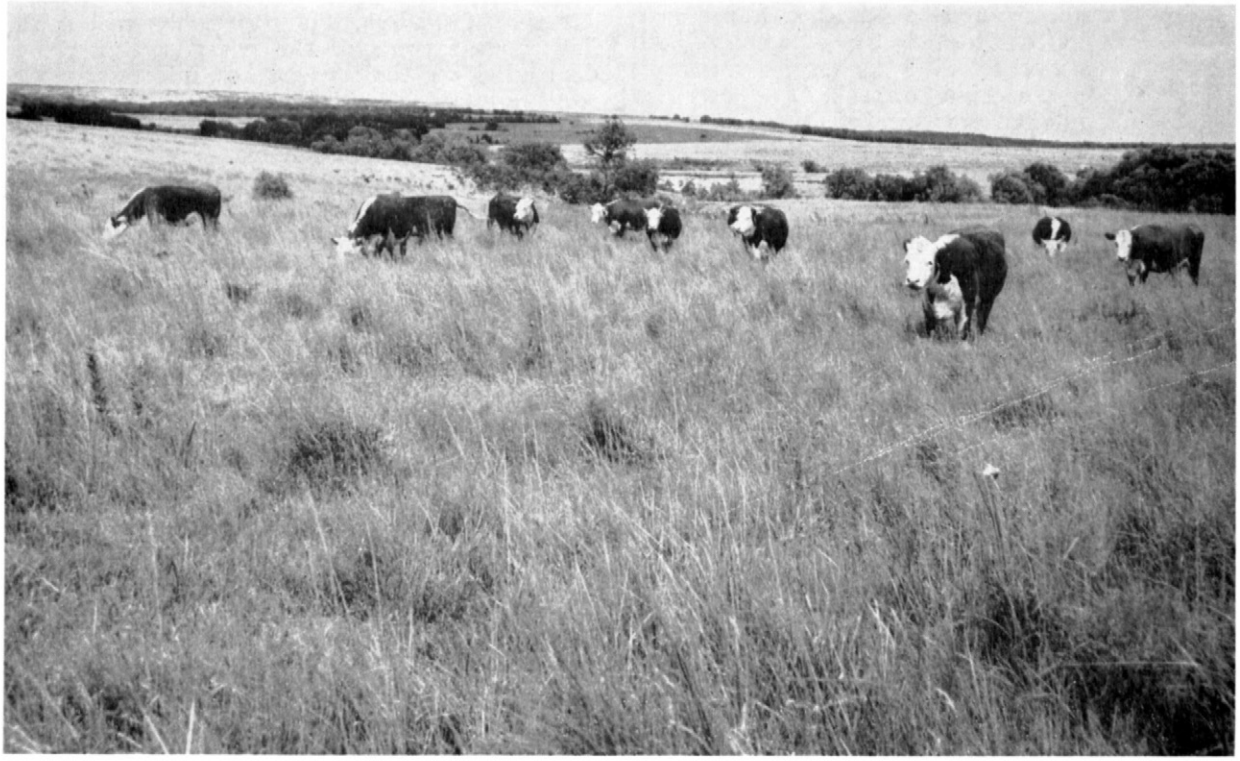
SOIL SURVEY

Stephens County
Oklahoma



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
OKLAHOMA AGRICULTURAL EXPERIMENT STATION

Series 1960, No. 20 Issued November 1964

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Stephens County will help farmers and ranchers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; aid those interested in managing woodland; serve as a reference for students and teachers; and add to our knowledge of soils.

Locating the soils

Use the index to map sheets to locate areas on the detailed soil map. The index is a small map of the county on which numbered rectangles have been drawn to show what part of the county is represented on each sheet of the detailed soil map. When the correct sheet of the detailed map is found, it will be seen that the soil areas are outlined and that each soil is designated by a symbol. All areas marked with the same symbol are the same kind of soil. Suppose, for example, an area located on the map has the symbol ReC. The legend for the detailed map shows that this symbol identifies Renfrow silt loam, 3 to 5 percent slopes. This soil and all others mapped in the county are described in the section "Descriptions of the Soils."

Finding information

Special sections of the report will interest different groups of readers, and some sections will be of interest to all.

Farmers and those who work with them can learn about the soils on their farms in the section "Descriptions of the Soils." They can then turn to the section "Use and Management of the Soils," to learn how these soils can be managed and what yields can be expected. Farmers who want to protect their fields, livestock, and homesteads from wind will want to read "Woodland and Windbreaks." Those interested in improving habitats for wildlife will find this information in the subsection "Wildlife."

Range conservationists and others interested in rangeland can refer to the subsection "Management of Rangeland." In that section the soils of the county have been placed in range sites, and factors affecting the management of rangeland are explained.

The "Guide to Mapping Units," which is at the back of the report, gives the map symbol for each soil, the name of the soil and the capability unit and range site in which it has been placed.

Engineers will want to refer to the subsection "Engineering Properties of Soils." Tables in that section show soil characteristics that affect engineering.

Soil scientists and others who are interested will find information about how the soils formed and how they are classified in the section "Genesis, Classification, and Morphology of the Soils."

Students, teachers, and other users will find various parts of the report useful, depending on their particular interests.

Newcomers in Stephens County and others not familiar with the county will 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," which describes the climate, relief, and drainage; discusses the water supply, cultural facilities, industries, transportation and markets; and gives some statistics on agriculture.

* * * * *

This soil survey was made as part of the technical assistance furnished to the Stephens County Soil Conservation District. The district was organized, through the efforts of local farmers, in 1938. Through this district the farmers receive technical help from the Soil Conservation Service in planning for the use and conservation of the soils on their farms.

Fieldwork for this survey was completed in 1960. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time.

Cover picture: Beef cattle on native range in Stephens County, Oklahoma.

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SOIL SURVEY OF STEPHENS COUNTY, OKLAHOMA

BY EDWARD J. ABERNATHY AND ROBERT C. REASONER, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE OKLAHOMA AGRICULTURAL EXPERIMENT STATION

STEPHENS COUNTY is in the south-central part of Oklahoma (fig. 1). It is rectangular, about 33 miles from east to west, and 27 miles from north to south. The total area is 571,520 acres, or 893 square miles.

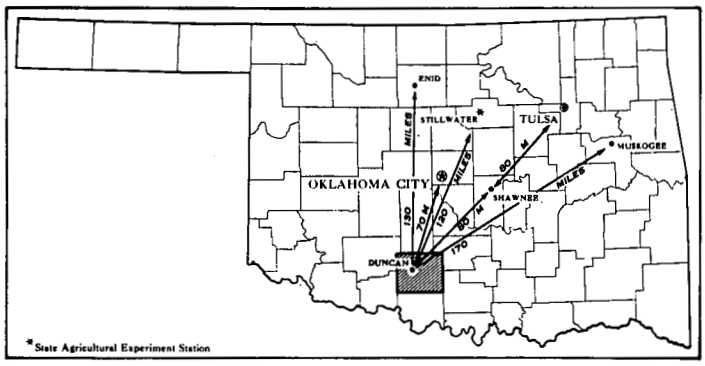

Figure 1.—**Location of Stephens County in Oklahoma.**

Duncan, the county seat, is about 5 miles west of the center of the county. It is about 70 miles southwest of Oklahoma City, 130 miles south of Enid, 160 miles southwest of Tulsa, and 170 miles southwest of Muskogee.

How Soils Are Named, Mapped, and Classified

Soil scientists made this survey to learn the kinds of soils in Stephens County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rocks; and many facts about the soils. They dug or bored 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 to the parent material that has not been changed much by leaching or by roots of plants.

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 uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, the major horizons of all the soils of one series 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. Chickasha and Stephenville, for example, are the names of two soil series in Stephens County. All the soils in the United States having the same series name are essentially alike in natural characteristics. Soils of one series can differ somewhat in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many series contain soils that differ in the texture of their surface layer. According to such differences, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Chickasha fine sandy loam and Chickasha loam are two soil types in the Chickasha series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Chickasha loam, 0 to 1 percent slopes, is one of several phases of Chickasha loam, a soil type that has a slope range of 0 to 8 percent.

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 greatly help in drawing boundaries accurately. The soil map in the back of this report 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 management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. 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 type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed or occur in such small indi-

vidual tracts that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major soil series in it. An example in Stephens County is the Stephenville-Darnell complex.

Occasionally, two or more similar soils may be mapped as a single unit, called an undifferentiated mapping unit, if the differences between them are too small to justify separate mapping. An example in this county is Nash and Noble fine sandy loams, 3 to 5 percent slopes. Also, in most mapping, there are areas to be shown that are so rocky, so shallow, or so frequently worked by wind and water that they are too variable to be classified into soil series. These areas are shown on the soil map, but they are given descriptive names, such as Eroded clayey land, and are called miscellaneous land types.

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 soils 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 soils. Yields under defined management are estimated for all the soils.

Only part of the 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 is then organized in such a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. Based on the yield and practice tables and other data, the soil scientists set up trial groups and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultations. 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[1]

In traveling over a county or other large tract, it is fairly easy to see differences in the landscape from place to place. There are many obvious differences, among them differences in shape, steepness, and length of slope; in the course, depth, and speed of streams; in the width of the flood plains or valleys that border the streams; in kinds of wild plants; and in the kinds of agriculture. With these obvious differences, there are less easily noticed differences in the patterns of soils. The soils differ along with the other parts of the environment.

By drawing lines around the different patterns of soils on a small map, one may obtain a map of the general soil areas, or soil associations. Such a map is useful to those who want a general idea of the soils, who want to compare different parts of a county, or who want to locate large areas suitable for a particular kind of farming or other land use. It does not show accurately the kind of soil on a single farm or a small tract.

Each soil association is named for the major soils in it. The major soils of one association may occur in another association also, but in a different pattern.

The eight soil associations in Stephens County shown on the colored map in the back of this report are described in the paragraphs that follow.

The soils of the Nash-Noble-Chickasha association, the Kirkland-Renfrow association, and the Port-Miller-Gowen association are cultivated extensively. The Zaneis-Chickasha-Vernon-Lucien association is used both for range and for cultivated crops. The other associations are used mostly for range and pasture.

1. Stephenville-Windthorst-Darnell association

Deep soils and shallow to very shallow soils formed under timber in weathered sandstone and clay

This association, the most extensive in the county, is widely distributed. It makes up about 45 percent of the acreage of the county.

About two-thirds of this association consists of the Stephenville soils, which have a slope range of 1 to 8 percent. About 15 percent is made up of the Stephenville-Darnell complex. The soils in this complex have strong slopes. The Windthorst soils, which have gentle to moderate slopes, make up about 20 percent of the association. Small areas of the deep, permeable, coarse-textured Dougherty soils occur on mounds and ridges that have short, irregular slopes. Also in this association are small areas of the deep, very sandy Eufaula soils.

Figure 2 shows the general pattern of the major soils in association 1.

The soils in this association are moderately coarse textured. The Stephenville soils have a permeable, well-developed subsoil of sandy clay loam that extends to a depth of 30 to 54 inches. The Windthorst soils have a subsoil of reddish clay or sandy clay over beds of clay. The Darnell soils are shallow to very shallow sandy soils that have many rock outcrops.

The soils in this association are moderately low in fertility. Cultivated areas should be protected from sheet and gully erosion. The Stephenville soils are suited to cultivation, except the areas that are part of the Stephenville-Darnell complex. Peanuts, watermelons, sorghum, and small grain are suitable crops. The Windthorst soils are suited to cultivation if erosion is controlled. The Dougherty soils are suited to cultivation, but they are susceptible to wind erosion.

If properly managed, fields formerly used for crops produce good yields of introduced pasture grasses and native grasses. Cleared areas of virgin soils are well suited to native grasses.

At one time, nearly all the farms in this association were between 80 and 160 acres in size. Many of these small farms have now been consolidated into larger livestock farms.

2. Port-Miller-Gowen association

Mixed soils of the bottom lands

This association covers about 10 percent of the county. It is made up of large areas of soils on bottom lands. These soils formed in recent alluvium.

The well drained and moderately well drained Port

[1] Prepared by ROBERT C. REASONER, soil scientist, Soil Conservation Service.

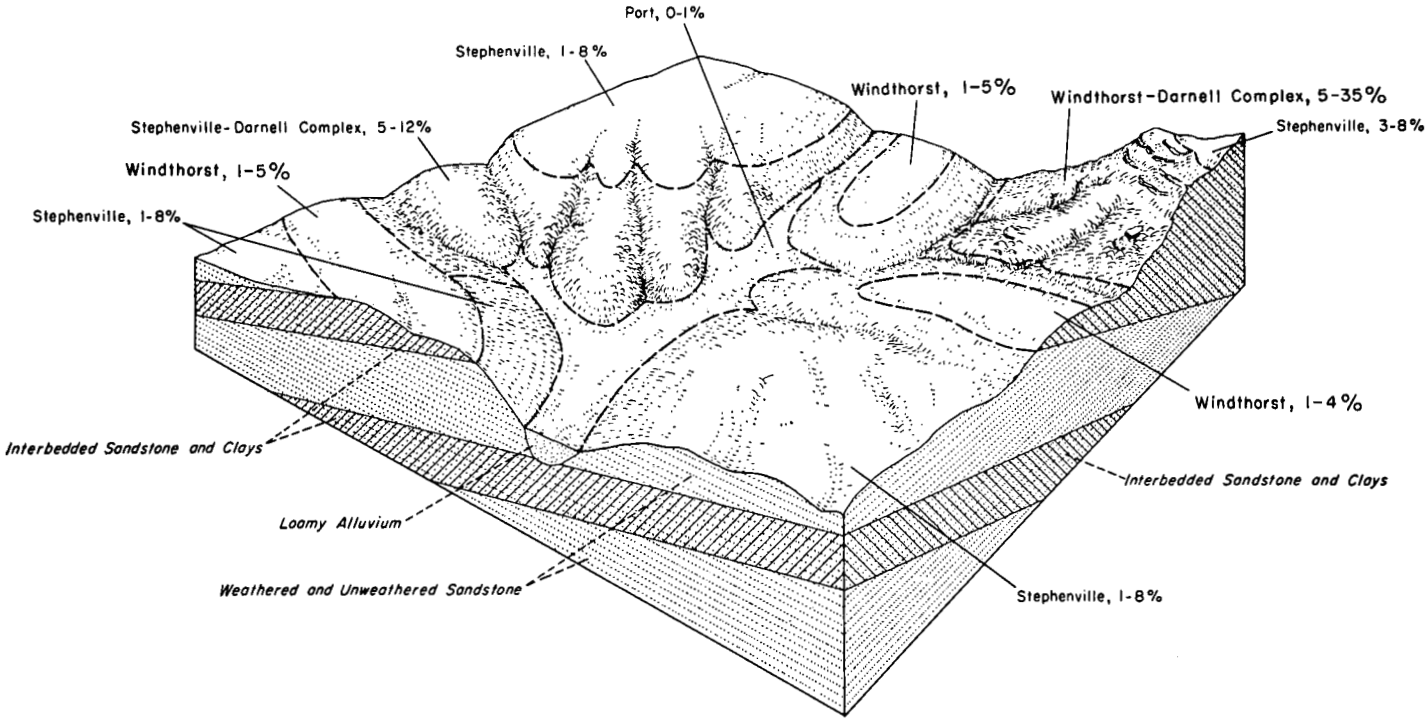

Figure 2.—**Typical pattern of soils in associations 1 and 5.**

soils occupy the largest acreage in this association. They have a surface layer of sandy loam, loam, or clay loam, and a subsoil of loam to clay loam. In small areas in the south-central part of the county, Port soils are intermixed with saline soils. The Gowen soils have a clay loam profile and are grayer than the Port soils. They occur mostly along streams that drain association 4. The moderately well drained Miller soils have a clay profile. They occur mainly along Big Beaver Creek in the southwestern part of the county.

All the soils in this association are flooded at least occasionally, and some areas are flooded frequently. The areas that are flooded frequently are of limited use for cultivated crops, but they can be planted to small grain to be used for pasture. Alfalfa can also be grown.

Areas of the Port and Gowen soils that are not subject to frequent flooding are highly productive of all crops commonly grown. Native pecan trees grow on these soils. The areas in which Port soils are intermixed with the saline soils are used for low-quality pasture.

Large areas of the Miller soils are cultivated, but wetness limits the choice of crops grown.

Because most areas of bottom land are narrow, the farms in this association usually include some soils of the uplands. Diversified farming is practiced. The arable bottom lands are used for cultivated crops, and the nonarable bottom lands and adjacent uplands are used for pasture.

3. *Nash-Noble-Chickasha association*

Deep and moderately deep soils formed under grass in weathered sandstone or in alluvium on slopes

This association makes up about 5 percent of the county. It consists of moderately permeable, gently sloping to strongly sloping soils that formed in soft, reddish sandstone. It is in the extreme north-central part of the county.

The deep Noble soils make up about half of this association. These soils occur as narrow bands on foot slopes below areas of the Nash soils and of Rough broken land. About half of the association consists of the moderately deep, reddish, gently sloping to strongly sloping Nash soils and the deep, brown, moderately sandy Chickasha soils. The Chickasha soils occur with the Nash soils on the gentler slopes.

Figure 3 shows the general pattern of soils in this association.

The soils in this association are moderately productive, but crop yields can be increased by good management. The soils are suited to a wide range of crops and are cultivated intensively. More peanuts, cotton, and broomcorn are grown in this association than in any other association in the county. Most of the farms are between 80 and 160 acres in size.

4. *Kipp-Kipson-Bethany-slickspot association*

Deep to very shallow soils formed in weathered gray and yellowish-brown Permian clay, shale, sandstone, and siltstone

This association is in the northeastern part of the county and makes up only a small percentage of the total acreage.

The gently sloping soils of the Bethany-slickspot complex cover about one-third of the association. The Bethany soils formed in material weathered from yellowish-brown clay and clayey shale, under a cover of mid and tall grasses. Numerous slickspots are associated with the Bethany soils. The rest of the association is made up of the Kipp-Kipson complex, a small acreage of Rough broken land, clayey, and Gowen soils on the bottom lands.

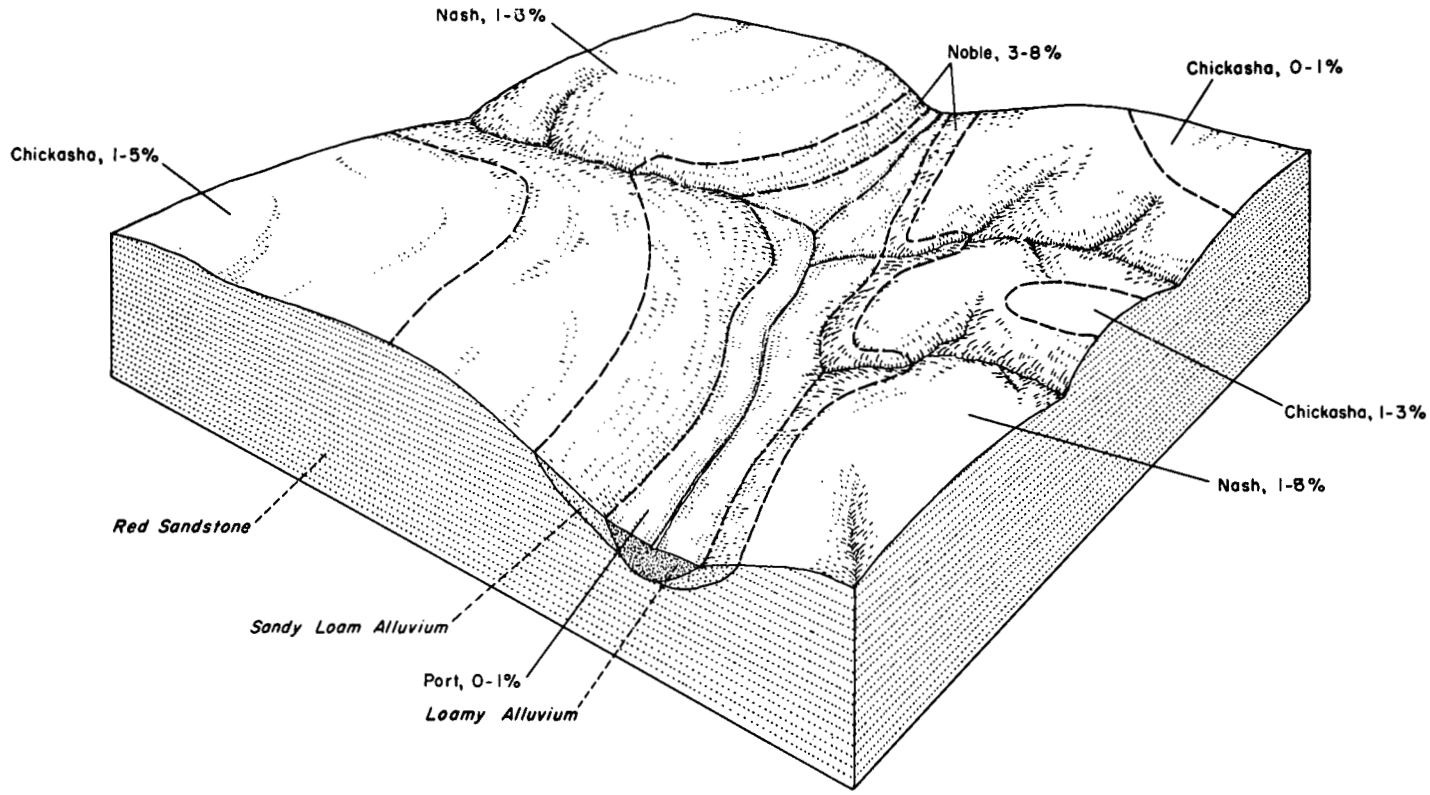

Figure 3.—**Typical pattern of soils in association 3.**

The moderately deep Kipp soils and the shallow to very shallow Kipson soils are on the steeper slopes. They formed in material weathered from gray shale and yellowish-brown sandstone and siltstone.

Figure 4 shows the general pattern of the major soils in association 4.

Most of this association is in native range, to which the soils are well suited. The soils that make up the Kipp-Kipson complex are too steep and shallow to be used for cultivated crops. Some areas of the Bethany-slickspot complex once cultivated are now in low-quality pasture. A few large ranches occupy most of the acreage in this association.

5. *Windthorst-Darnell association*

Deep soils and shallow to very shallow soils; steep and stony; formed under timber on interbedded sandstone and clay

This association of stony soils occupies a very small acreage in Stephens County. The largest area is south and west of Velma, in the section locally called the Santa Fe hills.

This association is made up of the deep Windthorst soils and the shallow to very shallow Darnell soils, all on strong, rocky slopes.

Most of this association is surrounded by the soils that make up association 1. The general pattern of the soils is shown in figure 2.

The soils in this association are used only for woodland range. The productivity of the range is low, and a few areas are inaccessible to livestock. This association is one of the largest oil- and gas-producing areas in Stephens County.

6. *Kirkland-Renfrow association*

Deep, very slowly permeable soils of the prairies; formed in Permian clay

The small areas that make up this association are mostly in the western part of the county. They make up about 10 percent of its total acreage.

About one-fourth of this association consists of nearly level Kirkland soils, and a small part consists of moderately sloping Renfrow soils. The rest of the association is made up of the gently sloping Kirkland-Renfrow complex of soils and small, scattered areas of the shallow Vernon and Lucien soils along drainageways. The general pattern of soils in this association is shown in figure 5.

The Kirkland and Renfrow soils formed in clayey red-bed material. They are referred to locally as claypan soils because their subsoil is compact, blocky clay that is very slowly permeable. The Kirkland soils have a dark grayish-brown or dark-brown subsoil. The Renfrow soils have a reddish-brown subsoil.

The soils in this association have a low moisture-supplying capacity, and they are very droughty during periods of inadequate rainfall. They are moderately high in fertility. Cultivated areas should be protected from sheet erosion. Small grain, cotton, and grain sorghum are the principal crops grown.

Many of the most productive and well-managed farms of the uplands are in this association. Some farms are of the crop-livestock type, and some are crop farms.

