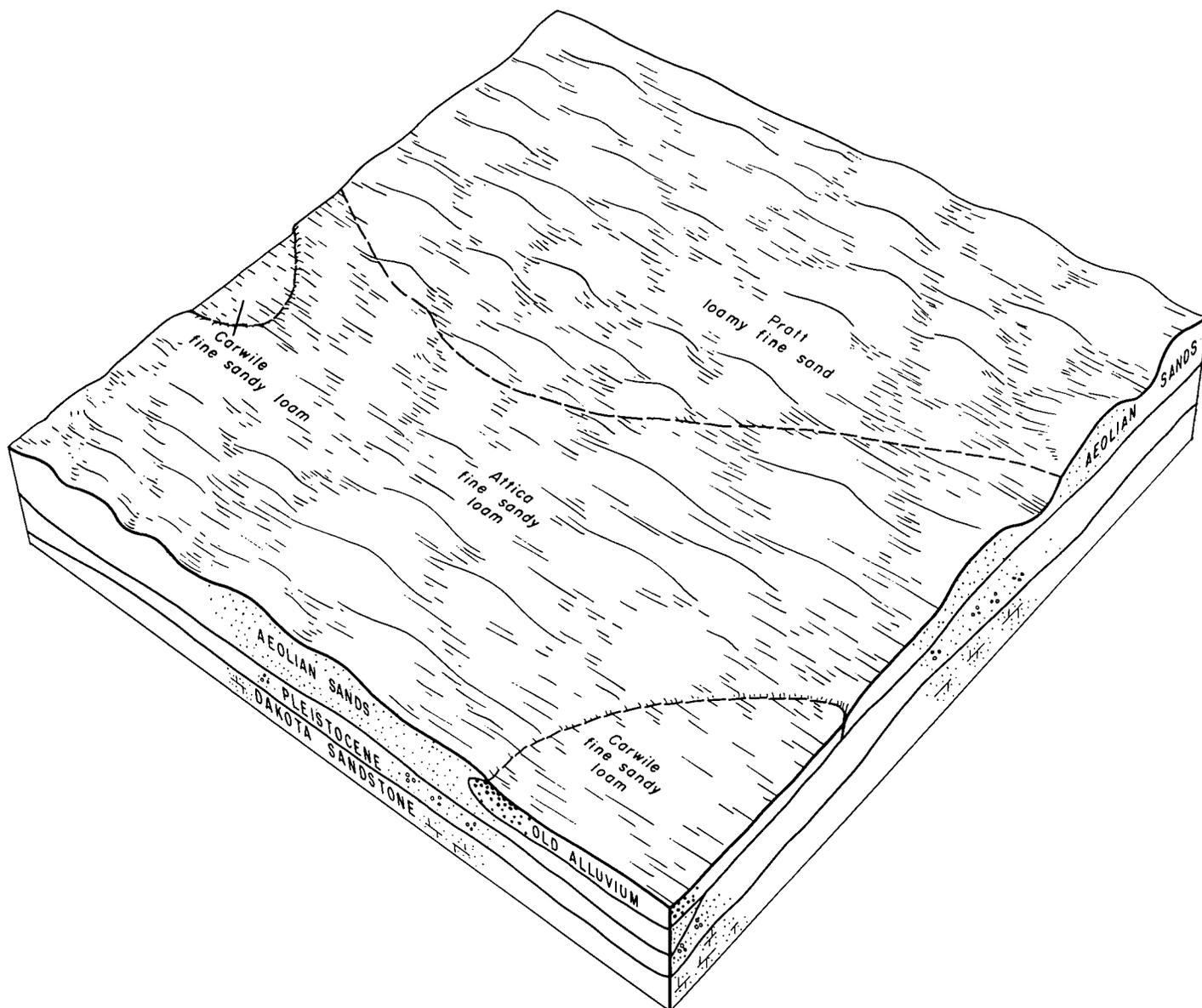


Figure 3.—Typical pattern of soils in association 4.

and Naron soils. The Farnum and Lubbock soils formed in old alluvium.

Farnum soils have a surface layer of loam about 8 inches thick. The subsoil, about 29 inches thick, is loam in the upper part and clay loam in the lower part. The substratum is loam.

Lubbock soils have a surface layer of silt loam about 10 inches thick. The subsoil, about 34 inches thick, is 6 inches of silty clay loam, 16 inches of clay, and 12 inches of silty clay loam. The substratum is silty clay loam.

Tabler, Carwile, Ness, and Naron soils are nearly level. All are on uplands. Ness soils are in depressions that are ponded. Naron soils are on ridges and have slopes of 1 to 3 percent.

This association is used mainly for wheat and sorghum. Soil blowing and water erosion are the major hazards.

#### 6. Naron-Carwile association

*Deep, nearly level to gently sloping, well-drained and somewhat poorly drained, loamy soils on uplands*

This association is dominantly nearly level, but it also includes slightly depressional areas. It makes up about 17 percent of the county. It is about 73 percent Naron soils, 15 percent Carwile soils, and 12 percent Slickspots and Attica, Farnum, and Tabler soils. The Naron and Carwile soils formed in windblown sand or old alluvium. A typical pattern of soils in this association and in association 5 is shown in figure 4.

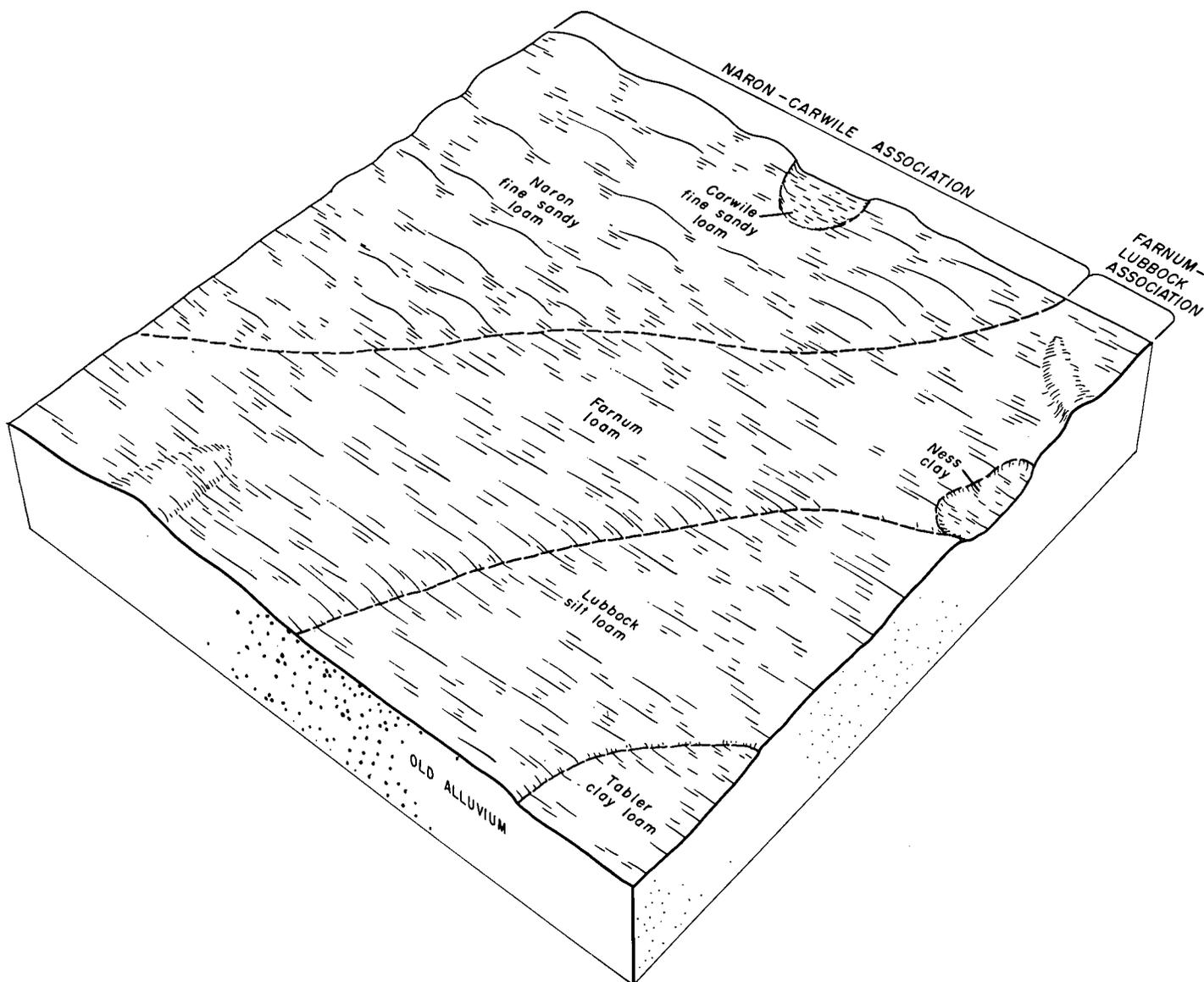


Figure 4.—Soils of associations 5 and 6.

Naron soils have a surface layer of fine sandy loam about 12 inches thick. The subsoil is about 48 inches thick. It is sandy clay loam in the upper part and heavy fine sandy loam in the lower part.

Carwile soils have a surface layer of fine sandy loam about 11 inches thick. The subsoil is light sandy clay loam in the upper 6 inches and clay in the lower 25 inches. The substratum is clay loam.

Attica, Farnum, and Tabler soils and Slickspots are on uplands. Attica soils have slopes of 1 to 3 percent. The others are nearly level.

This association is used mainly for wheat and sorghum. Soil blowing is the major hazard. Slow surface drainage is a hazard in low areas. Slickspots have a hard crust on the surface when dry and are very soft when wet. In these

areas cultivation is difficult and seedling emergence is poor.

#### 7. Zenda-Hord-Waldeck association

*Mainly deep, nearly level, somewhat poorly drained and well-drained loamy soils on bottom lands*

This association is nearly level. It occupies about 12 percent of the county. It is about 26 percent Zenda soils, 22 percent Hord soils, and 12 percent Waldeck soils. All formed in loamy alluvium. The rest of the association is Canadian, Platte, Lesho, Las Animas, and Tabler soils, and Slickspots. The relationship of this association to associations 1 and 3 is shown in figure 5.

Zenda soils are on low terraces. They have a surface layer of clay loam about 15 inches thick. The next layer is

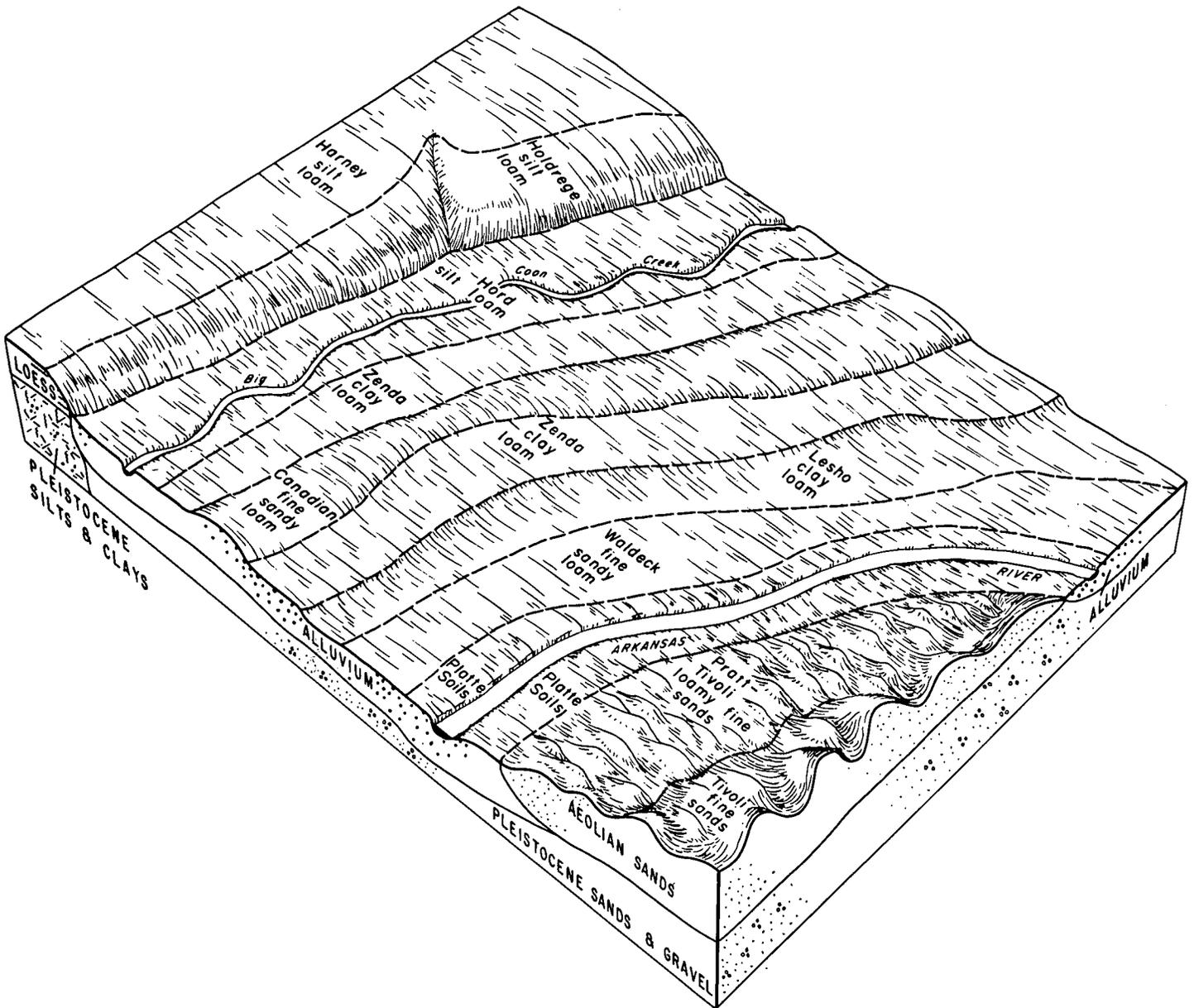


Figure 5.—Pattern of soils in associations 1, 3, and 7. Association 1 is to the left of Big Coon Creek. Association 7 extends from Big Coon Creek to the Arkansas River. Association 3 is to the right of the Arkansas River.

clay loam about 9 inches thick. The substratum is 16 inches of clay loam. It is underlain by 15 inches of sandy loam. Below this is sand.

Hord soils are on terraces. They have a surface layer of silt loam about 17 inches thick. Their subsoil is silt loam about 13 inches thick. The substratum is silt loam.

Waldeck soils are on flood plains. They have a surface layer of fine sandy loam about 10 inches thick. The next layer is sandy loam about 18 inches thick. The underlying material is sand.

Canadian, Platte, Lesho, Las Animas, and Tabler soils are nearly level. Platte and Lesho soils are on the flood plain adjacent to the Arkansas River. Canadian and Las Animas soils are on terraces. Tabler soils and Slickspots are on uplands in the vicinity of Big Coon Creek.

This association is used mainly for wheat and sorghum. Areas near the Arkansas River are in native grass. Wetness and soil blowing are the main hazards. The soils on flood plains have a fluctuating water table. Slickspots have a hard crust on the surface when dry and are very soft when wet. In these areas cultivation is difficult and seedling emergence is poor.

### Effects of Erosion

Erosion is the wearing away of the land surface, mainly by wind, running water, and gravity. The effects of erosion on the soils of Edwards County are described in the following paragraphs. These paragraphs deal with accel-

erated soil erosion, not with the gradual, normal process of soil removal, known as geologic erosion, that takes place in an undisturbed environment. Accelerated erosion is the increased rate of soil removal brought about by man through changes in the natural cover or in the condition of the soils.

Some effects of erosion are permanent; the soil is damaged to the extent that a change in use and management is required. Other effects are temporary, but impair the use of the soil until restorative measures are taken. Such measures include replanting crops, reseeding rangeland, and emergency tillage.

Wind and water are the main causes of soil erosion in Edwards County. Wind erosion is a hazard when the soils are dry and unprotected, and it becomes increasingly serious during recurring periods of drought. Strong winds and limited vegetative growth that are characteristic during periods of drought are conducive to widespread soil blowing. The soils that have a silty or clayey surface layer are more resistant to blowing than those that have a sandy surface layer. Maintaining a cloddy surface is easier on these silty and clayey soils than on sandy soils. Keeping the surface sufficiently cloddy or protecting the soils with a cover of growing plants or plant residue helps to restrict blowing.

Water erosion is a hazard on all the sloping, silty soils that are cultivated. Runoff and erosion occur during hard, dashing thunderstorms when rain falls faster than the water can enter the soil. In places runoff removes thin layers of soil material, more or less evenly, from the entire surface and causes sheet erosion. The evidence of sheet erosion is obliterated if the soils are cultivated; little evidence of destructive erosion is apparent until the material in the subsoil is exposed. Water tends to concentrate, however, and small channels develop in a short time. Unless the area is protected by vegetation or by practices that slow down or decrease runoff, the channels continue to increase in size with each successive rain. They are likely to form gullies too large to be smoothed over by normal tillage. The eroded material is sometimes deposited at the base of the slope, where it damages crops and other soils. Gully erosion is more evident in areas that have a well-defined pattern. Channels have been cut into the soils where water has concentrated. Plowing, which has removed the native vegetation, has caused accelerated erosion in the natural drainageways. In many places trails made by cattle through areas of native grass have eroded to a depth of several inches.

During fieldwork on this soil survey, observations of the effects of erosion were made. Some of the following results of soil blowing were observed.

Small, low hummocks and drifts of soil material form in cultivated fields, in fence rows, and in areas of native grass adjacent to cultivated fields where active soil blowing is in progress. In places, especially in sandy soils, the drifts in fence rows can be several feet high. These hummocks and drifts will blow again unless they are smoothed out and the soils are tilled to provide a rough surface that is resistant to erosion.

Soil material drifts from actively eroding cultivated fields onto adjacent rangeland and damages or destroys the native vegetation. No permanent damage occurs, but the use of the range is impaired until

the grass has been reestablished, either by deferred grazing or by reseeding.

During drought, overuse of some of the very sandy, nonarable rangeland results in the loss of protective vegetation and in severe soil blowing. These areas are permanently damaged, and their value for grazing is greatly reduced. Damage to cultivated crops and grass on adjacent areas is caused by the drifting sand. The sandy sediments also increase the hazard of blowing on the soils on which they are deposited.

Erosion is serious, not only because of the permanent modification of the soils, but also because of the short-time damage to crops and forage.

Replanting of crops, reseeding of rangeland, and emergency tillage and land smoothing correct most of the temporary effects of erosion, but these practices are time consuming and costly.

Measures needed to control erosion vary according to the kind of soil, the degree of slope, and the land use. Such measures are indicated for each capability unit in the section, "Use of the Soils for Crops and Pasture." For more specific and detailed information, consult a representative of the Soil Conservation Service.

## *Descriptions of the Soils*

This section describes the soil series and mapping units in Edwards County. Each soil series is described in considerable detail, and then, briefly, each mapping unit 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 unit 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, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, the colors given in the descriptions are those of a dry soil.

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

Following the name of each mapping unit is a symbol in parentheses. This symbol 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 windbreak group in which the mapping unit has been placed. The page for the description of each capability unit, range site, and windbreak group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the

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

Soil	Area		Extent
	Acres		
Attica fine sandy loam, 0 to 1 percent slopes.....	4,980		1.3
Attica fine sandy loam, 1 to 3 percent slopes.....	35,070		9.0
Attica-Carwile fine sandy loams.....	8,820		2.2
Blown-out land.....	400		.1
Breaks-Alluvial land complex.....	5,110		1.3
Campus-Canlon complex.....	310		.1
Canadian fine sandy loam.....	4,090		1.0
Canadian fine sandy loam, sandy subsoil.....	1,750		.4
Carwile fine sandy loam.....	18,470		4.7
Carwile-Slickspots complex.....	2,380		.6
Farnum loam, 0 to 1 percent slopes.....	21,850		5.6
Farnum loam, 1 to 3 percent slopes.....	2,740		.7
Harney silt loam, 0 to 1 percent slopes.....	47,880	12.2	
Harney silt loam, 1 to 3 percent slopes.....	16,320	4.2	
Harney silt loam, 3 to 6 percent slopes.....	4,440	1.1	
Harney-Uly complex, 1 to 3 percent slopes.....	1,410	.3	
Harney-Uly complex, 3 to 6 percent slopes.....	9,730	2.5	
Holdrege silt loam, 1 to 3 percent slopes.....	2,290	.6	
Holdrege silt loam, 3 to 6 percent slopes.....	1,150	.3	
Hord silt loam.....	10,520	2.7	
Las Animas loamy fine sand.....	1,480	.4	
Lesho clay loam.....	4,610	1.2	
Lubbock silt loam.....	10,610	2.7	
Naron loamy fine sand, 0 to 1 percent slopes.....	730	.2	
Naron fine sandy loam, 0 to 1 percent slopes.....	31,480	8.0	
Naron fine sandy loam, 1 to 3 percent slopes.....	20,890	5.3	
Ness clay.....	810	.2	
Platte soils.....	4,750	1.2	
Plevna fine sandy loam.....	730	.2	
Pratt loamy fine sand, hummocky.....	18,180	4.6	
Pratt loamy fine sand, undulating.....	26,540	6.8	
Pratt-Brazos loamy fine sands.....	1,550	.4	
Pratt-Tivoli loamy fine sands.....	26,160	6.7	
Tabler clay loam.....	7,930	2.0	
Tabler-Slickspots complex.....	2,980	.7	
Tivoli fine sand.....	12,040	3.1	
Tobin silt loam.....	2,490	.6	
Waldeck fine sandy loam.....	3,340	.8	
Waldeck loam.....	2,380	.6	
Zenda clay loam.....	9,560	2.4	
Zenda clay loam, saline.....	2,000	.5	
Zenda-Slickspots complex.....	1,210	.3	
Arkansas River.....	800	.2	
Total acreage.....	392,960	100.0	

terminology and methods of soil mapping can be obtained from the Soil Survey Manual (9).<sup>1</sup>

A given soil series in this county may be identified by a different name in a recently published soil survey of an adjacent county. Such differences in name result from changes in the concepts of soil classification that have occurred since publication. The characteristics of the soil series described in this county are considered to be within the range defined for that series. In those instances where a soil series has one or more features outside the defined range, the differences are explained.

### Attica Series

The Attica series consists of deep, well-drained, loamy soils that formed in eolian sands. Slopes are 0 to 3 percent.

In a representative profile the surface layer is grayish-

brown fine sandy loam about 11 inches thick. The subsoil is friable fine sandy loam about 19 inches thick. It is dark grayish brown in the upper part and brown in the lower part. The substratum is brown loamy fine sand.

Attica soils have moderately rapid permeability and moderate available water capacity.

These soils are well suited to wheat and sorghum. Fertility is medium. Soil blowing is a hazard. The native vegetation is chiefly mid and tall grasses.

Representative profile of Attica fine sandy loam, 1 to 3 percent slopes, in a cultivated field, 1,750 feet north and 150 feet west of the southeast corner of sec. 26, T. 25 S., R. 18 W.:

A1—0 to 11 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; soft when dry, very friable when moist; slightly acid; clear, smooth boundary.

B21t—11 to 17 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; slightly more clayey than A1 horizon; weak, medium, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.

B22t—17 to 30 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

C—30 to 60 inches, brown (10YR 5/3) heavy loamy fine sand, dark brown (10YR 4/3) when moist; massive; soft when dry, very friable when moist; neutral.

The A1 horizon ranges from 10 to 15 inches in thickness and from grayish brown to dark grayish brown in color. It is fine sandy loam to heavy loamy fine sand in the upper 6 inches and fine sandy loam in the lower part. The B2 horizon ranges from 15 to 30 inches in thickness and from dark grayish brown to pale brown in color. The C horizon is fine sandy loam to loamy fine sand.

Attica soils are near Pratt and Naron soils. They are more clayey in the A and B horizons than Pratt soils. They are less clayey in the B horizon than Naron soils.

**Attica fine sandy loam, 0 to 1 percent slopes (Aa).—**This soil is on uplands.

Included with this soil in mapping were small areas of Naron and Carwile soils and small areas of Attica soils that have slopes of 1 to 3 percent. Small depressional areas and limy spots are shown by spot symbols on the soil map. Each symbol represents an area about 1 to 5 acres in size.

Nearly all the acreage of this Attica soil is in wheat and sorghum. Small acreages near farmsteads are in native grass.

Controlling soil blowing and maintaining the supply of organic matter are the main concerns in management. Capability unit II-2, dryland; capability unit IIs-1, irrigated; Sandy range site; Sandy Upland windbreak group.

**Attica fine sandy loam, 1 to 3 percent slopes (Ab).—**This soil is on uplands. It has the profile described as representative for the series.

Included with this soil in mapping were small areas of Naron, Pratt, and Carwile soils. Small depressional areas are shown by spot symbols on the soil map. Each symbol represents an area about 1 to 5 acres in size.

Nearly all the acreage of this Attica soil is in wheat and sorghum. Small acreages near farmsteads are in native grass.

Controlling soil blowing and maintaining the supply of organic matter are the main concerns in management. Capability unit IIe-3, dryland; capability unit IIe-2, ir-

<sup>1</sup>Numbers in parentheses refer to Literature Cited, page 62.

rigated; Sandy range site; Sandy Upland windbreak group.

**Attica-Carwile fine sandy loams** (0 to 3 percent slopes) (Ac).—This mapping unit is about 75 percent Attica fine sandy loam and 25 percent Carwile fine sandy loam. These soils are on uplands. The Attica soil is on convex ridges, and the Carwile soil is in concave areas between the ridges. Each soil is described under the heading for its respective series.

Included in mapping were small areas of Naron, Pratt, and Tabler soils. Small depressional areas are shown by spot symbols on the map. Each symbol represents an area about 1 to 5 acres in size.

Nearly all the acreage of this mapping unit is in wheat and sorghum. Small acreages near farmsteads are in native grass.

Controlling soil blowing, maintaining the supply of organic matter, and eliminating wetness in concave areas are the main management needs. Capability unit IIe-3, dryland; capability unit IIe-2, irrigated; Sandy range site. Attica soil in Sandy Upland windbreak group. Carwile soil in Clayey Upland windbreak group.

## Blown-Out Land

Blown-out land (0 to 20 percent slopes) (Bd) is in the sandhills. It consists of hills, ridges, and cone-shaped dunes of fine sand. About 85 to 95 percent of the acreage has a cover of annual weeds and thickets of sandhill plum. The areas have not been stable long enough for native grasses to become established. About 5 to 15 percent of the acreage consists of barren active dunes that are continually shifted by the wind.

Blown-out land is excessively drained, has very low available water capacity, and has rapid permeability.

Blown-out land is used chiefly as range, but it has little value for grazing. It has low fertility and is highly susceptible to blowing. Capability unit VIIe-1, dryland; Choppy Sands range site; no irrigated capability unit or windbreak group.

## Brazos Series

The Brazos series consists of deep, somewhat excessively drained sandy soils that formed in old alluvium. Slopes are 0 to 1 percent.

In a representative profile the surface layer is grayish-brown loamy fine sand about 5 inches thick. The next layer is yellowish-brown, loose loamy sand about 9 inches thick. The substratum is brownish-yellow and light yellowish-brown sand.

Brazos soils have rapid permeability and very low available water capacity.

These soils are well suited to native grasses. They are low in fertility and are susceptible to blowing. The native vegetation is chiefly mid and tall grasses.

Representative profile of Brazos loamy fine sand in an area of Pratt-Brazos loamy fine sands in native grass, 750 feet south and 300 feet west of the northeast corner of sec. 23, T. 26 S., R. 17 W.:

A1—0 to 5 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; single grain; loose when moist and dry; neutral; clear, smooth boundary.

AC—5 to 14 inches, yellowish-brown (10YR 5/4) loamy sand, dark yellowish brown (10YR 4/4) when moist; single grain; loose when moist and dry; slightly acid; clear, smooth boundary.

C1—14 to 30 inches, brownish-yellow (10YR 6/6) sand, yellowish brown (10YR 5/6) when moist; single grain; loose when moist and dry; slightly acid; gradual, smooth boundary.

C2—30 to 60 inches, light yellowish-brown (10 YR 6/4) sand, yellowish brown (10YR 5/4) when moist; single grain; loose when moist and dry; medium acid.

The A1 horizon ranges from 4 to 8 inches in thickness, from grayish brown to pale brown in color, and from loamy sand and fine sandy loam in texture. The AC horizon ranges from 6 to 12 inches in thickness and from brown to light yellowish brown in color. The C horizon is loose sand. In places it contains a few fine pebbles in the lower part. The depth to sand ranges from 10 to 20 inches. Reaction in all horizons ranges from medium acid to neutral.

Brazos soils occur in the same landscape as Pratt soils and are mapped only with those soils. In contrast with Pratt soils, they do not have a B horizon, they have less clay below the A horizon, and they are shallow over sand.

## Breaks-Alluvial Land

Breaks-Alluvial land complex (0 to 15 percent slopes) (Bk) is on uplands along intermittent drainageways. It is about 75 percent Breaks and 25 percent narrow alluvial flood plain.

Included in mapping were small areas of Harney, Uly, Campus, Canlon and Tobin soils. Eroded spots and rock outcrops are shown on the map by spot symbols. Each symbol represents an area about 1 to 5 acres in size.

Breaks ranges from loam to silty clay loam in texture and from dark grayish brown to very pale brown in color. The depth to calcareous material is 0 to 12 inches. The slope gradient is 6 to 15 percent.

Alluvial land, the flood plain, is less than 125 feet wide. The soils are silt loam to silty clay loam in texture and range from brown to very dark grayish brown in color. In most places the depth to calcareous material is 12 to 24 inches. In some the material is calcareous at the surface.

Breaks-Alluvial land complex is well drained and has high available water capacity and moderate permeability.