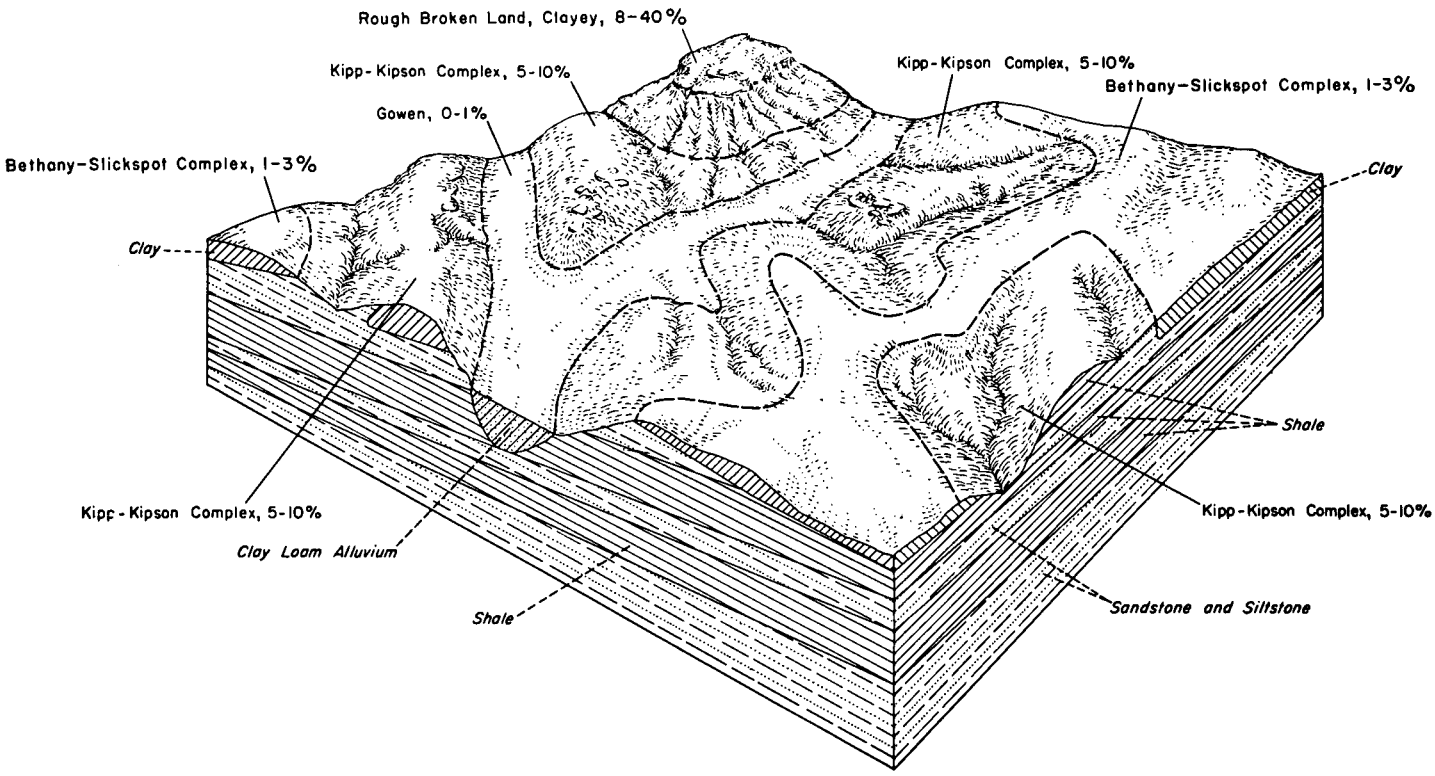

Figure 4.—Typical pattern of soils in association 4.

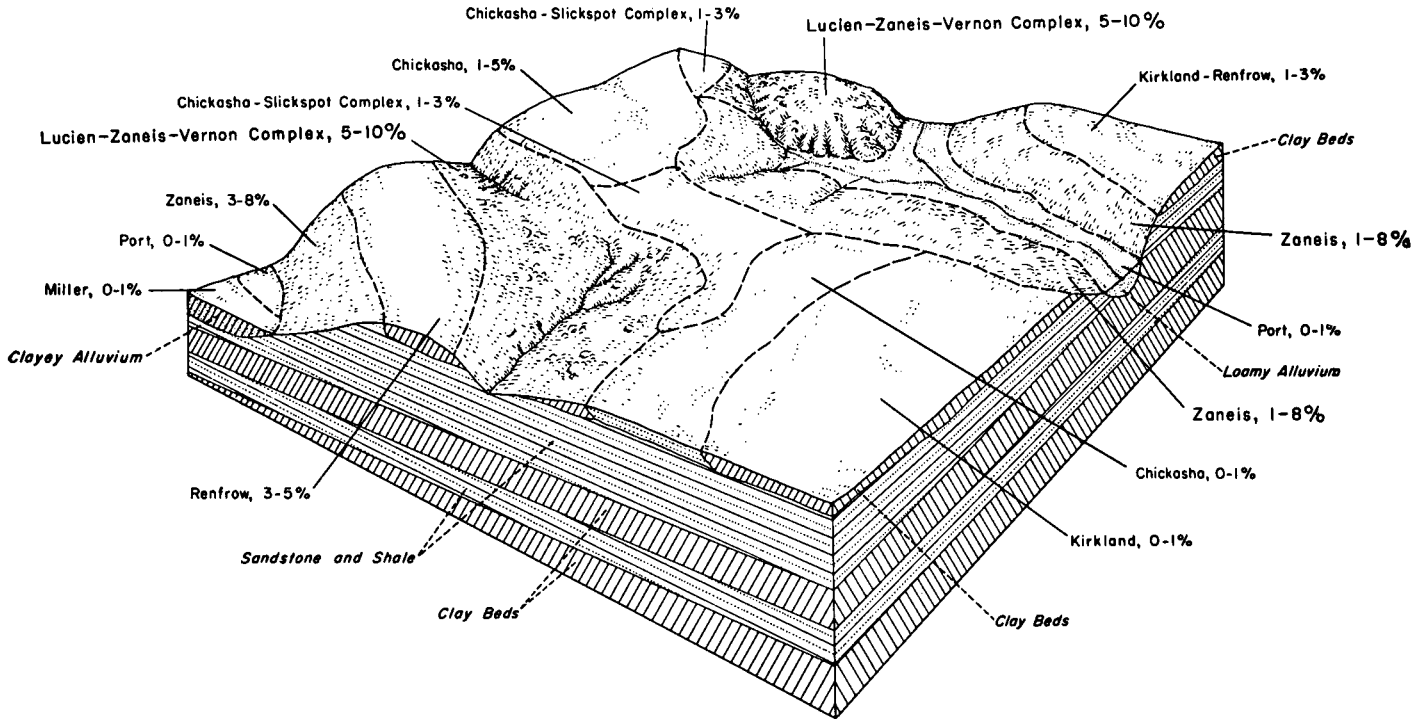

Figure 5.—Typical pattern of soils in associations 6, 7, and 8.

7. *Zaneis-Chickasha-Vernon-Lucien association*

Deep to very shallow soils of the uplands; formed under grass in weathered reddish clay, shale, and sandstone

This association, one of the most extensive in the county, occupies broad areas, mainly in the western half of the county, and makes up 15 percent of the total acreage.

The deep, permeable, well-drained Zaneis and Chickasha soils cover about half of the association. The rest of the association is made up of the Lucien-Zaneis-Vernon complex and a few areas of Rough broken land.

The soils in this association are nearly level to strongly sloping. The Chickasha soils occupy all the nearly level areas. They also occur with the Zaneis soils on the gentle and moderate slopes. A few areas of Chickasha and Zaneis soils are strongly sloping. The very shallow and shallow Lucien and Vernon soils and the moderately deep and deep Zaneis soils are strongly sloping. The general pattern of soils in this association is shown in figure 5.

The Lucien soils are underlain by sandstone, and the Vernon soils by clay. The Zaneis soils have a redder and less silty subsoil than the Chickasha soils.

The Zaneis and Chickasha soils are moderately high in productivity, and they respond to fertilization. Many areas once cultivated are now in improved pasture or have been reseeded to native grasses. The Lucien and Vernon soils are not suited to cultivation, but under good management they will produce moderate to good yields of native grasses.

Large areas of this association are suited to cultivation. The farms range from 160 to 320 acres in size. Because most farms include some arable and some nonarable soils, diversified farming is common.

8. *Chickasha-slickspot-Vernon-Lucien association*

Deep to very shallow soils of the prairies; numerous very slowly permeable slickspot areas; formed in weathered sandstone, shale, and clay

The scattered areas of this soil association are in the southern and central parts of the county and together make up about 10 percent of its total acreage.

The gently sloping soils of the Chickasha-slickspot complex cover about two-thirds of the association. These soils formed in material weathered from sandstone, clay, and shale, under a cover of mid, tall, and short grasses. The rest of the association is made up of the shallow Lucien and Vernon soils and the deep Zaneis soils, which are on the steeper slopes and along drainageways. The general pattern of soils in this association is shown in figure 5.

The Chickasha soils are deep, permeable, and productive. The slickspot soils that occur with them are deep and have a clayey, very slowly permeable subsoil. The slickspots are droughty and saline. They are easily recognized because of the difference in the kind and amount of vegetation.

Because the productivity of the slickspot soil is low, the Chickasha-slickspot complex is best suited to permanent grass. The slickspot areas produce a sparse cover of mid and short grasses and annual weeds. The Chickasha soils produce a good stand of mid and tall grasses. If grazing is properly managed, native grasses grow well on the Lucien, Vernon, and Zaneis soils.

Farms in this association range from 80 to 2,000 acres in size. On most of the farms, beef cattle have replaced cultivated crops as the main product. Many acres once cultivated are now in low-quality pasture.

Descriptions of the Soils

In this section the soil series and mapping units of Stephens County are described and the relationship of the soils to agriculture is given. Some of the characteristics that are important when classifying the soils for agricultural use are color, depth, and slope.

The color of the soil usually is related to the organic-matter content. A dark-colored surface layer is usually an indication of high organic-matter content. Streaks and spots of gray, yellow, and brown in the lower layers generally indicate poor drainage and poor aeration. The colors given in this report refer to the color of the dry soil.

Depth is a factor to be considered when determining the suitability of a soil for a specific use. It affects the water-holding capacity of the soil and determines the root zone, and thus affects the type of vegetation. Soils in this county are classified as deep (30 inches or more); moderately deep (20 to 30 inches); shallow (10 to 20 inches); and very shallow (10 inches or less).

Slope is expressed in descriptive terms or as a percentage that expresses the amount of rise or fall in 100 feet of horizontal distance. Descriptive terms applied to the soils of this county are level or nearly level (0 to 1 percent slopes); gently sloping (1 to 3 percent slopes); moderately sloping (3 to 5 percent slopes); strongly sloping (5 to 8 percent slopes) and steep (8 percent or more). Surface runoff and erosion are directly affected by slope.

Other characteristics considered in classifying the soils are the presence of gravel or stones in amounts that will interfere with cultivation; the degree of erosion; and the acidity or alkalinity of the soil as measured by chemical tests.

A more technical description of each soil series is included in the section "Genesis, Classification, and Morphology of the Soils." Information on the use and management of each soil is given in the section "Use and Management of the Soils." Technical terms used in the soil descriptions are defined in the Glossary.

The location and distribution of the individual soils are shown on the detailed map at the back of this report. The approximate acreage and proportionate extent of the soils are given in table 1.

Bethany Series

The Bethany series consists of deep soils formed in calcareous clay and weathered shale, under a cover of grass. These soils of the uplands are in the northeastern part of the county, near Hat Top Mountain.

A soil of the Bethany series has a surface layer of dark grayish-brown, friable, granular silt loam. This layer is about 10 inches thick, and it is generally less gray in the lower 5 inches. It grades to the subsoil, which in the upper 6 to 10 inches is brown, friable, subangular blocky or granular light silty clay loam. The lower subsoil is yellowish-brown, firm, blocky clay. The substratum is yellowish-brown, calcareous clay or weathered clayey shale.

These soils take water readily in the uppermost 14 to 22 inches but are slowly to very slowly permeable in the

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

Soil	Acres	Percent
Bethany-slickspot complex	5, 002	0. 9
Breaks-alluvial land complex	24, 640	4. 3
Chickasha fine sandy loam, 0 to 1 percent slopes	920	. 2
Chickasha fine sandy loam, 1 to 3 percent slopes	9, 117	1. 6
Chickasha fine sandy loam, 3 to 5 percent slopes	1, 595	. 3
Chickasha loam, 0 to 1 percent slopes	1, 947	. 3
Chickasha loam, 1 to 3 percent slopes	13, 803	2. 4
Chickasha loam, 3 to 5 percent slopes	4, 172	. 7
Chickasha loam, 5 to 8 percent slopes	1, 788	. 3
Chickasha-slickspot complex	48, 025	8. 4
Clayey saline alluvial land	3, 360	. 6
Dougherty loamy fine sand, hummocky	4, 838	.9
Dougherty loamy fine sand, undulating	1, 538	. 3
Dougherty soils, 1 to 5 percent slopes, eroded	342	. 1
Eroded clayey land	5, 490	1. 0
Eroded loamy land	9, 326	1. 6
Eufaula fine sand, hummocky	506	. 1
Gowen clay loam	2, 808	. 5
Gravel pits	112	(1)
Kipp-Kipson complex	14, 748	2. 6
Kirkland-Renfrow silt loams, 1 to 3 percent slopes	24, 252	4. 2
Kirkland silt loam, 0 to 1 percent slopes	7, 948	1. 4
Lucien-Zaneis-Vernon complex	39, 922	7. 0
Miller clay	993	. 2
Miller soils, frequently flooded	2, 414	. 4
Nash fine sandy loam, 1 to 3 percent slopes	1, 394	. 2
Nash and Noble fine sandy loams, 3 to 5 percent slopes	3, 024	. 5
Nash and Noble fine sandy loams, 5 to 8 percent slopes	5, 428	1. 0
Oil waste land	1, 138	. 2
Port clay loam	2, 648	. 5
Port fine sandy loam	19, 346	3. 4
Port loam	20, 237	3. 5
Port soils, frequently flooded	13, 944	2. 4
Renfrow and Kirkland soils, 1 to 5 percent slopes, eroded	4, 954	. 9
Renfrow silt loam, 3 to 5 percent slopes	3, 358	. 6
Rough broken land, clayey	5, 962	1. 0
Rough broken land, sandy	28, 150	4. 9
Sandy alluvial land	294	. 1
Stephenville and Windthorst soils, severely eroded	24, 822	4. 3
Stephenville-Darnell complex, 5 to 12 percent slopes	42, 454	7. 4
Stephenville fine sandy loam, 1 to 3 percent slopes	19, 254	3. 4
Stephenville fine sandy loam, 3 to 5 percent slopes	51, 494	9. 0
Stephenville fine sandy loam, 3 to 5 percent slopes, eroded	10, 366	1. 8
Stephenville fine sandy loam, 5 to 8 percent slopes	23, 282	4. 1
Windthorst-Darnell complex	5, 198	. 9
Windthorst fine sandy loam, 1 to 5 percent slopes	17, 368	3. 0
Windthorst fine sandy loam, 1 to 5 percent slopes, eroded	3, 028	. 5
Zaneis loam, 1 to 3 percent slopes	3, 193	. 6
Zaneis loam, 3 to 5 percent slopes	11, 072	1. 9
Zaneis loam, 3 to 5 percent slopes, eroded	3, 996	. 7
Zaneis loam, 5 to 8 percent slopes	14, 150	2. 5
Lakes	2, 360	. 4
Total	571, 520	100. 0

[1] Less than 0.1 percent.

more clayey part of the subsoil. They are noncalcareous to a depth of 30 to 36 inches but ordinarily are calcareous below a depth of 36 inches. The reaction is neutral or mildly alkaline. Erosion damage has been no more than slight, except in small spots.

The Bethany soils are closely associated with the Kipp and Kipson soils, both of which are shallower and grayer.

Bethany-slickspot complex (1 to 4 percent slopes) (Bc).—This complex consists of areas in which the Bethany and slickspot soils are so intricately mixed that it is impractical to show them separately on the soil map. About 50 percent of this mapping unit consists of Bethany soil, 25 percent of a slickspot soil, 20 percent of a soil having characteristics intermediate between those of the Bethany soil and the slickspot soil, and 5 percent of Chickasha and Renfrow soils.

The Bethany soil has a profile like the one described as representative of the Bethany series. The slickspot soil is like that described as part of the Chickasha-slickspot complex. The intermediate soil has an abrupt boundary between the surface layer and the subsoil but is less affected by salts than the slickspot soil.

In areas used for range, the slickspot soil can easily be distinguished from the Bethany soil by the type of vegetation (fig. 6).

***Figure 6.*—Contrasting vegetation on Bethany-slickspot complex. Bethany soil produces good growth of mid and tall grasses. Short grasses are dominant on the slickspots.**

Soils of this complex are used mostly for range. A few areas are used for small grain or sorghum. Yields are moderately good in years when rainfall is adequate.

For reseeding range, a mixture of short, mid, and tall grasses is suitable. King Ranch bluestem and Caucasian bluestem are suitable introduced grasses. (Capability unit IVe-3; Bethany soil is in Loamy Prairie range site, and slickspot soil is in Slickspot range site)

Breaks-Alluvial Land Complex (Ba)

This complex occurs in narrow drainageways; it is on the steep side slopes and in areas of mixed alluvial land on the narrow bottom lands. The drainageways are 125 to 250 feet wide and 15 to 50 feet deep. The side slopes have a gradient of 8 to 25 percent. In some areas vertical banks of exposed soil material border the deeply entrenched streams.

The texture of the soil material on the side slopes range from fine sandy loam to clay. The soil material is calcareous in some places. Outcrops of sandstone and shale

are common. The layer of soil material is thinnest on the outer rim of the slopes.

Alluvial land makes up about 20 percent of the acreage of the complex, and from 5 to 40 percent of individual areas. The bottom lands are 10 to 100 feet wide. The soil material ordinarily is stratified, and the layers differ in color, texture, and reaction. The texture ranges from fine sandy loam to clay loam.

The vegetation consists of short, mid, and tall grasses. Deciduous trees grow where the soil material is loamy.

Because this land type is so varied it does not have a range site classification. It is generally included in the same range sites as the adjoining areas. (Capability unit VIe–5)

Chickasha Series

The Chickasha series consists of deep soils formed in sandstone, shale, and sandy earths under a cover of grass. These soils of the uplands are extensive in the western half of the county.

A soil of the Chickasha series has an 8- to 14-inch surface layer of brown, friable, granular loam or fine sandy loam. This layer grades to a subsoil of yellowish-brown, friable, weak to moderate, subangular blocky clay loam or sandy clay loam. Small, black iron-manganese concretions are common below a depth of 20 inches. The substratum, beginning at a depth of 30 to 55 inches, is reddish-yellow, partly weathered red-bed material of sandy clay loam texture and is strongly mottled with pale yellow or yellowish red. At a greater depth, the red-bed material grades to sandstone, sandy shale, or sandy earths.

These soils take water well and are moderately permeable. The reaction is slightly acid. Some areas are severely eroded; others are only slightly eroded.

The Chickasha soils are easy to work and are among the most productive soils in the county. Crops respond to good management.

The Chickasha soils occur with the Renfrow, Kirkland, Zaneis, and Nash soils. Their subsoil is less clayey than that of the Kirkland and Renfrow soils but more clayey than that of the Nash soils. It is browner, less silty, and more acid than the subsoil of the Zaneis soils.

Chickasha fine sandy loam, 0 to 1 percent slopes (CaA).—This soil is susceptible to wind erosion. The profile is like the one described as representative of the series. About 10 percent of this mapping unit is made up of Zaneis fine sandy loam.

The principal crops are small grain, cotton, sorghum, and peanuts. Watermelons are grown in the northern part of the county. Bermudagrass, weeping lovegrass, and mid and tall native grasses are well suited. (Capability unit IIe–1; Loamy Prairie range site)

Chickasha fine sandy loam, 1 to 3 percent slopes (CaB).—This soil is susceptible to wind and water erosion. About 10 percent of the areas mapped consists of Zaneis fine sandy loam. Small areas of Nash fine sandy loam are also included.

This soil is suited to most crops commonly grown in the county. It is used extensively for cultivated crops. Crops respond to fertilizer and other good management practices. (Capability unit IIe–2; Loamy Prairie range site)

Chickasha fine sandy loam, 3 to 5 percent slopes (CaC).—This soil is susceptible to both wind and water erosion. It takes in and stores less water than Chickasha fine sandy loam, 0 to 1 percent slopes.

This soil occurs mostly in the north-central part of the county. It is associated with and includes small areas of Nash fine sandy loam. About 10 percent of the mapping unit consists of Zaneis fine sandy loam.

This soil is used for cultivated crops and tame or native pasture. (Capability unit IIIe–4; Loamy Prairie range site)

Chickasha loam, 0 to 1 percent slopes (ChA).—This soil is susceptible to wind erosion. The profile is like the one described as representative of the series. The organic-matter content is generally higher than that of Chickasha fine sandy loam.

Management practices that help to control wind erosion include returning all residues to the soil and growing a cover crop after cotton or after sorghum grown for silage.

Small grain, sorghum, and cotton are the principal crops grown on this soil. (Capability unit I–3; Loamy Prairie range site)

Chickasha loam, 1 to 3 percent slopes (ChB).—This is the most extensive of the Chickasha loams in this county. The profile is like the one described as representative of the series.

Included in the areas mapped are small areas of Zaneis loam, 1 to 3 percent slopes, and a few slickspots.

Most of the acreage is cultivated. If row crops are grown, terracing and contour farming are needed to help control erosion. (Capability unit IIe–3; Loamy Prairie range site)

Chickasha loam, 3 to 5 percent slopes (ChC).—Because this soil has a slightly thinner profile than Chickasha loam, 1 to 3 percent slopes, it has somewhat less moisture-supplying capacity. It is highly susceptible to water erosion and needs protection that will prevent severe gullying.

Included in the areas mapped are some areas of Zaneis loam and a few slickspots. About 5 percent of the mapping unit consists of Zaneis loam.

Most of the acreage is used for native range. (Capability unit IIIe–2; Loamy Prairie range site)

Chickasha loam, 5 to 8 percent slopes (ChD).—This strongly sloping soil is susceptible to water erosion. The depth to the parent material is 30 inches or more.

This soil is associated with the Kipp, Kipson, Lucien, Vernon, and Zaneis soils. Included in the areas mapped are small areas of Vernon, Lucien, Kipp, and Kipson soils. Most of the acreage is used for native range. (Capability unit IVe–4; Loamy Prairie range site)

Chickasha-slickspot complex (1 to 3 percent slopes) (Ck).—This complex consists of areas in which Chickasha and slickspot soils are so intricately mixed that it is impractical to show them separately on the soil map. It occurs mainly in the south-central part of the county.

About 50 percent of this mapping unit consists of a Chickasha soil, 30 percent of a slickspot soil, and 20 percent of a soil having characteristics intermediate between those of the Chickasha soil and the slickspot soil.

The Chickasha soil has a profile like the one described as representative of the Chickasha series. The intermediate soil is less affected by salts than the slickspot soil.

The slickspot soil has a 5- to 12-inch surface layer of

dark grayish brown or brown, very friable, granular fine sandy loam to loam. The boundary between the surface layer and the subsoil is abrupt. The uppermost 4 to 6 inches of the subsoil is brown, compact, columnar clay that breaks to coarse blocks. The blocks and columns have dark grayish-brown coatings. The lower part of the subsoil is brown or yellowish-brown, compact, blocky clay. The substratum is yellowish-brown clay loam to clay with streaks of red soft sandstone and shale and seams of salt crystals.

Some areas of the slickspot soil are so severely eroded that tillage will turn up some of the subsoil. In some places the surface layer is crusted. Runoff is rapid and internal drainage is very slow in these areas.

Soils of this complex are now used mostly for range. Some areas are used to grow sorghum and small grain. Yields are moderate in years of adequate rainfall.

The Chickasha soil is best suited to mid and tall native grasses. The slickspot areas are best suited to short grasses. King Ranch bluestem and Caucasian bluestem can be grown on these soils. (Capability unit IVe–3; Chickasha soil is in Loamy Prairie range site, and slickspot soil is in Slickspot range site)

Clayey Saline Alluvial Land (Cs)

This miscellaneous land type is on nearly level flood plains. It is about 15 percent clayey Port soils, 30 percent clayey saline soils, and 55 percent a soil having characteristics intermediate between those of the Port soil and the saline soil. These soils form an irregular pattern and commonly occur within a small area.

The Port soil has a profile like the one described as representative of Port clay loam.

The saline soil has a crusted surface layer of clay loam or clay that is platy in the uppermost 6 inches. The subsoil is clay. Streaks and blotches of salt occur all through the profile. Runoff and internal drainage are very slow. Areas of this soil range up to 1 acre in size. They are almost barren of vegetation.

The texture of the intermediate soil is clay loam or clay, predominantly clay. The surface cracks in dry weather. Runoff and internal drainage are very slow. In places there are streaks of salt. The vegetation consists of alkali sacaton, western wheatgrass, broomweed, and a few mesquite trees.

Most of the acreage is flooded frequently. Erosion and scouring have done only slight damage.

This land type is not suited to cultivation, even if protected from floods. It is low in productivity and is suited to only a few kinds of crops. (Capability unit Vs–1; Alkali Bottom Land range site)

Darnell Series

The Darnell series consists of shallow to very shallow soils formed, under timber, in material weathered from noncalcareous sandstone. In this county, Darnell soils are mapped only in complexes with the Stephenville soils and the Windthorst soils.

A soil of the Darnell series has a 4- to 20-inch surface layer of slightly acid, friable fine sandy loam. The upper half of this layer is grayish brown, and the lower part is brown to very pale brown. Directly under this layer is yellowish-red to brown, noncalcareous sandstone. Outcrops of hard sandstone are common.

These soils are somewhat droughty. Runoff is rapid, but erosion damage has been no more than slight. The vegetation consists of post oak and blackjack oak and mid and tall native grasses.

The Darnell soils are associated with the Stephenville and Windthorst soils, both of which are deeper and have a more clayey subsoil.

Dougherty Series

The Dougherty series consists of deep, slightly acid soils of the uplands. They formed in sandy alluvium under timber. These soils are inextensive but occur throughout the county.

A soil of the Dougherty series has a 4- to 7-inch surface layer of grayish brown to brown, weak granular or single-grain loamy fine sand, over a 9- to 24-inch layer of pale-brown, weak granular or single-grain loamy fine sand. The subsoil is yellowish-red to reddish-yellow, friable, moderately permeable sandy clay loam. The parent material, which is at a depth of 36 to 55 inches, consists of yellowish-red to brownish-yellow old sandy alluvium that ranges in texture from fine sandy loam to sand.

In some cultivated areas the dark-colored and the light-colored parts of the surface layer have become so mixed that the original colors are no longer evident.

These soils take water readily and are permeable. They are highly susceptible to both wind and water erosion and have been slightly to moderately damaged by erosion. Wind erosion is especially likely to be damaging in winter and early in spring. The reaction is slightly acid.

The Dougherty soils are closely associated with the Eufaula soils, which are more sandy in the subsoil, and with the Stephenville soils, which are less sandy in the surface layer.