The principal use is range. The vegetation is mid and short grasses on Breaks and mid and tall grasses on Alluvial land. The erosion hazard is very severe in cultivated areas. Capability unit VIe-1, dryland; Loamy Upland windbreak group; no irrigated capability unit. Breaks in Limy Upland range site. Alluvial land in Loamy Lowland range site.

## Campus Series

The Campus series consists of moderately deep, well-drained, calcareous, loamy soils that formed in outwash sediments of the Ogallala Formation. Slopes range from 6 to 15 percent.

In a representative profile the surface layer is dark grayish-brown loam about 8 inches thick. The next layer is grayish-brown, friable clay loam, about 9 inches thick, and contains many caliche fragments. The substratum is light brownish-gray clay loam. White, hard or semihard caliche is at a depth of about 24 inches.

Campus soils have moderate permeability and low available water capacity. They are calcareous throughout.

These soils are well suited to native grasses. If cultivated, they are highly susceptible to erosion. Fertility is medium. The native vegetation is chiefly mid and short grasses.

Representative profile of Campus loam in an area of Campus-Canlon complex in native grass, 975 feet south and 2,500 feet west of the northeast corner of sec. 7, T. 23 S., R. 20 W.:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous, few scattered caliche fragments; mildly alkaline; gradual, smooth boundary.

AC—8 to 17 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; strong, medium, granular structure; hard when dry, friable when moist; calcareous, many caliche fragments; moderately alkaline; gradual, smooth boundary.

Cca—17 to 24 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; highly calcareous; moderately alkaline; clear, wavy boundary.

R—24 to 60 inches, white (10YR 8/2), hard or semihard caliche, light gray (10YR 7/2) when moist.

The A1 horizon ranges from loam to light clay loam in texture, from 5 to 9 inches in thickness, and from dark grayish brown to grayish brown in color. The AC horizon ranges from 6 to 12 inches in thickness and from grayish brown to pale brown in color. The Cca horizon ranges from 6 to 12 inches in thickness and from light brownish gray to very pale brown in color. It is more than 25 percent calcium carbonate.

Campus soils occur in the same landscape as Canlon soils and are mapped only with those soils. They are deeper over caliche than Canlon soils.

**Campus-Canlon complex** (6 to 15 percent slopes) (Cc).—This mapping unit is about 75 percent Campus loam and 25 percent Canlon loam. These soils are on uplands. They are moderately deep to shallow over caliche.

Included in mapping were small areas of Breaks-Alluvial land complex and of soils that are shallow over limestone and chalky shale.

Nearly all the acreage of this mapping unit is in native grasses. Controlling erosion is the main concern in management. Capability unit VIe-2, dryland; no irrigated capability unit or windbreak group. Campus soils in Limy Upland range site. Canlon soils in Shallow Limy range site.

## Canadian Series

The Canadian series consists of well-drained, loamy soils that are moderately deep to deep over sand. These soils formed in alluvium. Slopes are 0 to 1 percent.

In a representative profile the surface layer is dark grayish-brown fine sandy loam about 10 inches thick. The next layer is dark-brown, friable fine sandy loam about 9 inches thick. The substratum is pale-brown fine sandy loam.

Canadian soils have moderately rapid permeability and moderate available water capacity.

These soils are well suited to wheat and sorghum. They are susceptible to blowing. Fertility is medium. The native vegetation is chiefly mid and tall grasses.

Representative profile of Canadian fine sandy loam in a cultivated field, 1,200 feet north and 400 feet east of southwest corner of sec. 17, T. 26 S., R. 20 W.:

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; moderately alkaline; clear, smooth boundary.

AC—10 to 19 inches, dark-brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; moderate, medium, granular structure; hard when dry, friable when moist; mildly alkaline; clear, smooth boundary.

C—19 to 60 inches, pale-brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, medium, granular structure; hard when dry, friable when moist; calcareous; moderately alkaline.

The A1 horizon ranges from 8 to 20 inches in thickness, from dark grayish brown to brown in color, and from fine sandy loam to loam in texture. The AC horizon ranges from 8 to 24 inches in thickness and from dark grayish brown to pale brown in color. Reaction in the A1 and AC horizons ranges from mildly alkaline to moderately alkaline. The C horizon ranges from fine sandy loam to loamy fine sand in texture. The depth to carbonates ranges from 15 to 30 inches.

Canadian soils occur in the same landscape as Hord and Waldeck soils. They are more sandy in all horizons than Hord soils. They are deeper over sand than Waldeck, and they are not mottled in the AC horizon.

**Canadian fine sandy loam** (0 to 1 percent slopes) (Cd).—This soil is on stream terraces. It has the profile described as representative for the series.

Included in mapping were small areas of Canadian fine sandy loam, sandy subsoil, and of Hord soils.

Nearly all the acreage of this Canadian soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

The main limitations are soil blowing and low organic-matter content. Capability unit IIe-2, dryland; capability unit IIs-1, irrigated; Sandy Terrace range site; Sandy Lowland windbreak group.

**Canadian fine sandy loam, sandy subsoil** (0 to 1 percent slopes) (Cf).—This soil is on the lowland. It has a profile similar to the one described as representative for the series, but sand is at a depth of 24 to 40 inches and, on convex ridges, coarse sand or fine gravel occurs in all layers of the soil.

Included with this soil in mapping were small areas of Lesho, Waldeck, and Canadian soils.

Nearly all the acreage of this Canadian soil is in wheat and sorghum.

The main limitations are low available water capacity, low organic-matter content, and soil blowing. Capability unit IIIs-1, dryland; capability unit IIIs-1, irrigated; Sandy Terrace range site; Sandy Lowland windbreak group.

## Canlon Series

The Canlon series consists of shallow, well-drained, calcareous, loamy soils that formed in outwash sediments of the Ogallala Formation. These soils occupy small areas along drainageways and have slopes of 6 to 15 percent.

In a representative profile the surface layer is grayish-brown loam about 4 inches thick. The next layer is very pale brown, friable loam about 7 inches thick. White, hard or semihard caliche is at a depth of 11 inches.

Canlon soils have moderate permeability and very low available water capacity. They are calcareous throughout.

These soils are well suited to native grasses. They are medium in fertility. They are droughty and are highly

susceptible to erosion if cultivated. The native vegetation is chiefly mid and short grasses.

Representative profile of Canlon loam in an area of Campus-Canlon complex in native grass, 1,200 feet north and 1,800 feet west of southeast corner of sec. 7, T. 23 S., R. 20 W.:

- A1—0 to 4 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; calcareous, many caliche fragments; moderately alkaline; clear, smooth boundary.
- ACca—4 to 11 inches, very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; calcareous, many caliche fragments; moderately alkaline; clear, wavy boundary.
- R—11 to 60 inches, white (10YR 8/2), hard or semihard caliche, light gray (10YR 7/2) when moist.

The A1 horizon ranges from 3 to 6 inches in thickness, from grayish brown to pale brown in color, and from loam to light clay loam in texture. The AC horizon ranges from 4 to 7 inches in thickness, from pale brown to very pale brown in color, and from loam to clay loam in texture. Depth to the R horizon ranges from 10 to 20 inches.

Canlon soils occur in the same landscape as Campus soils and are mapped only with those soils. They are shallower over caliche than Campus soils.

## Carwile Series

The Carwile series consists of deep, somewhat poorly drained, loamy soils that formed in old alluvium. Slopes are 0 to 1 percent.

In a representative profile the surface layer is dark grayish-brown fine sandy loam about 11 inches thick. The upper part of the subsoil is friable light sandy clay loam about 6 inches thick. It is grayish brown mottled with reddish yellow in the lower 3 inches. The lower part of the subsoil is very firm clay about 25 inches thick. It is light brownish gray distinctly mottled with strong brown. The substratum is light brownish-gray clay loam.

Carwile soils have slow surface drainage, slow permeability, high available water capacity, and a seasonal high water table.

These soils are well suited to wheat and sorghums. They are susceptible to blowing. Fertility is medium. The native vegetation is mid and tall grasses.

Representative profile of Carwile fine sandy loam in a cultivated field, 1,600 feet south and 850 feet east of northwest corner of sec. 22, T. 26 S., R. 17 W.:

- A1—0 to 11 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; hard when dry, very friable when moist; medium acid; clear, smooth boundary.
- B1—11 to 17 inches, grayish-brown (10YR 5/2) light sandy clay loam, very dark grayish brown (10YR 3/2) when moist; few, fine, faint, reddish-yellow mottles in lower 3 inches; moderate, medium, granular structure; hard when dry, friable when moist; slightly acid; clear, wavy boundary.
- IIB2t—17 to 42 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) when moist; few, fine, distinct, strong-brown mottles; weak to moderate, medium, blocky structure; very hard when dry, very firm when moist; moderately alkaline; gradual, wavy boundary.
- IIC—42 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) when moist; common, fine, distinct, reddish-yellow and strong-brown

mottles; massive; hard when dry, firm when moist; moderately alkaline.

The A1 horizon ranges from 6 to 12 inches in thickness and from very dark grayish brown to grayish brown in color. In the upper 6 inches it ranges from fine sandy loam to heavy loamy fine sand, and in the lower part from fine sandy loam to light loam. In reaction it ranges from medium acid to neutral. The B horizon ranges from 16 to 36 inches in thickness. In the upper part it ranges from dark grayish brown to brown in color and from heavy fine sandy loam to sandy clay loam in texture. In the lower part it ranges from dark gray to light gray in color and from clay loam to clay in texture. In reaction the B horizon ranges from slightly acid to moderately alkaline. The depth to mottled material ranges from 12 to 20 inches. The depth to the IIB2 horizon ranges from 16 to 24 inches. The IIC horizon ranges from clay loam to loamy sand.

Carwile soils occur in the same landscape as Farnum, Plevna, and Tabler soils. They have a more clayey B horizon than Farnum and Plevna soils. They have a sandier A horizon and are deeper over clay than Tabler soils.

**Carwile fine sandy loam** (0 to 1 percent slopes) (Cr).—This soil is on uplands. It has the profile described as representative for the Carwile series.

Included with this soil in mapping were small areas of Tabler, Attica, and Naron soils. Small depressional areas, limy spots, and Slickspots are shown on the map by spot symbols. Each depression and limy spot symbol represents an area about 1 and 5 acres in size, and each Slickspots symbol an area about 1 to 2 acres in size.

Nearly all the acreage of this Carwile soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

The main limitations are slow surface drainage, soil blowing, and an inadequate supply of organic matter. Capability unit IIw-2, dryland; capability unit IIw-2, irrigated; Sandy range site; Clayey Upland windbreak group.

**Carwile-Slickspots complex** (0 to 1 percent slopes) (Cs).—This mapping unit is on uplands. It is about 90 percent Carwile fine sandy loam and 10 percent Slickspots. Slickspots occur as small areas throughout areas of the Carwile soil.

Included in mapping were areas of Naron and Attica soils and of soils that have some characteristics of both Carwile soils and Slickspots.

The profile of the Carwile soil is similar to the one described as representative for the Carwile series.

Slickspots is puddled after a heavy rain. It has a high content of sodium and is slightly to moderately saline. The surface layer ranges from fine sandy loam to clay loam in texture and from 5 to 15 inches in thickness. The uppermost 1 or 2 inches is light colored and forms a crust when dry. The next layer ranges in texture from sandy clay loam to clay and has subangular blocky or blocky structure or is massive. It is gray to pale brown in color and is mottled in most places. The underlying material ranges from fine sandy loam to clay loam and is massive.

Nearly all the acreage of this mapping unit is used for wheat and sorghum. The hard crust and the clods on Slickspots make it difficult to obtain adequate stands of common crops. Crop growth is uneven also because the degree of salinity varies.

The main limitations are alkali and salinity, slow surface drainage, soil blowing, low organic-matter content, and poor tilth. Capability unit IVs-1, dryland; no irrigated capability unit. Carwile soil in Sandy range site

and Clayey Upland windbreak group. Slickspots in Saline Upland range site; no windbreak group.

## Farnum Series

The Farnum series consists of deep, well-drained, loamy soils that formed in wind-modified old alluvium. Slopes are 0 to 3 percent.

In a representative profile the surface layer is dark grayish brown loam about 8 inches thick. The subsoil is about 29 inches thick. It is friable, dark grayish-brown loam in the upper part and firm, dark-brown to brown clay loam in the lower part. The substratum is pale-brown loam.

Farnum soils have moderately slow permeability and high available water capacity.

These soils are well suited to wheat and sorghum. They are high in fertility. Erosion is a hazard. The native vegetation is chiefly mid and short grasses.

Representative profile of Farnum loam, 0 to 1 percent slopes, in a cultivated field, 200 feet south and 100 feet west of northeast corner of sec. 12, T. 24 S., R. 17 W.:

- Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.
- B1—8 to 16 inches, dark grayish-brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; neutral; clear, smooth boundary.
- B2t—16 to 26 inches, dark-brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; weak to moderate, medium, subangular blocky structure; hard when dry, firm when moist; mildly alkaline; clear, smooth boundary.
- B3—26 to 37 inches, brown (10YR 5/3) light clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; hard when dry, firm when moist; mildly alkaline; clear, smooth boundary.
- C—37 to 60 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, very friable when moist; calcareous; moderately alkaline.

The A1 horizon ranges from 7 to 14 inches in thickness and from grayish brown to very dark grayish brown in color. In most places its texture is loam. Where Farnum soils are associated with more sandy soils, it is fine sandy loam. In reaction this horizon is slightly acid or neutral. The B horizon ranges from 24 to 36 inches in thickness, from dark grayish brown to brown in color, and from heavy loam to clay loam in texture. In reaction it ranges from neutral to moderately alkaline. The C horizon ranges from fine sandy loam to clay loam in texture and from brown to pale brown in color.

Farnum soils occur in the same landscape as Carwile, Lubbock, and Naron soils. They have a less clayey B horizon than Carwile and Lubbock soils. The dark color extends to a greater depth than in Naron soils.

**Farnum loam, 0 to 1 percent slopes (Fc).**—This soil is on uplands. It has the profile described as representative for the Farnum series.

Included with this soil in mapping were small areas of Lubbock, Carwile, and Naron soils and small areas of Farnum soils where slopes are 1 to 3 percent. Small depressional areas and Slickspots are shown on the map by spot symbols. Each depression symbol represents an area about 1 to 5 acres in size, and each Slickspots symbol an area about 1 to 2 acres in size.

Nearly all the acreage of this Farnum soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

Inadequate rainfall is the principal limitation. The main concerns in management are conserving moisture and controlling soil blowing. Capability unit IIc<sup>1</sup>-1, dryland; capability unit I-1, irrigated; Loamy Upland range site; Loamy Upland windbreak group.

**Farnum loam, 1 to 3 percent slopes (Fr).**—This soil is on uplands.

Included in mapping were small areas of Naron and Lubbock soils and areas of Farnum soils where slopes are 0 to 1 percent. Small depressional areas are shown on the map by spot symbols. Each symbol represents an area about 1 to 5 acres in size.

Nearly all the acreage of this Farnum soil is in wheat and sorghum.

The main limitations are soil blowing, water erosion, and inadequate soil moisture. Capability unit IIe-4, dryland; capability unit IIe-1, irrigated; Loamy Upland range site; Loamy Upland windbreak group.

## Harney Series

The Harney series consists of deep, well-drained loamy soils that formed in loess. Slopes are 0 to 6 percent.

In a representative profile the surface layer is dark grayish-brown silt loam about 10 inches thick. The subsoil is about 32 inches thick. The upper 5 inches is dark grayish-brown, friable silty clay loam. The next 19 inches is grayish-brown, very firm silty clay loam, and the lower 8 inches is pale-brown, very firm silty clay loam. The substratum is pale-brown loess of silt loam texture.

Harney soils have moderately slow permeability and high available water capacity.

These soils are well suited to wheat and sorghum. They are high in fertility. No irrigation is possible because the supply of ground water is inadequate. Erosion is a hazard. The native vegetation is chiefly mid and short grasses.

Representative profile of Harney silt loam, 0 to 1 percent slopes, in a cultivated field, 1,320 feet east and 1,650 feet south of northwest corner of sec. 5, T. 24 S., R. 20 W.:

- A1—0 to 10 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; neutral; clear, smooth boundary.
- B1—10 to 15 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; mildly alkaline; clear, smooth boundary.
- B21t—15 to 21 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, subangular blocky structure; very hard when dry, very firm when moist; moderately alkaline; gradual, smooth boundary.
- B22t—21 to 28 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; strong, medium, blocky structure; very hard when dry, very firm when moist; moderately alkaline; clear, smooth boundary.
- B23tca—28 to 34 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, blocky structure; very hard when dry, very firm when moist; calcareous; moderately alkaline; clear, smooth boundary.

B3ca—34 to 42 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; calcareous; few fine lime concretions; moderately alkaline; gradual, smooth boundary.

C—42 to 60 inches, pale-brown (10YR 6/3) heavy silt loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist; calcareous; moderately alkaline.

The A1 horizon ranges from 4 to 12 inches in thickness, from dark grayish brown to grayish brown in color, and from silt loam to silty clay loam in texture. In reaction it is slightly acid or neutral. The B horizon ranges from silty clay loam to light silty clay in texture and from 20 to 40 inches in thickness. In reaction it ranges from neutral to moderately alkaline. The B1 horizon ranges from dark grayish brown to grayish brown, the B2 horizon from grayish brown to brown, and the B3 horizon from brown to pale brown. The depth to calcareous material ranges from 18 to 30 inches. In mapping units Hd and He, the depth to the B2t horizon is less than is commonly defined in the range for the series.

Harney soils occur in the same landscape as Holdrege and Uly soils. They have a more clayey B horizon than Holdrege soils. They have a more distinct, more clayey B horizon than Uly soils and are deeper over calcareous material.

**Harney silt loam, 0 to 1 percent slopes (Hc).**—This soil is on uplands. It has the profile described as representative for the Harney series.

Included with this soil in mapping were small depressional areas of Ness soils and areas of Harney soils where slopes are 1 to 3 percent. Small depressional areas and Slickspots are shown on the map by spot symbols. Each depression symbol represents an area about 1 to 5 acres in size, and each Slickspot symbol an area 1 to 2 acres in size.

Nearly all the acreage of this Harney soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

Inadequate rainfall is the principal limitation. The main concerns in management are conserving moisture and controlling soil blowing. Capability unit IIc-1, dryland; capability unit I-1, irrigated; Loamy Upland range site; Loamy Upland windbreak group.

**Harney silt loam, 1 to 3 percent slopes (Hb).**—This soil is on uplands.

Included in mapping were small areas of Uly soils and Harney soils where slopes are 0 to 1 percent. Small depressional and eroded areas and rock outcrops are shown on the map by spot symbols. Each depression and erosion symbol represents an area about 1 to 5 acres in size, and each rock outcrop symbol an area about 1 to 2 acres in size.

Nearly all the acreage of this Harney soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

The main concerns are controlling water erosion and soil blowing and conserving moisture. Capability unit IIe-1, dryland; capability unit IIe-1, irrigated; Loamy Upland range site; Loamy Upland windbreak group.

**Harney silt loam, 3 to 6 percent slopes (Hc).**—This soil is on uplands. Its surface layer is about 8 inches thick, and the subsoil is about 24 inches thick. Otherwise its profile is similar to the one described as representative for the Harney series.

Included with this soil in mapping were small areas of Uly soils and Harney soils where slopes are 1 to 3 percent. Small eroded areas and rock outcrops are shown on the

map by spot symbols. Each erosion symbol represents an area about 1 to 5 acres in size, and each rock outcrop symbol an area about 1 to 2 acres in size.

About 75 percent of the acreage of this Harney soil is in native grasses. The rest is in wheat and sorghum.

The main concerns are controlling soil blowing and water erosion. Capability unit IIIe-1, dryland; no irrigated capability unit; Loamy Upland range site; Loamy Upland windbreak group.

**Harney-Uly complex, 1 to 3 percent slopes (Hd).**—This mapping unit is on uplands. It is about 80 percent Harney silty clay loam and about 20 percent Uly silt loam. The Harney soil has a surface layer of silty clay loam 4 to 7 inches thick and a very firm silty clay loam subsoil. Otherwise its profile is similar to the one described as representative for the Harney series. The Uly soil is described under the heading "Uly Series."

Included with these soils in mapping were small areas of Holdrege soils, small areas of Harney silt loam, and areas of Harney and Uly soils where slopes are 3 to 6 percent.

Nearly all the acreage of this mapping unit is used for wheat and sorghum.

The main concerns are controlling soil blowing and water erosion and conserving moisture. Capability unit IIe-1, dryland; capability unit IIe-1, irrigated; Loamy Upland windbreak group; Loamy Upland range site.

**Harney-Uly complex, 3 to 6 percent slopes (He).**—This mapping unit is on uplands. It is about 70 percent Harney silty clay loam and about 30 percent Uly silt loam. The Harney soil has a surface layer of silty clay loam 4 to 7 inches thick and a very firm silty clay loam subsoil. Otherwise its profile is similar to the one described as representative for the Harney series. The Uly soil has the profile described as representative for the Uly series.

Included with these soils in mapping were small areas of Tobin soils and Harney silt loam. Small areas of rock outcrops are shown on the map by spot symbols. Each symbol represents an area about 1 to 2 acres in size.

Nearly all the acreage of this mapping unit is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

The main concerns are soil blowing and water erosion. Capability unit IIIe-1, dryland; no irrigated capability unit; Loamy Upland windbreak group; Loamy Upland range site.

## Holdrege Series

The Holdrege series consists of deep, well-drained, loamy soils that formed in loess. Slopes are 1 to 6 percent.

In a representative profile the surface layer is dark grayish-brown silt loam about 12 inches thick. The subsoil is firm brown to dark-brown silty clay loam about 34 inches thick. The substratum is brown loess of light silty clay loam texture.

Holdrege soils have moderate permeability and high available water capacity.

These soils are well suited to wheat and sorghum. They are high in fertility. Water erosion and soil blowing are hazards. The native vegetation is chiefly mid and short grasses.

Representative profile of Holdrege silt loam, 1 to 3 percent slopes, in a cultivated field, 2,100 feet north and 1,150 feet east of southwest corner of sec. 30, T. 24 S., R. 19 W.:

- A1—0 to 12 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; mildly alkaline; clear, smooth boundary.
- B21t—12 to 26 inches, dark-brown (10YR 4/3) light silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; moderately alkaline; clear, smooth boundary.
- B22t—26 to 37 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; moderately alkaline; clear, smooth boundary.
- B3ca—37 to 46 inches, brown (10YR 5/3) light silty clay loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard when dry, firm when moist; calcareous; moderately alkaline; clear, smooth boundary.
- C—46 to 60 inches, brown (10YR 5/3) light silty clay loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist; calcareous; moderately alkaline.

The A1 horizon ranges from 8 to 14 inches in thickness, from grayish brown to very dark grayish brown in color, and from slightly acid to mildly alkaline in reaction. The B horizon ranges from 25 to 40 inches in thickness, from dark grayish brown to brown in color, and from neutral to moderately alkaline in reaction. Depth to calcareous material ranges from 25 to 40 inches. The solum is generally more alkaline than is commonly defined in the range for the series.

Holdrege soils occur in the same landscape as Harney and Uly soils. They have a less clayey B horizon than Harney soils. They have a more distinct B horizon than Uly soils and are deeper over calcareous material.

**Holdrege silt loam, 1 to 3 percent slopes (Hg).**—This soil is on uplands. It has the profile described as representative for the Holdrege series.

Included with this soil in mapping were small areas of Harney soils and areas of Holdrege soils where slopes are 3 to 6 percent. Small eroded areas are shown on the map by spot symbols. Each symbol represents an area about 1 to 5 acres in size.

Nearly all the acreage of this Holdrege soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

The main concerns in management are controlling water erosion and soil blowing and conserving moisture. Capability unit IIc-4, dryland; capability unit IIe-1, irrigated; Loamy Upland range site; Loamy Upland windbreak group.

**Holdrege silt loam, 3 to 6 percent slopes (Hh).**—This soil is on uplands. Its surface layer is 8 to 12 inches thick, and the depth to calcareous material ranges from 25 to 32 inches. Otherwise its profile is similar to the one described as representative for the Holdrege series.

Included with this soil in mapping were small areas of Harney and Uly soils and areas of Holdrege soils where slopes are 1 to 3 percent. Small eroded areas are shown on the map by spot symbols. Each symbol represents an area about 1 to 5 acres in size.

Nearly all the acreage of this Holdrege soil is in wheat and sorghum. Only a small acreage is in native grasses.

The main limitations are water erosion and soil blowing. Capability unit IIIe-2, dryland; no irrigated capability unit; Loamy Upland range site; Loamy Upland windbreak group.

## Hord Series

The Hord series consists of deep, well-drained, loamy soils that formed in alluvium. Slopes are 0 to 1 percent.

In a representative profile the surface layer is dark grayish-brown silt loam about 17 inches thick. The subsoil is friable, dark grayish-brown silt loam about 13 inches thick. The substratum is grayish-brown alluvium of silt loam texture.

Hord soils have moderate permeability and high available water capacity.

These soils are well suited to wheat and sorghum. They are high in fertility. Soil blowing is a hazard. The native vegetation is chiefly mid and tall grasses.

Representative profile of Hord silt loam in a cultivated field, 1,300 feet west and 1,000 feet north of southeast corner of sec. 32, T. 25 S., R. 20 W.:

- A1—0 to 17 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; neutral; gradual, smooth boundary.
- B2—17 to 30 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; moderately alkaline; clear, smooth boundary.
- C—30 to 60 inches, grayish-brown (10R 5/2) heavy silt loam, dark grayish brown (10R 4/2) when moist; massive; soft when dry, very friable when moist; calcareous; moderately alkaline.

The A1 horizon ranges from 10 to 20 inches in thickness, from very dark grayish brown to grayish brown in color, and is neutral or mildly alkaline in reaction. The B horizon ranges from 10 to 18 inches in thickness, from dark grayish brown to grayish brown in color, from silt loam to light silty clay loam in texture, and from neutral to moderately alkaline in reaction. The solum is generally more alkaline than is commonly defined in the range for the series.

Hord soils occur in the same landscape as Canadian and Zenda soils and have a profile similar to that of Tobin soils. They are more silty and less sandy in all horizons than Canadian soils. They have no mottles, whereas Zenda soils are mottled within a depth of 30 inches. In contrast with Tobin soils, they are calcareous at a greater depth, they have a B horizon, and they are not stratified in the C horizon.

**Hord silt loam (0 to 1 percent slopes) (Ho).**—This soil is on stream terraces.

Included with this soil in mapping were small areas of Zenda and Canadian soils. Small depressional areas and Slickspots are shown on the map by spot symbols. Each depression symbol represents an area about 1 to 5 acres in size, and each Slickspots symbol an area about 1 to 2 acres in size.

Nearly all the acreage of this Hord soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses. Inadequate rainfall is the principal limitation. Conserving moisture and controlling wind erosion are the main concerns in management. Capability unit IIc-2, dryland; capability unit I-1, irrigated; Loamy Terrace range site; Loamy Lowland windbreak group.

## Las Animas Series

The Las Animas series consists of deep, somewhat poorly drained sandy soils that formed in alluvial sediments. Slopes are 0 to 1 percent.

In a representative profile the surface layer is grayish-brown loamy fine sand about 5 inches thick. The next layer is loose, grayish-brown loamy fine sand about 10 inches thick. The substratum is light brownish-gray loamy fine sand and very pale brown sandy loam. Underlying these layers is sand or sand and gravel.

Las Animas soils have rapid permeability and low available water capacity.

These soils are well suited to native grasses. They are medium in fertility. If cultivated, they are droughty and highly susceptible to blowing. The native vegetation is chiefly mid and tall grasses.

Representative profile of Las Animas loamy fine sand in native grass, 1,700 feet west and 500 feet north of southeast corner of sec. 9, T. 25 S., R. 19 W.:

- A1—0 to 5 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; soft when dry, very friable when moist; weakly calcareous; moderately alkaline; clear, smooth boundary.
- AC—5 to 15 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; single grain; loose when moist and dry; calcareous; moderately alkaline; clear, smooth boundary.
- C1—15 to 30 inches, light brownish-gray (10YR 6/2) loamy fine sand, brown (10YR 5/3) when moist; few, fine, faint, reddish-yellow mottles; single grain; loose when moist and dry; calcareous; moderately alkaline; clear, smooth boundary.
- IIC2—30 to 45 inches, very pale brown (10YR 7/3) sandy loam, brown (10YR 5/3) when moist; many, fine, distinct, reddish-yellow mottles; massive; hard when dry, friable when moist; calcareous; moderately alkaline; clear, wavy boundary.
- IIIC3—45 to 60 inches, very pale brown (10YR 7/4) sand, yellowish brown (10YR 5/4) when moist; single grain; loose when moist and dry; calcareous; moderately alkaline.

The A1 horizon ranges from 4 to 12 inches in thickness and from light brownish gray to brown in color. The AC horizon ranges from 4 to 12 inches in thickness and from grayish brown to very pale brown in color. The C and IIC horizons range from loamy fine sand to sandy loam in texture and from light brownish gray to very pale brown in color. In all horizons reaction is mildly alkaline or moderately alkaline. The depth to mottled material ranges from 8 to 20 inches, and the depth to sand from 36 to 60 inches. The water table fluctuates between depths of 3 to 7 feet, depending on the season. These soils are calcareous throughout.

Las Animas soils occur in the same landscape as Waldeck and Platte soils. They have a less clayey A1 horizon and are generally deeper over sand than Waldeck soils. They have a less clayey A1 horizon and are deeper over sand than Platte soils.

**Las Animas loamy fine sand** (0 to 1 percent slopes) (tc).—This soil is on stream terraces. Included with this soil in mapping were small areas of Waldeck, Platte, and Tivoli soils.

Nearly all the acreage of this Las Animas soil is in native grasses.

Low available water capacity, wetness, and soil blowing are the main limitations. Capability unit VI<sub>s</sub>-1, dryland; capability unit IV<sub>s</sub>-1, irrigated; Sandy Terrace range site; Wet Loamy and Sandy Lowland windbreak group.

## Lesho Series

The Lesho series consists of somewhat poorly drained, loamy soils that are moderately deep over sand. These soils formed in alluvium. Slopes are 0 to 1 percent.

In a representative profile the surface layer is clay loam about 18 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The substratum is light brownish-gray clay loam that is underlain by sand at a depth of 32 inches.

Lesho soils have moderately slow permeability and moderate available water capacity.

These soils are well suited to wheat and sorghum. They are high in fertility. They are subject to wetness because the water table fluctuates between depths of 2 to 7 feet. They are droughty during periods of below normal precipitation because they are shallow over sand. They are also subject to blowing. The native vegetation is chiefly mid and tall grasses.

Representative profile of Lesho clay loam in a cultivated field, 2,300 feet west and 180 feet north of southeast corner of sec. 18, T. 25 S., R. 19 W.:

- A11—0 to 10 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous; moderately alkaline; clear, smooth boundary.
- A12—10 to 18 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous; moderately alkaline; clear, smooth boundary.
- C1—18 to 32 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; common, fine, distinct mottles of reddish yellow (5YR 6/6); moderate, medium, granular structure; hard when dry, friable when moist; calcareous; moderately alkaline; weak stratification of texture and color; gradual, wavy boundary.
- IIC2—32 to 60 inches, pale-brown (10YR 6/3) fine and medium sand, yellowish brown (10YR 5/4) when moist; structureless; single grain; loose; calcareous; moderately alkaline.

The A1 horizon ranges from 15 to 24 inches in thickness, from grayish brown to dark grayish brown in color, and from heavy loam to clay loam in texture. The depth to mottled material ranges from 15 to 25 inches, and the depth to calcareous material from 0 to 12 inches. The depth to sand ranges from 20 to 40 inches. In places the IIC horizon contains fine gravel. In all horizons, reaction is mildly alkaline or moderately alkaline.

Lesho soils occur in the same landscape as Waldeck and Zenda soils. They have more clay throughout the profile than Waldeck soils. They are shallower over sand than Zenda soils.

**Lesho clay loam** (0 to 1 percent slopes) (lh).—This soil is on flood plains.

Included with this soil in mapping were small areas of Zenda and Platte soils. Small depressional areas and Slickspots are shown on the map by spot symbols. Each depression symbol represents an area about 1 to 5 acres in size, and each Slickspots symbol an area about 1 to 2 acres in size.

Nearly all the acreage of the Lesho soil is in wheat and sorghum. Only a small acreage is in native grasses.

Wetness, soil blowing, and poor tilth are the main limitations. Capability unit III<sub>w</sub>-2, dryland; capability unit

IIIw-1, irrigated; Saline Subirrigated range site; Wet Loamy and Sandy Lowland windbreak group.

## Lubbock Series

The Lubbock series consists of deep, well-drained, loamy soils that formed in old alluvium reworked by wind. Slopes are 0 to 1 percent.

In a representative profile the surface layer is dark grayish-brown silt loam about 10 inches thick. The subsoil is about 34 inches thick. The upper 6 inches of this layer is firm, dark grayish-brown silty clay loam; the next 16 inches is very firm, dark grayish-brown clay; and the lower 12 inches is firm, dark grayish-brown silty clay loam. The substratum is light-gray silty clay loam.

Lubbock soils have moderately slow permeability and high available water capacity.

These soils are well suited to wheat and sorghum. Fertility is high. Soil blowing is a hazard. The native vegetation is chiefly mid and short grasses.

Representative profile of Lubbock silt loam in a cultivated field, 750 feet west and 1,200 feet south of northeast corner of sec. 20, T. 24 S., R. 17 W.:

- A1—0 to 10 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, very friable when moist; neutral; clear, smooth boundary.
- B1—10 to 16 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak to moderate, medium, subangular blocky structure; hard when dry, firm when moist; mildly alkaline; clear, smooth boundary.
- B21t—16 to 23 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium, blocky structure; very hard when dry, very firm when moist; moderately alkaline; clear, smooth boundary.
- B22tca—23 to 32 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium, blocky structure; very hard when dry, very firm when moist; calcareous; common, small, hard carbonate concretions; moderately alkaline; gradual, smooth boundary.
- B3—32 to 44 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak to moderate, medium, subangular blocky structure; very hard when dry, firm when moist; calcareous; moderately alkaline; gradual, smooth boundary.
- C—44 to 60 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; massive; very hard when dry, friable when moist; calcareous; moderately alkaline.

The A1 horizon ranges from 7 to 12 inches in thickness and from very dark grayish brown to grayish brown in color. Its texture is silt loam or loam. In areas where the surrounding soils are sandy, the A horizon is loam. It is neutral or mildly alkaline in reaction. The B horizon ranges from 24 to 40 inches in thickness, from dark grayish brown to grayish brown in color, and from silty clay loam to clay in texture. This horizon is mildly alkaline or moderately alkaline in reaction.

Lubbock soils occur in the same landscape as Farnum and Tabler soils. They have a more clayey B horizon than Farnum soils. They have a browner B horizon than Tabler soils, and the depth to the clay B horizon is greater.

**Lubbock silt loam (0 to 1 percent slopes) (lk).**—This soil is on uplands.

Included with this soil in mapping were small areas of Farnum, Tabler, and Naron soils. Small depressional and eroded areas and Slickspots are shown on the map by spot

symbols. Each depression and erosion symbol represents an area about 1 to 5 acres in size, and each Slickspots symbol an area about 1 to 2 acres in size.

Nearly all the acreage of this Lubbock soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

Inadequate rainfall is the principal limitation. Conserving moisture and controlling soil blowing are the main concerns in management. Capability unit IIC-1, dryland; capability unit I-1, irrigated; Loamy Upland range site; Loamy Upland windbreak group.

## Naron Series

The Naron series consists of deep, well-drained, mainly loamy soils that formed in eolian sands. Slopes are 0 to 3 percent.

In a representative profile the surface layer is dark grayish-brown fine sandy loam about 12 inches thick. The subsoil is friable, brown, and about 48 inches thick. It is sandy clay loam in the upper part and heavy fine sandy loam in the lower part.

Naron soils have moderate permeability and moderate available water capacity.

These soils are well suited to wheat and sorghum. They are medium in fertility. Soil blowing is a hazard. The native vegetation is chiefly mid and tall grasses.

Representative profile of Naron fine sandy loam, 1 to 3 percent slopes, in a cultivated field, 1,650 feet south and 450 feet east of northwest corner of sec. 7, T. 25 S., R. 16 W.:

- A1—0 to 12 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; medium acid; clear, smooth boundary.
- B21t—12 to 18 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; slightly acid; gradual, smooth boundary.
- B22t—18 to 30 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; mildly alkaline; gradual, smooth boundary.
- B3—30 to 60 inches, brown (10YR 5/3) heavy fine sandy loam, dark brown (10YR 4/3) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; moderately alkaline.

The A1 horizon ranges from 6 to 14 inches in thickness, from grayish brown to very dark grayish brown in color, and from medium acid to neutral in reaction. The B horizon ranges from 25 to 50 inches in thickness and from brown to dark brown in color. In texture it ranges from fine sandy loam to sandy clay loam; the clay content is 18 to 25 percent. Reaction is slightly acid to moderately alkaline. The B22t and B3 horizons are generally more alkaline than is commonly defined in the range for the series, and the A1 horizon in mapping unit Na is more sandy and is lighter colored.

Naron soils occur in the same landscape as Attica and Farnum soils. They have a more clayey B horizon than Attica soils. They are not darkened so deep as Farnum soils.

**Naron loamy fine sand, 0 to 1 percent slopes (Nc).**—This soil is on uplands. Its surface layer is grayish-brown to light brown-gray loamy fine sand 10 to 14 inches thick. Otherwise, its profile is similar to the one described as representative for the Naron series.

Included with this soil in mapping were small areas of Pratt soils.

About 60 percent of the acreage of this Naron soil is in wheat and sorghum. The rest is in native grasses.

Controlling soil blowing and maintaining the supply of organic matter are the main concerns in management. Capability unit IIIe-3, dryland; capability unit IIIe-1, irrigated; Sands range site; Sandy Upland windbreak group.

**Naron fine sandy loam, 0 to 1 percent slopes (Nf).**—This soil is on uplands.

Included with this soil in mapping were small areas of Attica, Carwile, and Farnum soils and areas of Naron soils where slopes are 1 to 3 percent. Small depressional areas, limy spots, and Slickspots are shown on the map by spot symbols. Each depression and limy spot symbol represents an area about 1 to 5 acres in size, and each Slickspots symbol an area about 1 to 2 acres in size.

Nearly all the acreage of this Naron soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

Controlling soil blowing and maintaining the supply of organic matter are the main concerns in management. Capability unit IIe-2, dryland; capability unit IIs-1, irrigated; Sandy range site; Sandy Upland windbreak group.

**Naron fine sandy loam, 1 to 3 percent slopes (Ng).**—This soil is on uplands. It has the profile described as representative for the Naron series.

Included with this soil in mapping were small areas of Attica, Carwile, and Pratt soils and areas of Naron soils where slopes are 0 to 1 percent. Small depressional areas and limy spots are shown on the map by spot symbols. Each symbol represents an area about 1 to 5 acres in size.

Nearly all the acreage of this Naron soil is in wheat and sorghum. Small acreages near farmsteads or within areas of other soils that are not well suited to cultivated crops are in native grasses.

Controlling soil blowing and maintaining the supply of organic matter are the main concerns in management. Capability unit IIe-3, dryland; capability unit IIe-2, irrigated; Sandy range site; Sandy Upland windbreak group.

## Ness Series

The Ness series consists of deep, poorly drained, clayey soils that formed in clayey eolian material. Slopes are concave. The gradient is 0 to 1 percent.

In a representative profile the surface layer is dark-gray clay about 33 inches thick. The next layer is very firm, gray clay about 13 inches thick. The substratum is light brownish-gray silty clay loam.

Ness soils have very slow permeability and high available water capacity.

These soils are generally farmed along with surrounding soils. They are high in fertility. If dry and bare of vegetation, they are susceptible to blowing. They receive runoff from the surrounding soils.

Representative profile of Ness clay in a cultivated field, 300 feet north and 100 feet east of southwest corner of sec. 6, T. 24 S., R. 20 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; weak, medium, granular structure; very hard when dry, very firm when moist; neutral; clear, smooth boundary.

A1—7 to 33 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; weak to moderate, medium, blocky structure; some irregular shaped peds that have two long axes not parallel to the surface break to fine blocks; very hard when dry, very firm when moist; few slickenside faces on larger peds; moderately alkaline; gradual, smooth boundary.

AC—33 to 46 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; massive; very hard when dry, very firm when moist; moderately alkaline; few small lime concretions in lower 6 inches; gradual, smooth boundary.

C—46 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; massive; hard when dry, firm when moist; calcareous; few small lime concretions; moderately alkaline.

The A horizon ranges from 22 to 40 inches in thickness, from dark gray to gray in color, and from silty clay to clay in texture. The reaction ranges from neutral to moderately alkaline. The AC horizon ranges from 6 to 15 inches in thickness and from dark gray to gray in color. The C horizon ranges from silt loam to silty clay loam. The depth to calcareous material ranges from 35 to 48 inches. The thickness of the clay ranges from 24 to 48 inches.

Ness soils occur in the same landscape as Tabler soils. In contrast with those soils, they have a more clayey A horizon and do not have a B horizon.

**Ness clay (0 to 1 percent slopes) (Ns).**—This soil is on uplands, in depressions that range from a few inches to 10 feet in depth and from a few acres to more than 50 acres in size.

Included with this soil in mapping were small areas of Harney and Tabler soils.

Nearly all the acreage of this Ness soil is in wheat and sorghum. A small acreage is wasteland that is covered with trees and sedges.

Soil blowing, when the soil is dry and unprotected, and wetness are the main limitations. Capability unit VIw-1, dryland; capability unit IVs-2, irrigated; no range site or windbreak group.

## Platte Series

The Platte series consists of deep, somewhat poorly drained, loamy soils that formed in alluvium. These soils have slopes of 0 to 1 percent.

In a representative profile the surface layer is grayish-brown loam about 9 inches thick. The next layer is loose, pale-brown loamy sand about 8 inches thick. The substratum is very pale brown sand.

Platte soils have moderately rapid permeability and low available water capacity.

These soils are well suited to native grasses. Fertility is medium. Soil blowing is a hazard. Flooding is a hazard in areas not protected by dikes. The water table fluctuates between depths of 2 and 5 feet. The native vegetation is chiefly mid and tall grasses.

Representative profile of Platte loam in an area of Platte soils in native grass, 3,600 feet east and 1,300 feet south of northwest corner of sec. 36, T. 25 S., R. 20 W.:

A1—0 to 9 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; calcareous; moderately alkaline; clear, smooth boundary.

AC—9 to 17 inches, pale-brown (10YR 6/3) loamy sand, dark brown (10YR 4/3) when moist; common, fine, distinct, yellowish-brown mottles; single grain; loose when moist and dry; calcareous, moderately alkaline; clear, wavy boundary.

C—17 to 60 inches, very pale brown (10YR 7/4) sand, dark yellowish brown (10YR 4/4) when moist; single grain; loose when moist and dry; calcareous; moderately alkaline.

The A horizon ranges from clay loam to sandy loam but is dominantly loam. The A1 horizon ranges from 6 to 10 inches in thickness and from dark grayish brown to grayish brown in color. The AC horizon ranges from 6 to 12 inches in thickness, from grayish brown to very pale brown in color, and from loamy sandy to light sandy loam in texture. The C horizon ranges from sand to fine gravel. The depth to mottled material ranges from 6 to 15 inches, and the depth to sand from 10 to 20 inches.

Platte soils occur in the same landscape as Las Animas and Waldeck soils. They have a more clayey A horizon than Las Animas soils and are shallower over sand. They are shallower over sand than Waldeck soils.

**Platte soils** (0 to 1 percent slopes) (Pc).—These soils are on flood plains. The texture of the surface layer ranges from clay loam to sandy loam. Otherwise these soils have the profile described as representative for the Platte series.

Included with these soils in mapping were small areas of Waldeck, Lesho, and Las Animas soils.

Nearly all the acreage of these Platte soils is in native grasses. Small areas within areas of arable soils are in wheat and sorghum.

Wetness, flooding, and soil blowing are the main limitations. Capability unit VIw-2, dryland; no irrigated capability unit; Saline Subirrigated range site; Wet Loamy and Sandy Lowland windbreak group.

## Plevna Series

The Plevna series consists of deep, poorly drained, loamy soils that formed in old alluvium. Slopes are concave, and the gradient is 0 to 1 percent.

In a representative profile the surface layer is mottled gray fine sandy loam about 10 inches thick. The subsoil is friable, mottled yellowish-brown fine sandy loam about 29 inches thick. The substratum is mottled pale-brown fine sandy loam.

Plevna soils have moderately rapid permeability and moderate available water capacity.

These wet soils are well suited to native grasses. The water table fluctuates between depths of 2 and 5 feet. Fertility is medium. The native vegetation is chiefly mid and tall grasses.

Representative profile of Plevna fine sandy loam in native grass, 2,150 feet north and 350 feet east of southwest corner of sec. 2, T. 24 S., R. 18 W.:

A1—0 to 10 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) when moist; few, fine, distinct, strong-brown mottles; weak, medium, granular structure; hard when dry, friable when moist; moderately alkaline; gradual, smooth boundary.

B—10 to 39 inches, yellowish-brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4/4) when moist; common, fine, distinct, strong-brown and gray mottles; weak, medium, subangular blocky structure to massive; hard when dry, friable when moist; moderately alkaline; gradual, smooth boundary.

C—39 to 60 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; few, medium, faint, reddish-yellow mottles; massive; hard when dry, friable when moist; calcareous; moderately alkaline.

The A1 horizon ranges from 9 to 12 inches in thickness and from very dark grayish brown to gray in color. In texture the range is generally from fine sandy loam to light loam, but in a few places the upper 3 inches is loamy fine sand and in others

it is clay loam. The B horizon ranges from 20 to 35 inches in thickness and from gray to light yellowish brown in color. The C horizon ranges from fine sandy loam to sand. The depth to mottled material ranges from 0 to 10 inches. The depth to calcareous material ranges from 24 to 48 inches. The B horizon includes chroma of 3 and 4, which is higher than is commonly defined in the range for the series.

Plevna soils occur in the same landscape as Carwile soils, and their profile is similar to that of Waldeck soils. They have a less clayey B horizon than Carwile soils. Their A horizon is mottled, and that of Waldeck soils is unmottled.

**Plevna fine sandy loam** (0 to 1 percent slopes) (Pe).—This soil is on lowlands and in depressions on uplands. Included with this soil in mapping were small areas of Carwile, Lesho, and Waldeck soils.

Nearly all the acreage of this Plevna soil is in native grasses.

Wetness and flooding are the main limitations. Capability unit Vw-1, dryland; no irrigated capability unit; Subirrigated range site; Wet Loamy and Sandy Lowland windbreak group.

## Pratt Series

The Pratt series consists of deep, well-drained, sandy soils that formed in eolian sands. Slopes range from 1 to 15 percent.

In a representative profile the surface layer is grayish-brown loamy fine sand about 13 inches thick. The subsoil is friable, brown heavy loamy fine sand about 17 inches thick. The substratum is pale-brown loamy fine sand.

Pratt soils have rapid permeability and low available water capacity.

These soils are suited to wheat, sorghum, and native grasses. They are medium in fertility. They are highly susceptible to blowing. The native vegetation is chiefly mid and tall grasses.

Representative profile of Pratt loamy fine sand, undulating, in a cultivated field, 2,150 feet north and 100 feet west of southeast corner of sec. 9, T. 24 S., R. 18 W.:

A1—0 to 13 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; soft when dry, very friable when moist; medium acid; clear, smooth boundary.

B2t—13 to 30 inches, brown (10YR 5/3) heavy loamy fine sand, dark brown (10YR 4/3) when moist; weak, medium, granular structure; hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

C—30 to 60 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; single grain; loose when moist and dry; slightly acid.

The A1 horizon ranges from 7 to 16 inches in thickness and from grayish brown to dark brown in color. In reaction it is medium acid or slightly acid. The B2 horizon ranges from 15 to 30 inches in thickness and from pale brown to yellowish brown in color. It is loamy fine sand in texture; the absolute clay increase from the A horizon is 3 to 6 percent. The B horizon ranges from medium acid to neutral. The C horizon ranges from loamy fine sand to fine sand. It is slightly acid or neutral.

Pratt soils occur in the same landscape as Attica, Brazos, and Tivoli soils. They have less clayey A and B horizons than Attica soils. They are more clayey throughout the solum than Tivoli soils, which do not have a B horizon. They are more clayey below the A horizon and are deeper over sand than Brazos soils, which do not have a B horizon.

**Pratt loamy fine sand, hummocky** (4 to 10 percent slopes) (Pf).—This soil is on uplands.

Included with this soil in mapping were small areas of Tivoli and Carwile soils and areas of Pratt soils where slopes are 1 to 4 percent. Small depressional areas and blowouts are shown on the map by spot symbols. Each depression symbol represents an area about 1 to 5 acres in size, and each blowout symbol an area about 2 to 10 acres in size.

Nearly all the acreage of this Pratt soil is in native grasses. Acreages in wheat and sorghum occur within areas of other soils that are well suited to these crops.

Controlling soil blowing and maintaining the supply of organic matter are the main concerns in management. Capability unit IVe-1, dryland; capability unit IIIe-1, irrigated; Sands range site; Sandy Upland windbreak group.

**Pratt loamy fine sand, undulating** (1 to 4 percent slopes) (Pg).—This soil is on wetlands. It has the profile described as representative for the Pratt series.

Included with this soil in mapping were small areas of Attica and Carwile soils and areas of Pratt soils where slopes are 4 to 10 percent. Small depressional areas and limy spots are shown on the map by spot symbols. Each symbol represents an area about 1 to 5 acres in size.

Most of the acreage of this Pratt soil is in wheat and sorghum. Small acreages in native grasses occur within areas of nonarable soils.

Controlling soil blowing and maintaining the supply of organic matter are the main concerns in management. Capability unit IIIe-3, dryland; capability unit IIIe-1, irrigated; Sands range site; Sandy Upland windbreak group.

**Pratt-Brazos loamy fine sands** (0 to 4 percent slopes) (Pr).—This mapping unit is on uplands. It is about 65 percent Pratt loamy fine sand and 35 percent Brazos loamy fine sand. Each soil is discussed under the heading for its respective series. Pratt soils occupy convex ridges, and Brazos soils nearly level areas.

Included with these soils in mapping were small areas of Naron soils and areas of Pratt soils where slopes are 4 to 10 percent. Small limy spots are shown on the map by spot symbols. Each symbol represents an area about 1 to 5 acres in size.

Nearly all the acreage of this mapping unit is in native grasses.

Soil blowing is the main limitation. Capability unit VIe-3, dryland; no irrigated capability unit; Sands range site; Sandy Upland windbreak group.

**Pratt-Tivoli loamy fine sands** (5 to 15 percent slopes) (Pt).—This mapping unit is on uplands. It is about 65 percent Pratt loamy fine sand and 35 percent Tivoli loamy fine sand. Pratt soils are on slopes, and Tivoli soils on ridgetops. The Tivoli soil has a surface layer of loamy fine sand. Otherwise each soil has a profile similar to the one described as representative for its respective series.

Included with these soils in mapping were areas of Carwile soils and Tivoli fine sand. Small blowouts are shown on the map by spot symbols. Each symbol represents an area about 2 to 10 acres in size.

Nearly all the acreage of this mapping unit is in native grasses.

Soil blowing is the main limitation. Capability unit VIe-3, dryland; no irrigated capability unit; Sands range site; Sandy Upland windbreak group.

## Tabler Series

The Tabler series consists of deep, moderately well drained, loamy soils that formed in old alluvium. The slope gradient is 0 to 1 percent.

In a representative profile the surface layer is grayish-brown light clay loam about 8 inches thick. The subsoil is very firm clay about 32 inches thick. It is dark gray in the upper part and light gray in the lower part. The substratum is pale-brown clay loam.

Tabler soils have very slow permeability and high available water capacity.

These soils are well suited to wheat and sorghum. They are high in fertility. The major limitations are slow surface drainage, very slow permeability, and soil blowing. The native vegetation is chiefly mid and short grasses.

Representative profile of a Tabler clay loam in a cultivated field, 1,650 feet west and 600 feet north of southeast corner of sec. 21, T. 26 S., R. 19 W.:

- A1—0 to 8 inches, grayish-brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; slightly acid; clear, smooth boundary.
- B21t—8 to 16 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; moderate, fine, blocky structure; very hard when dry, very firm when moist; clear, smooth boundary.
- B22t—16 to 24 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; moderate, medium, blocky structure; very hard when dry, very firm when moist; moderately alkaline; gradual, smooth boundary.
- B3—24 to 40 inches, light-gray (10YR 6/1) clay, dark gray (10YR 4/1) when moist; moderate, medium, subangular blocky structure; very hard when dry, very firm moist; calcareous; moderately alkaline; clear, smooth boundary.
- C—40 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; common, fine, distinct, strong-brown mottles; massive; hard when dry, friable when moist; weakly calcareous; moderately alkaline.

The A horizon ranges from 6 to 12 inches in thickness, from very dark grayish brown to grayish brown in color, from heavy loam to clay loam in texture, and from slightly acid to mildly alkaline in reaction. The B horizon ranges from 24 to 40 inches in thickness and from neutral to moderately alkaline in reaction. The B2 horizon is gray to very dark grayish brown. The B3 horizon is gray to light gray.

Tabler soils occur in the same landscape as Carwile, Farnum, Lubbock, and Ness soils. They have a thinner A horizon than Lubbock soils. They have a less clayey A horizon than Ness soils, which do not have a B horizon. They are less sandy in the surface layer than the Carwile soils and not so deep over clay. Their B horizon is not so brown as that in Farnum soils, but it is more clayey.

**Tabler clay loam** (0 to 1 percent slopes) (Ta).—This nearly level to slightly depressional soil is on uplands. It has the profile described as representative for the Tabler series.

Included with this soil in mapping were small areas of Lubbock, Carwile, and Ness soils. Small depressional areas are shown on the map by spot symbols. Each symbol represents an area about 1 to 5 acres in size.

Nearly all the acreage of this Tabler soil is in wheat and sorghum. A small acreage is in native grasses.

The main limitations are very slow permeability, slow surface drainage, and soil blowing. Capability unit IIs-1, dryland; capability unit IIs-2, irrigated; Clay Upland range site; Clayey Upland windbreak group.

**Tabler-Slickspots complex** (0 to 1 percent slopes) (Tb).—This mapping unit is on uplands. It is about 90 percent Tabler clay loam and about 10 percent Slickspots.

Included with these soils in mapping were small areas of Farnum soils and of soils that have some characteristics of both the Tabler soils and Slickspots.

Slickspots occur as small areas throughout the mapping unit. They have a high content of sodium. The top 1 or 2 inches of the surface layer is light colored and crusted when dry, but it puddles after a heavy rain. The surface layer ranges from fine sandy loam to clay loam in texture and from 5 to 15 inches in thickness. The next layer ranges in texture from sandy clay loam to clay and has subangular blocky or blocky structure, or is massive. It is gray to pale brown in color and is mottled in most places. The substratum ranges from sandy loam to clay loam in texture and is massive.

Nearly all the acreage of this mapping unit is in wheat and sorghum. Small acreages near farmsteads are in native grasses. Crop growth is uneven because the degree of salinity varies. The hard-crusted, cloddy surface layer in areas of Slickspots makes it difficult to obtain adequate stands of the crops commonly grown.

The main limitations are salinity, slow surface drainage, soil blowing, an inadequate supply of organic matter, and poor tilth. Capability unit IVs-1, dryland; no irrigated capability unit. Tabler soils in Clay Upland range site and Clayey Upland windbreak group. Slickspots in Saline Upland range site; no windbreak group.

### Tivoli Series

The Tivoli series consists of deep, excessively drained, sandy soils that formed in eolian sands. Slopes range from 5 to 20 percent.

The surface layer is brown fine sand about 8 inches thick. The underlying material is light yellowish-brown fine sand about 52 inches thick.

Tivoli soils have rapid permeability and very low available water capacity.

These soils are well suited to native grasses. They are low in fertility and are susceptible to blowing. The native vegetation is chiefly mid and tall grasses.

Representative profile of Tivoli fine sand in native grass, 2,350 feet west and 1,000 feet south of northeast corner of sec. 23, T. 26 S., R. 20 W.:

- A1—0 to 8 inches, brown (10YR 5/3) fine sand, dark brown (10YR 4/3) when moist; single grain; loose when dry and moist; slightly acid; gradual, smooth boundary.  
 C—8 to 60 inches, light yellowish-brown (10YR 6/4) fine sand, yellowish brown (10YR 5/4) when moist; single grain; loose when dry and moist; slightly acid.

The A horizon ranges from 4 to 10 inches in thickness, from grayish brown to pale brown in color, and from fine sand to loamy fine sand in texture. The C horizon ranges from pale brown to brownish yellow. The reaction in all horizons is slightly acid or neutral.

Tivoli soils occur in the same landscape as Pratt soils. They are less clayey throughout than Pratt soils, and they lack a B horizon.

**Tivoli fine sand** (10 to 20 percent slopes) (Tf).—This soil is on uplands.

Included in mapping were small areas of Pratt and Las Animas soils and Blown-out land. Small blowouts are

shown on the map by spot symbols. Each symbol represents an area about 2 to 10 acres in size.

Nearly all the acreage of this Tabler soil is in native grasses.

The main limitation is soil blowing. Capability unit VIIe-1, dryland; Choppy Sands range site; no irrigated capability unit or windbreak group.

### Tobin Series

The Tobin series consists of deep, well-drained loamy soils that formed in alluvium. The slope gradient is 0 to 1 percent.

The surface layer is dark grayish-brown silt loam about 15 inches thick. The next layer is firm, grayish-brown light silt clay loam about 12 inches thick. The substratum is weakly stratified, grayish-brown and brown silt loam and silty clay loam.

Tobin soils have moderate permeability and high available water capacity.

These soils are well suited to wheat and sorghum. They are high in fertility, but are subject to blowing and frequent flooding. The native vegetation is chiefly mid and tall grasses.

Representative profile of Tobin silt loam in a cultivated field, 1,200 feet south and 1,100 feet east of northwest corner of sec. 8, T. 24 S., R. 20 W.:

- A1—0 to 15 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.  
 AC—15 to 27 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, firm when moist; mildly alkaline; clear, smooth boundary.  
 C1—27 to 40 inches, grayish-brown (10YR 5/2) light silty clay loam weakly stratified with darker colors about one-half unit lower in value, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, very friable when moist; calcareous; moderately alkaline; gradual, smooth boundary.  
 C2—40 to 60 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; massive; soft when dry, very friable when moist; calcareous; moderately alkaline.

The A1 horizon ranges from 10 to 30 inches in thickness, from very dark grayish brown to grayish brown in color, and from slightly acid to mildly alkaline in reaction. The AC horizon ranges from 10 to 20 inches in thickness, from dark grayish brown to grayish brown in color, from silt loam to silty clay loam in texture, and from neutral to moderately alkaline in reaction. The C horizon ranges from silt loam to silty clay loam in texture and from grayish brown to pale brown in color. The depth to calcareous material ranges from 18 to 30 inches.

Tobin and Hord soils have similar profiles and formed in similar material, but Tobin soils have a stratified C horizon, are calcareous at shallower depths than Hord soils, and lack a B horizon.

**Tobin silt loam** (0 to 1 percent slopes) (To).—This soil is on flood plains. Included in mapping were small areas of Hord soils and of Breaks-Alluvial land complex.

About 75 percent of the acreage of this Tobin soil is in native grasses. The rest is in wheat and sorghum.

The main limitations are frequent flooding and soil

blowing. Capability unit IIIw-1, dryland; no irrigated capability unit; Loamy Lowland range site; Loamy Lowland windbreak group.

## Uly Series

The Uly series consists of deep, well-drained, loamy soils that formed in loess. The slope gradient is 1 to 6 percent.

The surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil is friable silty clay loam about 22 inches thick. It is grayish brown in the upper part and pale brown in the lower part. The substratum is very pale brown silt loam.

Uly soils have moderate permeability and high available water capacity.

These soils are well suited to wheat, sorghum, and native grasses. They are high in fertility, but are susceptible to soil blowing and water erosion. The native vegetation is chiefly mid and short grasses.

Representative profile of Uly silt loam in an area of Harney-Uly complex, 3 to 6 percent slopes, in a cultivated field, 1,000 feet south and 600 feet east of northwest corner of sec. 16, T. 24 S., R. 19 W.:

- Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; calcareous; mildly alkaline; clear, smooth boundary.
- B1—8 to 16 inches, grayish-brown (10YR 5/2) light silty clay loam, dark brown (10YR 4/3) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; calcareous; mildly alkaline; clear, smooth boundary.
- B2ca—16 to 30 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; weak, medium, sub-angular blocky structure; hard when dry, friable when moist; calcareous; contains soft lime concretions; mildly alkaline; gradual, smooth boundary.
- C—30 to 60 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; calcareous; mildly alkaline.

The A horizon ranges from 6 to 12 inches in thickness, from dark grayish brown to grayish brown in color, and from silt loam to light silty clay loam in texture. The B horizon ranges from 14 to 24 inches in thickness, from grayish brown to pale brown in color, and from heavy silt loam to silty clay loam in texture. The C horizon is pale brown to very pale brown. The depth to calcareous material ranges from 0 to 12 inches.

Uly soils occur in the same landscape as Harney and Holdrege soils. They have a less well defined B horizon and are less deep over calcareous material than Harney and Holdrege soils. Also they are less clayey in the B horizon than Harney soils.

## Waldeck Series

The Waldeck series consists of somewhat poorly drained, loamy soils that are moderately deep over sand. These soils formed in alluvium. The slope gradient is 0 to 1 percent.

The surface layer is grayish-brown fine sandy loam about 10 inches thick. The next layer is friable sandy loam mottled with light brownish gray and is about 18 inches thick. The underlying material is very pale brown sand.

Waldeck soils have moderately rapid permeability and low available water capacity.

Waldeck soils are well suited to wheat, sorghum, and

native grasses. These soils are medium in fertility. They are subject to wetness and to soil blowing. The water table fluctuates between depths of 2 and 7 feet, depending on the season. It is usually highest in spring. The native vegetation is chiefly mid and tall grasses.

Representative profile of Waldeck fine sandy loam in a cultivated field, 1,900 feet east and 450 feet south of northwest corner of sec. 4, T. 24 S., R. 18 W.:

- A1—0 to 10 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous; mildly alkaline; clear, smooth boundary.
- AC—10 to 28 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; common, fine, distinct, reddish-yellow and strong-brown mottles and few, fine, gray mottles; weak, medium, granular structure; hard when dry, friable when moist; calcareous; moderately alkaline; gradual, wavy boundary.
- IIC—28 to 60 inches, very pale brown (10YR 7/4) sand, yellowish brown (10YR 5/4) when moist; single grain; loose when moist and dry; calcareous; moderately alkaline.

The A1 horizon ranges from 10 to 15 inches in thickness, from grayish brown to very dark grayish brown in color, and from loam to sandy loam in texture. The AC horizon ranges from 10 to 30 inches in thickness and from grayish brown to very pale brown in color. The reaction in all horizons is mildly alkaline or moderately alkaline. The depth to mottled material ranges from 10 to 20 inches. The depth to sand ranges from 24 to 40 inches.

Waldeck soils occur in the same landscape as Canadian, Las Animas, Lesho, and Platte soils. They have similar profiles as Plevna soils but have no mottles in the A horizon. They have a mottled AC horizon and are shallower over sand than Canadian soils. They are sandier throughout than Lesho soils. They have a more clayey B horizon than Las Animas soils and in most places are shallower over sand. They are deeper over sand than Platte soils.

**Waldeck fine sandy loam** (0 to 1 percent slopes) (Wc).—This soil is on flood plains. It has the profile described as representative for the Waldeck series.

Included with this soil in mapping were small areas of Lesho and Platte soils and of Waldeck loam. Small areas of Slickspots are shown on the map by spot symbols. Each symbol represents an area about 1 to 2 acres in size.

Nearly all the acreage of this Waldeck soil is in wheat and sorghum. A small acreage is in native grasses.

The main limitations are wetness, soil blowing, and an inadequate supply of organic matter. Capability unit IIIw-2, dryland and irrigated; Subirrigated range site; Wet Loamy and Sandy Lowland windbreak group.

**Waldeck loam** (0 to 1 percent slopes) (Wc).—This soil is on flood plains. Except for the loam surface layer, its profile is similar to the one described as representative for the Waldeck series.

Included with this soil in mapping were small areas of Lesho and Platte soils and Waldeck fine sandy loam. Small areas of Slickspots are shown on the map by spot symbols. Each symbol represents an area about 1 to 2 acres in size.

Nearly all the acreage of this Waldeck soil is in wheat and sorghum. A small acreage is in native grasses.

The main limitations are wetness, soil blowing, and an inadequate supply of organic matter. Capability unit IIIw-2, dryland and irrigated; Subirrigated range site; Wet Loamy and Sandy Lowland windbreak group.

## Zenda Series

The Zenda series consists of deep, somewhat poorly drained, loamy soils that formed in alluvium. The slope gradient is 0 to 1 percent.

The surface layer is dark grayish-brown clay loam about 15 inches thick. The next layer is firm, light-gray clay loam about 9 inches thick. The substratum is mottled light-gray clay loam. Below this is pale-brown sandy loam over very pale brown sand.

Zenda soils have moderate permeability and high available water capacity.

These soils are well suited to wheat, sorghum, and native grasses. They are high in fertility, but are subject to wetness and blowing. The water table fluctuates between depths of 3 and 10 feet, depending on the season. It is usually highest in spring. The native vegetation is chiefly mid and tall grasses.

Representative profile of Zenda clay loam in a cultivated field, 1,050 feet south and 2,550 feet east of north-west corner of sec. 4, T. 25 S., R. 19 W.:

- A1—0 to 15 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; moderately alkaline; clear, smooth boundary.
- AC—15 to 24 inches, light-gray (10YR 6/1) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; very hard when dry, firm when moist; calcareous; moderately alkaline; clear, smooth boundary.
- C1—24 to 40 inches, light-gray (10YR 6/1) clay loam, dark grayish brown (10YR 4/2) when moist; common, fine, distinct, brownish-yellow mottles; moderate, medium, granular structure; very hard when dry, firm when moist; calcareous; moderately alkaline; gradual, smooth boundary.
- IIC2—40 to 55 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; common, fine, distinct mottles; massive; hard when dry, friable when moist; calcareous; moderately alkaline; clear, wavy boundary.
- IIIC3—55 to 60 inches, very pale brown (10YR 7/4) sand, yellowish brown (10YR 5/4) when moist; single grain; loose when moist and dry; calcareous; moderately alkaline.

The A1 horizon ranges from 10 to 18 inches in thickness, from dark grayish brown to brown in color, from heavy loam to clay loam in texture, and from neutral to moderately alkaline in reaction. The AC horizon ranges from 8 to 14 inches in thickness and from gray to pale brown in color. The C horizon ranges from 10 to 20 inches in thickness and from gray to pale brown in color. The IIC horizon ranges from 6 to 20 inches in thickness, from gray to pale brown in color, and from sandy loam to clay loam in texture. The depth to mottled material ranges from 18 to 30 inches. The depth to sand ranges from 40 to 60 inches, and the depth to calcareous material from 0 to 15 inches.

Zenda soils occur in the same landscape as Lesho and Hord soils. They are deeper over sand than Lesho soils. They are mottled within a depth of 30 inches, whereas Hord soils are not mottled.

**Zenda clay loam** (0 to 1 percent slopes) (Zc).—This soil is on low stream terraces. It has the profile described as representative for the Zenda series.

Included with this soil in mapping were small areas of Hord, Lesho, and Waldeck soils. Small depressional areas and Slickspots are shown on the map by spot symbols. Each depression symbol represents an area about 1 to 5 acres in size, and each Slickspots symbol an area about 1 to 2 acres in size.

Nearly all the acreage of this Zenda soil is in wheat and sorghum. Small acreages near farmsteads are in native grasses.

The main concerns in management are eliminating wetness, controlling soil blowing, and maintaining good tilth. Capability unit IIw-1, dryland and irrigated; Loamy Terrace range site; Wet Loamy and Sandy Lowland windbreak group.

**Zenda clay loam, saline** (0 to 1 percent slopes) (Ze).—This soil occupies low stream terraces. Its profile is similar to the one described as representative for the Zenda series, but the surface layer is lighter colored and is very hard and crusty when dry, the layers below the surface layer contain slight to moderate amounts of salts, and permeability is moderately slow.

Included with this soil in mapping were small areas of Slickspots and of Zenda and Lesho soils.

Nearly all the acreage of this Zenda soil is in wheat and sorghum. A small acreage is in native grasses. Crop growth is uneven because the degree of salinity varies. The hard-crusted, cloddy surface layer makes it difficult to obtain adequate stands of the commonly grown crops.

The main limitations are salinity, slow surface drainage, soil blowing, and poor tilth. Capability unit IVs-1, dryland; no irrigated capability unit; Saline Terrace range site; Wet Loamy and Sandy Lowland windbreak group.

**Zenda-Slickspots complex** (0 to 1 percent slopes) (Zs).—This mapping unit is on low stream terraces. It is about 85 percent Zenda clay loam and 15 percent Slickspots.

Included in mapping were small areas of Lesho soils and Zenda clay loam, saline. Small depressional areas are shown on the map by spot symbols. Each symbol represents an area about 1 to 5 acres in size.

Slickspots occur as small areas throughout the mapping unit. They have a high content of sodium and are slightly to moderately saline. The top 1 or 2 inches of the surface layer is light colored and crusted when dry, but it puddles after a heavy rain. The surface layer ranges from fine sandy loam to clay loam in texture and from 5 to 15 inches in thickness. The next layer ranges in texture from sandy clay loam to clay and has subangular blocky or blocky structure or is massive. It is gray to pale brown in color and in most places is mottled. The substratum ranges from fine sandy loam to clay loam in texture and is massive.

Nearly all the acreage is in wheat and sorghum. A small acreage is in native grasses. Crop growth is uneven because the degree of salinity varies. The hard-crusted, cloddy surface layer in areas of Slickspots makes it difficult to obtain adequate stands of the crops commonly grown.

The main limitations are alkali and salinity, slow surface drainage, soil blowing, and poor tilth. Capability unit IVs-1, dryland; no irrigated capability unit. Zenda soil in Loamy Terrace range site and Wet Loamy and Sandy Lowland windbreak group. Slickspots in Saline Terrace range site; no windbreak group.

## Use of the Soils for Crops and Pasture

Cropland amounts to about 290,000 acres, or about 74 percent of the total acreage in Edwards County. Wheat and grain sorghum are the principal crops. About 15,000 acres is under irrigation.

The capability grouping used by the Soil Conservation Service, in which the soils are grouped according to their suitability for crops, is explained on the pages that follow. General management is described for both dryland and irrigated acreages, and suggested use and management of the soils are described by capability unit. Estimated yields of specified crops on the soils now under cultivation are shown in tables 2 and 3.

## Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

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

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These levels are described in the following paragraphs.

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

- Class I soils have few limitations that restrict their use.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, or range, woodland, or wildlife habitat.
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.
- Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.
- Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes.

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

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

**CAPABILITY UNITS** are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Described on the following pages are the practices commonly used in dryland management in Edwards County, the use and management of dryland soils by capability unit, the practices to be considered in irrigation management, and the use and management of irrigated soils by capability unit.

The names of the soil series represented are mentioned in the description of each unit, but this does not mean that all the soils of a given series are in the unit. The capability designation for each soil in the county can be found in the "Guide to Mapping Units."

## Dryland Management

Keeping a cover crop on the soil is one of the most effective ways to protect the soil against blowing and water erosion and to conserve moisture. Wheat and other close-growing crops provide more stubble and more protection than row crops.

A combination of practices provides maximum protection against erosion and conserves a maximum amount of moisture. If terracing, contouring, and stripcropping are used along with crop residue management, the cropping system can include more years of row crops and fewer years of close-growing crops.

### Capability unit IIe-1, dryland

This unit consists of deep, well-drained soils of the Harney and Uly series. These soils have a surface layer of silt loam and a subsoil of silty clay loam. Slopes are 1 to 3 percent.

These soils are easy to cultivate and have high fertility. The available water capacity is high, and permeability is moderate to moderately slow. Erosion is a hazard. Controlling erosion and conserving moisture are the major management needs.

These soils are suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue improves tilth. Terraces and contour farming help conserve moisture and control erosion.

#### ***Capability unit IIe-2, dryland***

This unit consists of deep, well-drained soils of the Attica, Canadian, and Naron series. These soils have a surface layer of fine sandy loam. It is underlain by fine sandy loam or sandy clay loam. Slopes are 0 to 1 percent.

These soils are easy to cultivate and have medium fertility. The available water capacity is moderate, and permeability is moderate to moderately rapid. Unless well managed, all soils in this unit are subject to soil erosion. Controlling soil blowing and maintaining the supply of organic matter are the major management needs.

These soils are suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops. Proper use of crop residue improves tilth, replenishes the supply of organic matter, and helps control erosion (fig. 6). Stripcropping helps control soil blowing.

#### ***Capability unit IIe-3, dryland***

This unit consists of deep soils of the Attica and Naron series and soils of the Attica-Carwile complex. Slopes are 0 to 3 percent. These soils have a surface layer of fine sandy loam. The Carwile soil has a clay subsoil. The others have a subsoil of fine sandy loam or sandy clay loam.

These soils have medium fertility and are easy to cultivate. The Carwile soil is somewhat poorly drained and has high available water capacity and slow permeability. Attica and Naron soils are well drained and have moderate available water capacity and moderate to moderately rapid permeability. All are subject to erosion unless properly managed. Controlling soil blowing and maintaining the supply of organic matter are the major management needs.

These soils are suited to the crops commonly grown in the county and to grasses and trees and the development



Figure 6.—Stubble mulch tillage protects a field of Attica fine sandy loam, 0 to 1 percent slopes, against erosion.

of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue helps control erosion, replenishes the supply of organic matter, and improves tilth. Drainage ditches improve the somewhat poorly drained low areas. Stripcropping helps control wind erosion.

#### ***Capability unit IIe-4, dryland***

This unit consists of deep, well-drained soils of the Farnum and Holdrege series. The surface layer of these soils is silt loam or loam, and the subsoil is silty clay loam or clay loam. Slopes are 1 to 3 percent.

These soils are easy to cultivate and have high fertility. They have high available water capacity and moderate to moderately slow permeability. All soils are subject to erosion unless properly managed. Controlling erosion and conserving moisture are the major management needs.

These soils are suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops. Forage sorghum is also grown.

Proper use of crop residue improves tilth and protects the soil against erosion. Terraces and contour farming help conserve moisture and control erosion.

#### ***Capability unit IIw-1, dryland***

The one soil in this unit, Zenda clay loam, is deep and somewhat poorly drained and has a fluctuating water table. It is clay loam to a depth of about 40 inches. Below this is sandy loam.

This soil has high fertility and is easy to cultivate. It has high available water capacity and moderate permeability. Eliminating wetness, controlling soil blowing, and maintaining tilth are the major management needs.

This soil is well suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Drainage ditches are needed in some wet areas. Proper use of crop residue improves tilth and helps control soil blowing.

#### ***Capability unit IIw-2, dryland***

The one soil in this unit, Carwile fine sandy loam, is deep and somewhat poorly drained. It has a fine sandy loam surface layer and a clay subsoil.

This soil has medium fertility and is easy to cultivate. It has high available water capacity and slow permeability. Wetness, soil blowing, and an inadequate supply of organic matter are major concerns in management.

This soil is well suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Drainage ditches are needed in some wet areas. Proper use of crop residue helps control erosion, replenishes the supply of organic matter, and improves tilth. Stripcropping helps control soil blowing.

#### ***Capability unit IIs-1, dryland***

The one soil in this unit, Tabler clay loam, is deep and moderately well drained. It has a clay loam surface layer and a clay subsoil.

This soil has high fertility, high available water capacity, and very slow permeability. The very slow permeability, poor surface drainage, and soil blowing are the major concerns in management.

This soil is well suited to the crops commonly grown in the county and to grasses and trees and development of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue helps control erosion and conserve moisture and improves tilth. In some places drainage ditches are needed in wet areas.

#### ***Capability unit IIc-1, dryland***

This unit consists of deep, well-drained soils of the Farnum, Harney, and Lubbock series. The surface layer of the soils is silt loam or loam, and the subsoil is clay loam, silty clay loam, or clay. Slopes are 0 to 1 percent.

These soils have high fertility and are easy to cultivate. They have high available water capacity and moderately slow permeability. Inadequate rainfall is the principal limitation. Conserving moisture and controlling soil blowing are the major management needs.

These soils are well suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops. Forage sorghum and alfalfa are also grown.

Proper use of crop residue helps conserve moisture and control soil blowing and improves tilth.

#### ***Capability unit IIc-2, dryland***

The one soil in this unit, Hord silt loam, is deep and well drained. It is silt loam in all horizons.

This soil has high fertility and is easy to cultivate. It has high available water capacity and moderate permeability. Inadequate rainfall is the principal limitation. Conserving moisture and controlling soil blowing are the major management needs.

This soil is well suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue helps conserve moisture and control soil blowing and improves tilth.

#### ***Capability unit IIIe-1, dryland***

This unit consists of deep, well-drained soils of the Harney and Uly series. These soils have a silt loam surface layer and a silty clay loam subsoil. Slopes are 3 to 6 percent.

These soils are easy to cultivate and have high fertility. They have high available water capacity and moderate to moderately slow permeability. They are subject to erosion unless properly managed. Erosion is the major concern in management.

These soils are suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue protects the soil from erosion and improves tilth. Terraces, waterways, and contour farming help conserve moisture and control erosion.

**Capability unit IIIe-2, dryland**

The one soil in this unit, Holdrege silt loam, 3 to 6 percent slopes, is deep and well drained. It has a silt loam surface layer and a silty clay loam subsoil.

This soil is easy to cultivate and has high fertility. It has high available water capacity and moderate permeability. It is subject to soil erosion unless properly managed. Erosion is the major concern in management.

This soil is suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue protects the soil against erosion and improves tilth. Terraces, waterways, and contour farming help control erosion and conserve moisture.

**Capability unit IIIe-3, dryland**

This unit consists of deep, well-drained soils of the Naron and Pratt series. These soils have a loamy fine sand surface layer and a loamy fine sand or sandy clay loam subsoil.

These soils have medium fertility and are easy to cultivate. The Pratt soil has low available water capacity

and rapid permeability. The Naron soil has moderate available water capacity and moderate permeability. Both are subject to blowing unless properly managed. Controlling soil blowing and maintaining the supply of organic matter are the major management needs.

These soils are suited to the crops commonly grown in the county and to native grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue helps control soil blowing, replenishes the supply of organic matter, and improves tilth. Stripcropping helps control soil blowing (fig. 7).

**Capability unit IIIw-1, dryland**

Tobin silt loam is the only soil in this unit. It is a deep, well-drained soil that has a surface layer of silt loam. The next layer is silty clay loam.

This soil has high fertility and is easy to cultivate. The available water capacity is high, and permeability is moderate. Frequent flooding and soil blowing are the main hazards.

This soil is well suited to native grasses, to the crops commonly grown in the county, and to trees and the de-



Figure 7.—Stripcropping on Pratt loamy fine sand, undulating.

velopment of wildlife habitat. Wheat and grain sorghum are the main crops.

Good management in the surrounding drainage area reduces the frequency of flooding. Proper use of crop residue helps in controlling soil blowing and conserving moisture and improves tilth.

#### ***Capability unit IIIw-2, dryland***

This unit consists of somewhat poorly drained soils of the Lesho and Waldeck series. These soils are moderately deep over sand and have a fluctuating water table. They have a clay loam, loam, or fine sandy loam surface layer that is underlain by clay loam or sandy loam.

These soils are easy to cultivate. The Lesho soil has high fertility, moderate available water capacity, and moderately slow permeability. The Waldeck soil has medium fertility, low available water capacity, and moderately rapid permeability. The major management concerns are wetness, tilth, soil blowing, and an inadequate supply of organic matter.

These soils are suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue helps control soil blowing, improves tilth, and replenishes the supply of organic matter.

#### ***Capability unit IIIs-1, dryland***

Canadian fine sandy loam, sandy subsoil, the only soil in this unit, is well drained and moderately deep over sand. It is fine sandy loam to a depth of about 30 inches. Below this is sand.

This soil has medium fertility and is easy to cultivate. It has low available water capacity and moderately rapid permeability. The major concerns in management are the low available water capacity, an inadequate supply of organic matter, and the hazard of soil blowing. This soil is droughty during years of average or below average precipitation.

This soil is suited to the crops commonly grown in the county and to grasses and trees and the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue helps control erosion, replenishes the supply of organic matter, and improves tilth. Stripcropping helps control soil blowing.

#### ***Capability unit IVE-1, dryland***

Pratt loamy fine sand, hummocky, the only soil in this unit, is deep and well drained. It has a loamy fine sand surface layer and subsoil.

This soil has medium fertility, low available water capacity, and rapid permeability. It is subject to erosion unless properly managed. The major management needs are controlling soil blowing and increasing the supply of organic matter.

This soil is better suited to native grasses than to cultivated crops, but under intensive management it can be used for cultivated crops. It is suited to trees and to the development of wildlife habitat. Wheat and grain sorghum are the main crops.

Proper use of crop residue helps control soil blowing, replenishes the supply of organic matter, and improves tilth. Stripcropping also helps control soil blowing.

#### ***Capability unit IVs-1, dryland***

This unit consists of deep, moderately well drained and somewhat poorly drained soils of the Carwile, Tabler, and Zenda series and Slickspots. The surface layer of these soils is fine sandy loam or clay loam. It is underlain by clay loam or clay. The Zenda soil and Slickspots are slightly to moderately affected by salts.

These soils have high available water capacity and very slow to moderate permeability. The hard-crusting surface layer and slow surface drainage of Slickspots and the saline Zenda soil make these soils difficult to cultivate. Salinity and excess sodium have a slight to severe effect on the growth of crops. Crop growth is uneven because the degree of salinity varies from place to place (fig. 8). Salinity, slow surface drainage, and soil blowing are the major limitations.

These soils are better suited to native grasses than to cultivated crops, but under intensive management they can be used for cultivated crops. They are suited to trees and to the development of wildlife habitat. The main crops are wheat and grain sorghum.

Drainage is needed in some wet areas. Proper use of crop residue helps control soil blowing, replenishes the supply of organic matter, and improves tilth. Stripcropping also helps control soil blowing. Manure improves tilth on Slickspots and the saline soils.

#### ***Capability unit Vw-1, dryland***

Plevna fine sandy loam, the only soil in this unit, is fine sandy loam in all horizons. It is deep and poorly drained and has a fluctuating water table.

This soil has medium fertility, moderate available water capacity, and moderately rapid permeability. The major limitations are wetness and flooding.

This soil is better suited to native grasses than to cultivated crops. It is suited to trees and to the development of wildlife habitat.

Proper range use and deferred grazing help in maintaining the more desirable native grasses. Tree and brush control improve the vigor and composition of the grasses.

#### ***Capability unit VIe-1, dryland***

Breaks-Alluvial land complex is the only mapping unit in this unit. These deep, well-drained soils are loam to silty clay loam in all horizons. On the narrow flood plains along drainageways, slopes are 0 to 3 percent. In other areas they are 6 to 15 percent.

These soils have high fertility, high available water capacity, and moderate permeability. Erosion is the major management concern.

Because the erosion hazard is severe, these soils are best suited to native grasses and trees and to the development of wildlife habitat.

Proper range use and deferred grazing help in controlling erosion and in maintaining or increasing the more desirable native grasses. Proper location of fences, salt, and water helps distribute the livestock so that the range is grazed uniformly.



Figure 8.—Spotty and uneven growth of winter wheat on Zenda-Slickspots complex.

#### **Capability unit VIe-2, dryland**

Only Campus-Canlon complex is in this unit. These moderately deep and shallow, well-drained soils are underlain by caliche. Their surface layer is loam, and the next layer is loam or clay loam.

These soils have medium fertility, low to very low available water capacity, and moderate permeability. The erosion hazard is severe unless native vegetation is maintained.

Because of the severe erosion hazard, these soils are best suited to native grasses and to the development of wildlife habitat.

Proper range use and deferred grazing help in controlling erosion and in maintaining or increasing the more desirable native grasses. Proper location of fences, salt, and water helps distribute the livestock so that the range is grazed uniformly.

#### **Capability unit VIe-3, dryland**

This unit consists of deep, well drained to excessively drained soils of the Pratt, Brazos, and Tivoli series. The surface layer of these soils is loamy fine sand. It is underlain by loamy fine sand to sand. Slopes are 0 to 15 percent.

These soils have low and medium fertility, very low to low available water capacity, and rapid permeability.

Because the erosion hazard is severe, these soils are best suited to native grasses (fig. 9). They are also suited to trees and to the development of wildlife habitat.

The proper range use and deferred grazing help in controlling erosion and in maintaining or increasing the more desirable native grasses. Proper location of fences, salt, and water helps distribute the livestock so that the range is grazed uniformly. Blowouts should be fenced off from livestock. Native grasses can be seeded in areas where a protective cover of sorghum or weeds is established.

#### **Capability unit VIw-1, dryland**

Ness clay, the only soil in this unit, is deep and poorly drained and receives runoff from surrounding soils. It is clay to a depth of about 46 inches. Below this is silty clay loam.

This soil has high fertility, high available water capacity, and very slow permeability. Ponding and soil blowing are the major limitations.

This soil is usually farmed along with adjoining soils. Because it is ponded, it is not well suited to crops, grasses,



Figure 9.—Native grasses on Pratt-Tivoli loamy fine sands.

trees, or wildlife habitat. Crops are frequently drowned out. Most areas are too wet to plant. The vegetation is dominantly Pennsylvania smartweed, bur-ragweed, cocklebur, sedges, and rushes.

Conserving moisture and controlling erosion on surrounding areas would help eliminate the ponding on this soil.

**Capability unit VIw-2, dryland**

Only Platte soils are in this unit. These soils have a sandy loam to clay loam surface layer that is underlain by loamy sand and sand. They are deep and somewhat poorly drained and have a fluctuating water table.

These soils have medium fertility, low available water capacity, and moderately rapid permeability. Wetness, flooding, soil blowing, and regulation of grazing are the major concerns in management.

These soils are best suited to native grasses. They are also suited to trees and to the development of wildlife habitat.

Proper range use and deferred grazing help in maintaining or increasing the more desirable native grasses. Proper location of fences, salt, and water helps distribute the livestock so that the range is grazed uniformly.

**Capability unit VIIs-1, dryland**

Las Animas loamy fine sand is the only soil in this unit. It is deep and somewhat poorly drained and has a fluctuating water table. It is loamy fine sand to a depth of about 30 inches. Below this is sandy loam.

This soil has medium fertility, low available water capacity, and rapid permeability. Soil blowing, wetness, and the low available water capacity are the major limitations.

This soil is well suited to native grasses and to the development of wildlife habitat.

Proper range use and deferred grazing help in controlling erosion and maintaining or increasing the more desirable native grasses. Proper location of fences, salt, and water helps distribute the livestock so that the range is grazed uniformly.

**Capability unit VIIe-1, dryland**

The deep, excessively drained Tivoli fine sand and Blown-out land are in this unit. The texture is fine sand in all horizons.

These soils have low fertility, very low available water capacity, and rapid permeability. Erosion and regulation of grazing are the chief management concerns.

Proper range use and deferred grazing help in controlling erosion and in maintaining or increasing the more desirable native grasses. Proper location of fences, salt, and water helps distribute the livestock so that the range is grazed uniformly. Blowouts should be fenced off from livestock. Native grasses can be seeded in areas where a protective cover of sorghum or weeds is established.

### Estimated Yields of Dryland Crops

Table 2 shows estimated average yields per seeded acre of dryland wheat and grain sorghum for the soils suitable for cultivation under high-level management. Information on which to base precise estimates is limited, however, because no long-time, accurate records of yields are available. Also, yields fluctuate greatly, mainly as the result of differences in the kind of diseases and insects, the supply of plant nutrients in the soil, and in the amount of precipitation.

TABLE 2.—*Estimated yields per acre of dryland seeded wheat and grain sorghum on arable soils under high-level management*

Soil	Wheat	Grain sorghum
	Bu.	Bu.
Attica fine sandy loam, 0 to 1 percent slopes----	25	42
Attica fine sandy loam, 1 to 3 percent slopes---	23	42
Attica-Carwile fine sandy loams-----	23	40
Canadian fine sandy loam-----	26	44
Canadian fine sandy loam, sandy subsoil-----	22	36
Carwile fine sandy loam-----	22	40
Carwile-Slickspots complex-----	19	30
Farnum loam, 0 to 1 percent slopes-----	30	50
Farnum loam, 1 to 3 percent slopes-----	28	48
Harney silt loam, 0 to 1 percent slopes-----	28	46
Harney silt loam, 1 to 3 percent slopes-----	26	42
Harney silt loam, 3 to 6 percent slopes-----	24	38
Harney-Uly complex, 1 to 3 percent slopes-----	23	38
Harney-Uly complex, 3 to 6 percent slopes-----	20	34
Holdrege silt loam, 1 to 3 percent slopes-----	28	46
Holdrege silt loam, 3 to 6 percent slopes-----	26	42
Hord silt loam-----	30	50
Lesho clay loam-----	21	36
Lubbock silt loam-----	28	44
Naron loamy fine sand, 0 to 1 percent slopes-----	23	42
Naron fine sandy loam, 0 to 1 percent slopes---	26	48
Naron fine sandy loam, 1 to 3 percent slopes---	25	45
Pratt loamy fine sand, hummocky-----	16	30
Pratt loamy fine sand, undulating-----	20	36
Tabler clay loam-----	25	40
Tabler-Slickspots complex-----	19	30
Tobin silt loam-----	30	42
Waldeck fine sandy loam-----	20	40
Waldeck loam-----	20	40
Zenda clay loam-----	25	42
Zenda clay loam, saline-----	20	28
Zenda-Slickspots complex-----	21	32

The estimates shown in table 2 were based on data obtained from farmers and on observations made by the Kansas Agricultural Experiment Station, the soil survey party, and other agricultural workers who are familiar with the soils. These are estimates of the yields to be expected over a long period of time under a high level of management. Under high-level management—

1. Practices are used that will conserve moisture and protect the soils from erosion. These include terracing, contour farming, and stripcropping.
2. Tillage is held to a minimum and is done in a way that leaves the crop residue on the surface. Tillage is performed only when it is necessary to kill weeds or to prepare a seedbed.
3. The cropping system is flexible. Wheat or sorghum is grown, or the soils are left fallow, depending on the amount of soil moisture.
4. The proper seeding rate is used.
5. The fertilization program provides for the use of fertilizer where required for maximum yields.
6. Grazing of crop residue is controlled so that the soils are protected at all times.