Dougherty loamy fine sand, hummocky (DoC).—This soil occurs as mounds and narrow ridges, 5 to 25 feet high. The slopes are short and irregular. The profile is like the one described as representative of the Dougherty series. This soil is low in organic-matter content. It is best suited to grasses, but it can be cultivated safely if properly managed. It is used mostly for woodland pasture, but a few areas are used for sorghum or small grain. (Capability unit IVe–6; Deep Sand Savannah range site)

Dougherty loamy fine sand, undulating (DoB).—This soil occurs as mounds 1 to 5 feet high, and as small, nearly level areas between mounds. The slopes are short and irregular. The profile is like the one described as representative of the Dougherty series.

This soil takes water readily. It is highly susceptible to wind erosion and needs to be protected with crop residues and winter cover crops. The organic-matter content is low. Winter cover crops and green-manure crops add organic matter and also improve the soil structure.

Most of this soil has been cleared and cultivated at some time, but most of the acreage is now used for pasture of weeping lovegrass or mid and tall native grasses. A small acreage is used for small grain, peanuts, cotton, and sorghum. (Capability unit IIIe–5; Deep Sand Savannah range site)

Dougherty soils, 1 to 5 percent slopes, eroded (DuB2).—These soils have been damaged by both wind and water

erosion, mainly by wind erosion. Soil material has been blown from some areas and has accumulated in adjacent areas, principally between the mounds. In some spots, the present surface layer is only 3 to 5 inches thick. In some, the subsoil has been mixed with the remnants of the surface layer, and in these the texture of the present surface layer is light sandy clay loam. Some rills and gullies have formed as a result of water erosion.

These soils are best suited to grass, but under good management they can be cultivated. Most of the acreage is used for pasture. Some areas have been seeded to tame or native grasses. (Capability unit IVe–6; Deep Sand Savannah range site)

Eroded Clayey Land (Es)

This miscellaneous land type occurs as small areas, mainly in the western two-thirds of the county. It is made up of severely eroded Kirkland, Renfrow, Vernon, Chickasha, and Bethany soils, and slickspots. All of these soils have a clayey subsoil. The slope range is 1 to 5 percent.

All or nearly all of the surface layer has been lost through erosion. Most of the soil loss has resulted from sheet erosion, but some gullies have formed. Wind erosion has done only minor damage.

These areas are not suited to cultivated crops, but they can be tilled enough to be seeded to grasses. King Ranch bluestem and Caucasian bluestem grow well. Buffalograss and the grama grasses are the best suited native grasses. (Capability unit VIe–1; Eroded Clay range site)

Eroded Loamy Land (Et)

This land type occurs mainly in the western two-thirds of the county. It is made up of severely eroded Chickasha, Lucien, Nash, Noble, and Zaneis soils. All of these soils have a subsoil of sandy loam, loam, or clay loam. The slope range is 1 to 8 percent. All or nearly all of the original surface layer has been lost through erosion, principally water erosion, and deep gullies are common.

These areas are not suited to cultivated crops, but they can be tilled enough to be seeded to grasses. Weeping lovegrass, King Ranch bluestem, and Caucasian bluestem are suitable. Native grasses that are well suited include big bluestem, little bluestem, Indiangrass, and switchgrass. (Capability unit VIe–2; Loamy Prairie range site)

Eufaula Series

The Eufaula series consists of deep, very sandy soils of the uplands. These soils formed under timber.

A soil of the Eufaula series has a 3- to 10-inch surface layer of dark grayish-brown to brown, loose fine sand. This layer grades to a 25- to 35-inch layer of light-brown to light yellowish-brown, loose fine sand. Below this layer, red streaks of loamy fine sand, ⅛ to ¼ inch thick, are common.

These soils take water readily but are droughty because of their rapidly permeable subsoil. Erosion has done only minor damage. The reaction is commonly slightly acid or medium acid.

The Eufaula soils are closely associated with the Doughty and Stephenville soils, both of which are less sandy throughout the profile.

Eufaula fine sand, hummocky (EuC).—This is the only Eufaula soil mapped in the county. The profile is like the one described as representative of the series. This soil occurs as mounds and long, narrow ridges, 10 to 25 feet high. The slopes are short and irregular. In some places the ridges are parallel to stream channels and are bordered on both sides by soils of the bottom lands.

This soil is used mostly for woodland range. It is not suited to cultivation. (Capability unit VIs–1; Deep Sand Savannah range site)

Gowen Series

The Gowen series consists of dark, loamy soils of the bottom lands. These soils consist of sediments washed from the Kipp, Kipson, and Bethany soils in the northeastern part of the county.

A soil of the Gowen series has a 5- to 20-inch surface layer of grayish-brown, friable, granular or subangular blocky clay loam, over layers of dark-gray to brown clay loam and silty clay loam. In some places there are layers of light silty clay below a depth of about 36 inches. Faint mottles are common below a depth of 36 inches.

These soils are neutral or mildly alkaline, but they are noncalcareous to a depth of 36 to 48 inches. In some places they are calcareous below a depth of 48 inches. Permeability is moderately slow. Scouring and erosion have caused very little damage.

The Gowen soils are associated with the Port soils. They are grayer than the Port soils.

Gowen clay loam (Go).—This soil is on nearly level flood plains. It is the only Gowen soil mapped in the county. The profile is like the one described for the series.

Included in the areas mapped are spots in which the surface layer is loam or fine sandy loam. Also included are some areas that have a calcareous overwash.

Large areas of this soil are cultivated. Some areas are flooded, but not often enough to prevent their use for crops. Crops respond to fertilization and to other good management practices.

Small grain, alfalfa, sorghum, and broomcorn are the main crops. A few areas are used as woodland pasture or bermudagrass pasture. (Capability unit I–1; Loamy Bottom Land range site)

Gravel Pits

These pits are areas from which material has been removed to be used in construction or for other purposes. They range from 1 to about 10 acres in size. They are bare of vegetation and are not suited to agricultural use. They are indicated on the detailed soil map by gravel-pit symbols. (Capability unit VIIIs–1)

Kipp Series

The Kipp series consists of dark-colored, moderately deep soils formed in material weathered from siltstone and calcareous gray shale, under a cover of grass. These soils of the uplands are in the northeastern part of the county, near Hat Top Mountain. They are mapped in a complex with the Kipson soils.

A soil of the Kipp series has a 5- to 12-inch surface layer of grayish-brown, friable, granular silt loam. It grades to the subsoil, which in the upper part is grayish-brown, friable, subangular blocky silty clay loam or clay loam. The lower 5 inches of the subsoil is calcareous and is olive or olive brown in color. The substratum begins at a depth of 24 inches. It is shale or weathered shale of clay loam or silty clay loam texture interbedded in places with siltstone.

These soils take water moderately well. Permeability is moderately slow. Surface runoff is rapid on some of the steeper slopes. The uppermost 20 inches is neutral but noncalcareous, and the material below a depth of 20 inches generally is calcareous and contains lime concretions. Because these soils have not been cultivated they have been damaged very little by erosion.

The Kipp soils occur with the Kipson soils, which are shallower and less developed, and with the Bethany soils, which are deeper and have a more clayey subsoil.

Kipp-Kipson complex (5 to 10 percent slopes) (Kk).—This complex is about 30 percent Kipp soils, 25 percent Kipson soils, and 30 percent a soil having characteristics intermediate between those of the Kipp soil and the Kipson soil. The remaining 15 percent consists of Vernon soils and soils that resemble the Lucien soils. These two soils formed in nonreddish parent material.

The Kipp and Kipson soils have profiles like the ones described as representative of the Kipp and Kipson series. The intermediate soil is deeper than the Kipson soils, and it lacks the developed subsoil of the Kipp soils. The texture is loam, silt loam, or clay loam to a depth of 20 to 30 inches. The substratum is weathered siltstone, sandstone, and interbedded shale.

In some areas soils of this complex are calcareous throughout. They are used for range and produce good yields of mid and tall native grasses. (Capability unit VIs–3; Loamy Prairie range site)

Kipson Series

The Kipson series consists of shallow to very shallow, grayish soils of the uplands. These soils formed in material weathered from interbedded sandstone, siltstone, and calcareous shale, under a cover of grass. Kipson soils occur in the northeastern part of Stephens County. They are mapped in a complex with Kipp soils.

A soil of the Kipson series has a 4- to 12-inch surface layer of grayish-brown, friable, granular silt loam or loam. The substratum is weathered or unweathered gray silty shale, grading to interbedded sandstone, siltstone, and shale. Chips of shale are common on or near the surface.

These soils are calcareous throughout. Permeability is moderate, but the water-holding capacity is limited because of the shallow profile. Erosion damage has been no more than slight.

The Kipson soils are associated with the Kipp soils, which are deeper and better developed, and with the Bethany soils, which are deeper.

Kirkland Series

The Kirkland series consists of deep soils formed in beds of red clay, under a cover of grass. These soils of the uplands are in the western half of the county.

A soil of the Kirkland series has an 8- to 14-inch surface layer of dark grayish-brown or dark-brown, friable, granular silt loam. This layer grades abruptly to the subsoil, which is dark grayish-brown or dark-brown, compact, blocky clay. The subsoil grades indistinctly to a layer of dark grayish-brown, yellowish-brown, or yellowish-red, compact, massive clay.

These soils take water readily until the surface layer becomes saturated; then the intake of water is slow because of the very slowly permeable subsoil. Runoff is rapid during heavy rains. The surface layer and subsoil are slightly acid or neutral. The substratum is mildly alkaline to moderately alkaline. Calcium carbonate concretions occur below a depth of 38 inches.

The Kirkland soils occur with the Renfrow soils, which are redder and have a clay loam layer in the upper part of the subsoil, and with the Zaneis and Chickasha soils, which are more clayey and grayer in the subsoil.

Kirkland-Renfrow silt loams, 1 to 3 percent slopes (KrB).—This complex consists of areas in which the Kirkland and Renfrow soils are so intricately mixed that it is impractical to show them separately on the soil map. It is about 60 to 70 percent Kirkland silt loam and 30 to 40 percent Renfrow silt loam.

The profiles of the two soils are very much like those described as representative of the series.

Because of the slope and the very slowly permeable subsoil, these soils are subject to water erosion. Sheet erosion is most common, but some gullies and rills have formed. A few slickspots occur, principally where the surface layer has been thinned by erosion.

Soils of this complex are used mostly for small grain. A few areas are used for cotton and sorghum. Yields are good during years of adequate rainfall. (Capability unit IIIe–1; Claypan Prairie range site)

Kirkland silt loam, 0 to 1 percent slopes (KnA).—The profile of this soil is like the one described as representative of the series. Surface runoff is generally adequate, but there are some small depressions in which water stands for short periods after heavy rains.

Small grain is the principal crop. Some cotton and sorghum are grown. (Capability unit IIs–1; Claypan Prairie range site)

Lucien Series

The Lucien series consists of shallow to very shallow soils of the uplands. These soils formed under a cover of grass in material weathered from sandstone and sandy shale. In this county the Lucien soils are mapped only in a complex with the Zaneis and Vernon soils.

A soil of the Lucien series has a 5- to 15-inch surface layer of brown or reddish-brown, friable, granular fine sandy loam or loam. This layer is directly over the substratum, which consists of red and gray sandstone interbedded with shale and clay. The boundary between the surface layer and the substratum is clear.

These soils are generally slightly acid or neutral throughout. In some places the substratum is calcareous in the seams. Surface runoff is moderate to rapid, and internal drainage is moderate.

The Lucien soils are closely associated with the Vernon soils, which are more clayey and more calcareous, and with the Zaneis soils, which are deeper and more clayey.

Lucien-Zaneis-Vernon complex (5 to 10 percent slopes) (Lz).—This complex is about 25 percent Lucien soils, 20 percent Zaneis soils, and 15 percent Vernon soils. The remaining 40 percent consists of shallow Zaneis soils, 20 to 24 inches thick over the parent material; shallow soils, 20 to 25 inches thick over the parent material, that resemble Lucien soils; very shallow Vernon soils, only 2 to 3 inches thick over the parent material; and small inclusions of Renfrow and Noble soils.

The Lucien soil has a profile like the one described as representative of the series. Profiles that are typical of the Zaneis and Vernon soils are described under the Zaneis and Vernon series.

These soils are not suited to cultivated crops. The Lucien and Zaneis soils are well suited to big bluestem, little bluestem, switchgrass, and Indiangrass. The Vernon soils are best suited to buffalograss and the grama grasses. (Capability unit VIs–2; Lucien soil is in Shallow Prairie range site, Zaneis soil is in the Loamy Prairie range site, and Vernon soil is in the Red Clay Prairie range site)

Miller Series

The Miller series consists of calcareous, clayey soils of the bottom lands. These soils consist of clayey alluvial sediments washed from the Kirkland, Renfrow, Vernon, and Zaneis soils. They occur in the southwestern part of the county, along Big Beaver Creek, and in the east-central part of the county, along Wildhorse Creek.

A soil of the Miller series has a 10-inch surface layer of reddish-brown to brown, granular to weak subangular blocky clay, over a layer of reddish-brown to dusky red, massive red clay that extends to a depth of more than 5 feet. The surface layer is very firm when moist and very hard when dry.

In some places the profile contains layers that range from clay loam to silty clay in texture and from dark grayish brown to red in color.

These soils have been damaged very little by erosion and scouring. The surface layer is neutral to moderately alkaline. The profile below the surface layer is moderately alkaline. Surface runoff and internal drainage are very slow. Wetness sometimes prevents the establishment of good stands of spring-planted crops, and ponded water sometimes damages established stands of alfalfa.

The Miller soils are closely associated with the Port soils, which are more loamy.

Miller clay (Mr).—This soil is on nearly level flood plains and in slight depressions. The profile is like the one described as representative of the series. Included in the areas mapped are small areas that have a loam surface layer up to 5 inches thick and small areas that are dark brown or very dark grayish brown throughout the profile.

Levees or other flood prevention structures protect most areas from floods, but wetness limits the use of this soil for cultivated crops. Cotton, sorghum, and small grain are the principal crops grown. Virginia wildrye, buffalograss, and Texas wintergrass are the principal grasses. (Capability unit IIIw–1; Heavy Bottom Land range site)

Miller soils, frequently flooded (Ms).—The profile of this soil is similar to the one described as representative of the Miller series but is more highly stratified near the surface. Included in the areas mapped are small areas that have a loam surface layer up to 5 inches thick, and small areas that are dark brown or very dark grayish brown throughout the profile.

This soil is so frequently flooded it is not suited to cultivated crops. Most of the acreage is used for spring and summer pasture, but a small acreage is planted to small grain to be used primarily for winter pasture. (Capability unit Vw–1; Heavy Bottom Land range site)

Nash Series

The Nash series consists of moderately deep or deep soils formed in soft, red sandstone. These soils of the uplands are in the north-central part of the county. The largest areas are east and north of Marlow.

A soil of the Nash series has a surface layer of yellowish-red to brown, very friable, granular fine sandy loam about 6 inches thick. It grades to the 14- to 30-inch subsoil, which is yellowish-red to red, friable, granular or massive fine sandy loam that contains small fragments of very soft, red sandstone.

In cultivated areas, the surface layer is yellowish red in color and the structure is massive.

The Nash soils are moderately productive. They respond to good management. Crops respond to fertilizer.

These soils are slightly acid or neutral throughout. They have been damaged by wind and water erosion, particularly by water erosion. Some areas are severely eroded, but others are only sligthly eroded.

The Nash soils occur with the Chickasha, Zaneis, and Noble soils. They are redder and more sandy in the subsoil than the Chickasha soils. They are shallower than the Noble soils and less clayey in the subsoil than the Zaneis soils.

Some areas of the Nash soils in Stephens County are mapped with the Noble soils in undifferentiated units.

Nash fine sandy loam, 1 to 3 percent slopes (NaB).—This soil has a profile very much like the one described as representative of the Nash series. In some cultivated areas soft sandstone fragments have been brought to the surface by deep tillage or have been exposed by erosion. These fragments are so soft that they readily break down to soil material.

Included in the areas mapped are small areas of Chickasha fine sandy loam and a deep, brown, granular, neutral soil that has a subsoil of friable, reddish-brown clay loam, and friable, loamy parent material. These soils have a more clayey subsoil than the Nash soils.

This soil requires management that includes control of both wind and water erosion.

Most of the acreage is in cultivation. Cotton, peanuts, broomcorn, small grain, sorghum, and watermelons are the main crops grown. (Capability unit IIe–2; Loamy Prairie range site)

Nash and Noble fine sandy loams, 3 to 5 percent slopes (NnC).—The soils in this undifferentiated group have profiles like those described as representative of the two series. Some areas consist entirely of Nash soils, others consist entirely of Noble soils, and others include some of both. East and north of Marlow are areas made up almost entirely of Nash soils, but also some that are as much as 20 percent Noble soils, which are on foot slopes near drainageways. In the northwestern part of the county are areas made up principally of Noble soils, but also some that are as much as 20 percent Nash soils.

In this part of the county, the Nash soils are on foot slopes, below areas of Vernon and Lucien soils or of Rough broken land.

These soils have been slightly damaged by wind and water erosion, particularly by water erosion. They are highly susceptible to gully erosion.

A large acreage is used to grow cotton, broomcorn, small grain, sorghum, and peanuts. These soils are well suited to weeping lovegrass, but mid and tall native grasses are most commonly grown. (Capability unit IIIe–3; Loamy Prairie range site)

Nash and Noble fine sandy loams, 5 to 8 percent slopes (NnD).—These soils are on strong slopes. They have profiles like those described as representative of the two series.

Included in the areas mapped are small areas of Vernon and Lucien soils. Most of these inclusions are within areas that are principally Noble soils.

These soils are highly susceptible to gully erosion. They are best suited to grass, but large areas have been cultivated. Areas made up principally of Noble soils are used for pasture. Some of the areas made up almost entirely of Nash soils are used to grow sorghum and small grain. (Capability unit IVe–4; Loamy Prairie range site)

Noble Series

The Noble series consists of deep, loamy soils that developed in alluvial soil material. These soils are on foot slopes.

A soil of the Noble series has a surface layer of reddish-brown to brown, very friable fine sandy loam. This layer is about 8 inches thick. It grades to the subsoil of reddish-brown, friable, granular loam or fine sandy loam that extends to a depth of 36 inches or more. The substratum is light clay loam or loam interbedded with weathered shale and sandstone.

These soils are moderately permeable. The reaction is slightly acid or neutral to a depth of 36 inches but is slightly acid to moderately alkaline below a depth of 36 inches.

The Noble soils are deeper than the Nash soils. They are less clayey in the subsoil than the Zaneis and Chickasha soils. They are redder than the Chickasha soils.

In this county, the Noble soils are mapped only in undifferentiated units with the Nash soils. These units are described under the heading "Nash Series."

Oil Waste Land (Ow)

Oil waste land is a miscellaneous land type consisting of slush pits and adjoining areas affected by waste material from oil wells. These areas range from 5 to 40 acres in size. They are not suited to agricultural use. They are practically barren of vegetation but many will probably revegetate naturally when waste material is no longer deposited. (Capability unit VIIIs–1)

Port Series

The Port series consists of brown or reddish-brown soils of the bottom lands. These soils consist of sediments washed from both timbered and grassland soils. They are the most extensive bottom-land soils in Stephens County.

The surface layer is clay loam, fine sandy loam, or loam. Permeability of the loam and fine sandy loam is moderate, and that of the clay loam is moderately slow. The surface layer is not commonly calcareous, but in many places the subsoil is calcareous below a depth of 24 to 36 inches.

The Port soils are easily managed and highly productive. Crops respond to fertilizer. The Port soils are closely associated with the Miller soils, which are more clayey, and with the Gowen soils, which are grayer.

Port clay loam (Po).—This soil is on nearly level flood plains. A representative profile has a 5- to 12-inch surface layer of brown to reddish-brown, friable, granular clay loam or silty clay loam, over a 10- to 25-inch layer of reddish-brown, friable to firm, subangular blocky clay loam. Below a depth of 24 to 36 inches is calcareous, reddish-brown clay loam.

In some places the profile, below about 30 inches, contains layers, 1 to 15 inches thick, that range from loam to silty clay in texture and from very dark grayish brown to yellowish red in color.

About 10 percent of the acreage mapped as Port clay loam has a loam surface layer up to 10 inches thick.

Large areas of this soil are cultivated. Some areas are flooded, but not often enough to prevent use for crops. Crops respond to good management. (Capability unit I–1; Loamy Bottom Land range site)

Port fine sandy loam (Pf).—This soil is on nearly level flood plains. The uppermost 10 to 30 inches is recent overwash of brown or yellowish-brown, friable fine sandy loam. Under this is brown or reddish-brown, friable, granular loam or silt loam. In some places the profile, below about 20 inches, contains layers of dark grayish-brown clay loam and sandy clay loam. About 5 percent of the acreage mapped is fine sandy loam to a depth of 48 inches or more.

The surface layer is generally noncalcareous. The reaction in the surface layer is slightly acid to mildly alkaline. In many places the soil is moderately alkaline at a depth of 20 to 30 inches.

Most of this soil is cultivated. It is suited to all locally grown crops. It is well suited to bermudagrass, johnsongrass, and native grasses. (Capability unit I–2; Loamy Bottom Land range site)

Port loam (Pr).—This soil is on nearly level flood plains. It has a 5- to 10-inch surface layer of brown to reddish-brown, granular loam underlain by reddish-brown granular loam or silt loam that contains grayish-brown and yellowish-red layers. Some of the layers are light clay loam or sandy clay loam.

This soil is slightly acid to mildly alkaline to a depth of 24 to 36 inches but ordinarily is moderately alkaline below a depth of 36 inches.

Included in the areas mapped are small areas of Port fine sandy loam and Port clay loam. The areas of Port fine sandy loam are usually near stream channels.

This soil is among the most productive and easily managed soils in the county. Most of the acreage is cultivated (fig. 7). Some areas are flooded infrequently—not often enough to prevent their use for crops. Crops respond to fertilizer. (Capability unit I–2; Loamy Bottom Land range site)

Figure 7.—**Grain sorghum growing on Port loam. This soil is among the most productive and easily managed soils in the county.**

Port soils, frequently flooded (Ps).—This mapping unit is on nearly level flood plains. It is made up of Port clay loam, Port loam, and Port fine sandy loam. Some areas are highly stratified because of recent deposits.

These soils are flooded often enough to limit their use for crops. Floods may occur at any time of the year but are most common in spring.

These soils are used mostly for pasture, but some areas are used to grow alfalfa or small grain. Alfalfa is damaged only slightly by floods, unless it has been cut and is still on the ground. Areas planted to small grain are used mainly for winter and spring pasture, but grain may be harvested in years when flooding is not severe. (Capability unit Vw–2; Loamy Bottom Land range site)

Renfrow Series

The Renfrow series consists of gently sloping and moderately sloping soils formed in clayey red beds, under a cover of grass. These soils of the uplands are in the western half of the county.

A soil of the Renfrow series has an 8- to 10-inch surface layer of dark brown or dark reddish-brown, friable, granular silt loam. This layer grades to a 2- to 4-inch layer of dark reddish-brown, friable clay loam. The next boundary is clear over a layer of compact, blocky clay that is reddish brown in the upper part and is redder in the lower part. The parent material, which is at a depth of 30 to 38 inches, is yellowish-red or red, calcareous, massive clay or clay and shale.

The reaction is slightly acid or neutral to a depth of 30 inches. These soils are mildly alkaline to moderately alkaline below a depth of 30 inches. There are calcium carbonate concretions below a depth of 30 to 38 inches. The very slowly permeable subsoil restricts the intake of water after the surface layer is saturated. Water erosion is a severe hazard during periods of excessive rainfall. Some areas are only slightly eroded, but others are moderately eroded or severely eroded.

The Renfrow soils occur with the Kirkland Zaneis, Vernon, and Lucien soils. They are redder than the Kirkland soils, and they are less clayey and more permeable in the upper part of the subsoil. The Renfrow soils are more clayey in the subsoil than the Zaneis soils. They are deeper than the Vernon and Lucien soils, and they are more clayey and more calcareous than the Lucien soils.

Renfrow and Kirkland soils, 1 to 5 percent slopes, eroded (RfB2).—This mapping unit consists of areas of Renfrow soils and of Kirkland soils so intermingled that it is impractical to show them separately on the soil map. Where the slope is 1 to 3 percent, about 60 percent of the acreage is Kirkland soils and about 40 percent is Renfrow soils. Where the slope is 3 to 5 percent, Renfrow soils predominate.

These soils have a thinner surface layer than the soils described as representative of the Renfrow and Kirkland series. They are eroded to the extent that on more than half of their acreage the surface layer is less than 5 inches thick. In some places subsoil is turned up during tillage. Sheet erosion is common, and there are some gullies and rills.

Small grain and sorghum are the principal cultivated crops. Yields are somewhat less on these soils than on the less eroded soils. (Capability unit IVe–2; Claypan Prairie range site)

Renfrow silt loam, 3 to 5 percent slopes (ReC).—This soil has a profile like the one described as representative of the series. Included in the areas mapped are small areas of Vernon and Zaneis soils and a few slickspots.

Large areas of this soil are used for range. Small grain is the principal crop. Controlling erosion, preserving structure, and maintaining fertility are the main management problems. (Capability unit IVe–1; Claypan Prairie range site)

Rough Broken Land, Clayey (Rg)

This stony and steep land type consists of interbedded yellowish-brown sandstone and calcareous, red and gray clay and shale. In some places unaltered soil material is exposed. Where the slopes are steepest, outcrops of sandstone make up 20 to 30 percent of the surface. The slope range is 15 to 40 percent.