### Irrigation Management

Most of the irrigated acreage in Edwards County, about 15,000 acres, is east of the sandhills and in the Arkansas River Valley. The area east of the sandhills has a large supply of good water and a large acreage of soils well suited to irrigation. This area has good potential for further irrigation development.

Several factors should be considered in planning an irrigation system, for example, soil, water supply, the control and conveyance of water, type of system, application of water, land preparation, drainage, and an overall management program.

The adequacy and reliability of the water supply affect both the type and the extent of the irrigation system as well as the crops.

The quality of the water is highly important. Heavy concentrations of dissolved salts are objectionable. The soils, climate, cropping system, and irrigation practices must all be considered in appraising water quality.

Various physical controls are needed after a suitable water supply for irrigation is found. It is necessary to control the supply and deliver the water economically from the point of origin to the point of use on the farm. Pumping plants, pipelines, ditches, and drop structures to control erosion are among the items to be considered.

Surface irrigation and sprinkler, or overhead, irrigation are used in Edwards County. The purpose of either method is to apply adequate water uniformly over the field, without damage to the soil or the crop, using a minimum of labor.

In surface irrigation, water completely covers the surface, from borders or basins, or flows in furrows or corrugations.

#### *Capability unit I-1, irrigated*

This unit consists of deep, well-drained soils of the Farnum, Harney, Hord, and Lubbock series. The surface layer of these soils is loam or silt loam. It is underlain by clay loam, silty clay loam, silt loam, or clay. Slopes are 0 to 1 percent.

These soils have high fertility and are easy to cultivate. They have high available water capacity and moderate to moderately slow permeability. Maintaining and improving fertility and tilth are the major concerns in management.

These soils are well suited to the crops commonly grown in the county (fig. 10). Sorghum and wheat are the main crops.



*Figure 10.*—Irrigated grain sorghum on a Farnum loam.

Proper use of crop residue replenishes the supply of organic matter and improves tilth.

Land leveling and proper use of irrigation water distribute water uniformly, help to control erosion, and provide good surface drainage. In places drainage is needed to remove excess irrigation water and precipitation.

#### ***Capability unit IIe-1, irrigated***

This unit consists of deep, well-drained soils of the Farnum, Harney, Holdrege, and Uly series. These soils have a loam or silt loam surface layer and a clay loam or silty clay loam subsoil. Slopes are 1 to 3 percent.

These soils have high fertility and are easy to cultivate. They have high available water capacity and moderate to moderately slow permeability. They are subject to erosion unless properly managed. Controlling water erosion and using irrigation water efficiently are the major management needs.

These soils are well suited to the crops commonly grown in the county. Sorghum and wheat are the main crops. Only a small acreage is irrigated. The irrigation water available is generally used on soils that have slopes of less than 1 percent.

Proper use of crop residue helps to control erosion and improve tilth. Contour furrows and sprinklers, supplemented with terraces and waterways, and bench leveling are beneficial in controlling water erosion and in using irrigation water efficiently. Close-growing crops provide more soil protection than row crops.

#### ***Capability unit IIe-2, irrigated***

This unit consists of deep soils of the Attica and Naron series and soils of the Attica-Carwile complex. These soils have a surface layer of fine sandy loam. The subsoil of the Attica and Naron soils is fine sandy loam or sandy clay loam, and that of the Carwile soil is clay. Slopes are 0 to 3 percent.

These soils have medium fertility and are easy to cultivate. Attica and Naron soils are well drained and have moderate available water capacity and moderate to moderately rapid permeability. Carwile soils are somewhat poorly drained and have high available water capacity and slow permeability. All are subject to erosion. Controlling erosion and using irrigation water efficiently are the major management needs.

These soils are well suited to the crops commonly grown and to potatoes, beans, and other vegetable crops. Sorghum and wheat are the main crops. Proper use of crop residue helps in controlling erosion, improving tilth, and replenishing the supply of organic matter. Close-growing crops provide more soil protection than row crops.

These soils are well suited to sprinkler irrigation. They can be leveled, but deep cuts and fills are needed where slopes are irregular. In places drainage is needed to remove excess irrigation water.

#### ***Capability unit IIw-1, irrigated***

Zenda clay loam, the only soil in this unit, is deep and somewhat poorly drained and has a fluctuating water table. It is clay loam to a depth of about 40 inches. Below this is sandy loam.

This soil has high fertility and is easy to cultivate. It has moderate permeability and high available water capacity, but it is only 40 to 60 inches deep over sand. Eliminating wetness and using irrigation water efficiently are the major concerns in management.

This soil is well suited to the crops commonly grown in the county. Sorghum and wheat are the main crops.

Proper use of crop residue replenishes the supply of organic matter and improves tilth. Land leveling and proper use of irrigation water distribute water uniformly, help in controlling erosion, and provide good surface drainage. In leveling, the depth of cut should be kept at a minimum because of the limited depth to sand. In places drainage is needed to remove excess irrigation water.

Applying water properly is important. Light irrigation is not desirable, because it favors the accumulation of harmful salts in the root zone. Excessive irrigation leaches out plant nutrients.

#### ***Capability unit IIw-2, irrigated***

Carwile fine sandy loam, the only soil in this unit, is deep and somewhat poorly drained. It has a clay subsoil.

This soil is easy to cultivate and has medium fertility. It has high available water capacity and slow permeability. Eliminating wetness and using irrigation water efficiently are the major concerns in management.

This soil is well suited to the crops commonly grown in the county. Sorghum and wheat are the main crops.

Land leveling and proper use of irrigation water distribute water uniformly, provide good surface drainage, and help to control erosion. In places drainage is needed to remove excess irrigation water. Proper use of crop residue helps to control soil blowing, replenishes the supply of organic matter, and improves tilth.

#### ***Capability unit IIs-1, irrigated***

This unit consists of deep, well-drained soils of the Attica, Canadian, and Naron series. Slopes are 0 to 1 percent. The surface layer of these soils is fine sandy loam. It is underlain by fine sandy loam or sandy clay loam.

These soils are easy to cultivate and have medium fertility. They have moderate available water capacity and moderate to moderately rapid permeability. Maintaining and improving fertility and soil tilth are the major management needs.

These soils are well suited to the crops commonly grown in the county. They are also suited to vegetable crops, such

as potatoes and beans. Sorghum and wheat are the main crops.

Proper use of crop residue replenishes the supply of organic matter, improves tilth, and helps to control soil blowing. Land leveling and proper use of irrigation water distribute water uniformly, help to control erosion, and provide good surface drainage. In places drainage is needed to remove excess irrigation water.

#### ***Capability unit IIs-2, irrigated***

Tabler clay loam is the only soil in this unit. It is deep and moderately well drained and has a clay subsoil.

This soil has high fertility, high available water capacity, and very slow permeability. Maintaining and improving fertility and tilth and using irrigation water efficiently are the major management needs.

This soil is suited to the crops commonly grown in the county. Sorghum and wheat are the main crops.

Proper use of crop residue replenishes the supply of organic matter and improves tilth. Land leveling and proper use of irrigation water distribute water uniformly, help to control erosion, and provide good surface drainage. In places drainage is needed to remove excess irrigation water.

#### ***Capability unit IIIe-1, irrigated***

This unit consists of deep, well-drained soils of the Pratt and Naron series. These soils have a loamy fine sand surface layer and a loamy fine sand or sandy clay loam subsoil. The Naron soil has slopes of 0 to 1 percent, and the Pratt soil, slopes of 1 to 10 percent.

These soils have medium fertility and are easy to cultivate. The Pratt soils has low available water capacity and rapid permeability, and the Naron soil, moderate available water capacity and moderate permeability. Both are subject to erosion unless properly managed. Controlling soil blowing and using irrigation water efficiently are the major management needs.

These soils are suited to the crops commonly grown in the county. Grain sorghum and wheat are the main crops.

Proper use of crop residue helps to control soil blowing, replenishes the supply of organic matter, and improves tilth. These soils are well suited to sprinkler irrigation because the surface layer is sandy and slopes are irregular. Close-growing crops provide more soil protection than row crops.

#### ***Capability unit IIIw-1, irrigated***

Lesho clay loam, the only soil in this unit, is clay loam in all horizons. It is moderately deep over sand, is somewhat poorly drained, and has a fluctuating water table.

This soil has high fertility and is easy to cultivate. It has moderate available water capacity because it is only 20 to 40 inches deep over sand and fine gravel. Permeability is moderately slow. Eliminating wetness and using irrigation water efficiently are the major management needs.

This soil is suited to the crops commonly grown in the county. Sorghum and wheat are the main crops.

Proper use of crop residue replenishes the supply of organic matter and improves tilth. Land leveling and proper use of irrigation water distribute water uniformly, help to control erosion, and provide good surface drainage. In leveling, the depth of cut should be kept at a mini-

mum because of the limited depth to sand. A drainage system may be needed to remove excess irrigation water.

Applying water properly is important. Light irrigation is not desirable, because it favors the accumulation of harmful salts in the root zone. Excessive irrigation leaches out plant nutrients.

#### ***Capability unit IIIw-2, irrigated***

This unit consists of somewhat poorly drained soils of the Waldeck series. These soils are moderately deep over sand and have a fluctuating water table. Their surface layer is loam or fine sandy loam. It is underlain by sandy loam.

These soils have medium fertility and are easy to cultivate. They have low available water capacity because they are only 24 to 40 inches deep over sand. Permeability is moderately rapid. Eliminating wetness and using irrigation water efficiently are the major management needs.

These soils are suited to the crops commonly grown in the county. Sorghum and wheat are the main crops.

Proper use of crop residue replenishes the supply of organic matter and improves tilth. Land leveling and proper use of irrigation water distribute water uniformly, help to control erosion, and provide good surface drainage. In leveling, the depth of cut should be kept at a minimum because of the limited depth to sand.

Applying water properly is important. Light irrigation is not desirable, because it favors the accumulation of harmful salts in the root zone. Excessive irrigation leaches out plant nutrients.

#### ***Capability unit IIIs-1, irrigated***

Canadian fine sandy loam, sandy subsoil, the only soil in this unit, is well drained and moderately deep over sand. It is fine sandy loam to a depth of about 30 inches. Below this is sand.

This soil has medium fertility and is easy to cultivate. It has low available water capacity, because it is only 24 to 40 inches deep over sand. Permeability is moderately rapid. Maintaining and improving fertility and tilth and using irrigation water efficiently are the major concerns in management.

This soil is suited to the crops commonly grown in the county. Sorghum and wheat are the main crops.

Proper use of crop residue replenishes the supply of organic matter and improves tilth. Land leveling and proper use of irrigation water distribute water uniformly, help to control erosion, and provide good surface drainage. In leveling, the depth of cut should be kept at a minimum because of the limited depth to sand. Excessive irrigation leaches out plant nutrients.

#### ***Capability unit IVs-1, irrigated***

Las Animas loamy fine sand is the only soil in this unit. The loamy fine sand extends to a depth of about 30 inches. Below this is sandy loam and sand. This soil is deep to moderately deep, is somewhat poorly drained, and has a fluctuating water table.

This soil is easy to cultivate and has medium fertility. The available water capacity is low, and permeability is rapid. Maintaining or improving fertility and tilth and controlling soil blowing are the major management needs.

This soil is better suited to grasses than to cultivated crops. Under intensive management, it can be used for cultivated crops.

Proper use of crop residue replenishes the supply of organic matter, improves tilth, and helps to control soil blowing.

This soil is better suited to sprinkler irrigation than to other types because it is sandy and rapidly permeable. Applying water properly is important. Light irrigation is not desirable because it favors the accumulation of harmful salts in the root zone. Excessive irrigation leaches out plant nutrients.

#### ***Capability unit IVs-2, irrigated***

Ness clay, the only soil in this unit, is deep and poorly drained and receives runoff from surrounding soils. It is clay to a depth of about 46 inches. Below this is silty clay loam.

This soil has high fertility, high available water capacity, and very slow permeability. It is difficult to cultivate because of the clay surface layer. Maintaining and improving tilth and fertility, improving surface drainage, and using irrigation water efficiently are major concerns in management.

This soil is suited to the crops commonly grown in the county. Sorghum and wheat are the main crops.

Proper use of crop residue improves tilth and replenishes the supply of organic matter. Land leveling and proper use of irrigation water distribute water uniformly, help control erosion, and provide good surface drainage. In places drainage is needed to remove excess irrigation water.

### **Estimated Yields of Irrigated Crops**

Table 3 shows estimated average yields per seeded acre of crops commonly grown under irrigation. Only the soils suitable for irrigation are listed. The estimates are based on high-level management. Information on which to base precise estimates is limited because no long-time, accurate records of irrigated yields are available. Also, yields fluctuate mainly as the result of differences in plant population, diseases, insects, and the supply of plant nutrients in the soil.

Estimates shown in table 3 were based on data obtained from farmers and on observations made by the Kansas Agricultural Experiment Station, the soil survey party, and other agricultural workers who are familiar with the soils. The estimates shown are the yields to be expected over a long period of time under a high level of management. Under high-level management—

1. Practices are used that protect the soil from erosion and improve soil tilth.
2. Tillage is held to a minimum. It is performed only when necessary to kill weeds or to prepare a seedbed.
3. A proper seeding rate of recommended varieties is used, and seeding is done at the right time.
4. A fertilization program is used that provides for the use of fertilizer for maximum yields.
5. The proper amount of irrigation water is used at the proper time.

TABLE 3.—Estimated yields per seeded acre of irrigated crops under high-level management

Soil	Wheat	Grain sorghum	Forage sorghum	Alfalfa
	Bu.	Bu.	Tons	Tons
Attica fine sandy loam, 0 to 1 percent slopes	40	125	27	6.5
Attica fine sandy loam, 1 to 3 percent slopes	38	105	24	6.0
Attica-Carwile fine sandy loams	38	105	24	6.0
Canadian fine sandy loam	40	125	27	6.5
Canadian fine sandy loam, sandy subsoil	35	115	24	5.5
Carwile fine sandy loam	40	125	27	6.5
Farnum loam, 0 to 1 percent slopes	45	130	30	7.0
Farnum loam, 1 to 3 percent slopes	38	110	27	6.5
Harney silt loam, 0 to 1 percent slopes	45	130	30	7.0
Harney silt loam, 1 to 3 percent slopes	36	110	27	6.5
Harney-Uly complex, 1 to 3 percent slopes	35	100	26	6.5
Holdrege silt loam, 1 to 3 percent slopes	38	110	27	6.5
Hord silt loam	45	130	30	7.0
Las Animas loamy fine sand	24	90	22	5.0
Lesho clay loam	35	100	24	5.5
Lubbock silt loam	45	130	30	7.0
Naron loamy fine sand, 0 to 1 percent slopes	35	105	24	6.0
Naron fine sandy loam, 0 to 1 percent slopes	42	125	27	6.5
Naron fine sandy loam, 1 to 3 percent slopes	38	110	25	6.0
Ness clay	25	90	22	4.5
Pratt loamy fine sand, hummocky	26	85	22	5.5
Pratt loamy fine sand, undulating	30	90	23	5.5
Tabler clay loam	40	120	27	6.5
Waldeck fine sandy loam	35	90	23	5.5
Waldeck loam	35	90	23	5.5
Zenda clay loam	40	125	27	6.5

## Management of Rangeland<sup>2</sup>

Rangeland amounts to about 90,000 acres, or about 23 percent of the total acreage in Edwards County. The principal range area is east of the Arkansas River. A less important area is in the southeast corner of the county, on either side of Rattlesnake Creek. Small tracts of rangeland intermingled with larger acreage of cropland occur throughout the county. Most ranchers make use of the wheat and sorghum stubble for temporary grazing.

The raising of livestock is the second largest agricultural enterprise in this county. The livestock are mainly feeder and stocker cattle. There are a few breeding herds in the county.

### Range Sites and Condition Classes

Range sites are areas of rangeland that differ in their ability to produce different kinds or amounts of native

<sup>2</sup> By H. RAY BROWN, range conservationist, Soil Conservation Service.

vegetation. The establishment of a range site is based on factors that result in a significant difference in the potential plant community, not in differences in soil or in climate, and it must be great enough to require some change in management, a different stocking rate, for example.

Plants on a native range site are of three main kinds, which respond to grazing in different ways, as explained in the following:

*Decreasers* are species in the potential plant community that tend to decrease in relative amount under close grazing. They generally are the tallest, most productive perennial grasses and forbs and the most palatable to livestock.

*Increasesers* are species in the potential plant community that increase in relative amount as the more desirable plants are reduced by close grazing. They are commonly shorter than decreaseers, and some are less palatable to livestock.

*Invaders* are plants that cannot withstand the competition for moisture, nutrients, and light in the potential plant community. Hence, they invade and grow along with the increaseers after the potential vegetation has been reduced by grazing. Many are annual weeds. Some are forbs that have limited grazing value, but others have little value for grazing.

Range condition is the present state of the vegetation compared with that of the potential plant community for the site. The purpose in classifying range condition is to provide an approximate measure of any deterioration that has taken place in the plant cover and thereby provide a basis for predicting the degree of improvement possible. Four condition classes are defined. Range is in *excellent condition* if 76 to 100 percent of the vegetation is characteristic of the climax vegetation on the same site; it is in *good condition* if the percentage is between 51 and 75; in *fair condition* if the percentage is between 26 and 50; and in *poor condition* if the percentage is less than 26 percent.

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

Range kept in good to excellent condition provides optimum forage yields, and the soil is protected against erosion and loss of water. Recognizing changes in the plant cover is one of the most important factors in good range management. Such changes take place gradually and are often misunderstood or overlooked. Growth following heavy rainfall, for example, may appear to improve the condition of the site, when actually the cover is weedy and productivity is declining. On the other hand, rangeland that has been closely grazed for short periods may have a degraded appearance that temporarily conceals its quality and ability to recover.

### Descriptions of Range Sites

The native grass cover in Edwards County is mostly mid and tall grasses. About 67 percent of the rangeland is in the Sands range site. Other sites recognized are Choppy Sands, Clay Upland, Limy Upland, Loamy Lowland, Loamy Terrace, Loamy Upland, Saline Subirrigated, Saline Terrace, Saline Upland, Sandy, Sandy Terrace, Shallow Limy, and Subirrigated.

Management practices needed to improve all sites are proper range use, deferred grazing, and rotation-deferred grazing. Range seeding, using an interseeder, is possible on the Sands and the Choppy Sand sites that are in poor condition. The shallow Limy Upland sites are too steep and rocky for range seeding. All the other sites can be plowed up, seeded to a cover crop, and then seeded. Because of differences in the soils, the range sites vary greatly in the amount of forage produced. The total annual yield of herbage varies because of variations in the amount of precipitation, in the amount of grazing in past years, and in relief. Trampling and the activities of rodents and insects are likely to damage forage plants or cause them to disappear.

The range sites in this county are described on the pages that follow. In each description are estimates of total herbage yields when the site is in excellent condition. Yields are given in air-dry weight per acre, one for favorable years and one for less favorable years.

The names of the soil series represented are mentioned in the description of each site, but this does not mean that all the soils of a given series are in the site. The range site designation for each soil in the county can be found in the "Guide to Mapping Units."

#### ***Choppy Sands range site***

This site consists of deep, excessively drained Tivoli fine sand and Blown-out land, both of which are fine sand throughout. Blowouts are common. The available water capacity is very low, and permeability is rapid.

The potential plant community is a mixture of decreaseers, such as little bluestem, sand bluestem, switchgrass, and big sandreed. These grasses make up about 70 percent of the total yield. Perennial forbs and other grasses make up the rest. The dominant increaseers are sand dropseed and sand paspalum. Common invaders are false buffalograss, six-weeks fescue, annual three-awn, and annual eriogonum. Blowoutgrass and big sandreed are the first perennial plants to stabilize blowouts or dunes.

Generally this site is in fair to good condition and produces approximately half of its potential in kind and amount of vegetation. No water developments or salting grounds should be located on this site because soil blowing is a hazard.

When this site is in excellent condition, the estimated total annual yield in normal years is 1,800 pounds. Yields range from 2,300 pounds in favorable years to 1,300 pounds in less favorable years. Approximately 70 percent of the yield is grass, mainly sand bluestem; 10 percent is forbs; and 20 percent is woody plants. About 80 percent of the yield provides forage for cattle.

#### ***Clay Upland range site***

This site consists of deep, moderately well drained soils of the Tabler series. These soils have a surface layer of clay loam and a subsoil of clay. The available water capacity is high, and permeability is very slow. This range site is readily accessible to livestock and is a favorite site for grazing early in spring and in fall and winter.

The potential plant community consists mostly of mid and short grasses. About 60 percent of the total plant yield is made up of such decreaseers as western wheatgrass, side-oats grama, tall dropseed, and perennial forbs and other

grasses. The dominant increaseers are blue grama, buffalograss, and sand dropseed. Other increaseers are western ragweed and pricklypear. The principal invaders are little barley, annual brome, snow-on-the-mountain, windmillgrass, and tumblegrass. Side-oats grama is usually the first species to decrease under continuous overgrazing, and western wheatgrass the second.

This range site varies considerably in the production of forage. If it is in excellent condition, about 30 percent of the forage is western wheatgrass. If precipitation is high in winter and spring, the production of western wheatgrass is high, but if drought prevails, production is low. Generally the site is in good condition. Blue grama and buffalograss carry the grazing load.

When this site is in excellent condition, the estimated total annual yield in normal years is 2,200 pounds. Yields range from 4,000 pounds in favorable years to 800 pounds in less favorable years. Approximately 80 percent of the yield is grass, mainly western wheatgrass; 15 percent is forbs, mostly western ragweed; and 5 percent is woody plants. Approximately 90 percent of the yield provides forage for cattle.

#### ***Limy Upland range site***

This site consists of well-drained, calcareous soils of the Campus series and the Breaks part of the Breaks-Alluvial land complex. The surface layer is loam to silty clay loam. It is underlain by clay loam or silty clay loam. Permeability is moderate. The moderately deep Campus soils have low available water capacity. Breaks are deep soils that have high available water capacity.

The potential plant community is a mixture of such decreaseers as little bluestem, side-oats grama, big bluestem, switchgrass, and prairie clover. The dominant increaseers are blue grama, buffalograss, and broom snakeweed. Continuous overuse results in an immediate decrease in big bluestem, followed by a decline in switchgrass and side-oats grama.

Generally this site is in fair condition, and blue grama and buffalograss carry the grazing load.

When this site is in excellent condition, the estimated total annual yield in normal years is 2,400 pounds. Yields range from 4,000 pounds in favorable years to 900 pounds in less favorable years. Approximately 80 percent of the yield is grass, mainly big bluestem; 15 percent is forbs; and 5 percent is woody plants. About 90 percent of the yield provides forage for cattle.

#### ***Loamy Lowland range site***

This site consists of deep, well-drained soils of the Tobin series and the Alluvial land part of the Breaks-Alluvial land complex. The surface layer is silt loam. The underlying material is silt loam or silty clay loam. These soils are frequently flooded. They have high available water capacity and moderate permeability.

The potential plant community consists of mid and tall grasses. About 80 percent of the total plant yield is made up of such decreaseers as big bluestem, switchgrass, indian-grass, Canada wildrye, and little bluestem. Perennial forbs and other grasses make up the rest. Important increaseers are western wheatgrass, blue grama, side-oats grama, buffalograss, and western ragweed. Common invaders are little barley, annual brome, windmillgrass, and tumblegrass.

Generally, under present grazing use, this site is in fair condition and blue grama and western wheatgrass carry the grazing load.

When this site is in excellent condition, the estimated total annual yield in normal years is 4,500 pounds. Yields range from 6,000 pounds in favorable years to 3,800 pounds in less favorable years. Approximately 85 percent of the yield is grass, mainly big bluestem; 10 percent is forbs; and 5 percent is woody plants. About 90 percent of the yield provides forage for cattle.

#### ***Loamy Terrace range site***

This site consists of deep, well drained to moderately well drained soils of the Hord and Zenda series. The texture is silt loam or clay loam throughout. The available water capacity is high, and permeability is moderate. These soils receive some runoff, but flooding from streams is infrequent.

Decreaser grasses in the potential plant community, such as switchgrass, big bluestem, little bluestem, side-oats grama, and Canada wildrye, make up about 75 percent of the total plant yield. Perennial forbs and other grasses make up the rest. The dominant increasers are western wheatgrass, blue grama, and buffalograss. Western ragweed and woolly verbena are common forb increasers. The principal invaders are silver bluestem, annual bromes, little barley, windmillgrass, and tumblegrass.

Under present grazing use, this site is generally in fair condition. Western wheatgrass is the main increaser under heavy grazing. Usually western wheatgrass and blue grama carry the grazing load. This site is more productive than the Loamy Upland site, but is less productive than the Loamy Lowland.

When this site is in excellent condition, the estimated total annual yield in normal years is 3,500 pounds. Yields range from 4,500 pounds in favorable years to 2,500 pounds in less favorable years. Approximately 85 percent of the yield is grass, mainly big bluestem; 10 percent is forbs; and 5 percent is woody plants. About 90 percent of the yield provides forage for cattle.

#### ***Loamy Upland range site***

This site consists of deep, well-drained soils of the Farnum, Harney, Holdrege, Lubbock, and Uly series. These soils have a surface layer of loam to silt loam and a subsoil of silty clay loam to clay. The available water capacity is high, and permeability is moderate to moderately slow. This site is readily accessible to livestock and is a favorite site for grazing.

The potential plant community consists of mid and short grasses. About 50 percent of the total plant yield is made up of such decreasers as side-oats grama, little bluestem, big bluestem, and switchgrass. Perennial forbs and other grasses make up the rest. Important increasers are blue grama, buffalograss, western wheatgrass, sand dropseed, red three-awn, and western ragweed. Common invaders are little barley, annual brome, and windmillgrass. Continuous overuse results in an immediate decrease in big bluestem and switchgrass, followed by a decrease in little bluestem and a rapid increase in buffalograss.

Generally this site is in fair condition. Buffalograss and blue grama usually carry the grazing load.

When this site is in excellent condition, the estimated total annual yield in normal years is 2,300 pounds per acre. Yields range from 4,000 pounds in favorable years to 1,000 pounds in less favorable years. Approximately 85 percent of the yield is grass, mainly side-oats grama, little bluestem, and blue grama; 10 percent is forbs, mostly western ragweed; and 5 percent is woody plants. About 90 percent of the yield provides forage for cattle.

#### ***Saline Subirrigated range site***

This site consists of deep and moderately deep, somewhat poorly drained soils of the Lesho and Platte series. The surface layer is sandy loam to clay loam. The underlying material is loamy sand or clay loam. These soils have low to moderate available water capacity and moderately slow or moderately rapid permeability. They receive additional moisture from a fluctuating water table.

The potential plant community is a mixture of decreasers, such as alkali sacaton, western wheatgrass, switchgrass, alkali cordgrass, indiangrass, side-oats grama, Illinois bundleflower, and American licorice. These plants make up at least 90 percent of the total production. Perennial forbs and grasses make up the rest. Common increasers are saltgrass, blue grama, and buffalograss. Common invaders are alkali muhly, kochia, tamarisk, and Russian-olive.

This site has a good water supply, green vegetation most of the year, and nearly level topography. Thus, it carries a heavy grazing load. It is usually in fair condition. Saltgrass is dominant.

When this site is in excellent condition, the estimated total annual yield is 7,000 pounds. The subirrigated condition tends to nullify the effect of precipitation. Approximately 80 percent of the yield is grass, mainly alkali cordgrass and alkali sacaton; 10 percent is forbs; and 10 percent is woody plants. About 85 percent of the yield provides forage for cattle.

#### ***Saline Terrace range site***

This site consists of deep, somewhat poorly drained Zenda clay loam, saline, and Slickspots of the mapping unit Zenda-Slickspots complex. The Zenda soil, which is clay loam in all horizons, and Slickspots have moderately slow permeability. Both are slightly to moderately saline. In addition, Slickspots are affected by alkali. The water table is generally below a depth of 4 feet during the growing season.

Decreaser grasses in the potential plant community, such as switchgrass, side-oats grama, alkali sacaton, and western wheatgrass, make up to 75 percent of the total plant yield. Perennial forbs and other grasses make up the rest. The principal increasers are inland saltgrass, blue grama, buffalograss, and western ragweed. Common invaders are kochia, little barley, and annual brome.

Under present grazing use, this site is generally in fair condition. Inland saltgrass increases rapidly under heavy grazing and usually carries the grazing load. This site is more productive than the Saline Upland site, but is less productive than the Saline Subirrigated site.

When this site is in excellent condition, the estimated total annual yield in normal years is 3,500 pounds. Yields range from 4,500 pounds in favorable years to 2,500 pounds in less favorable years. Approximately 85 percent

of the yield is grass, mainly alkali sacaton and western wheatgrass, and 15 percent is forbs. About 90 percent of the yield provides forage for cattle.