Included in the areas mapped, on slopes of 8 to 15 percent, are small areas of Vernon and Lucien soils.

This land type is used only for range (fig. 8). Mid and tall grasses grow where the surface layer is thickest. Other areas are sparsely covered with weeds and short grasses. (Capability unit VIIs–2; Breaks range site)

Rough Broken Land, Sandy (Rs)

This land type occurs in drainageways within areas of the Stephenville and Windthorst soils. The drainageways are 125 to 250 feet wide and 15 to 50 feet deep.

Figure 8.—**Representative area of Rough broken land, a land type that provides only a moderate amount of grazing.**

The side slopes have a gradient of 12 to 25 percent. In some of the areas, vertical banks of exposed soil material border the deeply entrenched streams.

The texture of the soil material on the side slopes ranges from fine sandy loam to sandy clay. Outcrops of sandstone and shale are common.

The vegetation consists of post oak, blackjack oak, and mid and tall native grasses. (Capability unit VIIe–1; Sandy Savannah range site)

Sandy Alluvial Land (Sa)

This miscellaneous land type is on nearly level flood plains. It consists of 20 to 60 inches or more of loamy sand over loam or clay loam.

This land type is flooded frequently. Scouring has done only slight damage. Bermudagrass or deciduous bushes grow in some areas, but some areas are almost bare of vegetation.

Sandy alluvial land does not have a range site classification, but it can be managed in the same way as soils of the Loamy Bottom Land range site. (Capability unit Vw–3)

Stephenville Series

The Stephenville series consists of deep, moderately permeable soils that formed under timber in weathered and unweathered sandstone. These soils of the uplands occur as broad areas throughout the county.

A soil of the Stephenville series has a surface layer of weak granular, friable fine sandy loam. This layer is 8 to 14 inches thick. The uppermost 4 to 6 inches is very dark grayish brown to yellowish brown and is moderately high in organic-matter content. The lower 5 to 8 inches is brown to light yellowish brown and is low in organic-matter content. The surface layer grades to a subsoil of yellowish-red, friable, weak subangular blocky sandy clay loam. The subsoil grades to weathered or partly weathered sandstone at a depth of 30 to 55 inches.

In some cultivated areas, the light-colored layer in the lower part of the surface layer is no longer evident.

These soils are moderately low to low in natural fertility. The reaction ranges from medium acid to neutral but is most commonly slightly acid. These soils are subject to both wind and water erosion. Some areas are no more than slightly eroded, but others are moderately or severely eroded.

If well managed, these soils are moderately high in productivity. Crops respond to fertilizer.

The Stephenville soils are closely associated with the Windthorst, Dougherty, Eufaula, and Darnell soils. The Stephenville soils have a less red and less clayey subsoil than the Windthorst soils. Their surface layer is less sandy than that of the Dougherty soils, which developed in old alluvium. Stephenville soils are less sandy than the Eufaula soils and are deeper than the Darnell soils.

Stephenville and Windthorst soils, severely eroded (Sw3).—Some areas of this undifferentiated group of soils consist principally of eroded Windthorst soils, other areas consist principally of eroded Stephenville soils, and others include both. Where the slope is 1 to 5 percent, soils of either series, or of both, may occur. Where the slope is 5 to 8 percent, the Stephenville soils are dominant.

Wind and water have caused erosion damage. Water erosion has been the more damaging, particularly where the slope is more than 3 percent.

The Windthorst soils have lost most or all of their surface layer through erosion, and some gullies have formed. Gullies are common in areas of the Stephenville soils. In some of these areas the surface layer is 8 inches thick between the gullies, but the gullies are so numerous these areas cannot be cultivated. In other areas, little or no surface layer remains between the gullies.

These soils are not suited to cultivated crops, but all except the very severely gullied areas can be seeded to grasses. Weeping lovegrass, big bluestem, little bluestem, Indiangrass, and switchgrass are suitable. (Capability unit VIe–3; Sandy Savannah range site)

Stephenville-Darnell complex, 5 to 12 percent slopes (SdE).—This complex is about 45 to 70 percent Stephenville soil and 30 to 55 percent Darnell soil. The Darnell soil occurs as areas up to 4 acres in size, in such an irregular pattern that separating these areas from the surrounding Stephenville soil is impractical.

The Stephenville soil has a profile like the one described as representative of the Stephenville series, except that in some places the parent material is at a depth of as little as 24 inches. The Darnell soil is like that described as representative of the Darnell series.

Soils of this complex are used for woodland range. Because of the slope and the pattern in which the shallow to very shallow Darnell soil occurs, the entire complex is unsuitable for cultivated crops. The vegetation consists of oaks and mid and tall native grasses. (Capability unit VIe–4; Stephenville soil is in the Sandy Savannah range site, and Darnell soil is in the Shallow Savannah range site)

Stephenville fine sandy loam, 1 to 3 percent slopes (SbB).—This soil has a profile similar to the one described for the Stephenville series. The depth to the parent material is greater than in the more strongly sloping Stephenville soils.

Included in the areas mapped are small areas of Windthorst fine sandy loam.

The principal management requirements are controlling erosion and maintaining fertility.

Most of this soil has been cultivated, but large areas are now used as pasture, some improved and some unimproved. (Capability unit IIe–2; Sandy Savannah range site)

Stephenville fine sandy loam, 3 to 5 percent slopes (SbC).—This is the most extensive Stephenville soil in the county. Its profile is much like the one described as representative of the series.

Included in the areas mapped are small, scattered areas of Darnell soils.

Water erosion is more damaging than wind erosion. Controlling erosion, supplying organic matter, and maintaining fertility are the main management problems.

Much of this soil has been cultivated, but large areas are uncleared and are presently used as woodland range. Sorghum is the principal crop grown on the small acreage now in cultivation. The remaining acreage once cultivated is now used as pasture, some improved and some unimproved. (Capability unit IIIe–4; Sandy Savannah range site)

Stephenville fine sandy loam, 3 to 5 percent slopes, eroded (SbC2).—This soil has lost much of its surface layer through erosion. The present surface layer is only

2 to 5 inches thick over at least half of the acreage. It is a mixture of the original surface layer and the original subsoil. Some rills and a few gullies have formed.

This soil is best suited to grasses, but it can be cultivated under good management. Sorghum is the principal cultivated crop. Most of the acreage is in pasture. (Capability unit IVe–5; Sandy Savannah range site)

Stephenville fine sandy loam, 5 to 8 percent slopes (SbD).—Most of this soil borders drainageways. The depth to the parent material is somewhat less than in Stephenville fine sandy loam, 1 to 3 percent slopes.

Little of this soil is now cultivated. Some areas have been seeded to weeping lovegrass or native grasses. Large areas have never been cultivated and are used as woodland range. (Capability unit IVe–5; Sandy Savannah range site)

Vernon Series

The Vernon series consists of very shallow or shallow clayey soils of the uplands. These soils formed in beds of calcareous red clay, under a cover of grass. They occur mostly in the western half of the county, and they are mapped in a complex with the Lucien and Zaneis soils.

A soil of the Vernon series has a surface layer of reddish-brown, granular clay or clay loam. This layer is 3 to 10 inches thick. It grades to the substratum of red clay or clayey shale.

These soils are neutral and in some places are calcareous in the surface layer. The substratum is calcareous and contains lime concretions. Surface runoff is rapid. Internal drainage is very slow.

The Vernon soils are closely associated with the Lucien soils, which are less clayey and less calcareous; with the Zaneis soils, which are deeper and less clayey; and with the Renfrow soils, which are deeper.

Windthorst Series

The Windthorst series consists of deep, slowly to very slowly permeable soils that formed in slightly acid parent material, under timber. These soils of the uplands are on the more gentle slopes along the tops of ridges.

A soil of the Windthorst series has a 3- to 5-inch layer of grayish-brown to dark-brown, very friable, weak granular fine sandy loam that grades to a 3- to 5-inch layer of yellowish-brown fine sandy loam. An abrupt boundary separates the surface layer and the subsoil. The subsoil is dark reddish-brown or red, subangular blocky sandy clay or clay that is very firm when moist and very hard when dry. The parent material is below a depth of 30 to 45 inches. It is red sandy clay and contains strata of soft, red sandstone.

In many cultivated areas, the lighter colored subsurface layer is mixed with the darker colored surface layer.

These soils are subject to both wind and water erosion. The clayey subsoil restricts the intake of water, and runoff is rapid; consequently, these soils are highly susceptible to sheet erosion. The reaction is medium acid to neutral. In a few areas the parent material is slightly calcareous.

The Windthorst soils are closely associated with the Stephenville and Darnell soils. They are deeper and more clayey than the Darnell soils, and their subsoil is more reddish and more clayey than that of the Stephenville soils.

Windthorst-Darnell complex (4 to 35 percent slopes) (Wn).—This complex is about 55 percent Windthorst soil, 35 percent Darnell soil, and 10 percent Stephenville soil. About 40 percent of the surface area is hard sandstone.

The Windthorst soil has a profile like the one described as representative of the Windthorst series, except that it has sandstone fragments in the surface layer. The Darnell soil is like that described for the Darnell series. It occurs on the stony, steep slopes (fig. 9). The Stephenville soil is shallower than the soil described for the Stephenville series. The parent material is at a depth of 18 to 22 inches.

Figure 9.—**Darnell soils are shallow over sandstone. Here, the sandstone is broken enough to permit penetration of roots.**

The soils of this complex are used for woodland range. They are not suited to cultivation. (Capability unit VIIs–1; Shallow Savannah range site)

Windthorst fine sandy loam, 1 to 5 percent slopes (WdB).—This soil is generally on gently sloping to moderately sloping ridgetops. The profile is like the one described as representative of the series. The side slopes and foot slopes of the ridges are occupied by the Stephenville soils.

The surface layer is moderately thin. In some cultivated areas there are a few reddish spots where erosion has exposed the subsoil.

Included in the areas mapped are small areas of Stephenville fine sandy loam.

Much of this soil has never been cultivated, and many areas once cultivated are now used for pasture. A small acreage is now in cultivation. Sorghum is the principal crop grown. Control of erosion, preservation of fertility, and maintenance of the organic-matter content are the main management needs. (Capability unit IIIe–6; Sandy Savannah range site)

Windthorst fine sandy loam, 1 to 5 percent slopes, eroded (WdB2).—This soil has a thinner surface layer than the soil described as representative of the series. In most places the surface layer is less than 5 inches thick. Rills and gullies have formed in some places. In cultivated areas the present surface layer consists of part of the reddish subsoil.

This soil is better suited to grasses than to cultivated crops. Many areas used as pasture have not been seeded, and the pasture is of poor quality. A small acreage is

used to grow sorghum. (Capability unit IVe–7; Sandy Savannah range site)

Zaneis Series

This series consists of deep soils formed in weathered shale, siltstone, and sandstone, under a cover of grass. These soils of the uplands are most extensive in the western half of the county.

A soil of the Zaneis series has a 7- to 12-inch surface layer of brown to reddish-brown, friable, granular loam. This layer grades to the subsoil, which is reddish-brown, friable, granular loam in the uppermost 3 to 6 inches and firm, subangular blocky clay loam in the lower part. The substratum, which is at a depth of 30 to 45 inches, is red or red and gray, partly weathered shale, siltstone, sandstone, and some clay.

These soils are generally slightly acid to mildly alkaline but noncalcareous. The substratum is calcareous to neutral. Permeability is moderate to slow. Runoff is rapid on the steeper slopes.

The Zaneis soils are moderately productive. They occur with the Chickasha, Renfrow, Lucien, and Vernon soils. The Zaneis soils are more silty than the Chickasha soils, and they developed in more calcareous material. They are deeper than the Vernon and Lucien soils. The subsoil of the Zaneis soils is less clayey than that of the Renfrow soils.

Zaneis loam, 1 to 3 percent slopes (ZaB).—This soil is deeper than the moderately sloping and strongly sloping phases of the Zaneis soils. The profile is like the one described as representative of the series.

Included in the areas mapped are small areas of Chickasha, Lucien, Renfrow, and Vernon soils.

Small grain, sorghum, and cotton are commonly grown on this soil. (Capability unit IIe–3; Loamy Prairie range site)

Zaneis loam, 3 to 5 percent slopes (ZaC).—This soil is more susceptible to water erosion and requires more intensive management than Zaneis loam, 1 to 3 percent slopes. Included in the areas mapped are small areas of Vernon and Lucien soils. Near these inclusions are spots of Zaneis soils that are shallower than normal.

Large areas of this soil are used for native range. Small grain and sorghum are the principal crops. (Capability unit IIIe–2; Loamy Prairie range site)

Zaneis loam, 3 to 5 percent slopes, eroded (ZaC2).—The surface layer of this soil is thinner than that of Zaneis loam, 1 to 3 percent slopes. In most places it is less than 5 inches thick. Some gullies and rills have formed. In cultivated areas the reddish surface layer is a mixture of the original surface layer and the original subsoil.

This soil is best suited to grasses, but sown crops can be grown. Small grain and sorghum are suited. (Capability unit IVe–4; Loamy Prairie range site)

Zaneis loam, 5 to 8 percent slopes (ZaD).—This soil is along drainageways in the western half of the county. About 10 percent of the mapping unit is made up of areas of the Vernon and Lucien soils that are too small to be mapped separately. Around these inclusions the soil is less than 30 inches thick. Some cultivated areas are eroded to the extent that less than 5 inches of the original surface layer remains.

This soil is best suited to grasses. It produces good yields of mid and tall native grasses. Large areas have been farmed at some time, but a very small acreage is now cultivated. (Capability unit IVe–4; Loamy Prairie range site)

Use and Management of the Soils

This section discusses the system of land capability classification used by the Soil Conservation Service and gives the classification of the soils of Stephens County according to that system. It describes general management practices for groups of soils that have similar potentialities and management requirements, and it predicts yields of specified crops. It groups the soils according to their suitability for use as range sites and gives information that is useful in the management of rangeland; it offers suggestions on the use of the soils for trees and wildlife; and it interprets the soil characteristics that are significant in road construction and other engineering uses.

General Management Practices for Crops and Tame Pastures [2]

To plan an effective system of soil management, a farmer must know what conservation practices are suited to the soils and to the climate, how much the soils will produce, and what their limitations are.

Following are discussions of conservation measures commonly required in Stephens County. For suggested combinations of practices for specific soils, see "Management by Capability Units."

Soil-improving crops.—Legumes and grasses are soil-improving crops. Other high-residue crops can, under certain conditions, be used to help maintain the soils.

Legumes can be grown throughout the county, except on tight, shallow soils. Vetch, alfalfa, sweetclover, cowpeas, mungbeans, and Austrian winter peas are the legumes most commonly grown. Alfalfa is especially beneficial. Much of its soil-improving effect is derived from its roots. At least 12 inches of the aftergrowth of alfalfa should be plowed under at the end of a rotation. All legumes should be inoculated.

Forage grasses can be grown for pasture in a long-term cropping system and then turned under for soil improvement (fig. 10). King Ranch bluestem, Caucasian bluestem, Caddo switchgrass, and weeping lovegrass are suitable. At least 6 inches of stubble should be left at the end of the growing season.

Other high-residue crops that can be utilized for soil improvement are—

Small grain, if only the grain is harvested and all straw is returned to the soil.

Grain sorghum, if more than 12 inches of stubble is left and grazing is controlled so that only loose leaves and heads are removed.

Forage sorghum, broadcast or in closely spaced rows, if more than 6 inches of stubble is left and grazing is controlled so that only loose leaves and heads are removed; or forage sorghum, in rows of standard spacing,

[2] By M. D. GAMBLE, conservation agronomist, Soil Conservation Service.

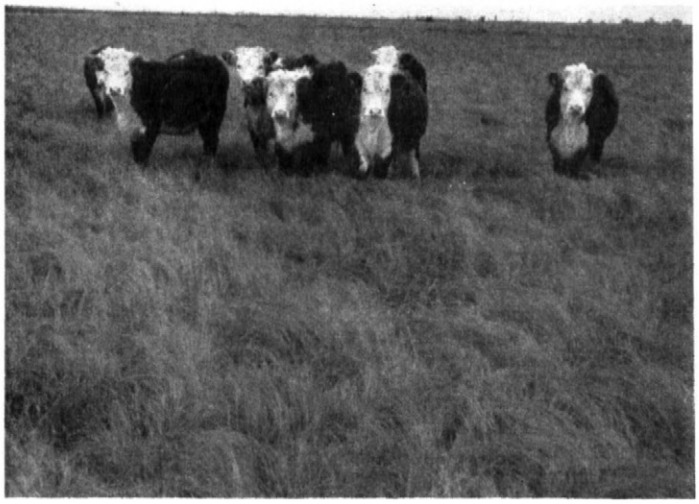

Figure 10.—**Cattle grazing in a winter pasture of weeping lovegrass.**

if more than 12 inches of stubble is left and grazing is controlled.

Corn and broomcorn, if enough stubble is left.

Cotton, peanuts, castorbeans, mungbeans, silage or soiling crops, and truck crops are soil-depleting, low-residue crops.

Use of crop residues.—Crop residues can be left on the surface as protection against wind and water erosion, or they can be turned under to provide organic matter, improve structure, and reduce surface crusting (fig. 11). It is especially important to keep residues on the surface of the sandy soils through the winter and spring, when the danger of wind erosion is greatest.

When the straw from a small-grain crop is plowed under, nitrogen should be applied to speed decomposition and to replace the nitrogen removed by a heavy crop of straw. In years when there is little rainfall and only a small amount of straw is produced, nitrogen need not be applied.

Stubble mulching.—Stubble mulching keeps a protective cover of crop residues on the soil from seeding time until a new crop is established. It is a minimum-treatment practice where wind erosion is a problem.

Cover crops.—Cover crops are included in a cropping system primarily to provide protection from erosion. Close-growing grasses, legumes, and small grain are grown as cover crops. Cover crops are grown extensively on the sandy soils of this county, to help control wind and water erosion in winter and early in spring.

Small grain can be seeded in cotton or grain sorghum early in September by using a specially constructed drill.

Contour farming.—Contour farming is a necessary practice in all terraced fields used for row crops. It consists of plowing, planting, and tilling across the slope instead of up and down the slope. Damage from water erosion is less likely if all farming operations are on the contour.

Minimum tillage.—Excessive tillage breaks down the structure of the soils. The soils then tend to puddle and to crust at the surface. As a result, runoff increases and less water is stored for plants. Consequently, it is important to limit tillage operations to the minimum essential for preparation of a seedbed and the control of weeds.

Fertilization.—The fertility of the cultivated soils in this county varies considerably. The sandy soils on uplands are low to very low in organic-matter content and in nitrogen. Almost all the soils are low in available phosphate. The amount of available potash has declined but is still adequate for average crop yields. Some of the soils in the eastern part of the county need lime if clover or alfalfa is to be grown. Fertilizer should be applied in accordance with needs indicated by current soil tests and past experience and with consideration of the requirement of the crops that are to be grown.

Grassed waterways.—Grassed waterways are broad, flat-bottomed, sodded channels, with a retaining dike on each side if such is needed. Grassed waterways are needed in most terraced fields to provide safe disposal of excess water (fig. 12). They are not used to control floodwaters from creeks, rivers, or very large drainage areas.

Each waterway must be individually designed as to width, depth, and vegetative cover. Assistance in design, construction, and sodding can be obtained from a local representative of the Soil Conservation Service. Either bermudagrass or native grass is commonly used for the vegetative cover.

Terraces.—Terraces reduce water erosion and help to conserve moisture in cultivated fields. They can also be used as guidelines for contour farming. In many areas they are essential for protection against erosion.

Each terrace system must be especially designed. Assistance can be obtained from the local representative of the Soil Conservation Service or from the county agricultural agent.

Irrigation.—Very little irrigation is presently being done in Stephens County. In extremely dry years, as much as 600 acres may be irrigated. About one-third of this acreage has been leveled and is irrigated by flooding. The rest is irrigated by sprinkler systems.

Two major factors to be considered in determining the feasibility of an irrigation system are the quality and amount of water available and the suitability of the soil for irrigation.

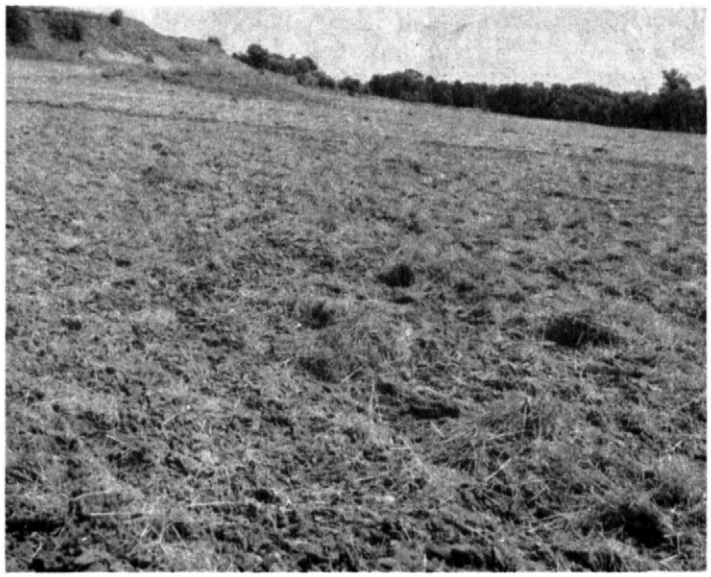

Figure 11.—**Small-grain residues protect soils against erosion and reduce crusting of the surface layer.**

Figure 12.—**A waterway sodded with bermudagrass.**

All water to be used for irrigation should be chemically analyzed to determine its suitability. Local farmers are using water from several different sources, including flood-prevention lakes, city disposal lagoons, creeks, and wells. Water from wells and creeks is commonly pumped into reservoirs, and then onto the land. This allows for accumulation of an additional supply of water when irrigation is not necessary.

Most of the soils being irrigated are on bottom lands. Deep, loamy, permeable soils are best suited to irrigation. They take water well and provide good conditions for plant growth. Other soils may be irrigated, but they are more limited as to water intake, moisture-supplying ability, and drainage.

Each irrigation system must be individually designed. Consult a technician of the Soil Conservation Service, the county agricultural agent, or a qualified engineer before installing an irrigation system.

Weed control.—Johnsongrass is prevalent in all cultivated sections of the county. In some areas it is considered a noxious weed. Roadsides, railroad rights-of-way, and creek banks are covered with it. Spot treatment of infested patches is practical, and control is achieved by tillage or the use of chemical sprays. Continuous pasturing through the growing season is also effective.

Bindweed is found in the western part of the county, generally in small areas within fields. It can be controlled by a combination of chemical spraying and tillage.

Field dodder, another common noxious weed, is difficult to control. Clean cultivation is the only known means of control.

Many other weeds grow in the county, but they can be controlled by proper cultivation, by the use of weed-free seed, and by a well planned program of spraying.

Management of tame pastures.—Establishing pastures can be profitable on most farms and ranches in Stephens County. Many acres once cultivated can be used for pasture. A grass-legume mixture, generally between 60 and 80 percent grass, makes the best pasture.

The base grass is the foundation of permanent tame pasture. In this county the principal base grasses are weeping lovegrass, bermudagrass, King Ranch bluestem, and Caucasian bluestem. Weeping lovegrass is best suited to the more sandy soils. Bermudagrass is best suited to the sandy and loamy soils of the bottom lands and to some of the deep loamy soils of the uplands. King Ranch bluestem and Caucasian bluestem grow best on the well-drained, medium-textured and fine-textured soils.

In planning for tame pastures it is important to consider the particular requirements of the area and the season in which additional forage is needed, and to select the best legumes to use with the base grasses.

Applications of fertilizer and control of grazing are important in establishing and maintaining productive pastures. The first consideration should be given to replacing the plant nutrients removed from the soil. Phosphorus and nitrogen requirements are high. Potash and lime requirements are variable. Fertilizer should be applied as indicated by records of forage yields, soil tests, fertilization and crop records, and the appearance and vigor of the plants. Other important management practices are control of weeds and brush, provision of adequate watering facilities, and location of salting and feeding areas so as to prevent the concentration of livestock on the erodible areas. Control of grazing is essential to maintain a stand of grasses and legumes of high quality over a long period of time and to provide a protective ground cover.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable the soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops or of wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated 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* means 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 country, indicates that the chief limitation is a climate that is too cold or too dry.

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

Within the subclasses are the capability units, groups of soils 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. The capability units are convenient groupings for making many statements about management of soils. Capability units are generally identified by numbers assigned locally, for example IIe–1 or IIIe–2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their

permanent limitations, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil, and without consideration of possible but unlikely major reclamation projects.

The eight classes in the capability system, and the subclasses and units in this county, are described in the list that follows.

Class I. Soils that have few limitations that restrict their use.
- Unit I–1. Moderately fine textured soils of the bottom lands.
- Unit I–2. Deep, loamy and moderately sandy soils of the bottom lands.
- Unit I–3. Deep, nearly level, loamy soils of the uplands.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe–1. Deep, nearly level, moderately sandy soils of the uplands.
  - Unit IIe–2. Deep and moderately deep, gently sloping, moderately sandy soils of the uplands.
  - Unit IIe–3. Deep, gently sloping, loamy soils of the uplands.
- Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.
  - Unit IIs–1. Deep, nearly level, very slowly permeable soils of the uplands.

Class III. Soils that have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.
- Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe–1. Deep, gently sloping, very slowly permeable soils of the uplands.
  - Unit IIIe–2. Deep, moderately sloping, loamy soils of the uplands.
  - Unit IIIe–3. Deep and moderately deep, moderately sloping, moderately sandy soils of the uplands.
  - Unit IIIe–4. Deep, permeable, moderately sloping, moderately sandy soils of the uplands.
  - Unit IIIe–5. Deep, undulating, sandy soils of the uplands.
  - Unit IIIe–6. Deep, gently sloping to moderately sloping soils of the uplands; slowly to very slowly permeable.
- Subclass IIIw. Soils severely limited by excess water.
  - Unit IIIw–1. Very slowly permeable, clayey soils of the bottom lands.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.
- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe–1. Moderately sloping, very slowly permeable soils of the uplands.
  - Unit IVe–2. Deep, gently sloping and moderately sloping, very slowly permeable soils of the uplands; moderately severe erosion.
  - Unit IVe–3. Gently sloping, loamy soils; numerous, very slowly permeable slickspot areas; on uplands.
  - Unit IVe–4. Gently sloping to strongly sloping, moderately deep and deep soils of the uplands; moderately severe erosion in some areas.
  - Unit IVe–5. Deep, moderately sloping and strongly sloping, moderately sandy soils of the uplands; moderately severe erosion in some areas.
  - Unit IVe–6. Deep, sandy, gently sloping soils with moderately severe erosion, and deep, sandy, strongly sloping soils; on uplands.
  - Unit IVe–7. Deep, gently sloping to moderately sloping, slowly to very slowly permeable soils of the uplands; moderately sandy surface layer; moderately severe erosion.

Class V. Soils that are not likely to erode but have other limitations that restrict their use to pasture, range, woodland, or food and cover for wildlife.
- Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.
  - Unit Vw–1. Very slowly permeable, clayey soils of the bottom lands; frequently flooded.
  - Unit Vw–2. Loamy soils of the bottom lands; frequently flooded.
  - Unit Vw–3. Sandy alluvium of recent origin; frequently flooded.
- Subclass Vs. Soils generally unsuitable for cultivation because of moisture capacity or tilth.
  - Unit Vs–1. Clayey soils of the bottom lands; high in salts.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture, range, woodland, or food and cover for wildlife.
- Subclass VIe. Soils severely limited, chiefly by risk of erosion, if protective cover is not maintained.
  - Unit VIe–1. Severely eroded soils of the uplands; clayey subsoil.
  - Unit VIe–2. Severely eroded soils of the uplands; sandy loam, loam, or clay loam subsoil.
  - Unit VIe–3. Severely eroded soils that have a surface layer of sandy loam and a subsoil of sandy clay loam to clay.
  - Unit VIe–4. Deep soils and shallow to very shallow soils; moderately sandy.
  - Unit VIe–5. Relatively narrow drainageways; steep side slopes; mixed alluvial land.
- Subclass VIs. Soils generally unsuitable for cultivation and limited for other uses by their moisture capacity, stones, or other features.
  - Unit VIs–1. Deep, droughty, moderately steep to steep, very sandy soils of the uplands.
  - Unit VIs–2. Strongly sloping, very shallow to deep soils of the uplands; underlain by beds of red clay and reddish sandstone.
  - Unit VIs–3. Strongly sloping, very shallow to moderately deep soils of the uplands; underlain by olive-gray shale and yellowish-brown siltstone and sandstone.

Class VII. Soils that have very severe limitations that make them unsuitable without major reclamation, and

that restrict their use largely to grazing, woodland, or food and cover for wildlife.

Subclass VIIe. Soils very severely limited by the risk of erosion if they are not protected.

Unit VIIe–1. Steep, broken side slopes along drainageways.

Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.

Unit VIIs–1. Deep soils and shallow to very shallow soils; steep and stony; under timber.

Unit VIIs–2. Very shallow, stony, and steep grassland soils; interbedded and intermixed red and olive-gray clay and shale and yellowish-brown to red sandstone.

Class VIII. Soils and landforms that have limitations that preclude their use, without major reclamation, for commercial production of plants and that restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Subclass VIIIs. Soils and land types that support little vegetation.

Unit VIIIs–1. Soils flooded with waste material from oil wells, and areas from which soil material has been removed.

Management by Capability Units

The soils of Stephens County have been placed in 37 capability units. In this section each unit is described, the soils in each are listed, and management is suggested for the soils suitable for cultivation. The management of rangeland is described in the section "Management of Rangeland."

Capability unit I–1

This unit consists of moderately fine textured soils of the bottom lands. These soils are—

Gowen clay loam.
Port clay loam.

These soils are generally well drained. The organic-matter content and the supply of plant nutrients are moderate. Permeability is moderately slow. Maintaining fertility and preserving structure are the principal management problems.

Small grain, sorghum, broomcorn, cotton, corn, and alfalfa and other legumes can be grown on these soils. Grow legumes for at least 2 years after 8 years of continuous use for small grain, or for 1 year after 4 years of small grain, or for 2 years after 4 years of row crops and 2 years of small grain. Grasses can replace legumes or be grown with legumes. Plant a cover crop after cotton or a silage crop. To eliminate the need for soil-improving crops, grow high-residue crops continuously and return all residues to the soil. Vary the depth of tillage to prevent the formation of a plowpan.

These soils are well suited to native and introduced grasses. Johnsongrass and bermudagrass yields are good.

Capability unit I–2

This unit consists of deep, loamy and moderately sandy soils of the bottom lands. These soils are—

Port fine sandy loam.
Port loam.

These soils are well drained. They take up moisture readily and are moderately permeable. The organic-matter content and the supply of plant nutrients are moderate. Maintaining good tilth and a high level of organic-matter content are the principal management problems.

Small grain, alfalfa, sorghum, broomcorn, cotton, and corn are the main crops. Grow legumes for 2 years after 7 years of continuous use for small grain or other sown crops, or for 1 year after 4 years of small grain, or for 2 or more years after 4 years of row crops and 2 years of small grain. Grasses can replace legumes or be grown with legumes. In years of adequate rainfall, grow legumes for green manure. Plant a cover crop after a low-residue crop.

Grow a high-residue crop continuously to improve soil structure, to increase the infiltration of water, to add organic matter, and to eliminate the need for legumes or similar soil-improving crops. Leave all residues on the surface to help control wind erosion. Vary the depth of tillage to prevent the formation of a plowpan.

These soils are suited to native and introduced grasses, but bermudagrass is most commonly grown.

Capability unit I–3

The only soil in this unit is Chickasha loam, 0 to 1 percent slopes, a deep, nearly level soil of the uplands.

This soil is well drained. It is moderately permeable and takes up moisture readily, but it supplies less moisture to plants than some soils of the bottom lands. The principal management requirements are maintaining fertility and structure.

Small grain, sorghum, and cotton are the principal crops grown. Corn can be grown in years of adequate rainfall. Do not grow row crops for more than 4 years consecutively. A suitable rotation consists of 4 years of a row crop, 2 years of small grain, and at least 2 years of legumes or grasses. Another consists of 1 year of sorghum, 1 year of legumes or grasses, 1 year of cotton, and 1 year of small grain. To eliminate the need for soil-improving crops, grow high-residue crops continuously, return part of the residues to the soil, and leave part on the surface to help control erosion. Vary the depth of tillage to prevent the formation of a plowpan, or to break up a pan already formed.

Some of the suitable grasses are weeping lovegrass, King Ranch bluestem, Caucasian bluestem, and native grasses.

Capability unit IIe–1

The only soil in this unit is Chickasha fine sandy loam, 0 to 1 percent slopes, a deep, nearly level soil of the uplands.

This soil is readily permeable to roots, air, and water. It is easy to till. Maintaining fertility, preserving soil structure, and controlling wind erosion are the main management problems.

This soil is suited to all locally grown crops. Summer and winter legumes can be grown to help increase fertility and to improve soil structure. Grow legumes for at least 2 years after 7 years of small grain, or for 1 year after 4 years of small grain. Grasses can replace legumes or be grown with legumes.

Do not grow row crops for more than 3 years consecutively. A suitable rotation consists of 3 years of row crops, 2 years of small grain, and 2 years of legumes and grasses. Plant winter cover crops after cotton and in cultivated areas that are not protected by stubble or other cover. Use stubble or residues to help control wind erosion, to help maintain the organic-matter content, and to increase the intake of water. Vary the depth of tillage to prevent the formation of a plowpan.

This soil is suited to weeping lovegrass, bermudagrass, and native grasses.

Capability unit IIe–2

This unit consists of deep and moderately deep, gently sloping soils of the uplands. These soils are—

Chickasha fine sandy loam, 1 to 3 percent slopes.
Nash fine sandy loam, 1 to 3 percent slopes.
Stephenville fine sandy loam, 1 to 3 percent slopes.

These soils take water readily but, unless well managed, may lose a large amount through runoff. They are subject to wind and water erosion. Maintaining fertility and preserving structure are additional problems.

These soils are suited to most locally grown crops, but peanuts, cotton, sorghum, small grain, and broomcorn are the chief crops. Watermelons are grown sometimes for a cash crop.

Grow a soil-improving crop for 1 year after 4 years of sown crops, or for 2 years or more after 7 years of sown crops.

Do not grow row crops for more than 3 years consecutively. A suitable rotation consists of 2 years of a vetch-small grain mixture, 3 years of a row crop, and 2 years of small grain. Plant a winter cover crop after cotton and in areas that are not protected by stubble or other cover.

If fields are not terraced and contour farmed, grow small grain for 4 years and follow with legumes, or grow a small grain-legume mixture continuously. Seed drainageways to grasses and legumes.

Use stubble or residues to help protect these soils against washing and blowing, to increase the intake of water, and to help maintain the organic-matter content. Construct terraces and farm on the contour to help control water erosion and to conserve moisture. In years of adequate rainfall, grow legumes for a green-manure crop. They will help to increase the organic-matter content and to improve tilth. Vary the depth of tillage to prevent the formation of a plowpan.

These soils are suited to weeping lovegrass, King Ranch bluestem, Caucasian bluestem, bermudagrass, and native grasses.

Capability unit IIe–3

This unit consists of deep, gently sloping soils of the uplands. These soils are—

Chickasha loam, 1 to 3 percent slopes.
Zaneis loam, 1 to 3 percent slopes.

These soils take water readily but still may lose a large amount through runoff. The supply of moisture is generally adequate in summer. Because of the slope, these soils are subject to erosion.

Maintaining the fertility of these soils and preserving their structure are additional management problems. If adequately fertilized, these soils produce good yields of the common crops. Fertilizer should be applied in amounts indicated by current soil tests and by experience. Summer and winter legumes can be grown to help increase fertility and to improve soil structure.

If terracing and contour farming are practiced, grow legumes for at least 2 years after 7 years of continuous use for small grain or other sown crops, or for 1 year after 4 years of small grain or other sown crops. Grasses can replace legumes or be grown with legumes.

Do not grow row crops for more than 3 years consecutively. A suitable rotation consists of 3 years of cotton or grain sorghum, 2 years of small grain, and 2 years of legumes and grasses. Plant a cover crop after cotton or a similar low-residue crop.

If fields are not terraced, grow sown crops continuously. One suitable cropping system consists of 4 years of small grain followed by 4 years of sweetclover or perennial grasses. Another consists of a small grain-legume mixture, such as vetch and rye, grown continously. Seed drainageways to grasses, legumes, or both.

Use stubble or residues to help protect these soils against wind and water erosion, to help maintain the organic-matter content, and to increase the intake of water. In years of adequate rainfall, grow green-manure crops to increase the organic-matter content and to improve tilth. Vary the depth of tillage to prevent the formation of a plowpan.

Some of the best suited grasses are weeping lovegrass, King Ranch bluestem, Caucasian bluestem, bermudagrass, and native grasses.

Capability unit IIs–1

Kirkland silt loam, 0 to 1 percent slopes, is the only soil in this unit. It is a deep, nearly level, very slowly permeable soil of the uplands.

The clay subsoil restricts the intake of water. This soil is very droughty in periods of inadequate rainfall. Fertility is moderate, and the organic-matter content is moderate. Erosion can be controlled by use of crop residues. Maintaining fertility and supplying organic matter are the main management problems.

Because this soil is droughty, it is best suited to small grain, but cotton, sorghum, and alfalfa can be grown.

Grow legumes or grasses for 2 years after 7 years of small grain, or for at least 1 year after 4 years of small grain, or grow a small grain-legume mixture continuously. A suitable rotation including row crops consists of 3 years of row crops, 3 years of small grain, and 2 years of legumes and grasses. Another consists of 2 years of row crops, 2 years of small grain, and 1 year of a legume. Legumes and grasses can be grown together. They are not necessary in the rotation if high-residue crops are grown continuously and the residues are managed for soil improvement. Vary the depth of tillage to prevent the formation of a plowpan.

King Ranch bluestem, Caucasian bluestem, and short and mid native grasses are suited to this soil.

Capability unit IIIe–1

This unit consists of Kirkland-Renfrow silt loams, 1 to 3 percent slopes, a complex of deep, gently sloping, very slowly permeable soils of the uplands.

The clayey subsoil restricts the intake of water, and runoff is rapid after the surface layer is saturated. These

soils are very droughty during long periods of inadequate rainfall. Maintaining fertility and preserving structure are additional management problems.

Small grain, cotton, and sorghum are the principal crops grown on these soils. Yields of small grain are more dependable than yields of row crops, because the soils are droughty. Fertility is fair, but crop yields are increased by applying fertilizer.

If terracing and contour farming are practiced, grow legumes or grasses for at least 2 years after 7 years of continuous use for sown crops, or for 1 year after 4 years of sown crops.

Do not grow row crops for more than 2 years consecutively. A suitable rotation consists of small grain and a legume for 1 year, followed by 2 years of row crops, and 2 years of small grain. Vetch and Austrian winter peas are good soil-improving crops. Grow a cover crop after cotton or other low-residue crops.

If fields are not terraced, grow sown crops continuously. One suitable cropping system consists of 4 years of small grain followed by 4 years of legumes or grasses. Another consists of a small grain-legume mixture grown continuously. A cover of perennial vegetation should be established in drainageways.

Return part of the crop residues to the soil, but leave enough on the surface to help control erosion. Vary the depth of tillage to prevent the formation of a plowpan.

These soils are suited to King Ranch bluestem, Caucasian bluestem, and short and mid native grasses.

Capability unit IIIe-2

This unit consists of deep, moderately sloping soils of the uplands. These soils are—

Chickasha loam, 3 to 5 percent slopes.
Zaneis loam, 3 to 5 percent slopes.

Unless controlled by proper management, runoff is rapid enough to cause erosion and to limit the intake of water. Natural fertility and productivity are moderately high.

Small grain, sorghum, and some cotton are grown on these soils. Crops respond to fertilizer.

Grow legumes for at least 2 years after 6 years of small grain or sorghum, or for 1 year after 3 years of sown crops. Grasses can replace legumes or be grown with legumes. Another cropping system consists of a small grain-legume mixture grown continuously.

Do not grow row crops for more than 2 years consecutively. A suitable rotation consists of 1 year of a row crop, 1 year of small grain, and 1 year of legumes and grasses.

If fields are not terraced, seed drainageways to grasses and legumes. To increase the supply of nitrogen and the organic-matter content, grow legumes after 4 years of continuous use for small grain.

Use stubble or residues to help to protect these soils from washing and blowing, to improve soil structure, and to increase organic-matter content. Grow green-manure crops to increase organic-matter content and to improve tilth. Construct terraces and farm on the contour to help control erosion and to conserve moisture. Vary the depth of tillage to prevent the formation of a plowpan.

These soils are suited to weeping lovegrass, King Ranch bluestem, Caucasian bluestem, and native grasses.

Capability unit IIIe-3

This unit consists of Nash and Noble fine sandy loams, 3 to 5 percent slopes, an undifferentiated group of deep and moderately deep, moderately sloping soils of the uplands.

These soils are permeable. They take water readily, but they still may lose a large amount through surface runoff. They are moderately productive. Because of the slope, they are subject to erosion. Maintaining fertility and preserving structure are the additional management requirements.

Most locally grown crops are suited to these soils. If terracing and contour farming are practiced, grow cotton or other row crops for 2 years, legumes and grasses for at least 2 years, and small grain for 2 years. To help control erosion, grow a cover crop or use crop residues.

Do not grow small grain, sorghum, or other sown crops for more than 5 years consecutively. A suitable rotation consists of 5 years of sown crops and at least 2 years of legumes or grasses, or a mixture of both, or 3 years of sown crops followed by 1 year of legumes.

If fields are not terraced, do not grow row crops. Do not grow small grain for more than 3 years consecutively. Grow legumes or grasses for at least 3 years after 3 years of small grain. For winter and spring grazing, grow vetch and rye, or some other small grain-legume mixture, continuously.

Use stubble or residues to provide protection against erosion, to increase organic-matter content, and to improve tilth. Grow soil-improving crops and use crop residues to help maintain fertility and to improve soil structure. Apply fertilizer to increase crop yields. Vary the depth of tillage to prevent the formation of a plowpan or to break up a pan already formed.

The grasses most commonly grown are weeping lovegrass and mid and tall native grasses.

Capability unit IIIe-4

This unit consists of deep, moderately sloping, permeable soils of the uplands. These soils are—

Chickasha fine sandy loam, 3 to 5 percent slopes.
Stephenville fine sandy loam, 3 to 5 percent slopes.

These soils take up water readily but still may lose a large amount through runoff. They are subject to wind and water erosion. The additional management problems are maintaining fertility and preserving structure.

Peanuts, sorghum, small grain, and cotton are the main crops. If terracing and contour farming are practiced, grow legumes or grasses for 2 or more years after 4 years of continuous use for sown crops, or vetch or other legumes for 1 year after 2 years of sown crops.

Do not grow row crops for more than 2 years consecutively. To provide a cover in winter, grow rye and vetch after a row crop, and plow them under for green manure.

If fields are not terraced, alternate grasses and legumes with small grain. Do not grow small grain for more than 3 years consecutively. A suitable cropping system consists of a small grain-legume mixture grown continuously. Seed natural drainageways to permanent vegetation.

Use stubble, residues, or cover crops; construct terraces; and farm on the contour to help protect these soils against erosion, to slow runoff, and to conserve moisture. Delay

tillage until seeding time. Vary the depth of tillage to prevent the formation of a plowpan.

These soils are suited to weeping lovegrass, bermudagrass, and native grasses.

Capability unit IIIe-5

The only soil in this unit is Dougherty loamy fine sand, undulating, a deep soil of the uplands. This soil is highly susceptible to wind and water erosion. Natural fertility is low, and the organic-matter content is low.

Peanuts, sorghum, cotton, and small grain are the main crops grown on this soil. Watermelons are sometimes grown for a cash crop. Soil-improving crops should be included in the rotation, and fertilizers are needed. Terracing and contour farming are not practical. For control of erosion, grow legumes for 2 years after 4 years of sown crops, or for 1 year after 2 years of sown crops. Grasses can replace legumes or be grown with legumes. Another suitable cropping system consists of a small grain-legume mixture grown continuously. Sorghum can be grown every year if the sorghum is planted in rows no more than 24 inches apart and if a winter legume is grown. Drainageways should be kept in permanent sod.

Do not grow row crops for more than 2 years consecutively. A suitable rotation consists of 2 years of a row crop followed by 2 years or more of weeping lovegrass or a legume.

Use stubble, all crop residues, or a growing crop to help protect this soil against wind erosion. If this soil is seeded to a legume-small grain mixture for winter cover, allow grazing only late in winter and early in spring. Delay tillage in spring until near the end of the windy season.

Weeping lovegrass, bermudagrass, and native grasses are well suited to this soil.

Capability unit IIIe-6

The only soil in this unit is Windthorst fine sandy loam, 1 to 5 percent slopes. It is a deep, gently sloping to moderately sloping, slowly to very slowly permeable soil of the uplands.

The clayey subsoil restricts the intake of water, and runoff is rapid after the surface layer is saturated. This soil is very droughty during long periods of inadequate rainfall. Fertility is moderately low. Maintaining fertility and preserving structure are additional management problems.

The principal crops are sorghum and small grain. If terracing and contour farming are practiced, grow legumes for 2 years or more after 7 years of use for sown crops, or for 1 year after 4 years of use for sown crops, or grow a small grain-legume mixture continuously.

Do not grow row crops for more than 2 years consecutively. A suitable rotation consists of 2 years of a row crop, 2 years of small grain, and 1 year or more of legumes or grasses. Plant a winter cover crop after cotton or a silage crop.

If fields are not terraced, do not grow row crops continuously. Alternate sown crops with legumes and grasses, or grow a small grain-legume mixture, such as vetch and rye, continuously. Do not grow small grain or sorghum for more than 4 years consecutively.

Use stubble or residues to help control wind and water erosion, to increase the intake of water, and to maintain the organic-matter content. Construct terraces and farm on the contour to help control water erosion, to slow surface runoff, and to increase the intake of water. Grow green-manure crops to increase the organic-matter content and to improve soil tilth. Vary the depth of tillage to prevent the formation of a plowpan.

Weeping lovegrass and native grasses are well suited to this soil.

Capability unit IIIw-1

This unit consists of Miller clay, a very slowly permeable soil of the bottom lands.

This soil absorbs water slowly and becomes droughty during periods of inadequate rainfall. Natural fertility is high. Drainage is the main management problem.

This soil drains very slowly; consequently, it is too wet to be cultivated until late in spring in some years, and in wet seasons good stands of crops are difficult to obtain. The clay surface layer makes tillage difficult. Small grain, cotton, and sorghum are the best suited crops.

To increase the organic-matter content and to help prevent surface crusting, grow a high-residue crop and plow the residue under, or grow perennial grasses or deep-rooted legumes, such as sweetclover. Plant a cover crop after cotton or other low-residue crops, and plow the cover crop under. Vary the depth of tillage to prevent the formation of a plowpan or to break up a pan already formed.

Virginia wildrye, buffalograss, and Texas wintergrass are the principal grasses grown on this soil.

Capability unit IVe-1

This unit consists of Renfrow silt loam, 3 to 5 percent slopes, a moderately sloping, very slowly permeable soil of the uplands.

This soil is droughty. Because of the slope and the clayey subsoil, runoff is rapid and erosion is a hazard.

Small grain, which matures early, before the driest part of the year, is the most dependable crop.

If terracing and contour farming are practiced, grow sown crops continuously, or grow legumes for at least 2 years after 4 years of continuous use for a sown crop, or grow legumes for 1 year after 2 years of sown crops. Grasses can replace legumes or be grown with legumes. Another suitable cropping system consists of a small grain-legume mixture grown continuously.

If fields are not terraced, grow close-growing crops for 1 to 4 years and legumes and grasses for an equal number of years. Seed natural drainageways to perennial vegetation.

Use crop residues to help control erosion, to increase the intake of water, and to increase the organic-matter content. Use residues and grow green-manure crops to help maintain fertility and to preserve soil structure.

King Ranch bluestem, Caucasian bluestem, and short and mid native grasses are suited to this soil.

Capability unit IVe-2

This unit consists of Renfrow and Kirkland soils, 1 to 5 percent slopes, eroded. This is an undifferentiated group of deep, gently sloping and moderately sloping, very slowly permeable soils of the uplands.

More than half the acreage is eroded to the extent that less than 5 inches of the original surface layer remains. The loss of surface soil has reduced the intake of water and decreased the water-holding capacity; consequently,

these soils are very droughty. Runoff is rapid because water moves slowly through the subsoil and the thin surface layer quickly becomes saturated. Natural fertility is moderately high but has been reduced by erosion.

Small grain and sorghum are the principal cultivated crops.

If terracing and contour farming are practiced, grow legumes or grasses for at least 2 years after 4 years of small grain or sown sorghum, or for 1 year after 2 years of sown crops. Another suitable cropping system consists of a small grain-legume mixture grown continuously.

If fields are not terraced, do not grow sown crops for more than 4 years consecutively. A suitable rotation consists of 4 years of a sown crop and 4 years of legumes, grasses, or both. A small grain-legume mixture, grown continuously, helps to control erosion and to improve soil structure, and it can be used as temporary pasture. Seed natural drainageways to permanent vegetation.

Use stubble or residues to help protect these soils against further erosion.

Capability unit IVe-3

This unit consists of gently sloping, loamy soils and very slowly permeable slickspot soils on uplands. These soils are—

Bethany-slickspot complex.
Chickasha-slickspot complex.

The Chickasha and Bethany soils are moderately high in fertility. The Bethany soil is more slowly permeable than the Chickasha soil, and it is more droughty during periods of inadequate rainfall. Crusting of the surface, the concentration of salts, and the slow rate of infiltration make surface runoff and accelerated erosion serious problems in areas where the slickspot soil occurs.

These soils are better suited to grasses than to cultivated crops, but high-residue sown crops can be grown. If crops are grown, construct diversion terraces, seed drainageways to permanent vegetation, and manage residues for soil improvement. Practice stubble mulch tillage, and do not till to a depth of more than 4 inches. No terraces except diversions should be built, because of the dispersed condition of the slickspot soils.

A mulch of cotton burs, straw, or hay at the rate of 3 or 4 tons an acre is beneficial to these soils. Apply 20 pounds of nitrogen for each ton of mulch material. It may be practical to treat the slickspots with gypsum, if gypsum is available at reasonable cost. Mulch and fertilize the spots treated with gypsum, and do not till them for at least 2 years.

Mid and tall grasses will grow on the Chickasha and Bethany soils. Short native grasses and a small amount of the mid grasses will grow on the slickspot soils. King Ranch bluestem and Caucasian bluestem are introduced grasses that will grow on all the soils in this unit.

Capability unit IVe-4

This unit consists of gently sloping to strongly sloping, moderately deep and deep soils of the uplands. The soils are—

Chickasha loam, 5 to 8 percent slopes.
Nash and Noble fine sandy loams, 5 to 8 percent slopes.
Zaneis loam, 3 to 5 percent slopes, eroded.
Zaneis loam, 5 to 8 percent slopes.