#### ***Saline Upland range site***

This site consists of deep soils that are slightly to moderately saline and are affected by alkali. These are the Slickspots of the mapping units Carwile-Slickspots complex and Tabler-Slickspots complex. They have a fine sandy loam to clay loam surface layer and a sandy clay loam to clay subsoil. The available water capacity is high, and permeability is slow to very slow.

Decreaser grasses in the potential plant community, such as alkali sacaton, side-oats grama, and western wheatgrass, make up at least 60 percent of the total plant yield. Perennial forbs and other grasses make up the rest. Common increasers are saltgrass, blue grama, buffalograss, and western ragweed. Common invaders are tumblegrass, kochia, and little barley.

Generally this site is in fair condition, and saltgrass carries the grazing load.

When this site is in excellent condition, the estimated total annual yield in normal years is 2,200 pounds. Yields range from 4,000 pounds in favorable years to 1,000 pounds in less favorable years. Approximately 85 percent of the yield is grass, mainly alkali sacaton and western wheatgrass, and 15 percent is forbs. About 90 percent of the yield provides forage for cattle.

#### ***Sands range site***

This site consists of deep, well-drained to excessively drained soils of the Pratt, Brazos, Tivoli, and Naron series. These soils have a loamy fine sand surface layer that is underlain by sandy clay loam, loamy fine sand, or sand. The available water capacity is moderate to very low. Permeability is moderate to rapid.

Decreaser grasses in the potential plant community, such as sand bluestem, little bluestem, switchgrass, and big sandreed, make up to 70 percent of the total yield. Perennial forbs, woody plants, and other grasses make up the rest. The dominant increasers are blue grama, sand dropseed, and sand paspalum. Sandhill plum is a common woody increaser. Invaders, such as false buffalograss, purple sandgrass, and red lovegrass, are common when the site is continuously overused.

Unless protected, this site is highly susceptible to soil blowing. If well managed, it produces a good stand of mid and tall grasses. Under present grazing use, it is generally in poor to fair condition. Blue grama, sand dropseed, and sand paspalum usually carry the grazing load. Sand dropseed appears to dominate the site.

When this site is in excellent condition, the estimated total annual yield in normal years is 3,000 pounds. Yields range from 3,500 pounds in favorable years to 2,000 pounds in less favorable years. Approximately 80 percent of the yield is grass, mainly sand bluestem; 10 percent is forbs; and 10 percent is woody species, mainly sandhill plum. About 85 percent of the yield provides forage for cattle.

#### ***Sandy range site***

This site consists of deep, well-drained to somewhat poorly drained soils of the Attica, Carwile, and Naron series. These soils have a fine sandy loam surface layer and

a fine sandy loam, sandy clay loam, and clay subsoil. They have moderate to high available water capacity and slow, moderate, and moderately rapid permeability.

Decreaser grasses in the potential plant community, such as sand bluestem, little bluestem, switchgrass, and side-oats grama, make up to 70 percent of the total annual yield. Forbs, shrubs, and other perennial grasses make up the rest. The dominant increasers are blue grama, sand dropseed, buffalograss, sand paspalum, and perennial three-awn. Small soapweed is the dominant woody increaser. Common invaders are windmillgrass, tumblegrass, annual three-awn, and six-weeks fescue.

Generally, under present grazing use, this site is in poor to fair condition and blue grama and sand dropseed carry the grazing load.

When this site is in excellent condition, the estimated total annual yield in normal years is 2,400 pounds per acre. Yields range from 3,000 pounds in favorable years to 1,800 pounds in less favorable years. Approximately 85 percent of the yield is grass, mainly sand bluestem and little bluestem, and 15 percent is forbs. About 85 percent of the yield provides forage for cattle.

#### ***Sandy Terrace range site***

This site consists of well-drained and somewhat poorly drained soils that are deep and moderately deep over sand. These are soils of the Canadian and Las Animas series. They have a fine sandy loam to loamy fine sand surface layer that is underlain by fine sandy loam to loamy fine sand. The available water capacity is low to moderate, and permeability is moderately rapid to rapid.

Decreaser grasses in the potential plant community, such as sand bluestem, little bluestem, switchgrass, and indian-grass, make up to 80 percent of the total annual yield. Other perennial grasses, forbs, and shrubs make up the rest. The dominant increasers are blue grama, sand dropseed, buffalograss, sand paspalum, and perennial three-awn. Small soapweed is the dominant woody increaser. Common invaders are windmillgrass, tumblegrass, annual three-awn, and six-weeks fescue.

Generally, under present grazing use, this site is in poor to fair condition and blue grama and sand dropseed carry the grazing load.

When this site is in excellent condition, the estimated total annual yield in normal years is 3,500 pounds. Yields range from 4,500 pounds in favorable years to 2,800 pounds in less favorable years. Approximately 85 percent of the yield is grass, mainly sand bluestem and little bluestem, and 15 percent is forbs. About 85 percent of the yield provide forage for cattle.

#### ***Shallow Limy range site***

The well-drained Canlon soil in the mapping unit Campus-Canlon complex is the only soil in this site. It is loam in all horizons and is shallow over caliche. The available water capacity is very low. Permeability is moderate.

The potential plant cover is a mixture of such decreasers as little bluestem, big bluestem, indiangrass, switchgrass, and prairie clover. In places these grasses make up at least 70 percent of the total yield. Perennial forbs and other grasses make up the rest. Dominant increasers are side-oats grama, hairy grama, and blue grama. Common invaders are ring muhly, tumblegrass, and annual three-awn.

Generally this site is in good to excellent condition, and little bluestem and side-oats grama carry the grazing load. Because of rough topography, it is not readily accessible to livestock.

When this site is in excellent condition, the estimated total annual yield in normal years is 1,700 pounds. Yields range from 2,500 pounds in favorable years to 600 pounds in less favorable years. Grass, mainly little bluestem, provides about 75 percent of the yield; forbs, 15 percent; and woody species, 10 percent. About 85 percent of the yield provides forage for cattle.

#### **Subirrigated range site**

This site consists of somewhat poorly drained to poorly drained soils of the Waldeck and Plevna series. These soils are moderately deep to deep over sand. Their surface layer is loam and fine sandy loam. It is underlain by sandy loam or fine sandy loam. The available water capacity is low to moderate, and permeability is moderately rapid. The water table is at a depth of 2 to 4 feet most of the growing season.

The potential plant community consists of such decreasers as big bluestem, indiangrass, switchgrass, Canada wildrye, little bluestem, Illinois bundleflower, and prairie cordgrass. These decreasers make up to 90 percent of the total annual production. The principal increasers are side-oats grama, western wheatgrass, blue grama, foxtail barley, western ragweed, buffalograss, and sedges. Common invaders are silver bluestem, windmillgrass, tumblegrass, annual brome, and cocklebur.

This site has a good water supply, green vegetation most of the year, and nearly level topography. Thus, it carries a heavy grazing load. It is usually in fair condition. Western wheatgrass is dominant.

When this site is in excellent condition, the estimated total annual yield is 7,500 pounds. The subirrigated condition tends to nullify the effect of precipitation. Approximately 80 percent of the yield is grass, mainly big bluestem; 15 percent is forbs, mainly Illinois bundleflower and American licorice; and 5 percent is woody species, principally indigoplant (*Amorpha*). About 90 percent of the yield provides forage for cattle.

#### **Livestock Management**

Stocking the right kind and number of livestock to the range results in the highest production and in the best use of the range resources. A feed and forage program, including available range forage, concentrates, tame and native hay, silage, and tame pastures, is needed. Reserving roughage for feed during an emergency, in addition to normal winter requirements, and deferring the grazing of native pasture conserve soil and water and the plant cover. Feed shortages can be avoided by carrying in reserve the surplus produced in years of high yields.

In addition to providing adequate forage and reserve feed supplies, it is often desirable to keep part of the livestock readily saleable, such as stocker steers. This allows ranchers to balance the number of livestock on hand and the available forage, without marketing breeding stock.

The breeding program depends on the range management. It should provide for the selection of animals best

suited to the ranching system and to the grasslands and the climate of the area, as well as to the economic condition. The herd can be improved by culling the nonproductive animals and by breeding for the arrival of calves at a time when forage is the most nutritious. A consistent culling program results in an overall increase in meat production and contributes greatly to range management.

#### **Management of Windbreaks**

Edwards County has no native forests or large areas of woodland. Some areas on the flood plains of creeks and the Arkansas River support mixed stands of cottonwood, tamarisk, and willow. Because the supply of moisture is limited, tree plantings have been limited to farmstead windbreaks and to trees grown for shade or ornamental purposes.

Windbreak plantings reduce soil blowing and furnish protection for farmsteads and livestock. They also improve the appearance of the farmstead, increase the value of the property, and provide food and cover for wildlife.

Windbreaks can be successfully established and maintained if they are well planned and well cared for. During the early life of all windbreaks, it is necessary to cultivate often enough to keep weeds under control. On upland sites, it is necessary to cultivate for weed control during the whole life span of the windbreak. Tree plantings also need protection against fire, livestock, insects, rabbits, and rodents.

The soils of the county suitable for growing trees for windbreaks have been placed in six windbreak groups. The soils in each group are essentially the same in productivity and in management requirements.

The Loamy Lowland group consists of deep, well-drained soils of the Hord and Tobin series. The surface layer is silt loam. It is underlain by silt loam or silty clay loam. The available water capacity is high, and permeability is moderate.

The Sandy Lowland group consists of well-drained, deep soils and well-drained soils that are moderately deep over sand. All are soils of the Canadian series. The deep soils are fine sandy loam in all horizons. The moderately deep soils have sand at a depth of 24 to 40 inches. All have low to moderate available water capacity and moderately rapid permeability.

The Loamy Upland group consists of deep, well-drained soils of the Farnum, Harney, Holdrege, Lubbock, and Uly series and the mapping unit Breaks-Alluvial land complex. The surface layer is loam to silty clay loam. It is underlain by silty clay loam, clay loam, or clay. The available water capacity is high, and permeability is moderate to moderately slow.

The Sandy Upland group consists of deep, well-drained to excessively drained soils of the Attica, Brazos, Naron, and Pratt series and the Tivoli soil in the mapping unit Pratt-Tivoli loamy fine sands. The surface layer is fine sandy loam to loamy fine sand. It is underlain by sand to sandy clay loam. The available water capacity is very low to moderate, and permeability is moderate to rapid. These soils are highly susceptible to blowing.

The Clayey Upland group consists of deep, somewhat poorly drained to moderately well drained soils of the Carwile and Tabler series. These soils have a fine sandy loam or clay loam surface layer and a clay subsoil. They have high available water capacity and slow or very slow permeability.

The Wet Loamy and Sandy Lowland group consists of poorly drained and somewhat poorly drained soils that are moderately deep to deep over sand. These are soils of the Las Animas, Lesho, Platte, Plevna, Waldeck, and Zenda series. They have a fluctuating water table. The surface layer is loamy fine sand to clay loam. It is underlain by sand to clay loam. The available water capacity is low to high, and permeability is moderately slow to rapid.

Table 4 lists the trees and shrubs that are suitable for use in windbreaks and that can be grown best on each site. The suitability ratings are based on the general vigor and condition of the trees in the windbreak. A rating of *excellent* indicates good survival expectancy and excellent growth in a normal length of life for the species. A rating of *good* indicates good survival expectancy, but a slower growth rate and a somewhat shorter life than is normal for the species. A rating of *fair* indicates a survival expectancy of 75 percent or less and a growth rate of 75 percent or less than is normal for the species. A rating of *poor* indicates a survival expectancy of less than 50 percent.

Blown-out land, Campus-Canon complex, Slickspots, Ness clay, Tivoli fine sand, and Zenda clay loam, saline, are not well suited to windbreak plantings.

Additional information on the planting of trees, such as the species and spacing for windbreak development, can be obtained from a local technician of the Soil Conservation Service or from the county agriculture extension agent.

## Management for Fish and Wildlife<sup>3</sup>

Many research projects have been reported concerning the importance of soils to wildlife habitat. Investigations conducted in Missouri showed a relationship between soil fertility and the size and abundance of deer, rabbits, muskrats, opossums, and raccoons. The abundance of quail, pheasant, and turkey has been correlated to specific soils.

Edwards County has a variety of wildlife species. The abundance of any particular species is influenced by the vegetation and land use. Wildlife populations react to a change in land use, for example, an increase in acreage under irrigation or a change in kinds of crops grown.

Pheasant densities are medium to high throughout the county. The highest densities are on soil associations 1, 2, and 5. These associations are intensively cropped to wheat and grain sorghum.

The bobwhite quail occurs on all soil associations but is particularly abundant on soil association 7. These associations also support habitat that is utilized by white-tailed deer and, to a lesser extent, mule deer.

Lesser prairie chickens occur mainly within the grassland areas on soil association 3. They are few in number and consequently are not considered a game bird in Edwards County. This species of prairie chicken differs from the greater prairie chicken, which occurs in the Flint Hills area of Kansas.

The mourning dove, a migratory species and game bird, nests within the county. It occurs on all soil associations where trees for nesting are available. Hunting seasons are set within the framework established each year by the Bureau of Sport Fisheries and Wildlife.

<sup>3</sup> By JACK W. WALSTROM, biologist, Soil Conservation Service.

TABLE 4.—Growth and survival expectancy of specified trees and shrubs, by windbreak groups

Trees and shrubs	Windbreak groups					
	Loamy Lowland	Sandy Lowland	Loamy Upland	Sandy Upland	Clayey Upland	Wet Loamy and Sandy Lowland
Coniferous trees:						
Eastern redcedar .....	Excellent.....	Excellent.....	Excellent.....	Excellent.....	Excellent.....	Excellent.
Ponderosa pine .....	Excellent.....	Excellent.....	Good.....	Excellent.....	Fair.....	Good.
Austrian pine .....	Excellent.....	Excellent.....	Excellent.....	Excellent.....	Good.....	Good.
Deciduous trees:						
American elm .....	Excellent.....	Excellent.....	Good.....	Excellent.....	Poor.....	Poor.
Black locust .....	Fair.....	Poor.....	Fair.....	Excellent.....	Poor.....	Poor.
Cottonwood .....	Excellent.....	Excellent.....	Poor.....	Fair.....	Poor.....	Fair.
Green ash .....	Excellent.....	Excellent.....	Good.....	Good.....	Poor.....	Poor.
Hackberry .....	Excellent.....	Good.....	Fair.....	Excellent.....	Poor.....	Fair.
Honeylocust (thornless) .....	Good.....	Fair.....	Fair.....	Good.....	Poor.....	Poor.
Osage-orange .....	Excellent.....	Excellent.....	Good.....	Good.....	Fair.....	Fair.
Russian-olive .....	Excellent.....	Excellent.....	Fair.....	Excellent.....	Poor.....	Good.
Russian mulberry .....	Excellent.....	Excellent.....	Good.....	Good.....	Poor.....	Fair.
Siberian elm .....	Excellent.....	Excellent.....	Good.....	Excellent.....	Fair.....	Good.
Catalpa .....	Fair.....	Good.....	Poor.....	Fair.....	Poor.....	Fair.
Shrubs:						
Tamarisk .....	Excellent.....	Excellent.....	Good.....	Excellent.....	Good.....	Excellent.
American plum .....	Excellent.....	Good.....	Good.....	Excellent.....	Poor.....	Fair.
Western chokecherry .....	Good.....	Fair.....	Fair.....	Good.....	Poor.....	Poor.
Skunkbush .....	Good.....	Good.....	Fair.....	Good.....	Poor.....	Good.

Furbearers, including mink, muskrat, beaver, raccoon, and opossum, are most numerous along the Arkansas River and Rattlesnake Creek. Badger and skunk inhabit most upland sites on all soil associations.

Cottontails and jackrabbits occur throughout the county.

Rio Grande turkeys have been released along the Arkansas River, on soil association 7. The first release was in March 1965. The turkeys were live trapped from flocks in Texas.

In January 1966, 33 antelope were obtained from Nebraska and released in Edwards County, on soil association 3.

Fishing opportunities are limited, but the Arkansas River and Rattlesnake Creek offer fishermen a chance to catch catfish, bullheads, bass, carp, and other native species.

Few locations within the county are suitable for the construction of livestock ponds. The best sites are on soil association 2.

Proper grazing, stripcropping, stubble mulching, terracing, and windbreak management are beneficial for wildlife, in creating and conserving wildlife habitat and reducing pollution of streams and rivers. Stripcropping reduces the hazard of soil blowing on soil association 4 and 6. This practice is most beneficial for wildlife because it provides alternate strips of food and cover and narrow open areas. Crop residue left on the soil after the grain has been harvested provides food and cover during the critical winter period.

Practices harmful to wildlife include burning roadside ditches, draining marshes, clearing trees and shrubs, and overgrazing range and pastureland.

Technical assistance in the planning and application of wildlife developments can be obtained from the Soil Conservation Service. Additional information and assistance can be obtained from the Kansas Forestry, Fish, and Game Commission, the Bureau of Sport Fisheries and Wildlife, and the County Agricultural Extension Service.

## Management for Recreational Facilities<sup>4</sup>

Knowledge of soils is necessary in planning, developing, and maintaining areas for recreation. In table 5 the soils of Edwards County are rated according to limitations that affect their suitability for campsites, picnic areas, play areas, paths and trails, and golf fairways.

The degree and kind of limitation of the soils for these specified recreational uses are shown in table 5. Limitations are indicated as *slight*, *moderate*, or *severe*. For all 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 can easily 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, intense maintenance, or a combination of these, is required.

<sup>4</sup> By JACK W. WALSTROM, biologist, Soil Conservation Service.

The information in the following paragraphs and in table 5 can be used as a guide in determining the suitability of sites in Edwards County for recreational development.

*Intensive campsites.*—The areas used frequently during the camping season for tents and small camp trailers and related activities should be suitable for heavy foot or vehicular traffic. The suitability of the soil for vegetation is not considered in the ratings shown in table 5.

*Picnic areas.*—The limitations of the soils for use as picnic areas are based on soil features only. Other factors, such as lakes, trees, or beauty that affects the desirability of the site, were not considered.

*Intensive play areas.*—Areas used for playgrounds and for organized games, including baseball, football, and badminton, should be nearly level and have good drainage. The most desirable soils are also free of rocks. It is assumed that good vegetative cover can be established and maintained where needed.

*Trails and paths.*—The limitations of the soils for use as trails, cross-country hiking, bridle paths, and other non-intensive uses are based on soil features only. Other factors important in the selection of a site for this use are not considered. It is not anticipated that soils will have to be graded and shaped to any great extent.

*Golf fairways.*—Golf fairways, exclusive of roughs, hazards, traps, and greens, require soils that have good trafficability, a minimum number of coarse fragments or stones, and slopes that are not too steep. The turf can be improved by frequent applications of fertilizer and by supplemental water through irrigation.

## Use of the Soils in Engineering<sup>5</sup>

This section provides information of special interest to engineers, contractors, farmers, and others who use soil as structural material or as foundation material upon which structures are built. Considered in this section are those properties of the soils that affect construction and maintenance of roads and airports, pipelines, building foundations, water-storage facilities, erosion-control structures, drainage systems, and sewage-disposal systems. Among the soil properties most important in engineering are permeability, shear strength, density, shrink-swell potential, available water capacity, grain-size distribution, plasticity, and reaction.

Information concerning these and related soil properties is given in tables 6 and 7. The estimates and interpretations of soil properties in these tables can be used in—

1. Planning agricultural drainage systems, farm ponds, irrigation systems, diversion terraces, and other structures for controlling water and conserving soil.
2. Selecting potential locations for highways, airports, pipelines, and underground cables.
3. Locating probable sources of sand, gravel, or rock suitable for use as construction material.
4. Selecting potential industrial, commercial, residential, and recreational sites.

<sup>5</sup> FRED MEYER JR., civil engineer, Soil Conservation Service, helped prepare this section.

TABLE 5.—*Soil interpretations for recreational facilities*

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 symbols	Degree and kind of limitation for—				
	Intensive campsites	Picnic areas	Intensive play areas	Trails and paths	Golf fairways
*Attica: Aa, Ab, Ac----- For Carwile part of Ac, see Carwile series.	Slight-----	Slight-----	Slight if slope is 2 percent or less, moderate if more than 2 percent.	Slight-----	Slight.
Blown-out land: Bd-----	Severe: fine sand surface layer.	Severe: fine sand surface layer.	Severe: fine sand surface layer.	Severe: fine sand surface layer.	Severe: fine sand surface layer.
Brazos----- Mapped only with Pratt soils.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.
Breaks-Alluvial land complex: Bk.	Moderate: slope.	Moderate: slope.	Severe: slope----	Slight-----	Slight.
*Campus: Cc----- For Canlon part, see Canlon series.	Moderate: slope.	Moderate: slope.	Severe: slope----	Slight-----	Slight.
Canadian: Cd, Cf-----	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
Canlon----- Mapped only with Campus soils.	Moderate: slope.	Moderate: slope.	Severe: slope; less than 20 inches to caliche.	Slight-----	Slight.
*Carwile: Cr, Cs----- For Slickspots part of Cs, see Slickspots.	Moderate: slow permeability; ponding.	Moderate: some- what poor drainage; ponding.	Moderate: some- what poor drainage; ponding.	Moderate: ponding.	Moderate: ponding.
Farnum: Fa, Fr-----	Slight-----	Slight-----	Slight if slope is 2 percent or less, moderate if more than percent.	Slight-----	Slight.
*Harney: Ha, Hb, Hc, Hd, He. For Uly part of Hd and He, see Uly series.	Slight-----	Slight-----	Slight if slope is 2 percent or less, moderate if more than 2 percent.	Slight-----	Slight.
Holdrege: Hg, Hh-----	Slight-----	Slight-----	Slight if slope is 2 percent or less, moderate if more than 2 percent.	Slight-----	Slight.
Hord: Ho-----	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
Las Animas: La-----	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.
Lesho: Lh-----	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.
Lubbock: Lk-----	Slight-----	Slight-----	Slight-----	Slight-----	Slight.

TABLE 5.—*Soil interpretations for recreational facilities—Continued*

Soil series and map symbols	Degree and kind of limitation for—				
	Intensive campsites	Picnic areas	Intensive play areas	Trails and paths	Golf fairways
Naron: Na, Nf, Ng-----	Slight-----	Slight-----	Slight if slope is 2 percent or less, moderate if more than 2 percent.	Slight-----	Slight.
Ness: Ns-----	Severe: ponding--	Severe: ponding--	Severe: ponding--	Severe: ponding--	Severe: ponding; clay surface layer.
Platte: Pa-----	Moderate: somewhat poor drainage.	Moderate: somewhat poor drainage.	Moderate: somewhat poor drainage.	Slight-----	Moderate: somewhat poor drainage.
Plevna: Pe-----	Severe: poor drainage.	Severe: poor drainage.	Severe: poor drainage.	Severe: poor drainage.	Severe: poor drainage.
*Pratt: Pf, Pg, Pr, Pt----- For Brazos part of Pr, see Brazos series. For Tivoli part of Pt, see Tivoli series.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.
Slickspots----- Mapped only with Carwile, Tabler, and Zenda soils.	Severe: slow surface drainage.	Severe: slow surface drainage.	Severe: slow surface drainage.	Severe: slow surface drainage.	Moderate: slow surface drainage.
*Tabler: Ta, Tb----- For Slickspots part of Tb, see Slickspots.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer; very slow permeability.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.
Tivoli: Tf-----	Severe: fine sand and loamy fine sand surface layer.	Severe: fine sand and loamy fine sand surface layer.	Severe: fine sand and loamy fine sand surface layer.	Severe: fine sand and loamy fine sand surface layer.	Severe: fine sand and loamy fine sand surface layer.
Tobin: To-----	Severe: flooding--	Moderate: flooding.	Severe: flooding--	Moderate: flooding.	Moderate: flooding.
Uly----- Mapped only with Harney soils.	Slight-----	Slight-----	Slight if slope is 2 percent or less, moderate if more than 2 percent.	Slight-----	Slight.
Waldeck: Wa, Wc-----	Moderate: somewhat poor drainage.	Moderate: somewhat poor drainage.	Moderate: somewhat poor drainage.	Moderate: somewhat poor drainage.	Slight.
*Zenda: Za, Zs----- For Slickspots part of Zs, see Slickspots.	Moderate: clay loam surface layer; somewhat poor drainage.	Moderate: clay loam surface layer; somewhat poor drainage.	Moderate: clay loam surface layer; somewhat poor drainage.	Moderate: clay loam surface layer; somewhat poor drainage.	Moderate: clay loam surface layer.
Ze-----	Severe: moderately slow permeability; slow surface drainage.	Moderate: moderately slow permeability; slow surface drainage.	Severe: moderately slow permeability; slow surface drainage.	Severe: moderately slow permeability; slow surface drainage.	Moderate: clay loam surface layer; moderately slow permeability.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads or excavations deeper than the depths reported (ordinarily about 5 feet). Even in these situations, however, the soil map is useful in planning more detailed field investigations and in indicating the kinds of problems that may be expected.

Some terms used by soil scientists have special meanings in soil science that may not be familiar to engineers. These terms are defined in the Glossary.

## Engineering Classification of Soils

The two systems most commonly used in classifying soils for engineering are the AASHO system, adopted by the American Association of State Highway Officials, and the Unified system, used by the SCS, the Department of Defense, and others.

The AASHO (1) is used to classify soils according to those properties that affect use in highway construction. In this system, all soil material is classified in seven basic groups. The groups range from A-1, which consists of soils that have the highest bearing strength and are the best soils for road fill, to A-7, which consists of soils that have the lowest strength when wet. Soil material on the borderline between two classifications is designated by symbols for both classes; for example, A-2 or A-4.

In the Unified system (11) soils are classified according to their texture and plasticity and their performance as engineering construction material. 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, SP-SM.

Soil scientists use the USDA textural classification (9). In this, the texture of the soil is determined according to the proportion of soil particles smaller than 2 millimeters in diameter, that is, the proportion of sand, silt, and clay. Textural modifiers, such as gravelly, stony, shaly, and cobbly, are used as needed.

Table 6 shows the estimated classification of all the soils in the county according to all three systems of classification.

## Estimated Properties of the Soils

Estimates of soil properties significant in engineering are shown in table 6. They are based on field classification and soil descriptions, on test data from comparable soils in adjacent areas, and on experience with the same kinds of soil in other counties.

Permeability is the quality that enables the soil to transmit water or air. As used in table 6, it relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of the soils are not considered.

Available water capacity is the capacity of the soils to hold water available for use by most plants. It is com-

monly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. Reaction of the soils in this county ranges from medium acid to moderately alkaline. Information about the reaction of each soil is given in the section "Descriptions of the Soils." The pH value and relative terms used to describe soil reaction are explained in the Glossary.

Salinity refers to the amount of soluble salts in the soil. It is expressed as the electrical conductivity of a saturation extract, in millimhos per centimeter at 25° C. Salinity tests have been made on only a few of the soils in this county. These tests indicate that Zenda clay loam, saline, and Slickspots, which are mapped with other soils, are slightly to moderately saline. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its corrosiveness to metals and concrete.

Most soils in the survey area are deep enough over bedrock that bedrock generally does not affect their use. Caliche is at a depth of about 11 inches in Canlon soils and 24 inches in Campus soils.

Concrete may corrode if buried in a soil. It corrodes more rapidly in some soils than in others. The rate of deterioration of concrete depends on soil properties, such as acidity and amount of sodium or magnesium sulfate. Acidity is likely in Pratt and Tivoli soils. Sodium or magnesium sulfate may be present in sufficient quantity to cause corrosion of concrete in Las Animas, Lesho, Platte, Plevna, Waldeck, and Zenda soils. The mapping units Carville-Slickspots complex, Tabler-Slickspots complex, Zenda-Slickspots complex, and Zenda clay loam, saline, have the highest corrosion probability because of the presence of sodium or magnesium sulfate.

## Engineering Interpretations

Table 7 provides information useful to engineers and others who plan to use soil material in the construction of highways, farm facilities, buildings, and sewage-disposal systems. Interpretations in this table are based on the estimated engineering properties of the soils in table 6, on available test data, and on field experience.

Ratings in table 7 summarize the degree of limitation or the suitability of the soils for specified purposes. The degrees of limitation are indicated as *slight*, *moderate*, *severe*, or *very severe*.

*Slight* indicates soil properties generally favorable, or in other words, limitations that are minor and easily overcome. *Moderate* indicates some soil properties that are unfavorable but can be overcome or modified by special planning and design. *Severe* indicates soil properties so unfavorable and so difficult to correct or overcome that major soil reclamation and special design are required.

TABLE 6.—*Estimates of 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 soils. The soils in for referring to other series that appear in the first column of this

Soil series and map symbols	Depth to seasonal high water table	Depth from surface (typical profile)	Classification
			Dominant USDA texture
*Attica: Aa, Ab, Ac----- For Carwile part of Ac, see Carwile series.	>10	0-30 30-60	Fine sandy loam----- Loamy fine sand-----
Blown-out land: Bd. No valid estimates can be made.			
Breaks-Alluvial land complex: Bk. No valid estimates can be made.			
Brazos----- Mapped only with Pratt soils.	>10	0-14 14-60	Loamy fine sand----- Sand-----
*Campus: Cc----- For Canlon part of Cc, see Canlon series.	>10	0-8 8-24 24	Loam----- Clay loam----- Caliche.
Canadian: Cd-----	>5	0-60	Fine sandy loam-----
Cf-----	>5	0-30 30-60	Fine sandy loam----- Sand-----
Canlon----- Mapped only with Campus soils.	>10	0-11 11	Loam----- Caliche.
*Carwile: Cr, Cs----- For Slickspots part of Cs, see Slickspots.	0-3	0-11 11-17 17-42 42-60	Fine sandy loam----- Sandy clay loam----- Clay----- Clay loam-----
Farnum: Fa, Fr-----	>10	0-16 16-37 37-60	Loam----- Clay loam----- Loam-----
*Harney: Ha, Hb, Hc, Hd, He----- For Uly part of Hd and He, see Uly series.	>10	0-10 10-42 42-60	Silt loam----- Silty clay loam----- Silt loam-----
Holdrege: Hg, Hh-----	>10	0-12 12-60	Silt loam----- Silty clay loam-----
Hord: Ho-----	>10	0-60	Silt loam-----
Las Animas: La-----	1 3-7	0-30 30-45 45-60	Loamy fine sand----- Sandy loam----- Sand-----
Lesho: Lh-----	1 2-7	0-32 32-60	Clay loam----- Sand-----
Lubbock: Lk-----	>10	0-10 10-16 16-32 32-60	Silt loam----- Silty clay loam----- Clay----- Silty clay loam-----

See footnotes at end of table.