The surface layer is loamy to moderately sandy, and the subsoil is fine sandy loam to clay loam. Zaneis loam, 3 to 5 percent slopes, eroded, has a surface layer less than 5 inches thick. Runoff is rapid, and erosion is a hazard. Fertility is moderate. Maintaining fertility and controlling erosion are additional management problems.

These soils are best suited to grasses, but they can be used for sown crops. If terracing and contour farming are practiced, grow legumes or grasses for 2 years or more after 4 years of continuous use for sown crops, or for 1 year after 2 years of sown crops, or grow a small grain-legume mixture continuously.

If fields are not terraced, keep a vegetative cover on these soils at all times. One suitable cropping system consists of 3 years of small grain and 3 years of legumes or perennial grasses. Another consists of a small grain-legume mixture grown continuously.

Use residues to help control runoff and erosion, to improve fertility, and to maintain soil structure. Vary the depth of tillage to prevent the formation of a plowpan.

King Ranch bluestem, Caucasian bluestem, and mid and tall native grasses are suited to these soils.

Capability unit IVe-5

This unit consists of deep, moderately sloping and strongly sloping soils of the uplands. In some areas erosion has already done moderately severe damage. These soils are—

Stephenville fine sandy loam, 3 to 5 percent slopes, eroded.
Stephenville fine sandy loam, 5 to 8 percent slopes.

These soils are susceptible to wind and water erosion, particularly to water erosion. Natural fertility is moderately low, and the organic-matter content is moderately low. Controlling water erosion, maintaining fertility, and preserving soil structure are the main management problems if these soils are cultivated.

These soils are best suited to grasses, but small grain and sorghum can be grown. Terracing is not feasible. Grow legumes or grasses for at least 2 years after 3 years of continuous use for sown crops or close-rowed high-residue crops. A common legume-grass mixture that helps to increase fertility and to improve structure consists of vetch and weeping lovegrass. To increase the supply of nitrogen in the soil and to help control erosion, plant vetch and rye as a cover crop.

Use stubble or residues and grow cover crops to help to control runoff and erosion, to increase the organic-matter content, to improve productivity, and to help maintain soil structure. Seed drainageways to perennial vegetation. Delay tillage in spring until near the end of the windy season. Vary the depth of tillage to prevent the formation of a plowpan or to break up a pan already formed.

Under good management, mid and tall grasses grow well on these soils. Weeping lovegrass will grow well, even where erosion has done moderately severe damage, if the seedbed is carefully prepared and fertilizer is applied.

Capability unit IVe-6

This unit consists of deep, sandy, gently sloping soils with moderately severe erosion, and deep, sandy, strongly sloping soils. These soils occur on uplands. These soils are—

Dougherty loamy fine sand, hummocky.
Dougherty soils, 1 to 5 percent slopes, eroded.

These are the most sandy arable soils in the county. They are highly susceptible to wind and water erosion. Natural fertility is low, and the organic-matter content is low. The response to fertilizer is good.

These soils are suited to grasses and to sown crops or close-rowed high-residue crops. A suitable cropping system consists of 2 years or more of weeping lovegrass or other grass or a legume in a 5-year rotation with sown crops or row crops in rows not more than 24 inches apart. A mixture of rye and vetch makes a good winter cover crop.

Terracing and contour farming are not practical, because of the sandy texture and the irregular topography. Control erosion by the use of stubble and residues, by stripcropping, and by establishing field windbreaks. Delay tillage in spring until near the end of the windy season. Avoid excessive and pulverizing tillage.

Mid and tall native grasses are well suited to these soils. Bermudagrass grows well if the moisture supply is adequate.

Capability unit IVe–7

This unit consists of Windthorst fine sandy loam, 1 to 5 percent slopes, eroded, a deep, gently sloping to moderately sloping, slowly to very slowly permeable soil of the uplands.

More than half of the acreage is eroded to the extent that less than 5 inches of the original surface layer remains. The loss of surface soil has reduced the moisture-holding capacity; consequently, these soils are very droughty. Runoff is rapid because the thin surface layer quickly becomes saturated and water moves slowly through the subsoil. Natural fertility is moderately low.

This soil is best suited to grasses, but small grain and sown sorghum can be grown. Grow legumes for 2 years or more after 4 years of sown crops, or for 1 year after 2 years of sown crops. Grasses can replace legumes or be grown with legumes. Another suitable cropping system consists of a small grain-legume mixture grown continuously. Another consists of 1 to 4 years of small grain, and legumes or grasses for an equal number of years. Seed drainageways to perennial vegetation.

Terraces can be constructed to provide for safe disposal of runoff. They also serve as guides for contour tillage. To help prevent further erosion, keep a cover of stubble, residues, or growing crops on this soil at all times.

King Ranch bluestem, Caucasian bluestem, and native grasses are best suited to this soil.

Capability unit Vw–1

This unit consists only of Miller soils, frequently flooded. These are very slowly permeable, clayey soils of the bottom lands.

Floods may occur on these soils at any time of the year but are most common in spring.

Miller soils, frequently flooded, are used mainly for range. A small acreage is planted to small grain to be used for winter pasture. These soils are in the Heavy Bottom Land range site.

Capability unit Vw–2

This unit consists of Port soils, frequently flooded, which are loamy soils of the bottom lands.

These soils are fertile, but they are flooded frequently. Therefore, cultivation is not practical. Floods may occur at any time of the year but are most common in spring.

These soils are used primarily for spring and summer pasture, but some areas are planted to small grain and are used for winter pasture. Bermudagrass is well suited. If overseeded with vetch, it provides year around grazing. These soils are in the Loamy Bottom Land range site.

Capability unit Vw–3

This unit consists of Sandy alluvial land, a miscellaneous land type made up of recent sandy alluvium.

This land type is flooded frequently. It is not suited to cultivated crops, but it can be used for pasture. It is well suited to bermudagrass. Yields can be increased by applying fertilizer and growing legumes.

This land type does not have a range site classification, but it can be managed in the same way as soils of the Loamy Bottom Land range site.

Capability unit Vs–1

This unit consists of Clayey saline alluvial land, a miscellaneous land type of the bottom lands. This land type is made up of a clayey saline soil, Port soils, and a soil having characteristics intermediate between those of the Port soils and the saline soil. These soils form an irregular pattern. All three commonly occur within a small area. This land type is flooded frequently. Surface crusting, poor structure, and extreme droughtiness are other limitations.

This land type is not suited to cultivation. It is used only as pasture, and is in the Alkali Bottom Land range site. The pasture is of poor quality. The vegetative cover consists chiefly of broomweed, western wheatgrass, alkali sacaton, and mesquite trees.

Capability unit VIe–1

This unit consists of Eroded clayey land, a miscellaneous land type of the uplands. This land type is made up of severely eroded areas of Kirkland, Renfrow, and Vernon soils and soils of the Chickasha-slickspot complex and the Bethany-slickspot complex. Most, and in places all, of the original surface layer has been lost through erosion.

Under proper management, good yields of grasses can be obtained. King Ranch bluestem, Caucasian bluestem, and mid and short native grasses are suited. This land type is not suited to cultivation. It is in the Claypan Prairie range site.

Capability unit VIe–2

This unit consists of Eroded loamy land, a land type made up of areas of Chickasha, Nash, Noble, Zaneis, and Lucien soils that have been severely damaged by both wind and water erosion, particularly by water erosion. Most, and in places all, of the original surface layer has been removed, and many gullies have formed. The subsoil is sandy loam, loam, or clay loam.

This land type is not suited to cultivation, but it will produce grass. Some areas that have not been cultivated recently have reverted to grass; other areas need to be seeded. Weeping lovegrass, King Ranch bluestem, Caucasian bluestem, and mid and tall native grasses are suited to this land type. Some areas are suited to bermudagrass. This land type is in the Loamy Prairie range site.

Capability unit VIe–3

This unit consists of Stephenville and Windthorst soils, severely eroded, an undifferentiated unit of severely

eroded soils. The surface layer is sandy loam, and the subsoil is sandy clay loam to clay.

These soils are suited to weeping lovegrass and native grasses. They are so severely eroded that they are not suited to cultivated crops. Controlling surface runoff and erosion are the main management problems. These soils are in the Sandy Savannah range site.

Capability unit VIe–4

This unit consists only of the Stephenville-Darnell complex, 5 to 12 percent slopes, a complex of deep soils and shallow to very shallow soils that are moderately sandy.

The shallow to very shallow Darnell soils make up less than half of this complex, but they occur in such a pattern as to make the entire complex unsuitable for cultivation. Outcrops of sandstone are common in some areas. The natural vegetation consists of post oak, blackjack oak, and mid and tall native grasses. Good yields of native grasses are obtained in some areas of these soils. The Stephenville soils are in the Sandy Savannah range site; the Darnell soils are in the Shallow Savannah range site.

Capability unit VIe–5

This unit consists of Breaks-alluvial land complex, a miscellaneous land type made up of the steep side slopes of narrow drainageways and areas of mixed alluvial land. The areas of alluvial land are flooded frequently.

If grazing is properly managed, these areas produce good yields of short, mid, and tall native grasses. Deciduous trees grow where the soil material is loamy. A cover of trees on the side slopes helps to control erosion.

Some of the drainageways are good sites for farm ponds and wildlife habitats.

This land type does not have a range site classification. It is usually included in the same range site as the adjoining area.

Capability unit VIs–1

This unit consists of Eufaula fine sand, hummocky, a deep, droughty, moderately sloping to strongly sloping soil of the uplands. This soil occurs as mounds and long, narrow ridges. The slopes are short and irregular.

This soil is best suited to woodland range. Because it is low in fertility and highly susceptible to wind erosion, it is not suited to cultivation. The vegetation consists of post oak, blackjack oak, and mid and tall native grasses. This soil is in the Deep Sand Savannah range site.

Capability unit VIs–2

This unit consists only of the Lucien-Zaneis-Vernon complex, a group of strongly sloping, very shallow to deep soils of the uplands. They formed in beds of red clay and reddish sandstone.

The more sandy Lucien and Zaneis soils take water readily. Because of the slope and the clayey subsoil, the Vernon soil has rapid runoff. To increase the intake of water, keep areas of this soil under a cover of grass.

The soils in this complex are used for range. If grazing is controlled, they support a good cover of native grasses. The Vernon soil is in the Red Clay Prairie range site; the Zaneis and Lucien soils are in the Loamy Prairie range site.

Capability unit VIs–3

This unit consists of the Kipp-Kipson complex, which is made up of strongly sloping, very shallow to moderately deep soils of the uplands. These soils are underlain by olive-gray shale and yellowish-brown siltstone and sandstone.

These soils are best suited to native grasses. They are fertile and produce good yields of forage. Keep these soils under a cover of grass to help control surface runoff and erosion. This complex is in the Loamy Prairie range site.

Capability unit VIIe–1

This unit is made up of Rough broken land, sandy, a land type that consists of steep, broken side slopes along drainageways. The soil material ranges from fine sandy loam to sandy clay. Vertical banks of exposed soil material are common, and outcrops of rock are numerous.

The vegetation consists of post oak, blackjack oak, and native grasses. Keep a good vegetative cover on the side slopes to help control erosion. Many farm ponds have been built along these drainageways. This land type is in the Sandy Savannah range site.

Capability unit VIIs–1

This unit consists of the Windthorst-Darnell complex, which is made up of deep soils and shallow to very shallow soils that are steep and stony. These soils formed under timber.

These soils are moderately sandy. Rock is at the surface in many places. The areas of deep and shallow soils are intermixed. The vegetation consists of scrubby post oak, blackjack oak, and mid and tall native grasses.

The soils in this complex are suited only to woodland range. The productivity of the range is low, and some areas are too steep and stony for easy grazing. This complex is in the Shallow Savannah range site.

Capability unit VIIs–2

This unit consists of one very shallow, stony, steep land type, Rough broken land, clayey, which is made up of interbedded and intermixed red and olive-gray clay and shale and yellowish-brown to red sandstone. On the gentler slopes, there is a loamy surface layer 2 to 8 inches thick. In some places unaltered soil material is exposed.

Mid and tall grasses grow where the surface layer is thickest. Other areas are sparsely covered with weeds and short grasses. This land type is used only for range. Some areas are inaccessible to cattle. Rough broken land, clayey, is in the Breaks range site.

Capability unit VIIIs–1

This unit consists of Oil waste land and Gravel pits. Oil waste land is made up of areas affected by waste material from oil wells. Gravel pits are areas from which the soil material has been removed. These areas serve no useful purpose now but eventually may become partly revegetated. Treatment of these areas is not feasible.

Predicted Yields [3]

In table 2 are predicted long-term average acre yields for the principal crops grown in Stephens County. Yields

[3] Roy M. Smith, soil scientist, Oklahoma Agricultural Experiment Station, assisted in the preparation of this subsection.

are given under two levels of management. In columns A are listed yields to be expected under management practices commonly used in the county. In columns B are those to be expected under improved management.

These predictions are based on records of yields obtained from farmers and on fertility studies, crop variety tests, and the results of rotation and tillage trials recorded by the Oklahoma Agricultural Experiment Station. The experiments were conducted on permanent experiment station sites and on plots belonging to cooperating farmers. Crop failures were considered in predicting the yields. The records provide excellent long-term yield averages for a few soils. For example, reliable records of wheat yields on Kirkland silt loam are available for 63 years; of cotton yields, for 40 years; and of sorghum yields, for 37 years. Similar information covering 10 years or more is available for several other soils.

Customary management (level A) includes (1) proper seeding rates, appropriate planting dates, and efficient harvesting methods; (2) control of weeds, insects, and plant disease; (3) terracing and contour farming where necessary; (4) little or no use of fertilizer, and (5) use of moldboard plow, one-way disk plow, and chisel-type cultivator.

Improved management (level B) includes (1) proper seeding rates, appropriate planting dates, and efficient harvesting methods; (2) control of weeds, insects, and plant diseases; (3) terracing and contour farming where necessary; (4) fertilization according to results of tests; (5) selection of suitable crop varieties; (6) planting cover crops on sandy soils subject to wind erosion; (7) stubble-mulch tillage of sandy and loamy soils; (8) plowing early and leaving a rough, trashy surface where erosion is a hazard; (9) a cropping system that is suited to the operator's goal and the needs of the specific soil.

Management of Rangeland [4]

About 60 percent of the acreage of Stephens County is used for native range. A large acreage in native range is not suited to cultivation. Large areas once cultivated have been seeded to native grasses because the soils were eroded or were too low in fertility to be suitable for cultivated crops.

Most of the native rangeland is used to graze beef cattle. Feeder and stocker calves are usually sold at weaning time. Most areas of range are grazed throughout the year, except where supplemental grazing is provided by tame pastures.

Range sites and condition classes

Range sites are distinctive kinds of rangeland that differ from each other in their capacity for producing native plants. They are the product of a number of factors that influence natural vegetative growth and development. These factors include soils and climate. Soils are of primary consideration in Stephens County since the climate does not produce abrupt site changes within the county. Each site is made up of soils that are capable of producing similar kinds and amounts of vegetation. Any given range site must differ enough from other sites to require different stocking rates or other management methods.

[4] By CHESTER F. FRY, range conservationist, Soil Conservation Service.

Range condition is the present state of the vegetation on a particular site in relation to the climax vegetation for that site. The potential, or climax, vegetation is determined by studying rangeland that has never been overgrazed. Climax vegetation is the stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment remains unchanged. Generally, it is the most productive combination of forage plants for a particular site. Most of the climax plants are palatable to and nutritious for grazing animals.

The kind and amount of vegetation presently on a range site depend on grazing use and other management practices.

The purpose of determining range condition is to establish a basis for predicting the degree of improvement possible under good management. Four classes of range condition are used to indicate the degree to which the climax vegetation has been changed by grazing or other use.

A range is in *excellent condition* if 76 to 100 percent of the vegetation is of the same kind as that in the original stand. A range site in excellent condition and properly grazed is producing almost the maximum amount of vegetation for the site and the climate. Continued good grazing management maintains high productivity, but the amount of forage produced fluctuates considerably with changes in weather.

A range is in *good condition* if 51 to 75 percent of the vegetation is of the same kind as that in the original stand. If a range is in good condition, production of desirable forage can be increased rapidly by managing grazing to encourage the better plants. The actual time required to improve the range to excellent condition through management naturally depends partly on the weather.

A range is in *fair condition* if 26 to 50 percent of the vegetation is of the same kind as that in the original stand. A range in fair condition is unsatisfactory. The plant cover has been damaged, and the soils are subject to erosion. Deferment of grazing during the growing season is generally required for rapid improvement. Supplemental summer pasture can be used to make this possible. Control of weeds and woody plants may be needed to speed recovery on some sites.

A range is in *poor condition* if less than 25 percent of the vegetation is of the same kind as that in the original stand. A range site in poor condition produces only a fraction of the desirable forage it is capable of producing. Most of the vegetation is neither very palatable nor very productive. The soils are subject to deterioration and to erosion. Restoring full productivity is difficult. Supplemental summer pasture, deferment of grazing during the growing season, and control of weeds and woody plants are required. Seeding may be necessary, also.

The plants on each range site can be grouped as decreasers, increasers, and invaders.

Decreasers are plants in the climax vegetation that tend to decrease in abundance under continued heavy grazing. Usually, these are the most productive plants on the given site and the ones most palatable to livestock. They tend to recover if grazing pressure is reduced.

Increasers are plants in the climax vegetation that tend to increase in abundance as the decreasers decline. Some plants increase at first, but then decrease if heavy grazing continues. Increasers are commonly shorter, less productive, and less palatable to livestock than decreasers. Most of them are displaced by decreasers under light

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*

[Yields in columns A are the average yields obtained over a period of years under common management; those in columns B are yields to be expected under improved management. Absence of figure indicates crop is not commonly grown, crop is not suited to soil specified, or soil is not arable]

Soil	Wheat		Oats		Grain sorghum		Forage sorghum		Cotton (lint)		Alfalfa		Broomcorn (brush)		Peanuts	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons* [1]	*Tons* [1]	*Lb.*	*Lb.*	*Tons*	*Tons*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Bethany-slickspot complex	12	17	17	24	15	22	1.3	2.0	----	----	----	----	----	----	----	----
Breaks-alluvial land complex	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Chickasha fine sandy loam, 0 to 1 percent slopes	15	21	28	38	22	32	2.5	3.2	270	360	1.3	2.3	370	450	800	1,300
Chickasha fine sandy loam, 1 to 3 percent slopes	13	19	24	34	20	29	2.0	2.8	230	305	1.0	2.0	350	430	700	1,200
Chickasha fine sandy loam, 3 to 5 percent slopes	11	17	20	30	18	27	1.5	2.3	190	250	----	----	320	400	600	1,100
Chickasha loam, 0 to 1 percent slopes	16	22	30	40	23	33	2.7	3.4	290	380	1.5	2.5	----	----	----	----
Chickasha loam, 1 to 3 percent slopes	14	20	26	32	21	30	2.1	2.9	260	335	1.1	2.1	----	----	----	----
Chickasha loam, 3 to 5 percent slopes	12	18	20	30	17	26	1.7	2.4	200	260	----	----	----	----	----	----
Chickasha loam, 5 to 8 percent slopes	10	15	16	25	----	----	1.5	2.1	----	----	----	----	----	----	----	----
Chickasha-slickspot complex	12	17	17	24	15	22	1.3	2.0	150	200	----	----	----	----	----	----
Clayey saline alluvial land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Dougherty loamy fine sand, hummocky	9	16	13	23	14	22	1.4	2.3	----	----	----	----	----	----	----	----
Dougherty loamy fine sand, undulating	10	18	17	28	18	26	1.8	2.7	140	220	----	----	----	----	800	1,300
Dougherty soils, 1 to 5 percent slopes, eroded	8	15	----	----	13	21	1.3	2.2	----	----	----	----	----	----	----	----
Eroded clayey land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Eroded loamy land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Eufaula fine sand, hummocky	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Gowen clay loam	19	26	35	45	28	38	2.9	3.9	325	415	2.5	3.4	380	470	----	----
Kipp-Kipson complex	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Kirkland-Renfrow silt loams, 1 to 3 percent slopes	12	18	22	35	15	20	1.7	2.5	215	260	----	----	----	----	----	----
Kirkland silt loam, 0 to 1 percent slopes	13	20	25	40	18	24	2.0	2.8	234	290	1.0	2.0	----	----	----	----
Lucien-Zaneis-Vernon complex	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Miller clay	20	24	30	45	28	36	2.9	3.7	300	380	----	----	----	----	----	----
Miller soils, frequently flooded	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Nash fine sandy loam, 1 to 3 percent slopes	13	18	22	32	20	30	2.0	2.8	210	250	----	----	335	415	800	1,400
Nash and Noble fine sandy loams, 3 to 5 percent slopes	11	15	18	28	16	24	1.5	2.0	185	225	----	----	270	330	600	1,100
Nash and Noble fine sandy loams, 5 to 8 percent slopes	9	13	15	25	----	----	1.2	1.7	----	----	----	----	250	300	----	----
Oil waste land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Port clay loam	22	30	40	55	30	40	3.0	4.0	340	430	2.8	3.7	----	----	----	----
Port fine sandy loam	19	25	33	43	30	40	2.8	3.8	320	400	2.4	3.3	380	470	----	----
Port loam	22	30	38	50	32	42	3.0	4.0	340	430	2.6	3.5	400	490	----	----
Port soils, frequently flooded	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Renfrow and Kirkland soils, 1 to 5 percent slopes, eroded	9	14	17	27	11	16	1.3	2.0	160	210	----	----	----	----	----	----
Renfrow silt loam, 3 to 5 percent slopes	10	15	18	30	12	17	1.4	2.1	----	----	----	----	----	----	----	----
Rough broken land, clayey	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rough broken land, sandy	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Sandy alluvial land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stephenville and Windthorst soils, severely eroded	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stephenville-Darnell complex, 5 to 12 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stephenville fine sandy loam, 1 to 3 percent slopes	10	17	17	28	13	20	1.5	2.5	110	180	----	----	----	----	800	1,300
Stephenville fine sandy loam, 3 to 5 percent slopes	9	16	14	22	10	17	1.1	1.8	100	170	----	----	----	----	700	1,200
Stephenville fine sandy loam, 3 to 5 percent slopes, eroded	8	15	13	20	9	15	1.0	1.5	----	----	----	----	----	----	600	1,100
Stephenville fine sandy loam, 5 to 8 percent slopes	----	----	----	----	8	12	----	----	----	----	----	----	----	----	----	----
Windthorst-Darnell complex	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Windthorst fine sandy loam, 1 to 5 percent slopes	8	14	13	20	10	16	1.0	1.5	----	----	----	----	----	----	----	----
Windthorst fine sandy loam, 1 to 5 percent slopes, eroded	7	12	11	18	----	----	.8	1.3	----	----	----	----	----	----	----	----
Zaneis loam, 1 to 3 percent slopes	14	20	26	32	21	30	2.0	2.8	225	300	1.0	2.0	----	----	----	----
Zaneis loam, 3 to 5 percent slopes	12	18	20	29	17	26	1.7	2.3	200	260	----	----	----	----	----	----
Zaneis loam, 3 to 5 percent slopes, eroded	11	17	18	27	----	----	1.5	2.1	----	----	----	----	----	----	----	----
Zaneis loam, 5 to 8 percent slopes	10	15	16	25	----	----	1.5	2.0	----	----	----	----	----	----	----	----

[1] Ovendry weight.

grazing, but some, such as oak, coralberry, ironweed, western ragweed, and pricklypear, may have to be controlled by other means.

Invaders are not part of the climax vegetation. They become established after the decreasers have been weakened by overgrazing or other disturbance. They may be native to nearby sites, or they may have been transported from a considerable distance. Generally, they are less productive, less palatable, and less dependable for forage than the climax plants.

Range condition is the state of the vegetation in relation to the climax condition for that site. It does not indicate whether the range is improving or deteriorating. The trend must be determined in order to plan grazing management that will maintain or improve the range. Some of the factors that indicate the trend in range condition are plant vigor, abundance of seedlings and young plants, a change in the composition of the vegetation, an accumulation of plant residues, and the condition of the soil surface.

Descriptions of range sites

In this subsection the range sites in Stephens County are described; the soils in each are listed; and the important characteristics of the soils and the names of the principal grasses are given.

Breaks-alluvial land complex, Gravel pits, Oil waste land, and Sandy alluvial land have no range site classifications. Breaks-alluvial land complex is considered part of whatever site the soils surrounding it are in. Gravel pits and Oil waste land are not suited to agricultural use. Sandy alluvial land can be managed in the same way as soils of the Loamy Bottom Land range site.

ALKALI BOTTOM LAND SITE

This site consists only of Clayey saline alluvial land, a land type on nearly level bottom lands.

The moisture relations are unfavorable for the growth of native tall grasses. The irregular intermixture of soils results in many differences in vegetation. There are occasional bare spots and, also, some productive areas. The vegetation is limited to plants that resist drought and tolerate salts. It consists of side-oats grama, blue grama, western wheatgrass, white tridens, gummy lovegrass, windmillgrass, tumblegrass, vine-mesquite, silver bluestem, buffalograss, and annual grasses that grow in cool seasons. Windmillgrass, tumblegrass, pricklypear, mesquite trees, and cool-season annual grasses will eventually take over if the site is overgrazed.

Some areas of saline soils are sparsely covered with rhombopod, whorled dropseed, alkali sacaton, inland saltgrass, tumblegrass, and Texas wintergrass. The vegetation varies according to the severity of the effect of the alkali. The more severely affected areas have no vegetation.

BREAKS SITE

This site consists of Rough broken land, clayey, a steep, stony land type. Some areas have a thin surface layer of loamy soil material. Small barren areas are common where the parent material is exposed and outcrops of rock occur.