*significant in engineering*

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

Classification—Continued		Percentage passing sieve—				Permeability	Available water capacity	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 40	No. 200			
SM SM or SC	A-4 or A-2	100	100	95-100	30-50	2.00-6.30	0.12	Low.
	A-2	100	100	85-100	15-25	>6.30	.06	Low.
SM SP-SM	A-2	100	100	85-100	15-25	>6.30	.06	Low.
	A-3	100	100	80-100	5-10	>6.30	.04	Low.
ML CL	A-4	100	90-100	80-95	60-75	0.63-2.00	.18	Low.
	A-6	95-100	85-95	60-80	50-70	0.63-2.00	.18	Moderate.
SM	A-4 or A-2	100	100	90-100	30-50	2.00-6.30	.12	Low.
SM SP-SM	A-4 or A-2	100	100	90-100	30-50	2.00-6.30	.12	Low.
	A-3	100	100	80-100	5-10	>6.30	.04	Low.
ML	A-4	95-100	85-95	60-80	55-70	0.63-2.00	.18	Low.
SM C CL CL	A-4 or A-2	100	100	95-100	30-50	2.00-6.30	.12	Low.
	A-6 or A-2	100	100	95-100	30-50	0.63-2.00	.15	Low.
	A-7	100	100	95-100	75-95	0.06-0.20	.18	High.
	A-6	100	100	90-100	70-80	0.20-0.63	.18	Moderate.
ML CL CL	A-4	100	100	90-100	60-75	0.63-2.00	.18	Low.
	A-6	100	100	90-100	70-80	0.20-0.63	.18	Moderate.
	A-6	100	100	90-100	70-80	0.63-2.00	.18	Low.
ML or CL CL CL	A-4 or A-6	100	100	95-100	70-90	0.63-2.00	.18	Low.
	A-7	100	100	95-100	90-95	0.20-0.63	.18	High.
	A-6	100	100	95-100	70-90	0.63-2.00	.18	Low.
ML or CL CL	A-4 or A-6	100	100	95-100	70-90	0.63-2.00	.18	Low.
	A-6	100	100	95-100	90-95	0.63-2.00	.18	Moderate.
ML or CL	A-4 or A-6	100	100	95-100	70-90	0.63-2.00	.18	Low.
	A-2	100	100	85-100	15-25	>6.30	.06	Low.
	A-2	100	100	90-100	25-35	>6.30	.12	Low.
SP-SM	A-3	100	100	80-100	5-10	>6.30	.04	Low.
	A-6	100	100	90-100	70-80	0.20-0.63	.18	Moderate.
SP-SM	A-3	100	100	75-95	5-10	>6.30	.04	Low.
	A-6	100	100	90-100	70-80	0.20-0.63	.18	Moderate.
ML or CL CL CL CL	A-4 or A-6	100	100	95-100	70-90	0.63-2.00	.18	Low.
	A-7	100	100	95-100	90-95	0.20-0.63	.18	Moderate.
	A-7	100	100	95-100	75-95	0.20-0.63	.18	High.
	A-7	100	100	95-100	90-95	0.20-0.63	.18	Moderate.

TABLE 6.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface (typical profile)	Classification
			Dominant USDA texture
	<i>Feet</i>	<i>Inches</i>	
Naron: Na, Nf, Ng-----	>10	0-12 12-30 30-60	Fine sandy loam----- Sandy clay loam----- Fine sandy loam-----
Ness: Ns-----	(?)	0-46 46-60	Clay----- Silty clay loam-----
Platte: Pa-----	<sup>1</sup> 2-5	0-17 17-60	( <sup>3</sup> )----- Sand-----
Plevna: Pe-----	<sup>1</sup> 2-5	0-60	Fine sandy loam-----
*Pratt: Pf, Pg, Pr, Pt----- For Brazos part of Pr, see Brazos series. For Tivoli part of Pt, see Tivoli series.	>10	0-60	Loamy fine sand-----
Slickspots. No valid estimates can be made. Mapped only with Carwile, Tabler, and Zenda soils.			
*Tabler: Ta, Tb----- For Slickspots part of Tb, see Slickspots.	>10	0-8 8-40 40-60	Clay loam----- Clay----- Clay loam-----
Tivoli: Tf-----	>10	0-60	Fine sand-----
Tobin: To-----	(1)	0-15 15-40 40-60	Silt loam----- Silty clay loam----- Silt loam-----
Uly----- Mapped only with Harney soils.	>10	0-8 8-30 30-60	Silt loam----- Silty clay loam----- Silt loam-----
Waldeck: Wa-----	<sup>1</sup> 2-7	0-10 10-28 28-60	Fine sandy loam----- Sandy loam----- Sand-----
Wc-----	<sup>1</sup> 2-7	0-10 10-28 28-60	Loam----- Sandy loam----- Sand-----
*Zenda: Za, Ze, Zs----- For Slickspots part of Zs, see Slickspots.	3-10	0-40 40-55 55-60	Clay loam----- Sandy loam----- Sand-----

<sup>1</sup> Subject to flooding.    <sup>2</sup> Subject to ponding.    <sup>3</sup> Variable.

significant in engineering—Continued

Classification—Continued		Percentage passing sieve—				Permeability	Available water capacity	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 40	No. 200			
SM	A-4 or A-2	100	100	95-100	30-50	2.00-6.30	.12	Low.
SC	A-6 or A-2	100	100	95-100	30-50	0.63-2.00	.15	Low.
SM	A-4 or A-2	100	100	95-100	30-50	2.00-6.30	.12	Low.
CH	A-7	100	100	95-100	75-95	<0.06	.18	High.
CL	A-6	100	100	90-100	90-95	0.63-2.00	.18	Moderate.
( <sup>3</sup> ) SP-SM	( <sup>3</sup> ) A-3	( <sup>3</sup> ) 100	( <sup>3</sup> ) 100	( <sup>3</sup> ) 75-95	( <sup>3</sup> ) 5-10	2.00-6.30 >6.30	( <sup>3</sup> ) .04	( <sup>3</sup> ) Low.
SM	A-4 or A-2	100	100	95-100	30-50	2.00-6.30	.12	Low.
SM	A-2	100	100	85-100	15-25	>6.30	.06	Low.
CL	A-6	100	100	90-100	70-80	0.20-0.63	.18	Moderate.
CL	A-7	100	100	95-100	75-95	<0.06	.18	High.
CL	A-6	100	100	90-100	70-80	0.20-0.63	.18	Moderate.
SP-SM	A-3	100	100	80-100	5-12	>6.30	.04	Low.
ML or CL	A-4 or A-6	100	100	95-100	70-90	0.63-2.00	.18	Low.
CL	A-6	100	100	95-100	90-95	0.63-2.00	.18	Moderate.
ML or CL	A-4 or A-6	100	100	95-100	70-90	0.63-2.00	.18	Low.
ML or CL	A-4 or A-6	100	100	95-100	70-90	0.63-2.00	.18	Low.
CL	A-6	100	100	95-100	90-95	0.63-2.00	.18	Moderate.
ML or CL	A-4 or A-6	100	100	95-100	70-90	0.63-2.00	.18	Low.
SM	A-4 or A-2	100	100	95-100	30-50	2.00-6.30	.12	Low.
SM	A-2	100	100	90-100	25-35	2.00-6.30	.12	Low.
SP-SM	A-3	100	100	80-100	5-10	>6.30	.04	Low.
ML	A-4	100	100	90-100	60-75	2.00-6.30	.18	Low.
SM	A-2	100	100	90-100	25-35	2.00-6.30	.12	Low.
SP-SM	A-3	100	100	80-100	5-10	>6.30	.04	Low.
CL	A-6	100	100	90-100	70-80	0.63-2.00	.18	Moderate.
SM	A-2	100	100	90-100	25-35	2.00-6.30	.12	Low.
SP-SM	A-3	100	100	80-100	5-10	>6.30	.04	Low.

TABLE 7.—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. The soils in for referring to other series that appear

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade <sup>1</sup>	Road fill <sup>1</sup>	Highway location <sup>1</sup>	Dikes and levees	Farm ponds
							Reservoir areas
*Attica: Aa, Ab, Ac... For Carwile part of Ac, see Carwile series.	Fair-----	Unsuitable..	Good-----	Good-----	Good drainage; erodible slopes.	Fair stability; erodible slopes.	Moderately rapid permeability.
Blown-out land: Bd. No interpretations. Material too variable.							
Brazos----- Mapped only with Pratt soils.	Poor-----	Fair-----	Good-----	Good-----	Somewhat excessive drainage; erodible slopes.	High seepage; erodible slopes.	Rapid permeability.
Breaks-Alluvial land complex: Bk. No interpretations. Material too variable.							
*Campus: Cc----- For Canlon part of Cc, see Canlon series.	Fair to poor.	Unsuitable..	Poor-----	Fair-----	Caliche at a depth of 2 feet; erodible slopes.	Slopes erodible; low gradient or slope protection needed in places.	Moderate seepage.
Canadian: Cd, Cf-----	Fair-----	Poor: localized pockets.	Good-----	Good-----	Good drainage; erosion hazard.	Fair stability; moderately rapid permeability; erosion hazard.	Moderately rapid permeability.
Canlon----- Mapped only with Campus soils.	Fair to poor.	Unsuitable..	Poor-----	Fair-----	Caliche at a depth of less than 20 inches; low susceptibility to frost action; erodible slopes.	Slopes erodible; low gradient or slope protection needed in places.	Moderate seepage.
*Carwile: Cr, Cs----- For Slickspots part of Cs, see Slickspots.	Fair-----	Unsuitable..	Surface layer good; subsoil poor.	Fair-----	Somewhat poor drainage; seasonal high water table.	Seasonal high water table; erodible slopes.	Slow permeability; seasonal high water table.

See footnotes at end of table.

*interpretations*

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions in the first column of this table]

Soil features affecting—Continued					Degree and kind of limitation affecting—		
Farm ponds— Continued	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Embankments							
Erodible slopes; subject to piping; fair stability.	Good drainage; moderately rapid permea- bility.	Moderate available water capacity; moderately rapid permea- bility.	Subject to soil blow- ing.	Highly susceptible to soil blowing; medium fertility.	Slight-----	Slight-----	Severe: moderately rapid permea- bility.
High seepage; easily eroded; needs binder.	Somewhat excessive drainage.	Rapid permea- bility; very low available water capacity; subject to soil blowing.	( <sup>2</sup> )-----	( <sup>2</sup> )-----	Slight-----	Slight. Severe if pollution hazard exists.	Severe: rapid permea- bility.
Erodible slopes; sub- ject to pip- ing; fair stability.	Good drainage; moderate permeabil- ity.	( <sup>2</sup> )-----	( <sup>2</sup> )-----	Moderately deep soil; difficult to vegetate; construc- tion and mainte- nance cost high.	Severe: moderate shear strength; caliche at a depth of 2 feet.	Severe: caliche at a depth of 2 feet.	Severe: caliche at a depth of 2 feet.
Erosion haz- ard; subject to piping; fair stability.	Good drainage; moderately rapid permea- bility.	Moderately rapid permea- bility; moderate or low avail- able water capacity.	Erosion haz- ard; near- ly level topogra- phy.	Erosion haz- ard; medi- um fertili- ty.	Slight-----	Slight. Severe if pollution hazard exists.	Severe: moderately rapid permea- bility.
Erodible slopes; sub- ject to pip- ing; fair stabil- ity.	Good drainage; moderate permea- bility.	( <sup>2</sup> )-----	( <sup>2</sup> )-----	Shallow soil; difficult to vegetate; construc- tion and mainte- nance cost high.	Severe: moderate shear strength; caliche at a depth of 11 inches.	Severe: caliche at a depth of less than 20 inches.	Severe: caliche at a depth of less than 20 inches.
Fair stability and compac- tion; erodible slopes.	Somewhat poor drainage; seasonal high water table; slow permea- bility.	Somewhat poor drainage; slow permea- bility.	Nearly level; somewhat poor drain- age; erod- ible slopes.	Erodible slopes; medium fertility.	Moderate: seasonal high water table; high shrink- swell potential in subsoil.	Severe: seasonal high water table; slow permeabil- ity.	Moderate to severe: seasonal high water table.

TABLE 7.—Engineering

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade <sup>1</sup>	Road fill <sup>1</sup>	Highway location <sup>1</sup>	Dikes and levees	Farm ponds
							Reservoir areas
Farnum: Fa, Fr-----	Good-----	Unsuitable..	Fair-----	Fair-----	Good drainage..	Fair stability---	Moderately slow permeability.
*Harney: Ha, Hb, Hc, Hd, He. For Uly part of Hd and He, see Uly series.	Good-----	Unsuitable..	Poor-----	Fair-----	Good drainage..	Moderate stability and compaction; high shrink-swell potential.	Moderately slow permeability.
Holdrege: Hg, Hh-----	Good-----	Unsuitable..	Fair-----	Good-----	Good drainage..	Moderate stability.	Moderate permeability.
Hord: Ho-----	Good-----	Poor to unsuitable.	Fair-----	Good-----	Good drainage..	Moderate stability.	Moderate permeability.
Las Animas: La-----	Poor-----	Substratum good for sand; poor for gravel; occasional pockets.	Poor to good.	Good-----	Somewhat poor drainage; fluctuating water table between 3 and 7 feet.	Probable underflow and sandy soils.	( <sup>2</sup> )-----
Lesho: Lh-----	Surface layer good.	Substratum good for sand; poor for gravel; local pockets.	Poor in upper 20 to 40 inches; good below if confined.	Good-----	Somewhat poor drainage; seasonal high water table.	Moderately erodible; possible seepage.	Porous substratum; good for pits dug to water table.
Lubbock: Lk-----	Surface layer good; subsoil poor.	Unsuitable..	Poor-----	Fair-----	Good drainage..	Fair to poor stability; highly plastic; high shrink-swell potential.	Moderately slow permeability.

See footnotes at end of table.

*interpretations—Continued*

Soil features affecting—Continued					Degree and kind of limitation affecting—		
Farm ponds— Continued	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Embankments							
Fair stability---	Good drainage; moderately slow per- meability.	Moderately slow perme- ability.	Moderately erodible.	Moderately erodible.	Moderate: low to moderate shear strength and shrink- swell potential.	Severe: moderately slow per- meability.	Slight if slope is less than 2 percent, moderate if more than 2 percent.
Low to moderate shear strength; moderate stability and compaction; high shrink- swell potential.	Good drainage; moderately slow per- meability.	High available water capacity; moderately slow perme- ability.	Moderately erodible.	Moderately erodible.	Moderate: low to moderate shear strength; high shrink- swell potential.	Severe: moderately slow per- meability.	Slight if slope is less than 2 percent, moderate if more than 2 percent.
Moderate stability and compaction; low to moderate shear strength.	Good drainage; moderate permeability.	High available water capacity; moderate permeability.	Moderately erodible.	Moderately erodible.	Moderate: low to moderate shear strength; moderate shrink- swell potential.	Slight to moderate: moderate perme- ability.	Moderate: moderate perme- ability.
Moderate shear strength; moderate to high com- pressibility; erodible slopes.	Good drainage; moderate permeability.	High available water capacity; moderate permeability.	Moderately erodible.	Moderately erodible.	Moderate: moderate shear strength.	Slight to moderate: moderate perme- ability.	Moderate: moderate perme- ability.
( <sup>2</sup> )-----	Somewhat poor drainage; fluctuating water table between 3 and 7 feet.	Low available water capacity; somewhat poor drainage; rapid perme- ability.	( <sup>2</sup> )-----	( <sup>2</sup> )-----	Moderate: fluctuating water table; somewhat poor drainage.	Severe: pollution hazard; seasonal high water table.	Severe: pollution hazard; occasional high water table; rapid perme- ability.
Substratum material needs binder; probable water table interference in excava- tions.	Somewhat poor drainage; seasonal high water table.	Somewhat poor drainage; seasonal high water table.	( <sup>2</sup> )-----	( <sup>2</sup> )-----	Moderate: seasonal high water table.	Severe: seasonal high water table; mod- erately slow per- meability.	Severe: porous sub- stratum; seasonal high water table.
Fair to poor stability; high shrink- swell po- tential.	Good drainage--	Moderately slow permeability; high availa- ble water capacity.	Moderately erodible.	Moderately erodible.	Moderate: moderate shear strength; high shrink- swell po- tential.	Severe: moderately slow per- meability.	Slight.

TABLE 7.—Engineering

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade <sup>1</sup>	Road fill <sup>1</sup>	Highway location <sup>1</sup>	Dikes and levees	Farm ponds
							Reservoir areas
Naron: Na, Nf, Ng---	Good-----	Unsuitable..	Fair-----	Good-----	Good drainage; erodible slopes.	Fair stability and compaction.	Moderate permeability.
Ness: Ns-----	Poor-----	Unsuitable..	Poor-----	Poor-----	Highly plastic; depressional area ponding.	High shrink-swell potential; cracks when dry.	In depressions; very slow permeability.
Platte: Pa-----	Poor-----	Unsuitable..	Good if confined or stabilized.	Good-----	Somewhat poor drainage; highly susceptible to frost action; seasonal high water table.	Subject to severe piping; erodible; needs slope protection.	Seasonal high water table; in places suitable for dugouts.
Plevna: Pe-----	Poor-----	Poor-----	Good-----	Good-----	Poor drainage; fluctuating water table between 2 and 5 feet; occasional flooding.	Fair stability; erodible slopes.	Porous substratum; good for pits dug to water table.
*Pratt: Pf, Pg, Pr, Pt. For Brazos part of Pr, see Brazos series. For Tivoli part of Pt, see Tivoli series.	Poor-----	Fair-----	Good-----	Good-----	Good drainage; erodible slopes.	High seepage; erodible slopes.	Rapid permeability.
Slickspots. No interpretations. Material too variable. Mapped only with Carwile, Tabler, and Zenda soils.							
*Tabler: Ta, Tb----- For Slickspots part of Tb, see Slickspots.	Fair to good.	Unsuitable..	Poor-----	Fair-----	Moderately good drainage; high shrink-swell potential.	Fair to poor stability; cracks when dry.	Very slow permeability.
Tivoli: Tf-----	Poor-----	Unsuitable..	Good if confined.	Good if confined.	Excessive drainage; highly erodible slopes.	Excessive seepage; highly erodible slopes.	Excessive seepage; rapid permeability.

See footnotes at end of table.

## interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitation affecting—		
Farm ponds— Continued	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Embankments							
Fair stability and com- paction.	Good drainage--	Moderate avail- able water capacity; moderate permea- bility.	Subject to blowing.	Moderately erodible by blowing and by water.	Slight-----	Slight to moderate: moderate permea- bility.	Moderate: moderate permea- bility.
Low shear strength; high shrink- swell po- tential; cracks when dry.	Poor drainage; depressional area pond- ing; remote outlets.	High available water capac- ity; very slow perme- ability; de- pressions; poor drain- age.	(2)-----	(2)-----	Severe: subject to ponding; high shrink- swell po- tential.	Severe: very slow permea- bility; de- pressional area pond- ing.	Severe: de- pressional area pond- ing.
(2)-----	Somewhat poor drainage; seasonal high water table.	(2)-----	(2)-----	(2)-----	Severe: seasonal high water table; occa- sional flooding.	Severe: pollution hazard; high water table.	Severe: high water table; mod- erately rapid per- meability; pollution hazard.
(2)-----	Poor drainage; water table at a depth of 2 to 5 feet.	(2)-----	(2)-----	(2)-----	Severe: water table at a depth of 2 to 5 feet; occa- sional flooding.	Severe: pollution hazard; high water table.	Severe: high water table.
High seepage; easily eroded; needs binder.	Good drainage--	Rapid permea- bility; low available water ca- pacity; sub- ject to blowing.	Subject to blowing; little or no runoff.	Droughty; medium fertility; subject to blowing.	Slight-----	Slight. Severe if pollu- tion hazard exists.	Severe: rapid per- meability.
Fair to poor stability; high shrink- swell poten- tial.	Moderately good drain- age.	Moderately good drain- age; very slow perme- ability.	Nearly level; moderately good drain- age.	Nearly level; moderately good drain- age.	Moderate: moderate shear strength; high shrink-swell potential.	Severe: very slow permea- bility.	Slight.
Excessive seep- age; highly erodible slopes.	Excessive drainage.	(2)-----	(2)-----	(2)-----	Moderate: moderate bearing strength.	Severe: in- adequate filtering qualities; pollution hazard.	Severe: rapid per- meability.

TABLE 7.—*Engineering*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade <sup>1</sup>	Road fill <sup>1</sup>	Highway location <sup>1</sup>	Dikes and levees	Farm ponds
							Reservoir areas
Tobin: To-----	Good-----	Poor to unsuitable.	Fair-----	Good-----	Good drainage; occasional flooding; erodible slopes.	Moderate shear strength; erodible slopes.	Moderate permeability.
Uly----- Mapped only with Harney soils.	Fair to good.	Unsuitable.	Fair-----	Good-----	Good drainage; erodible slopes.	Moderate shear strength; good to fair stability.	Moderate permeability.
Waldeck: Wa, Wc----	Good to poor.	Good-----	Good in upper 20 to 40 inches; good below if confined.	Good-----	Somewhat poor drainage; seasonal high water table.	Porous and seepy; fair stability.	Moderately rapid permeability.
*Zenda: Za, Ze, Zs--- For Slickspots part of Zs, see Slickspots.	Good to poor.	Poor-----	Poor to fair.	Good to fair.	Somewhat poor drainage; seasonal high water table.	Moderately erodible slopes; possible seepage.	Porous substratum; good for pits dug to water table.

<sup>1</sup> Herbert E. Worley, soil research engineer, and John E. Huffman, soil engineer, Kansas State Highway Commission, helped prepare

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitation affecting—		
Farm ponds— Continued	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Embankments							
Moderate shear strength; moderate to high compressibility; erodible slopes.	Good drainage; moderate permeability; occasional flooding.	Moderate permeability; high available water capacity; occasional flooding.	Moderately erodible.	Moderately erodible.	Severe: occasional flooding; moderate shear strength.	Severe: occasional flooding.	Severe: occasional flooding.
Moderate shear strength; good to fair stability; impervious if compacted.	Good drainage.	Moderate permeability; high available water capacity.	Moderately erodible.	Moderately erodible.	Moderate: moderate shear strength; moderate shrink-swell potential.	Slight to moderate: moderate permeability.	Moderate: moderate permeability; slopes erodible.
Porous and seepy; needs binder; fair stability.	Somewhat poor drainage; seasonal high water table.	Moderately rapid permeability; seasonal high water table.	(?) -----	(?) -----	Moderate: seasonal high water table.	Severe: pollution hazard; seasonal high water table.	Severe: porous substratum; seasonal high water table.
Substratum material needs binder; probable water table interference in excavations.	Somewhat poor drainage; seasonal high water table.	Moderate permeability; high available water capacity.	(?) -----	(?) -----	Moderate: seasonal high water table; moderate shear strength.	Severe: seasonal high water table.	Severe: porous substratum; seasonal high water table.

these columns. <sup>2</sup> Practice not applicable or not needed.

*Very severe* indicates one or more properties so unfavorable for a particular use that overcoming the limitation is most difficult and costly and is commonly not practical.

Following are explanations of some of the columns in table 7.

Topsoil is a term used to designate a fertile soil or soil material, ordinarily rich in organic matter, used to top-dress lawns, gardens, and roadbanks.

Ratings for sand and gravel are based on the probability that the soil contains deposits of sand and gravel. The ratings do not indicate the quality or extent of the deposits.

Ratings for road fill and subgrade are based on the performance of the soil material borrowed for these purposes.

Considered under the heading "Highway location" are those features of the soil that affect load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. Evaluations are for the entire soil profile in undisturbed soil, which is not artificially drained but from which the organic surface layer has been removed.

The column "Dikes and levees" indicates the predicted behavior of soil material borrowed for low height and low hazard embankments.

Considered under the heading "Reservoir areas" are those soil features that affect the seepage rate of water through undisturbed soils of impoundment areas.

Considered under the heading "Embankments" is the behavior of soil material borrowed for earth embankments for farm ponds. Both the subsoil and substratum are considered if the thickness of these layers is significant.

Agricultural drainage is influenced chiefly by such soil features as permeability, height of the water table, and location of the soil.

The column "Irrigation" indicates those features that affect the suitability of the soil when used for this purpose.

The column "Terraces and diversions" indicates the predicted behavior of soil material borrowed for the ridge of these structures.

Considered under the heading "Grassed waterways" are those features of the soil that make it suitable for establishing vegetation and the safe disposal of runoff.

Considered under the heading "Foundations for low buildings" are those features of an undisturbed soil, to a depth of approximately 6 feet, that affect its suitability for supporting low buildings and normal foundation loads.

The column "Septic tank filter fields" indicates those features of the undisturbed soil that limit the absorption of effluent.

The column "Sewage lagoons" indicates those features of the undisturbed soil that limit its ability to hold sewage for the time required for bacterial decomposition.

## **Formation and Classification of the Soils**

This section tells how the factors of soil formation have affected the development of soils in Edwards County. It also explains the system of soil classification currently used and classifies each soil series in the county according to that system.

## **Factors of Soil Formation**

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agents. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

### **Parent material**

The soils of the county formed in several different kinds of parent material. The principal kinds are eolian material that is high in sand, loess, alluvium, and outwash sediments.

Outwash sediments deposited in middle Pliocene time are the oldest parent materials. These are the caliche beds of the Ogallala Formation, the only outwash sediments that occur in the county. They are the parent material of Campus and Canlon soils.

In early Pleistocene time alluvium was deposited over most of the county. This material occurs south and east of the Arkansas River Valley. Soils formed in this old alluvium that has been modified by wind include the Farnum and Lubbock soils. Carwile soils also formed in old alluvium.

The loess deposits consist of relatively sand-free silty material that was deposited by wind in late Pleistocene time. The dominant soils formed in this parent material are the Harney, Holdrege, and Uly soils. The mantle of loess generally ranges from 15 to 40 feet in thickness and occurs on the upland, north and west of the Arkansas River Valley.

Eolian material that is high in sand is the major parent material of the soils in the sandhills. Most of this material was deposited during Recent time, after the loess was deposited. The sandhill areas occur south and east of the Arkansas River Valley; the deepest and coarsest material is next to the valley. Tivoli soils formed in fine sand, Attica and Pratt soils in loamy fine sand, and Naron soils in fine sandy loam. Tivoli and Pratt soils occur in areas of undulating to dune topography. Attica, Naron, and Pratt

soils occur in areas of nearly level to undulating topography, east of the dune sand areas.

The alluvium that has been deposited in Recent time is the most variable of all the parent material in the county. It ranges from sand to clay loam. The sandy alluvium occurs near the stream channel. The dominant soils in this parent material are the weakly developed Platte soils. The more loamy alluvium occupies the broad flood plain and low terraces. The dominant soils in this parent material are the Hord and Zenda soils.

### ***Climate***

Edwards County has a continental climate. The average annual precipitation is 22½ inches. A large part of the precipitation falls in the growing season during thunderstorms. During the hot, dry summers, the prevailing winds are from the south. Evaporation is high because of the low humidity, warm temperature, and high winds. Thus, only a limited amount of moisture is available for plant growth. The kinds of crops that can be grown must be able to withstand periods of hot, dry weather and then respond quickly when moisture is available. The native plants are adapted to this type of climate.

The effect that climate has had on soils of this county varies according to parent material, the lay of the land, the time the forces of soil formation have had to act, and the kind of plant and animal life. The type of parent material and the lay of the land determine the amount of moisture that enters the soil; hence the amount of leaching. The sandier the soil, the greater the amount of leaching. None of the soils have been excessively leached of plant nutrients. The lay of the land affects the soil temperature; south slopes have higher soil temperatures than north slopes.

The subhumid climate of this county favors the growth of grasses. Grasses produce large amounts of organic matter, both on the surface and in the upper part of the soil; therefore, most of the soils have a dark-colored surface layer.

### ***Plant and animal life***

Plants and animals, both in and on the soil, are active in soil-forming processes. The kinds of plants, animals, and micro-organisms that live in and on the soil are determined by the other environmental factors of soil formation—climate, parent material, relief, and age of the soils. Climate strongly influences plant and animal life and thereby exerts a strong indirect influence upon the morphology of soils.

Organic material is added to the soil as plants and animals die and decay. Most of it is added to the surface layer, where it is acted upon by micro-organisms, earthworms, and other forms of life and by chemicals in the soil and in the plant remains.

The soils of Edwards County developed under grass. As a result, the upper layers of most of the soils are dark colored.

### ***Relief***

The effect of climate and vegetation on parent material is modified by relief. For example, sloping areas lose water through runoff, and this loss modifies the effect of precipi-

tation and increases the amount of erosion. As a result, with increasing slope soil development is less rapid.

Harney and Uly soils are examples of the effect of relief on the formation of soils. The parent material of these two soils was similar. Differences in profile characteristics result from differences in relief.

Harney soils are nearly level and well drained and have a well-developed profile. Uly soils are sloping, have rapid runoff, and have a weakly developed profile.

Ness soils are in depressions and receive additional runoff from adjacent areas. Their clayey texture and gray color show the effects of additional moisture and poor drainage.

### ***Time***

The development of a soil profile requires time, usually a long time. The degree of development depends on the interaction of all soil-forming factors. Hord soils developed in recently deposited alluvium and have weakly developed soil horizons. Harney soils developed in parent material that has been in place long enough for distinct soil horizons to develop.