Sand bluestem, little bluestem, Indiangrass, and switchgrass grow in the areas where the surface layer is the thickest. Hairy grama, Texas grama, side-oats grama, blue grama, and buffalograss grow in the other areas. Short grasses and weeds will replace the tall and mid grasses if the site is overgrazed. Mesquite trees have invaded some areas.

CLAYPAN PRAIRIE SITE

This site consists of deep, nearly level to moderately sloping soils on divides and upper slopes between natural drainageways. The soils are—

Kirkland-Renfrow silt loams, 1 to 3 percent slopes.
Kirkland silt loam, 0 to 1 percent slopes.
Renfrow and Kirkland soils, 1 to 5 percent slopes, eroded.
Renfrow silt loam, 3 to 5 percent slopes.

The surface layer is silt loam that becomes saturated in wet seasons and extremely dry in seasons of inadequate rainfall. The subsoil is compact, blocky clay that restricts the penetration of moisture and roots and causes slow internal drainage and poor aeration. The surface layer is slightly acid to neutral. The subsoil is slightly acid to moderately alkaline.

About 60 percent of the vegetation consists of climax decreasers, such as side-oats grama, blue grama, western wheatgrass, and tall dropseed. Switchgrass, little bluestem, vine-mesquite, and wildrye grow on this site, but, because of poor moisture relations, only in small amounts. Increasers make up about 40 percent of the climax vegetation. The principal species are buffalograss, windmillgrass, tumblegrass, gummy lovegrass, silver bluestem, and hairy grama.

Any deterioration in the vegetation results in immediate and rapid invasion by annual three-awn, Japanese brome, little barley, Texas grama, Texas wintergrass, red three-awn, and weedy forbs. Continued overuse results in the invasion of pricklypear and mesquite trees.

This site is limited in productivity because the soils are droughty. Once the vegetation has deteriorated, recovery is very slow. Restricting grazing to winter and spring helps to maintain and improve the vegetation. The warm-season grasses cure well, and they will provide good winter grazing if mixed with the cool-season grasses.

DEEP SAND SAVANNAH SITE

This site consists of deep, sandy to very sandy soils of the uplands. These soils formed under trees. They take up moisture readily, but they are droughty because of their low moisture-holding capacity. These soils are—

Dougherty loamy fine sand, hummocky.
Dougherty loamy fine sand, undulating.
Dougherty soils, 1 to 5 percent slopes, eroded.
Eufaula fine sand, hummocky.

The climax vegetation consists of open stands of oak brush and an understory of grasses and forbs, of which sand bluestem, little bluestem, Indiangrass, switchgrass, perennial lespedeza, and tickclover are the most common.

If the grass cover is thinned out by fire or overgrazing, oak and other woody plants increase in density. Other increasers are fringeleaf paspalum, sandgrass, sandbur, and snakecotton. The original productivity of this site can be restored by controlling the brush and deferring grazing during the growing season.

ERODED CLAY SITE

This site consists of Eroded clayey land, a land type of severely eroded soils that occur as small areas. These areas were cultivated at one time, but most of the original surface layer has been lost through erosion and some gullies have formed.

This site is low in productivity, and desirable vegetation is difficult to establish. A mixture of grasses, such as blue grama, side-oats grama, buffalograss, and some of the taller native prairie grasses can be seeded.

HEAVY BOTTOM LAND SITE

This site consists of clayey soils of the bottom lands. These soils take water very slowly. Some areas are frequently flooded. Forage yields vary in relation to frequency of overflow. These soils are—

Miller clay.
Miller soils, frequently flooded.

A high percentage of the climax vegetation consists of cool-season grasses, mainly Virginia wildrye. Other grasses included are eastern gamagrass, switchgrass, Indiangrass, sand bluestem, big bluestem, and little bluestem. Sedges are very common. Sumpweed usually grows in poorly drained areas. Trees and brush grow in some areas, especially in those that are frequently flooded.

Overgrazing causes the productive tall grasses to give way to plants that are not grazed because they are not palatable to livestock or because they are too short. These plants include buffalograss, sumpweed, meadow dropseed, silver bluestem, western ragweed, Texas wintergrass, and windmillgrass.

LOAMY BOTTOM LAND SITE

This site is made up of deep soils of the bottom lands. These soils range from clay loam to fine sandy loam in texture. Included are small areas of loamy sand that are used mostly for tame pasture. In most areas, moisture relations are favorable for trees, grasses, and forbs. Much of the acreage has been cleared for cultivation. Some of the areas once cultivated are now used for tame pasture consisting mostly of bermudagrass. Some areas are densely covered with trees and brush, and some are open grassland. These soils are—

Gowen clay loam.
Port clay loam.
Port fine sandy loam.
Port loam.
Port soils, frequently flooded.

The climax vegetation consists of eastern gamagrass, big bluestem, sand bluestem, Indiangrass, switchgrass, Canada wildrye, Virginia wildrye, perennial sunflower, compassplant, perennial lespedeza, tickclover, and pecan, elm, oak, hackberry, and cottonwood trees.

In some places heavy grazing has reduced the vigor and density of the productive grasses and, as a result, dense stands of woody plants have developed. In other areas the less palatable and less productive grasses, such as silver bluestem, meadow dropseed, Texas wintergrass, and buffalograss, have become dominant. Productivity can be restored by controlling the brush and regulating grazing.

LOAMY PRAIRIE SITE

This site consists of nearly level to rolling soils that have a surface layer of loam, silt loam, and fine sandy loam. The texture and depth are such that the moisture relations are favorable for the growth of the highly productive tall grasses. These soils are—

Bethany-slickspot complex (Bethany portion).
Chickasha fine sandy loam, 0 to 1 percent slopes.
Chiskasha fine sandy loam, 1 to 3 percent slopes.
Chickasha fine sandy loam, 3 to 5 percent slopes.
Chickasha loam, 0 to 1 percent slopes.
Chickasha loam, 1 to 3 percent slopes.
Chickasha loam, 3 to 5 percent slopes.
Chickasha loam, 5 to 8 percent slopes.
Chickasha-slickspot complex (Chickasha portion).
Eroded loamy land.
Kipp-Kipson complex.
Lucien-Zaneis-Vernon complex (Zaneis portion).
Nash and Noble fine sandy loams, 3 to 5 percent slopes.
Nash and Noble fine sandy loams, 5 to 8 percent slopes.
Nash fine sandy loam, 1 to 3 percent slopes.
Zaneis loam, 1 to 3 percent slopes.
Zaneis loam, 3 to 5 percent slopes.
Zaneis loam, 3 to 5 percent slopes, eroded.
Zaneis loam, 5 to 8 percent slopes.

This is the most productive range site in the uplands (fig. 13). Approximately 80 percent of the climax vegetation consists of decreaser grasses, such as little bluestem, switchgrass, sand bluestem, Indiangrass, and big bluestem. About 10 percent of the climax vegetation is legumes, other forbs, and woody plants, and about 10 percent is increasers, such as side-oats grama, blue grama, and hairy grama.

Figure 13.—**Loamy Prairie range site in excellent condition.**

Over grazing results in openings in the ground cover and permits invasion by annual three-awn, Japanese brome, little barley, annual broomweed, western ragweed, and other weedy grasses and forbs. Light to moderate grazing usually results in the return of the climax vegetation. Improvement is generally faster if grazing is deferred during the growing season.

The normal grazing season is late spring and summer, but some areas can be grazed throughout the year.

RED CLAY PRAIRIE SITE

This site consists of shallow or very shallow, red, clayey Vernon soils that are mapped as part of the Lucien-Zaneis-Vernon complex. The high clay content of these soils restricts the intake of water and the depth to which roots penetrate; consequently, the moisture relations are not favorable for the growth of tall grasses.

A large part of the climax vegetation consists of side-oats grama and tall dropseed. The other decreasers are mainly sand bluestem, western wheatgrass, little bluestem, switchgrass, and vine-mesquite. The increasers are blue grama, hairy grama, and buffalograss.

As the climax vegetation declines, annual grasses and forbs invade. Dense stands of Japanese brome and little

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barley develop in areas where the moisture supply is favorable in winter. Other invaders are three-awn, broomweed, Texas grama, Texas wintergrass, and buffalograss. Continued overuse often results in invasion by pricklypear and mesquite trees.

Once the vegetation has deteriorated, recovery is usually slow because the soils are droughty.

SANDY SAVANNAH SITE

This site consists of deep soils that have a surface layer of fine sandy loam. Some of the acreage was cultivated and then abandoned and now either is in some stage of natural revegetation or has been seeded to climax grasses; some was overgrazed or damaged by fire and now is densely covered with oak brush; and some has been treated with herbicides to control the oak brush and now supports stands of native grass. These soils are—

Rough broken land, sandy.
Stephenville and Windthorst soils, severely eroded.
Stephenville-Darnell complex, 5 to 12 percent slopes (Stephenville portion).
Stephenville fine sandy loam, 1 to 3 percent slopes.
Stephenville fine sandy loam, 3 to 5 percent slopes.
Stephenville fine sandy loam, 3 to 5 percent slopes, eroded.
Stephenville fine sandy loam, 5 to 8 percent slopes.
Windthorst fine sandy loam, 1 to 5 percent slopes.
Windthorst fine sandy loam, 1 to 5 percent slopes, eroded.

About 75 percent of the climax vegetation consists of decreasers, such as little bluestem, switchgrass, bluestem, Indiangrass, perennial lespedeza, and tickclover. Post oak, blackjack oak, and other woody plants make up about 15 percent of the increasers, and purpletop and side-oats grama about 10 percent.

Overgrazing results in a rapid increase in oak brush and invasion by broomsedge bluestem, splitbeard bluestem, silver bluestem, partridgepea, deervetch, and other grasses and forbs.

Mechanical or chemical means of brush control are needed, in addition to general good management, to restore the productivity of this site (fig. 14). The normal grazing season is late spring and summer, but some areas can be grazed throughout the year.

SHALLOW PRAIRIE SITE

This site consists of shallow loamy soils. It occurs above the sandstone outcrops that form narrow bands across slopes. It is made up of the Lucien soils that are mapped as part of the Lucien-Zaneis-Vernon complex.

Figure 14.—**Sandy Savannah range site where oak brush was sprayed in 1959 and grazing was deferred for two seasons.**

Shallowness limits the development of plant roots and the water-holding capacity of the soils that make up this site.

The climax vegetation consists of approximately 50 percent decreasers, such as little bluestem, switchgrass, and Indiangrass. Common increasers are side-oats grama, hairy grama, and blue grama. Invaders include annual three-awn, puffsheath dropseed, and annual cool-season grasses.

SHALLOW SAVANNAH SITE

This site consists of shallow to very shallow soils formed in sandstone. It occurs in irregular patterns in association with the Sandy Savannah range site. These soils are—

Windthorst-Darnell complex.
Stephenville-Darnell complex, 5 to 12 percent slopes (Darnell portion).

Shallowness limits the water-holding capacity of these soils. Outcrops of hard sandstone are common.

The climax vegetation consists of an open stand of post oak, blackjack oak, and an understory of grasses and forbs. The most common grasses are little bluestem, side-oats grama, tall grama, and switchgrass. Slender lespedeza and other native legumes are abundant. Rock outcrops and areas near them are nearly barren. Hairy grama is the most common increaser.

This range site can be grazed and managed in about the same way as the Sandy Savannah range site.

SLICKSPOT SITE

This site consists of deep soils that have a loamy surface layer and a compact, columnar clay subsoil. In some places the surface layer is crusted. Runoff is rapid and internal drainage is very slow in these areas. These soils are—

Bethany-slickspot complex (slickspot portion).
Chickasha-slickspot complex (slickspot portion).

About 50 percent of the climax vegetation consists of decreasers, such as alkali sacaton, white tridens, blue grama, tall dropseed, switchgrass, and yellow neptunia. Common increasers are whorled dropseed, purple three-awn, mourning lovegrass, gummy lovegrass, and fall switchgrass. Rhombopod, pricklypear, and curlycup gumweed are common forbs.

Any deterioration in the vegetation results in a rapid invasion by annual three-awn, Japanese brome, little barley, Texas grama, Texas wintergrass, and weedy forbs. This site is limited in productivity because the soils are droughty. Once the vegetation has deteriorated, recovery is very slow.

Range management practices

The principal requirements for good range management are selecting the kind of livestock to which the range is best suited, limiting grazing to protect the plant cover, and making seasonal adjustments to make the best use of seasonal palatable plants. Supplemental practices are grazing, development of water, range seeding, control of brush, and control of weeds.

Proper range use.—Limiting grazing so as to maintain cover adequate to protect the soil and to maintain or improve the quality and quantity of desirable vegetation is

an important range practice. Generally, this means leaving at least half of the annual growth at the end of the grazing season.

Recommended stocking rates are not included in this report, because range condition and productivity are variable. Recommended rates are available at the local office of the Soil Conservation Service. These data are useful as a guide, but the effects of grazing should be observed and adjustments should be made in the number of livestock and in the length of time a site is grazed.

Deferred grazing.—Periodically postponing or deferring grazing for a prescribed time during any period of plant growth helps to improve the range. Maximum range improvement can be expected if grazing is deferred till the end of the growing season. Deferment in spring usually increases the vigor and productivity of warm-season range grasses. Deferment in fall generally increases the production of seed.

Development of water.—Water for livestock is usually provided by building ponds. Wells may be needed, however, in the deep sandy range sites. Properly spaced stock ponds and wells will make for a more even distribution of grazing within large pastures.

Range seeding.—Seeding suitable grasses and legumes, primarily native plants, is an important range practice. The climax plants listed in the descriptions of the range sites give the most satisfactory results. Seed is usually planted in a clean-tilled, firm seedbed, except in sandy areas that are subject to damage by wind erosion. In these areas, grass can be seeded in a cover of sorghum stubble by means of a grass-seed drill. Until a stand of grass is well established, at least 2 years, a seeded field should not be grazed during the growing season, and no more than half the plant growth should be removed by winter grazing.

Control of brush.—Brush can be controlled by the use of chemical sprays, by mechanical methods, or through natural succession. Chemical control is usually the most practical for large areas, but mechanical methods can be used on small areas. Either method requires treatment periodically, but the areas treated with chemical sprays require retreatment less often. Growing highly productive tall native grasses on the treated areas will help to crowd out the brush.

Control of weeds.—Generally, weeds can be kept under control by properly regulated grazing, but chemical sprays may be needed if dense stands of western ragweed or other persistent perennial weeds have developed. Grazing should be deferred until forage plants have filled the openings left by removal of the weeds.

Range site productivity

Data on actual production of herbage are limited. Table 3 gives estimated annual yields for each range site during both favorable and unfavorable weather cycles. Yields may be higher if the weather is unusually favorable for a year or two in a cycle of favorable weather, and they may be lower if there are periods of extreme drought during an unfavorable cycle.

The estimates in table 3 are for range in excellent condition, and they represent the total amount of air-dried herbage, clipped to the ground. Some of the herbage produced, however, is consumed by rodents and insects, and some is lost through weathering. If grazing is managed so that half of the current annual growth is left, only about 25 to 35 percent may have been consumed by the livestock.

TABLE 3.—*Estimated average acre yields of annual herbage during favorable and unfavorable weather cycles*

Range site	Total annual yield of air-dried herbage—	
	Favorable weather cycle	Unfavorable weather cycle
	Lb. per acre	*Lb. per acre*
Alkali Bottom Land	1, 800	1, 000
Breaks	2, 000	1, 200
Claypan Prairie	2, 600	1, 400
Deep Sand Savannah	3, 400	1, 800
Eroded Clay	1, 200	500
Heavy Bottom Land	5, 000	2, 400
Loamy Bottom Land	8, 000	4, 200
Loamy Prairie	5, 500	2, 800
Red Clay Prairie	2, 200	1, 000
Sandy Savannah	4, 200	2, 400
Shallow Savannah	2, 500	1, 500
Shallow Prairie	3, 000	1, 500
Slickspot	1, 800	800

Woodland and Windbreaks [5]

About one-third of the total land area of Stephens County is woodland. About 173,000 acres of this is in the uplands, and about 9,000 acres is in the bottom lands.

Post oak, blackjack oak, and hickory are the main trees in the uplands. In some areas the post oak and hickory have been cut and the blackjack oak is now dominant. These hardwoods, though not managed for commercial use, once supplied posts and rough lumber for local use.

Intermittent and open stands of elm, hackberry, hickory, cottonwood, and willow grow in the bottom lands. Chinquapin oak, post oak, bur oak, red oak, and black oak trees also are scattered through the stands. At one time a number of small sawmills processed lumber cut from the bottom lands, and portable mills are still operated occasionally in some localities.

Field windbreaks would help control wind erosion and protect crops on many areas of Dougherty loamy fine sand, Stephenville fine sandy loam, Windthorst fine sandy loam, and Chickasha fine sandy loam.

To be fully effective, field windbreaks should be planted in planned protective patterns and not as isolated strips. Belts of three rows, consisting of two rows of tall trees and one row of shrubs or of a dense growth of low-growing trees will provide adequate protection. The intervals between the belts should be no more than 20 times the height the tall trees reach at maturity. The trees in each row can be 6 to 8 feet apart. The distance between the rows should be no less than 10 feet, and ordinarily no more than is necessary to accommodate cultivating equipment. Proper crop rotations, utilization of crop residues, and cover crops are needed to supplement

[5] By HERBERT R. WELLS, soil conservationist, Soil Conservation Service.

the protection provided by field windbreaks, particularly before the trees reach maturity. All windbreak plantings need shallow cultivation until the time that the closing branches are injured by passing machinery.

Shrubs and trees suitable for field windbreaks and readily available include Chinese elm or Siberian elm (*Ulmus pumila*), sycamore, honeylocust, cottonwood, redcedar, Austrian pine, and shortleaf pine. Russian mulberry and redcedar, spaced 4 feet apart, can be used in the shrub row.

Farmstead windbreaks generally need not be so high as field windbreaks. Because of this, it is possible to plant farmstead windbreaks on less favorable soils, especially if additional cultivation is possible and if supplemental water can be applied in prolonged droughts. The kinds of trees suitable for field windbreaks are suitable for farmstead windbreaks, but taller species are generally not needed. Redcedar and Austrian pine are suitable for the shrub row, as well as other species locally available.

Postlots can be established on the permeable soils of the bottom lands. Catalpa, black locust, and Osage-orange are the trees commonly planted for posts. Spacing and management are about the same as for windbreaks. Pruning may be necessary, and after some trees have been cut, the sprouts that develop should be thinned and managed for later harvests.

Wildlife

The population of game and furbearing species of wildlife is moderate throughout Stephens County, but the soils and vegetation provide a suitable environment, and the wildlife population would increase and stabilize if more attention were given to proper management and to the prevention of range and wood fires.

The principal game species in this county are bobwhite, dove, cottontail rabbit, and fox squirrel. There are white-tail deer in sufficient numbers to permit a short open season on the bucks. Furbearing animals are not numerous in the county. Some skunk, opossum, raccoon, muskrat, and mink inhabit areas along Cow Creek, Beaver Creek, and Wildhorse Creek.

Of the upland areas, the extensive cross-timbers area, which includes the Stephenvillle, Dougherty, and other sandy soils, supports the most wildlife and has the greatest potential for development of new habitats. Post oak, blackjack oak, chinquapin oak, bluestem, and annual grasses and forbs are the principal food and cover plants in the cross timbers. Thinning the denser stands of blackjack oak and planting small grain and other suitable plants would provide additional food for wildlife. In all of the upland areas, the native vegetation along rights-of-way, field borders, and margins of woods provide suitable wildlife habitats.

This county has a complex drainage system, although it has no major streams. The drainageways and bottom lands provide good wildlife habitats. Furbearing animals are more common in these areas than in the uplands. Oak, elm, hackberry, hawthorn, blackhaw, bumelia, and roughleaf dogwood are the principal trees. There are more kinds of oaks and more large den trees than in the uplands. Larger trees are common on the bottom lands of Cow Creek, Beaver Creek, and Wildhorse Creek, and pecans are a major item of food for wildlife in these areas.

Good fishing is provided by many farm ponds and flood control reservoirs and by several lakes, some as much as 1,300 acres in size. The ponds and reservoirs are stocked mainly with largemouth bass, bluegill, red-ear sunfish, channel catfish, and crappie. Silting and pollution with oil-field waste have killed most of the catfish in the creeks. During periods of high water there are influxes of fish from the larger streams outside the county. Controlling aquatic weeds, keeping the water clear, and removing rough fish will help to increase the number of game fish in the ponds.

Waterfowl provide some hunting in areas near streams, particularly in areas that are near cultivated fields and fields of small grain. Areas in and around the flood-control structures can be managed to attract wildlife. Controlling the water level and planting millet in these areas will attract ducks and geese for a longer period in spring and fall. Upland birds and animals can also be attracted to these areas by planting patches of black locust, multiflora rose, lovegrass, and other plants suitable for food and cover.

Engineering Properties of Soils [6]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, drainage systems, irrigation systems, and sewage disposal systems. The properties most important to the engineer are permeability to water, shrink-swell potential, consolidation characteristics, texture, plasticity, and pH. Topography and depth of unconsolidated materials are also important.

The information in this report can be used to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of soil properties that will help in the planning of agricultural drainage systems, farm ponds, irrigation systems, terraces, waterways, and diversion terraces.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting highway, airport, and pipeline locations and in planning detailed investigations at selected locations.
4. Locate probable sources of gravel, sand, and other construction material.
5. Correlate performance of engineering structures with soil mapping units to develop information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soil units for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photographs to make maps and reports that will be more useful to engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular areas.

[6] By V. T. Bergschneider and W. E. Hardesty, engineers, Soil Conservation Service.

This report does not eliminate the need for on-site sampling and testing for specific engineering works and uses. It should be used primarily in planning more detailed field investigations to determine the in-place condition of the soil at proposed construction sites.

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and other terms may have special meanings in soil science. These terms are defined in the Glossary at the back of this report.

Engineering classifications, interpretations, and soil test data

The engineer needs to know the physical properties of the soil materials and the in-place condition of the soils in order to make the best use of the soil map and the soil survey report. The information and interpretations of most significance to engineers are presented in tables 4, 5, and 6. Additional information can be found in these sections of the report: "General Soil Map" and "Descriptions of the Soils." Brief explanations of how the information in the tables was obtained and explanations of the significance of some of the items follow.

TABLE 4. Table 4 gives brief descriptions of most of the soils mapped in Stephens County and estimates of the soil properties that affect engineering work. These properties are based on a typical profile for each soil mapped. Since these estimates are for a typical profile only, considerable variation should be anticipated. The soil profile is divided into significant layers by depth, in inches, from the surface. More complete descriptions of each soil may be found in the section "Genesis, Classification, and Morphology of the Soils."

Table 4 also gives estimated engineering classifications for the soils according to the Unified system,[7] and according to the system used by the American Association of State Highway Officials (AASHO).[8]

In the Unified system, the soils are grouped on the basis of their texture and plasticity and their performance as material for engineering structures. Soil materials are identified as coarse grained, that is, gravels (G) and sands (S); fine grained, that is, silts (M) and clays (C); or highly organic (O). Clean sands are identified by the symbols SW or SP; sands mixed with fines of silt and clay are identified by the symbols SM and SC; silts and clays that have a low liquid limit are identified by the symbols ML and CL; and silts and clays that have a high liquid limit are identified by the symbols MH and CH.

In the AASHO system, classification is based on physical properties of the soil materials and the field performance of the soils in highways. The soils are placed in seven principal groups. The groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, consisting of clay soils that have low strength when wet. Within each group, the relative engineering value of the soil material is indicated by a group index number. Group indexes range from 0 for the best materials to 20 for the poorest. The group index number is shown in parentheses after the soil group symbol, for example, A–4(7).

The shrink-swell potential is an indication of the volume change to be expected with a change in moisture content. Soils with a high clay content (CH, A–7) have a high shrink-swell potential; sandy soils (SM, A–2) have a low shrink-swell potential.

TABLE 5. Table 5 rates the soils in the county as sources of material for engineering uses and lists specific characteristics that affect the suitability of each soil as a site for engineering structures and those that affect the need for or applicability of engineering structures and practices. The data in this table are based on the estimates given in table 4, on actual test data given in table 6, on field experience, and on the observed performance of the soils.

TABLE 6. Table 6 summarizes data obtained by laboratory analysis of samples taken from 10 profiles representing soils of Stephens County. The modal profile is the one that is most nearly typical of the series. The nonmodal profiles show significant variations within the concept of the series or mapping unit. These samples were tested for liquid limit, plasticity index, shrinkage limit, shrinkage ratio, volume change, and grain-size distribution. The data were obtained by mechanical analysis and by tests made to determine the liquid limit and the plastic limit. The tests were made by the Materials and Research Department, Oklahoma Department of Highways, in accordance with standard procedures of the American Association of State Highway Officials.

The thickness of each horizon sampled is shown in the column headed "Depth." Not all layers of each profile were sampled. Samples of Kipp silt loam, for example, were taken at 0 to 9 inches, and at 16 to 32 inches.

Liquid limit and plastic limit measure the effect of water on the consistence of soil material. As the moisture content of a clayey soil increases from a dry state, the material changes from a solid to a semisolid, or a plastic, state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the material passes from a solid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

Shrinkage limit is the moisture content at which shrinkage stops. As moisture leaves the soil, the soil shrinks and decreases in volume in proportion to the loss in moisture until a condition of equilibrium is reached where shrinkage stops even if additional moisture is removed. Shrinkage limit is related to clay content. For soils that contain a great deal of clay, the shrinkage limit is generally a low number. For sand that contains little or no clay, the shrinkage limit is close to the liquid limit and therefore is considered insignificant. Sand that contains some silt and clay has a shrinkage limit of about 14 to 25. Clay has a shrinkage limit of about 9 to 14. The load-carrying capacity of most soils is at a maximum when the moisture content is at or below the shrinkage limit. Sand does not follow this rule, because if confined it has a uniform load-carrying capacity within a considerable range in moisture content.