A soil profile develops in less time in easily weathered parent material, a favorable climate, and smooth topography than in weather-resistant parent material and steep topography. The combined action of all the soil-forming factors is reflected in the degree of profile development.

## **Classification of the Soils**

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories, so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (2) and revised later (8). The system currently used by the National Cooperative Soil Survey was developed in the early sixties (7) and was adopted in 1965 (10). It is under continual study.

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 8 shows the classification of each soil series of Edwards County by family, subgroup, and order, according to the current system. The classes of the current system are briefly defined in the following paragraphs.

TABLE 8.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Attica	Coarse-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Brazos	Sandy, mixed, thermic	Typic Ustifluvents	Entisols.
Campus	Fine-loamy, mixed, mesic	Typic Calcicustolls	Mollisols.
Canadian	Coarse-loamy, mixed, thermic	Udic Haplustolls	Mollisols.
Canon	Loamy, mixed, calcareous, mesic	Lithic Ustorthents	Entisols.
Carwile	Fine, mixed, noncalcareous, thermic	Typic Argiaquolls	Mollisols.
Farnum	Fine-loamy, mixed, thermic	Pachic Argiustolls	Mollisols.
Harney	Fine, montmorillonitic, mesic	Typic Argiustolls	Mollisols.
Holdrege <sup>1</sup>	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Hord <sup>2</sup>	Fine-silty, mixed, mesic	Pachic Haplustolls	Mollisols.
Las Animas	Coarse-loamy, mixed, calcareous, mesic	Fluventic Haplaquepts	Inceptisols.
Lesho	Fine-loamy over sandy or sandy-skeletal, mixed, thermic.	Aquic Fluventic Haplustolls	Mollisols.
Lubbock	Fine, mixed, mesic	Pachic Argiustolls	Mollisols.
Naron <sup>3</sup>	Fine-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Ness	Fine, montmorillonitic, mesic	Udic Pellusterts	Vertisols.
Platte	Mixed, mesic	Mollic Psammaquents	Entisols.
Plevna <sup>4</sup>	Coarse-loamy, mixed, noncalcareous, thermic	Fluventic Haplaquolls	Mollisols.
Pratt	Sandy, mixed, thermic	Psammentic Haplustalfs	Alfisols.
Tabler	Fine, montmorillonitic, thermic	Pachic Argiustolls	Mollisols.
Tivoli	Mixed, thermic	Typic Ustipsamments	Entisols.
Tobin	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Uly	Fine-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Waldeck	Coarse-loamy, mixed, thermic	Aquic Fluventic Haplustolls	Mollisols.
Zenda	Fine-loamy, mixed, thermic	Aquic Fluventic Haplustolls	Mollisols.

<sup>1</sup> The Holdrege soils in this county are taxadjuncts to the Holdrege series because their solum is generally more alkaline than is defined in the range for the series.

<sup>2</sup> The Hord soils in this county are taxadjuncts to the Hord series because their solum is generally more alkaline than is defined in the range for the series.

<sup>3</sup> The Naron soils in this county are taxadjuncts to the Naron series because their B2t and B3 horizons are generally more alkaline than is defined in the range for the series.

<sup>4</sup> The Plevna soils in this county are taxadjuncts to the Plevna series because their B horizon has chroma higher than is defined in the range for the series.

**Order.**—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Ardisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions are the Entisols and Histosols, which occur in many different kinds of climate. Five soil orders are recognized in Edwards County: Entisols, Vertisols, Inceptisols, Mollisols, and Alfisols.

Entisols are light-colored soils that do not have natural genetic horizons or that have only very weakly expressed beginnings of such horizons. These soils do not have features that reflect soil mixing caused by shrinking and swelling.

Vertisols are clay soils that swell and shrink enough to cause cracking, shearing, and mixing of the soil material when climate and relief result in alternate wetting and drying of the soil mass.

Mollisols formed under grass and have a thick, dark-colored surface horizon containing colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

Inceptisols are mineral soils that have weakly expressed genetic horizons. They do not have features that reflect soil mixing caused by shrinking and swelling. Their surface layer is usually lighter colored than that of the Mollisols.

Alfisols are mineral soils that contain horizons of clay accumulation. Unlike the Mollisols, they lack a thick, dark-colored surface layer that contains colloids dominated

by bivalent cations. The base status of the lower horizons in Alfisols is not extremely low.

**Suborder.**—Each order is divided into suborders, primarily on the basis of the characteristics that seem to produce classes that have the greatest genetic similarity. The suborder has a narrower climatic range than the order. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or the soil differences resulting from the climate or vegetation.

**Great Groups.**—Each suborder is divided into great groups on the basis of uniformity in kind and sequence of genetic horizons and major soil features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that contain a pan that interferes with the growth of roots or movement of water. Among the features considered are the self-mulching properties of clays, the soil temperature, and major differences in chemical composition, mainly calcium, magnesium, sodium, and potassium.

**Subgroup.**—Each great group is divided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, representing the soils that have mostly properties of one great group but also have 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.

**Family.**—Families are established within a subgroup primarily on the basis of properties important to the

growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

### ***Additional Facts About the County***

Facts about the physiography, relief, and drainage of the county, the climate, and the farming are provided in the following pages. Unless otherwise indicated, the statistics indicated are from records of the U.S. Bureau of the Census.

Edwards County was organized in 1874. It was named for W. C. Edwards and R. E. Edwards, two of the early settlers and businessmen in the county. In Kinsley, the county seat, the population was 457 in 1874 and 2,494 in 1965.

Other towns in the county are Offerle, Lewis, Belpre, Trousdale, Fellsburg, and Centerview. The population ranges from about 20 to 600. Some of these towns are unincorporated.

### **Physiography, Relief, and Drainage**

Most of Edwards County is in the High Plains section of the Great Plains physiographic province (6). The highest altitude, about 2,320 feet, is in the northwestern part of the county. The lowest altitude, about 2,020 feet, is at the point where Rattlesnake Creek leaves the county. Locally, differences in relief do not exceed 100 feet. Figure 11 is a drawing of the landscape of Edwards County.

Edwards County can be divided into three areas—the upland area, the valley area, and the dune-sand area.

The upland area is in the northwestern part of the county, north and west of the Arkansas River Valley. This

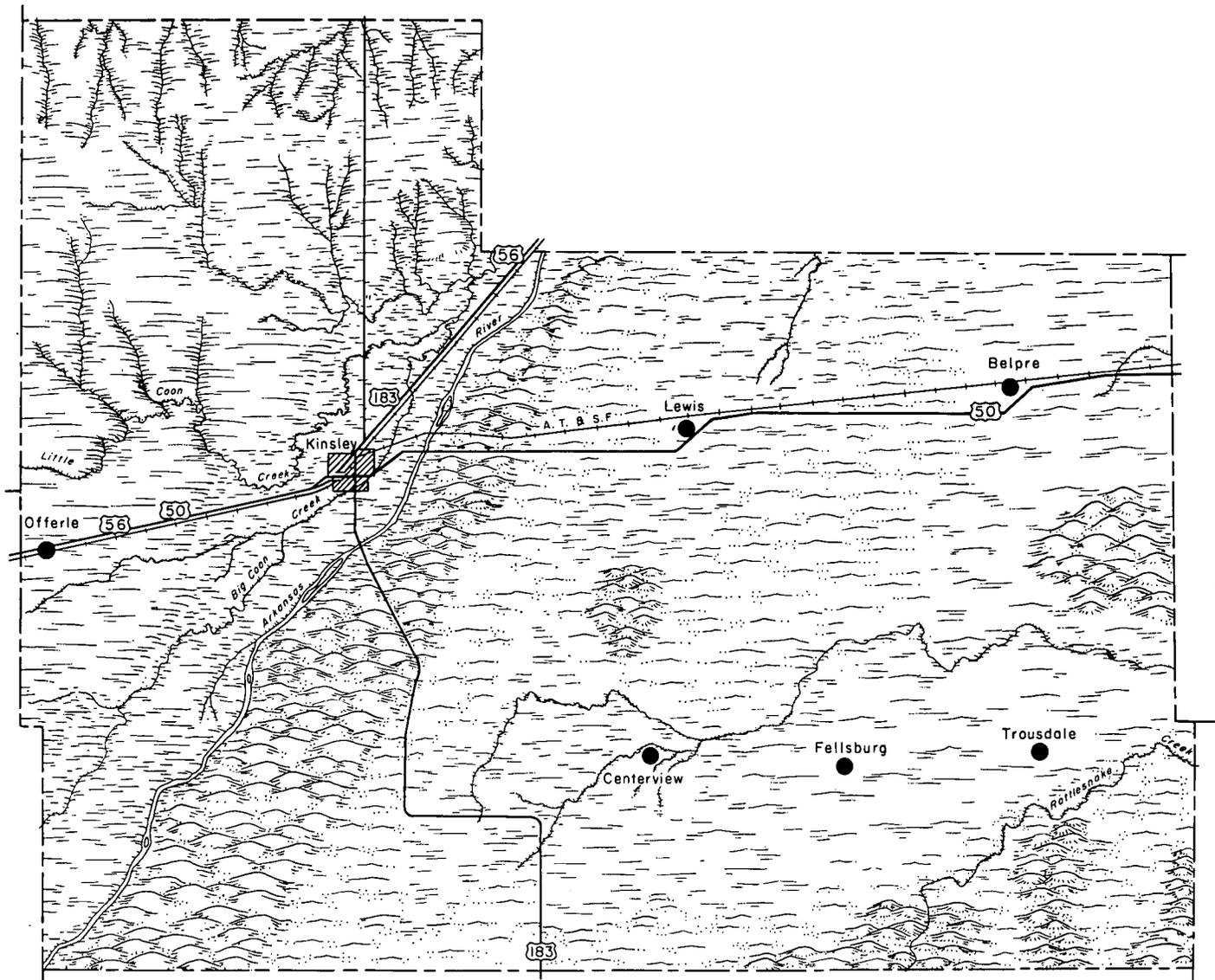


Figure 11.—Landscape of Edwards County.

area is nearly level to sloping. It consists of windblown deposits classified as Peorian Loess, which is of early Wisconsin age (5). The loess is approximately 15 to 40 feet thick.

The valley area consists mainly of the Arkansas River Valley, the present flood plain, and the terraces that border the flood plain. The Arkansas River flows eastward through western Kansas and makes the Great Bend in south-central Kansas. It enters the southwest corner of the county, flows northeastward through the county, and leaves the county about 16 miles west of the northeast corner.

The dune-sand area is south and east of the Arkansas River Valley. It is divided into two parts. The hummocky sandhills are near the Arkansas River and Rattlesnake Creek and in other small areas. The nearly level to undulating area occurs east of the sandhills. This area has no defined drainage pattern. It consists of locally reworked fine sands, silts, and clays of the Meade Formation (fig. 12), which is of Pleistocene age.

### Climate<sup>6</sup>

Edwards County has a typical continental climate, characterized by dry and relatively cold winters, warm to hot summers, a late spring-early summer precipitation maximum, moderate surface winds, and large daily and annual variations in temperature. Except for the shortage of rainfall in most growing seasons, the climate is well suited to the production of a variety of crops.

Two climate controls contribute to the precipitation pattern in Edwards County. The Rocky Mountains are effective in producing a "rain shadow" over western Kansas. The Gulf of Mexico is the principal source of moisture for precipitation in the area (4).

Annual precipitation in Kansas ranges from 16 inches along the southwest border to about 41 inches over the extreme southeastern part. In Edwards County, the sub-

<sup>6</sup> By MERLE J. BROWN, climatologist for Kansas, National Weather Service, U.S. Department of Commerce.

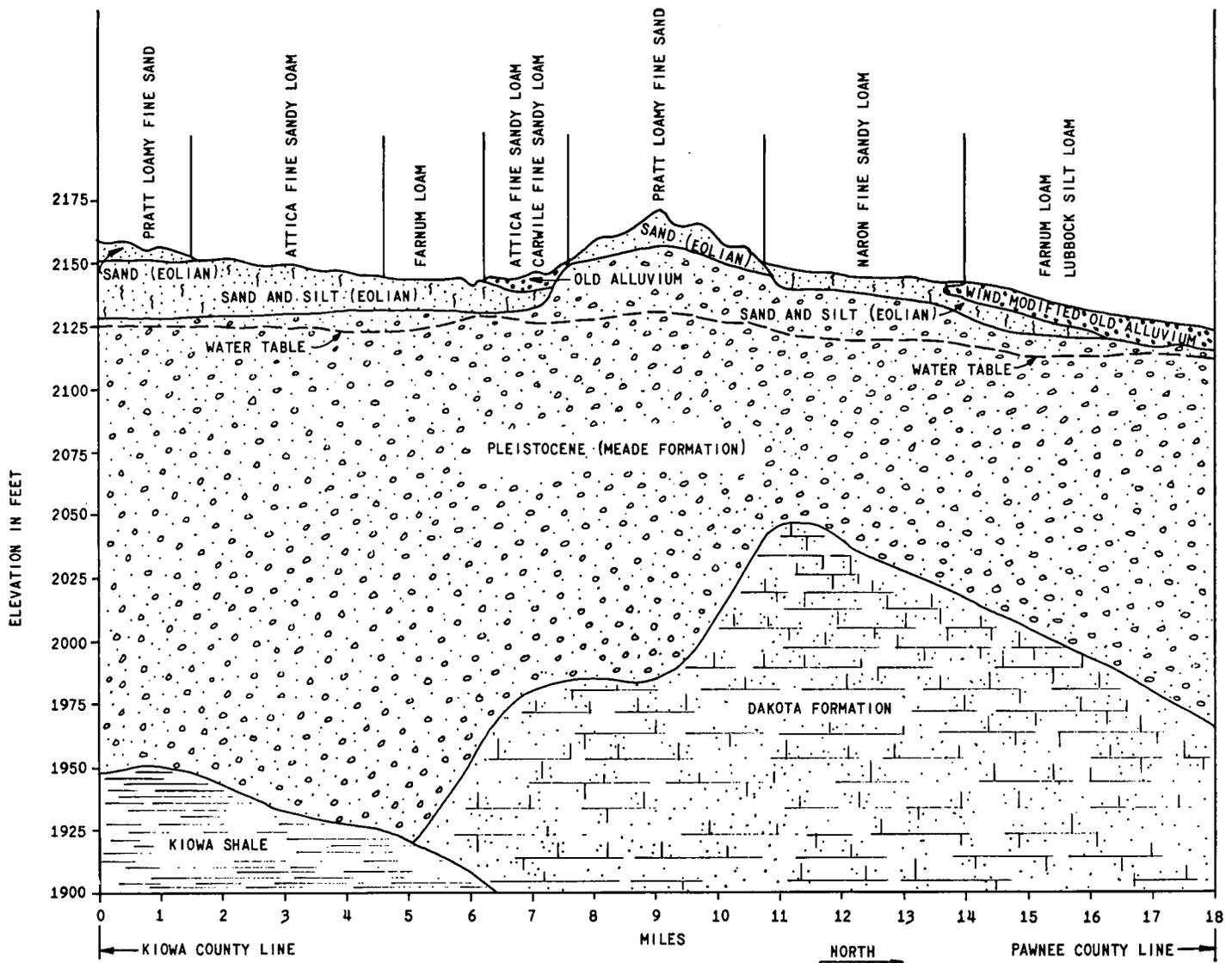


Figure 12.—Approximate geologic cross section (south to north) through dune-sand area (6).

humid precipitation region of central Kansas, annual precipitation is about 22½ inches.

The "effective" precipitation is considerably less than the average annual rainfall. A number of light showers occur, and much of this moisture evaporates from the soil with little or no benefit to growing crops. At the other extreme, occasional heavy downpours in spring, summer, and fall cause appreciable runoff from cultivated fields.

Lack of moisture is the most frequent limiting factor in the production of crops on dryland farms in Edwards County. Summer fallowing, which minimizes the effects of deficient rainfall, is a common practice. It is significant that a large part of the precipitation falls during the growing season. The 6-month period, April through September, accounts for about three-fourths of the annual precipitation. Rainfall is heaviest late in spring and early in summer, averaging more than 3 inches in May and in June.

Precipitation varies markedly from year to year. During the period 1907 to 1966, annual totals at Greensburg ranged from 10.51 inches in 1939 to 36.29 inches in 1949. Greensburg is in Kiowa County, but weather data for that location are generally representative of Edwards County.

Dry weather of several months duration is not uncommon, and droughts that extend over a period of several years occur at irregular intervals. Droughts were especially severe during the 1930's and from 1952 to 1957.

Because of the continental climate, the county has a wide range in annual temperature and sudden transitions between cold and warm seasons, as shown in table 9. In March, the average temperature is 44.2° F. In April, it is 55.0°. In October, the temperature is 59.0°, and in November 44.5°. Annual and record temperature extremes

are typical of a midlatitude, land-controlled climate. At Greensburg the highest temperature of record is 113° and the lowest is -20°.

The probabilities of the last freeze in spring and the first in fall in central Edwards County are given for five thresholds in table 10. The freeze-free period (above 32° F.) averages 180 to 185 days in length and extends from about April 23 to October 22 (3). The average growing season in Edwards County is a month longer than in extreme northwestern Kansas and about 15 days shorter than along the southern border of southeastern Kansas.

Snowfall is light, averaging about 18 inches per year. Snow that accumulates on the ground usually melts within a week. Blizzards occur infrequently and are generally of short duration.

The prevailing wind direction is southerly. Winds are moderate to occasionally strong in all seasons. Spring has a greater number of windy days than the other seasons.

Tornadoes occur occasionally, but generally affect only small, local areas. Hail accompanied by strong winds probably cause more damage than any other type of severe storm. Hailstorms, however, occur in an irregular pattern and affect relatively small areas in any given year.

## Farming

According to the U.S. Census of Agriculture, there were 510 farms in Edwards County in 1964. The average size was 803 acres. In 1930, there were 823 farms and the average size was 250 acres. In 1964, about 59 percent of the total income derived from the sale of farm products was from livestock and 41 percent from the sale of field crops.

TABLE 9.—Temperature and precipitation data

[Based on data recorded at Greensburg, in Kiowa County]

Month	Temperature				Precipitation				
	Average daily maximum <sup>1</sup>	Average daily minimum <sup>1</sup>	2 years in 10 will have about 4 days with—		Average monthly total <sup>1</sup>	1 year in 10 will have—		Number of days with snow cover of 1 inch or more <sup>3</sup>	Average depth of snow on days with snow cover <sup>3</sup>
			Maximum temperature equal to or higher than <sup>2</sup>	Minimum temperature equal to or lower than <sup>2</sup>		Less than <sup>1</sup>	More than <sup>1</sup>		
° F.	° F.	° F.	° F.	In.	In.	In.		In.	
January	44.5	19.9	63	2	0.51	0.01	0.92	6	2.7
February	49.5	23.2	67	7	1.00	.02	2.25	4	3.0
March	58.2	30.2	77	12	1.15	.05	2.69	3	3.2
April	68.8	41.2	85	27	2.26	.36	4.12	(4)	2.0
May	76.8	51.3	92	39	3.46	1.08	6.63		
June	87.4	61.7	101	52	3.28	1.18	6.76		
July	93.6	66.4	105	59	2.43	.74	4.11		
August	93.1	65.5	105	58	2.58	.81	4.68		
September	85.0	57.0	99	42	2.35	.24	4.71		
October	72.8	45.1	90	31	1.58	.14	3.50		
November	57.9	31.1	73	15	1.15	.01	2.79	1	2.8
December	46.8	22.5	65	9	.70	.01	2.18	5	3.4
Year	69.5	42.9	<sup>5</sup> 106	<sup>6</sup> -7	22.45	14.40	29.42	19	3.0

<sup>1</sup> Period of record 1907-60.

<sup>2</sup> Period of record 1936-60.

<sup>3</sup> Period of record 1942-66.

<sup>4</sup> Less than 0.5 day.

<sup>5</sup> Average annual maximum during the period 1907-66.

<sup>6</sup> Average annual minimum during the period 1907-66.

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

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than.....	March 31	April 8	April 11	April 23	May 8
2 years in 10 later than.....	March 25	April 2	April 6	April 18	May 3
5 years in 10 later than.....	March 13	March 23	March 28	April 8	April 23
Fall:					
1 year in 10 earlier than.....	November 10	November 2	October 24	October 19	October 8
2 years in 10 earlier than.....	November 16	November 7	October 28	October 24	October 12
5 years in 10 earlier than.....	November 28	November 18	November 7	November 2	October 22

Most towns have facilities for handling and storing grain. Railroads transport the grain to terminal elevators. Federal and State highways crisscross the county and provide access to market by truck.

Wheat and grain sorghum are the most important cash crops grown in the county. Wheat is usually grown on land that has been fallowed. Weeds compete for moisture and must be controlled during fallow.

An abundance of subsurface water is available in the area east of the Arkansas River Valley, and irrigation has become increasingly important. Most of the water supply is from wells, most of which are less than 150 feet deep. Grain sorghum is the major crop grown under irrigation. Wheat, alfalfa, corn, and forage sorghum are also irrigated.

In 1966, according to the Kansas State Board of Agriculture, wheat was sown on 134,000 acres and harvested from 129,000 acres. Also harvested was grain sorghum, 14,000 acres; forage sorghum, 2,300 acres; barley, 1,000 acres; corn, 300 acres; and alfalfa, 7,900 acres.

Raising livestock, chiefly beef cattle, is an important source of income in Edwards County. Records of the Kansas State Board of Agriculture show that in 1966 there were 700 milk cows; 35,300 other cattle; 1,300 hogs; 2,700 sheep; and 12,000 chickens.

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## 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.
- Alkali soil.** Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.
- Alluvium.** Soil material, such as sand, silt, or clay, that has been deposited on land by streams.
- Available water capacity** (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.
- Blowout.** An excavation produced by wind action in a loose soil, generally sand.
- Calcareous soil.** A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.
- Caliche.** A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.
- Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent 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.
- 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.

**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 water-holding capacity.

*Somewhat excessively drained* soils are also very permeable and are free from mottling throughout their profile.

*Well-drained* soils are nearly free from mottling and are commonly of intermediate texture.

*Moderately well drained* soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

*Somewhat poorly drained* soils are wet for significant periods but not all the time, and commonly have mottlings in the B and C horizons.

*Poorly drained* soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

*Very poorly drained* soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

**Eolian soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

**Erosion.** The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

**Flood plain.** Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

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

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

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

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

true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

*C horizon.*—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

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

**Loess.** Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

**Mottling, soil.** Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common, and many*; size—*fine, medium, and coarse*; and contrast—*faint, distinct, and prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

**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.

**Permeability.** The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid*.

**pH value.** A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

**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 or 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

**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 soils having diameters ranging 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.

**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.

**Slickspots.** Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

**Soil.** A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

**Solum.** The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike

those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

**Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Substratum.** Technically the part of the soil below the solum.

**Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

**Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in

fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

**Terrace (geological).** An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing 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."

**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.

**Water table.** The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. All windbreak groups are described on pages 38 and 39. Other information about the mapping units is given in tables as follows:

Acreage and extent, table 1, page 8.  
 Estimated yields of dryland crops, table 2, page 30.  
 Estimated yields of irrigated crops, table 3, page 34.

Soil interpretations for recreational facilities, table 5, page 41.  
 Use of the soils in engineering, table 6, page 44, and table 7, page 48.

Map symbol	Mapping unit	Page	Capability unit Dryland		Irrigated		Range site		Windbreak group
			Number	Page	Number	Page	Name	Page	Name
Aa	Attica fine sandy loam, 0 to 1 percent slopes-----	8	IIe-2	24	IIs-1	32	Sandy	37	Sandy Upland
Ab	Attica fine sandy loam, 1 to 3 percent slopes-----	8	IIe-3	24	IIe-2	31	Sandy	37	Sandy Upland
Ac	Attica-Carwile fine sandy loams-----	9							
	Attica-----		IIe-3	24	IIe-2	31	Sandy	37	Sandy Upland
	Carwile-----		IIe-3	24	IIe-2	31	Sandy	37	Clayey Upland
Bd	Blown-out land-----	9	VIIe-1	29	-----	--	Choppy Sands	35	-----
Bk	Breaks-Alluvial land complex--	9							
	Breaks-----		VIe-1	27	-----	--	Limy Upland	35	Loamy Upland
	Alluvial land-----		VIe-1	27	-----	--	Loamy Lowland	35	Loamy Upland
Cc	Campus-Canlon complex-----	10							
	Campus-----		VIe-2	28	-----	--	Limy Upland	35	-----
	Canlon-----		VIe-2	28	-----	--	Shallow Limy	37	-----
Cd	Canadian fine sandy loam-----	10	IIe-2	24	IIs-1	32	Sandy Terrace	37	Sandy Lowland
Cf	Canadian fine sandy loam, sandy subsoil-----	10	IIIs-1	27	IIIs-1	33	Sandy Terrace	37	Sandy Lowland
Cr	Carwile fine sandy loam-----	11	IIw-2	25	IIw-2	32	Sandy	37	Clayey Upland
Cs	Carwile-Slickspots complex---	11							
	Carwile-----		IVs-1	27	-----	--	Sandy	37	Clayey Upland
	Slickspots-----		IVs-1	27	-----	--	Saline Upland	37	-----
Fa	Farnum loam, 0 to 1 percent slopes-----	12	IIc-1	25	I-1	30	Loamy Upland	36	Loamy Upland
Fr	Farnum loam, 1 to 3 percent slopes-----	12	IIe-4	25	IIe-1	31	Loamy Upland	36	Loamy Upland
Ha	Harney silt loam, 0 to 1 percent slopes-----	13	IIc-1	25	I-1	30	Loamy Upland	36	Loamy Upland
Hb	Harney silt loam, 1 to 3 percent slopes-----	13	IIe-1	23	IIe-1	31	Loamy Upland	36	Loamy Upland
Hc	Harney silt loam, 3 to 6 percent slopes-----	13	IIIe-1	25	-----	--	Loamy Upland	36	Loamy Upland
Hd	Harney-Uly complex, 1 to 3 percent slopes-----	13	IIe-1	23	IIe-1	31	Loamy Upland	36	Loamy Upland
He	Harney-Uly complex, 3 to 6 percent slopes-----	13	IIIe-1	25	-----	--	Loamy Upland	36	Loamy Upland
Hg	Holdrege silt loam, 1 to 3 percent slopes-----	14	IIe-4	25	IIe-1	31	Loamy Upland	36	Loamy Upland
Hh	Holdrege silt loam, 3 to 6 percent slopes-----	14	IIIe-2	26	-----	--	Loamy Upland	36	Loamy Upland
Ho	Hord silt loam-----	14	IIc-2	25	I-1	30	Loamy Terrace	36	Loamy Lowland
La	Las Animas loamy fine sand----	15	VIIs-1	29	IVs-1	33	Sandy Terrace	37	Wet Loamy and Sandy Lowland
Lh	Lesho clay loam-----	15	IIIw-2	27	IIIw-1	32	Saline Subirrigated	36	Wet Loamy and Sandy Lowland
Lk	Lubbock silt loam-----	16	IIc-1	25	I-1	30	Loamy Upland	36	Loamy Upland
Na	Naron loamy fine sand, 0 to 1 percent slopes-----	16	IIIe-3	26	IIIe-1	32	Sands	37	Sandy Upland

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak group		
			Dryland	Irrigated	Name	Page	Name	Page	
Nf	Naron fine sandy loam, 0 to 1 percent slopes-----	17	IIe-2	24	IIs-1	32	Sandy	37	Sandy Upland
Ng	Naron fine sandy loam, 1 to 3 percent slopes-----	17	IIe-3	24	IIe-2	31	Sandy	37	Sandy Upland
Ns	Ness clay-----	17	VIw-1	28	IVs-2	33	-----	--	-----
Pa	Platte soils-----	18	VIw-2	29	-----	--	Saline Subirri- gated	36	Wet Loamy and Sandy Lowland
Pe	Plevna fine sandy loam-----	18	Vw-1	27	-----	--	Subirrigated	38	Wet Loamy and Sandy Lowland
Pf	Pratt loamy fine sand, hum- mocky-----	18	IVe-1	27	IIIe-1	32	Sands	37	Sandy Upland
Pg	Pratt loamy fine sand, undulating-----	19	IIIe-3	26	IIIe-1	32	Sands	37	Sandy Upland
Pr	Pratt-Brazos loamy fine sands-----	19	VIe-3	28	-----	--	Sands	37	Sandy Upland
Pt	Peatt-Tivoli loamy fine sands-----	19	VIe-3	28	-----	--	Sands	37	Sandy Upland
Ta	Tabler clay loam-----	19	IIs-1	25	IIs-2	32	Clay Upland	35	Clayey Upland
Tb	Tabler-Slickspots complex---- Tabler----- Slickspots-----	20	IVs-1	27	-----	--	Clay Upland	35	Clayey Upland
Tf	Tivoli fine sand-----	20	IVs-1	27	-----	--	Saline Upland	37	-----
To	Tobin silt loam-----	20	VIIe-1	29	-----	--	Choppy Sands	35	-----
Wa	Waldeck fine sandy loam-----	21	IIIw-1	26	-----	--	Loamy Lowland	35	Loamy Lowland
Wc	Waldeck loam-----	21	IIIw-2	27	IIIw-2	33	Subirrigated	38	Wet Loamy and Sandy Lowland
Za	Zenda clay loam-----	22	IIIw-2	27	IIIw-2	33	Subirrigated	38	Wet Loamy and Sandy Lowland
Ze	Zenda clay loam, saline-----	22	IIw-1	25	IIw-1	32	Loamy Terrace	36	Wet Loamy and Sandy Lowland
Zs	Zenda-Slickspots complex----- Zenda----- Slickspots-----	22	IVs-1	27	-----	--	Saline Terrace	36	Wet Loamy and Sandy Lowland
			IVs-1	27	-----	--	Loamy Terrace	36	Wet Loamy and Sandy Lowland
			IVs-1	27	-----	--	Saline Terrace	36	-----

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