[7] WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS. THE UNIFIED SOIL CLASSIFICATION SYSTEM. Tech. memo. 3–357, 2 v. and app., 49 pp., illus. 1953.

[8] AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS. STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING. Ed. 8, 2 v., 401 and 617 pp., illus. 1961.

713-464—64——4

TABLE 4.—*Brief description of soils and their*

Map symbol	Soil names	Description of soil and site	Depth from surface	Classification: USDA texture
			In.	
Bc	Bethany-slickspot complex.	Complex of deep, gently sloping, loamy soils on uplands; clayey subsoil; substratum of clayey material or weathered shale. Properties of Bethany soils described here. For properties of slickspot soils, see description of Chickasha-slickspot complex.	0 to 10	Silt loam
			10 to 18	Silty clay loam
			18 to 40	Clay
			40 to 50+	Clay
Ba	Breaks-alluvial land complex.	Highly variable soil material on steep side slopes of narrow drainageways; slope range is 8 to 25 percent; varying amounts of mixed alluvial land in drainageways. All properties variable.	----------	----------
CaA	Chickasha fine sandy loam, 0 to 1 percent slopes.	Deep, well-drained, moderately sandy soils on uplands; subsoil of sandy clay loam and clay loam; developed from sandstone, sandy shale, and sandy earths.	0 to 11	Fine sandy loam
CaB	Chickasha fine sandy loam, 1 to 3 percent slopes.		11 to 37	Sandy clay loam or clay loam.
CaC	Chickasha fine sandy loam, 3 to 5 percent slopes.		37 to 52+	Clay loam
ChA	Chickasha loam, 0 to 1 percent slopes.	Deep, well-drained, loamy soils on uplands; subsoil of sandy clay loam and clay loam; developed from sandstone, sandy shale, and sandy earths.	0 to 10	Loam
ChB	Chickasha loam, 1 to 3 percent slopes.		10 to 45	Clay loam
ChC	Chickasha loam, 3 to 5 percent slopes.		45 to 60+	Sandy clay loam
ChD	Chickasha loam, 5 to 8 percent slopes.			
Ck	Chickasha-slickspot complex.	Complex of deep, gently sloping soils on uplands. Slickspot soils have a more clayey subsoil than Chickasha soils and have slow to very slow internal drainage. Properties of slickspot soils described here. For properties of Chickasha soils, see description of Chickasha loams and fine sandy loams.	0 to 10	Fine sandy loam
			10 to 21	Clay loam
			21 to 29	Clay loam
			29 to 50+	Clay loam
Cs	Clayey saline alluvial land.	Level or nearly level, clayey soils on bottom lands; locally saline; frequently flooded; depressed areas poorly drained; very slow internal drainage.	0 to 6	Clay loam to clay
			6 to 60+	Clay
DoB	Dougherty loamy fine sand, undulating.	Deep soils on uplands; sandy surface layer; sandy clay loam subsoil; substrata of old sandy alluvium; short, irregular slopes, steeper and somewhat more irregular in hummocky phase than in undulating phase.	0 to 21	Loamy fine sand
			21 to 43	Sandy clay loam
DoC	Dougherty loamy fine sand, hummocky.		43 to 72+	Fine sand
DuB2	Dougherty soils, 1 to 5 percent slopes, eroded.	Sandy soils on uplands; like Dougherty loamy fine sands, except that a large amount of the original surface layer has been removed by erosion.	0 to 5	Loamy fine sand to sandy clay loam.
			5 to 43	Sandy clay loam
			43 to 72+	Fine sand
Es	Eroded clayey land.	Severely eroded soils on uplands; clayey subsoil; slope range is 1 to 5 percent. Includes Bethany, Chickasha, Kirkland, Renfrow, and Vernon soils and slickspots. Properties described are those of a hypothetical profile covering range of conditions in this land type.	0 to 2	Silt loam to clay
			2 to 6	Clay loam to clay
			6 to 24	Clay
			24 to 54+	Clay

See footnotes at end of table.

estimated physical and chemical properties

Classification—Continued		Percentage passing sieve [1]—		Permeability	Available water capacity	Reaction	Salinity [2]	Shrink-swell potential
Unified	AASHO	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
				In. per hr.	*In. per in.*	*pH*		
ML-CL	A-4(7)	100	65 to 75	0. 8 to 2. 5	0. 14	6. 1 to 6. 5	None	Moderate to low.
ML	A-7-6	100	80 to 90	0. 8 to 1. 5	. 14	6. 1 to 6. 5	None	Moderate to high.
CL	A-6	100	85 to 95	0. 05 to 0. 2	. 17	6. 6 to 7. 8	None	High to moderate.
CL	A-6	100	80 to 90	0. 05 to 0. 2	. 17	7. 4 to 8. 4	None	High to moderate.
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SM	A-4(2)	100	40 to 50	0. 8 to 2. 5	. 12	6. 1 to 6. 5	None	Low.
CL	A-6(6)	100	55 to 65	0. 8 to 1. 5	. 14	6. 1 to 6. 5	None	Low to moderate.
CL	A-6(8)	100	60 to 70	0. 8 to 1. 5	. 14	6. 1 to 6. 5	None	Low to moderate.
ML	A-4	100	55 to 65	0. 8 to 2. 5	. 14	6. 1 to 6. 5	None	Low to moderate.
CL	A-6	100	60 to 70	0. 8 to 2. 5	. 14	6. 1 to 6. 5	None	Moderate.
ML-CL	A-4	100	55 to 65	0. 8 to 2. 5	. 14	6. 1 to 6. 5	None	Low to moderate.
ML	A-4	100	50 to 60	0. 05 to 0. 2	. 14	6. 1 to 6. 5	Moderate	Low.
CL	A-6	100	55 to 65	0. 05 to 0. 2	. 14	6. 1 to 6. 5	Moderate	Moderate.
CL	A-6	100	50 to 60	0. 05 to 0. 2	. 14	6. 1 to 6. 5	Moderate	Moderate.
CL	A-6	100	50 to 60	0. 05 to 0. 2	. 14	6. 1 to 6. 5	Moderate	Moderate.
ML-CL	A-6, A-7	100	80 to 100	0. 05 to 0. 2	. 17	6. 6 to 7. 3	None to severe.	Moderate to high.
CL, CH	A-6, A-7	100	80 to 100	0. 05 to 0. 2	. 17	6. 6 to 7. 8	None to severe.	High.
SM	A-2	100	20 to 30	2. 5 to 5. 0	. 07	6. 1 to 6. 5	None	Low.
SM-SC, ML-CL	A-4	100	45 to 55	0. 8 to 2. 5	. 12	6. 1 to 6. 5	None	Low to moderate.
SM	A-2	100	20 to 30	2. 5 to 5. 0	. 07	6. 1 to 6. 5	None	Low.
SM	A-2, A-4	100	20 to 45	2. 5 to 5. 0	. 07	6. 1 to 6. 5	None	Low.
SM-SC, ML-CL	A-4	100	45 to 55	0. 8 to 2. 5	. 12	6. 1 to 6. 5	None	Low to moderate.
SM	A-2	100	20 to 30	2. 5 to 5. 0	. 07	6. 1 to 6. 5	None	Low.
ML-CL	A-7	100	85 to 95	0. 05 to 0. 2	. 17	6. 3 to 7. 3	None to moderate.	Moderate to high.
ML-CL	A-7	100	90 to 100	0. 05 to 0. 2	. 17	6. 6 to 7. 3	None to moderate.	Moderate to high.
CL-CH	A-7	100	90 to 100	0. 05 to 0. 2	. 17	7. 4 to 7. 8	None to moderate.	High.
CL-CH	A-7	100	90 to 100	0. 05 to 0. 2	. 17	7. 4 to 7. 8	None to moderate.	High.

TABLE 4.—*Brief description of soils and their estimated*

Map symbol	Soil names	Description of soil and site	Depth from surface	Classification: USDA texture
			In.	
Et	Eroded loamy land.	Severely eroded soils on uplands; subsoil of sandy loam, loam, or clay loam; slope range is 1 to 8 percent. Includes Chickasha, Nash, Noble, Zaneis, and a small amount of Lucien soils. Properties described are those of a hypothetical profile covering range of conditions in this land type.	0 to 2	Fine sandy loam to sandy clay loam.
			2 to 27	Fine sandy loam to clay loam.
			27 to 45+	Sandy clay loam to shale or sandstone.
EuC	Eufaula fine sand, hummocky.	Deep, very sandy soils on uplands; developed from old alluvium or eolian material; short, irregular slopes.	0 to 35	Fine sand
			35 to 65+	Fine sand
Go	Gowen clay loam.	Deep, dark-colored, nearly level soils on bottom lands; soils consist of sediments from the Kipp-Kipson-Bethany soil area; moderate surface drainage and moderate to slow internal drainage.	0 to 16	Clay loam
			16 to 65+	Silty clay loam and clay loam.
Kk	Kipp-Kipson complex.	Kipp part of complex consists of loamy, moderately deep soils on uplands; subsoil of clay loam or silty clay loam; developed from sandstone, siltstone, and shale; slope range is 5 to 10 percent.	0 to 8	Silt loam
			8 to 25	Silty clay loam
			25 to 32+	Silty clay loam
		Kipson part of complex consists of loamy, very shallow soils on uplands; developed from sandstone, siltstone, and shale; slope range is 5 to 10 percent.	0 to 12	Silt loam
			12 to 40+	Silt loam, sandstone, siltstone, and shale.
KrB	Kirkland-Renfrow silt loams, 1 to 3 percent slopes.	See description of Kirkland silt loam and of Renfrow silt loam.		
KnA	Kirkland silt loam, 0 to 1 percent slopes.	Deep, nearly level soils on uplands; loamy surface layer; clay subsoil; very slow internal drainage; developed from clay.	0 to 11	Silt loam
			11 to 38	Clay
			38 to 52+	Clay
Lz	Lucien-Zaneis-Vernon complex.	Lucien part of complex consists of shallow and very shallow, loamy soils on uplands; substratum of sandstone or shale; slope range is 5 to 10 percent.	0 to 12	Fine sandy loam
			12 to 16+	Sandstone
		Vernon part of complex consists of shallow and very shallow, clayey soils on uplands; substratum of clay; slope range is 5 to 10 percent.	0 to 6	Clay loam
			6 to 15	Clay
			15 to 20+	Clay and shale
		Zaneis part of complex is like Zaneis loams.		
Mr	Miller clay.	Calcareous, clayey soils on bottom lands; subject to occasional overflow; very slow surface runoff and internal drainage.	0 to 7	Clay
			7 to 60+	Clay
Ms	Miller soils, frequently flooded.	Calcareous, clayey soils on bottom lands; frequently flooded; very slow runoff and internal drainage.	0 to 7	Clay loam and clay
			7 to 60+	Clay
NaB	Nash fine sandy loam, 1 to 3 percent slopes.	Well-drained soils on uplands; underlain by soft sandstone at depth of 2 to 3 feet; commonly on upper part of slope.	0 to 6	Fine sandy loam
			6 to 10	Fine sandy loam
			10 to 32	Fine sandy loam
			32 to 38+	Sandstone
NnC	Nash and Noble fine sandy loams, 3 to 5 percent slopes.	Well-drained, loamy soils on uplands; underlain by soft sandstone at depth of 2 to 6 feet; slope range is 3 to 8 percent.	0 to 6	Fine sandy loam
			6 to 38	Loam
NnD	Nash and Noble fine sandy loams, 5 to 8 percent slopes.	Properties of Noble soils described here. For properties of Nash soils see description of Nash fine sandy loam.	38 to 44	Clay loam
			44 to 50+	Sandstone and loam
Po	Port clay loam.	Deep, moderately clayey, nearly level soils on bottom lands; occasional overflow; moderate to slow surface drainage and internal drainage.	0 to 25	Clay loam
			25 to 42+	Silty clay loam and clay loam.

See footnotes at end of table.

physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve [1]—		Permeability	Available water capacity	Reaction	Salinity [2]	Shrink-swell potential
Unified	AASHO	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
				In. per hr.	*In. per in.*	*pH*		
SM to ML-CL	A-4, A-6	100	40 to 65	0. 8 to 2. 5	. 12	6. 1 to 7. 3	None	Low to moderate.
SM to ML-CL	A-4, A-6, A-7	100	40 to 95	0. 2 to 2. 5	. 12	6. 1 to 7. 8	None	Low to high.
SC, CL	A-4, A-6	100	40 to 70	0. 2 to 2. 5	. 12	6. 1 to 7. 8	None	Low to moderate.
SM	A-2	100	15 to 25	5. 0 to 10. 0	. 07	6. 1 to 6. 5	None	Low.
SM	A-2	100	15 to 25	5. 0 to 10. 0	. 07	5. 6 to 6. 0	None	Low.
CL	A-6	100	85 to 95	0. 2 to 0. 8	. 17	6. 6 to 7. 3	None	Moderate.
CL	A-6	100	85 to 95	0. 2 to 0. 8	. 17	7. 4 to 7. 8	None	Moderate.
ML-CL	A-4(8)	100	80 to 90	0. 8 to 2. 5	. 17	6. 6 to 7. 3	None	Moderate.
ML-CL	A-7	100	90 to 100	0. 2 to 0. 8	. 17	6. 6 to 7. 8	None	Moderate to high.
ML-CL	A-7-6(10)	100	90 to 100	0. 2 to 0. 8	. 17	7. 9 to 8. 4	None	Moderate to high.
ML-CL	A-4	100	80 to 90	0. 8 to 2. 5	. 17	7. 4 to 8. 4	None	Moderate.
ML-CL	A-4	100	80 to 90	0. 8 to 1. 5	. 17	6. 1 to 6. 5	None	Low.
CL, CH	A-7	100	90 to 100	0. 05 to 0. 2	. 17	6. 6 to 7. 3	None	High.
CL, CH	A-7	100	90 to 100	0. 05 to 0. 2	. 17	7. 4 to 8. 4	None	High.
SM	A-4(2)	100	40 to 50	0. 8 to 2. 5	. 17	6. 1 to 6. 5	None	Low.
SM-SC	A-4(3)	100	45 to 50			6. 1 to 6. 5	None	Low.
CL	A-6	100	85 to 95	0. 2 to 0. 8	. 17	7. 4 to 7. 8	None	Moderate
CL, CH	A-7	100	90 to 100	0. 05 to 0. 2	. 17	7. 9 to 8. 4	None	High.
CL	A-7	100	90 to 100	0. 05 to 0. 2	. 17	7. 9 to 8. 4	None	High.
MH-CH	A-7	100	90 to 100	0. 05 to 0. 2	. 17	7. 4 to 7. 8	None	High.
CL, CH	A-7	100	90 to 100	0. 05 to 0. 2	. 17	7. 9 to 8. 4	None	High.
CL	A-6, A-7	100	85 to 95	0. 05 to 0. 2	. 17	7. 4 to 7. 8	None	Moderate to high.
CL, CH	A-7	100	90 to 100	0. 05 to 0. 2	. 17	7. 9 to 8. 4	None	High.
SM	A-4	100	40 to 50	0. 8 to 2. 5	. 12	6. 1 to 6. 5	None	Low.
SM	A-4	100	40 to 50	0. 8 to 2. 5	. 12	6. 1 to 6. 5	None	Low.
SM	A-4	100	40 to 50	0. 8 to 2. 5	. 12	6. 1 to 6. 5	None	Low.
SM	A-4	100	40 to 50	0. 8 to 2. 5	. 12	6. 6 to 7. 3	None	Low.
ML	A-4	100	55 to 65	0. 8 to 2. 5	. 12	6. 6 to 7. 3	None	Low.
CL	A-6	100	60 to 70	0. 8 to 1. 5	. 14	6. 6 to 7. 3	None	Moderate to low.
CL	A-6	100	85 to 95	0. 2 to 0. 8	. 17	6. 6 to 7. 3	None	Moderate.
CL	A-6	100	85 to 95	0. 2 to 0. 8	. 17	7. 4 to 8. 4	None	Moderate.

TABLE 4.—*Brief description of soils and their estimated*

Map symbol	Soil names	Description of soil and site	Depth from surface	Classification: USDA texture
			In.	
Pf	Port fine sandy loam.	Deep, well-drained, moderately sandy, nearly level soils on bottom lands; underlain by loam or silt loam at depth of 10 to 30 inches; subject to occasional overflow.	0 to 15 15 to 60+	Fine sandy loam Loam and silt loam
Pr Ps	Port loam. Port soils, frequently flooded.	Deep, well-drained, loamy, nearly level soils on bottom lands; subject to occasional or frequent overflow.	0 to 10 10 to 60+	Loam Loam and silt loam
RfB2	Renfrow and Kirkland soils, 1 to 5 percent slopes, eroded.	See description of Renfrow silt loam and of Kirkland silt loam. Moderately severe erosion damage.	----------	----------
ReC	Renfrow silt loam, 3 to 5 percent slopes.	Deep soils on uplands; loamy surface layer and clay subsoil; developed from clayey red beds; moderate surface drainage and very slow internal drainage.	0 to 8 8 to 12 12 to 30 30 to 60+	Silt loam Clay loam Clay Clay
Rg	Rough broken land, clayey.	Steep, stony upland; interbedded sandstone and calcareous clay and shale; slope range is 15 to 40 percent. All properties variable.	----------	----------
Rs	Rough broken land, sandy.	Steep drainageways; soil material ranges from sandy loam to sandy clay; outcrops of sandstone and small amounts of shale. All properties variable.	----------	----------
Sa	Sandy alluvial land.	Nearly level, frequently flooded soils on bottom lands; sandy surface layer; loam and clay loam at depth of 20 to 60 inches.	0 to 35 35 to 60+	Loamy sand Loam and clay loam
Sw3	Stephenville and Windthorst soils, severely eroded.	See description of Stephenville and of Windthorst soils. Severe erosion has removed most of the surface soil; gullies common; slope range is 1 to 8 percent.	----------	----------
SdE	Stephenville-Darnell complex, 5 to 12 percent slopes.	Complex of deep Stephenville soils and shallow or very shallow Darnell soils; substratum of sandstone at depth of 4 to 55 inches. Properties of Darnell soils described here. For properties of Stephenville soils, see description of Stephenville fine sandy loams.	0 to 12 12 to 18+	Fine sandy loam Sandstone
SbB SbC SbC2 SbD	Stephenville fine sandy loam, 1 to 3 percent slopes. Stephenville fine sandy loam, 3 to 5 percent slopes. Stephenville fine sandy loam, 3 to 5 percent slopes, eroded. Stephenville fine sandy loam, 5 to 8 percent slopes.	Deep, well-drained, moderately sandy soils on uplands; subsoil of sandy clay loam; developed from sandstone; slope range is 1 to 8 percent. Some areas that have slopes of 1 to 5 percent have a thinned surface layer as a result of erosion.	0 to 12 12 to 41 41 to 58+	Fine sandy loam Sandy clay loam Sandstone
WdB WdB2	Windthorst fine sandy loam, 1 to 5 percent slopes. Windthorst fine sandy loam, 1 to 5 percent slopes, eroded.	Deep, slowly to very slowly permeable soils on uplands; surface soil of fine sandy loam, and subsoil of sandy clay or clay; developed from sandy clay with some interbedded sandstone. Eroded phase has lost much of the surface layer.	0 to 9 9 to 36 36 to 42+	Fine sandy loam Sandy clay Sandy clay
Wn	Windthorst-Darnell complex.	Complex of deep soils and shallow or very shallow, stony soils on uplands; slope range is 4 to 35 percent; surface runoff is rapid; internal drainage is rapid to very slow. For properties of Windthorst soils, see description of Windthorst fine sandy loams.	----------	----------

See footnotes at end of table.

physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve [1]—		Permeability	Available water capacity	Reaction	Salinity [2]	Shrink-swell potential
Unified	AASHO	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
				In. per hr.	*In. per in.*	*pH*		
SM	A-2, A-4	100	30 to 40	0. 8 to 2. 5	. 12	6. 1 to 7. 8	None	Low.
CL	A-4, A-6	100	75 to 85	0. 8 to 2. 5	. 14	7. 4 to 8. 4	None	Low to moderate.
ML, CL	A-4	100	65 to 75	0. 8 to 2. 5	. 14	6. 1 to 7. 8	None	Low to moderate.
ML-CL	A-4	100	80 to 90	0. 8 to 2. 5	. 14	7. 4 to 8. 4	None	Low to moderate.
ML-CL	A-4(8)	100	80 to 90	0. 8 to 1. 5	. 17	6. 6 to 7. 3	None	Low.
ML-CL	A-7	100	85 to 95	0. 05 to 0. 2	. 17	6. 6 to 7. 3	None	Moderate to high.
ML-CL	A-7-6(12)	100	90 to 100	0. 05 to 0. 2	. 17	7. 4 to 7. 8	None	Moderate to high.
ML-CL	A-4(8)	100	90 to 100	0. 05 to 0. 2	. 17	7. 4 to 8. 4	None	Moderate to high.
SM	A-2	100	20 to 30	2. 5 to 5. 0	. 07	6. 1 to 6. 5	None	Low.
ML-CL	A-4, A-6	100	55 to 70	0. 8 to 2. 5	. 14	6. 6 to 7. 4	None	Moderate to high.
SM	A-2, A-4	100	20 to 45	0. 8 to 2. 5	. 12	6. 1 to 6. 5	None	Low.
						5. 6 to 6. 0	None	Low.
SM	A-2, A-4	100	20 to 45	0. 8 to 2. 5	. 07 to . 12	6. 1 to 6. 5	None	Low.
SC	A-4	100	40 to 50	0. 8 to 2. 5	. 12	6. 1 to 6. 5	None	Low to moderate.
SM, SC	A-2, A-4	100	25 to 40			6. 1 to 6. 5	None	Low.
SM	A-2, A-4	100	20 to 40	0. 8 to 2. 5	. 12	5. 6 to 6. 0	None	Low.
CL	A-6	100	55 to 65	0. 05 to 0. 2	. 17	5. 6 to 6. 5	None	Moderate.
CL	A-6	100	55 to 65	0. 05 to 0. 2	. 17	6. 1 to 6. 5	None	Moderate.

TABLE 4.—*Brief description of soils and their estimated*

Map symbol	Soil names	Description of soil and site	Depth from surface	Classification: USDA texture
			In.	
		For properties of Darnell soils, see description of Stephenville-Darnell complex.		
ZaB	Zaneis loam, 1 to 3 percent slopes.	Deep soils on uplands; loamy surface layer; clay loam subsoil; developed from shale, siltstone, and sandstone; slope range is 1 to 8 percent; surface runoff is moderate to excessive; internal drainage is moderate to slow. Some areas that have slopes of 1 to 5 percent have a thinned surface layer as a result of erosion.	0 to 9	Loam
ZaC	Zaneis loam, 3 to 5 percent slopes.			
ZaC2	Zaneis loam, 3 to 5 percent slopes, eroded.		9 to 42	Clay loam
ZaD	Zaneis loam, 5 to 8 percent slopes.		42 to 60+	Siltstone and shale

[1] None of the soils contains particles too large to pass a No. 10 sieve.
[2] Based on experience and estimates; no field tests made.

TABLE 5.—*Interpretation of*

Soil series and map symbols	Suitability as source of—				Soil features affecting highway location
	Topsoil	Sand and gravel	Select grading material	Road fill	
Breaks-alluvial land complex (Ba).	Fair to a depth of 4 to 10 inches, except on rock outcrops.	Unsuitable	Poor; rock outcrops; limited material on slopes and variable material along drainage-ways.	Fair	Steep slopes; alluvial land frequently flooded.
Bethany-slickspot complex (Bc).	Good to a depth of 10 inches except in slickspots.	Unsuitable	Good, except for slickspots.	Fair to poor	Soil features favorable, except in slickspots.
Chickasha (CaA, CaB, CaC, ChA, ChB, ChC, ChD).	Good to a depth of 8 to 14 inches.	Unsuitable	Good	Good	Soil features favorable.
Chickasha-slickspot complex (Ck).	Good to a depth of 8 to 14 inches, except in slickspots.	Unsuitable	Good, except for slickspots.	Good, except for dispersed slickspot soils.	Soil features favorable, except in slickspots.
Clayey saline alluvial land (Cs).	Poor; saline soil material.	Unsuitable	Poor; saline soil; dispersed.	Poor; saline soil; dispersed.	Very slow internal drainage; occasional overflow; very slow surface drainage.
Darnell (SdE, Wn)	Fair to a depth of 4 to 12 inches; may be stony.	Unsuitable	Poor; sandstone at a depth of 4 to 20 inches.	Fair to poor; amount limited; sandstone at depth of 4 to 20 inches.	Steep slopes; sandstone at a depth of 4 to 20 inches.
Dougherty (DoB, DoC, DuB2).	Fair; low fertility	Unsuitable; gradation too fine.	Good, but easily eroded on slopes.	Good if slopes are stabilized.	Erodible in cut slopes.

See footnotes at end of table.

physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve[1]—		Permeability	Available water capacity	Reaction	Salinity[2]	Shrink-swell potential
Unified	AASHO	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
				In. per hr.	*In. per in.*	*pH*		
ML	A-4(3)	100	50 to 65	0. 8 to 2. 5	. 12	6. 6 to 7. 3	None	Low to moderate.
SM	A-4(1)	100	85 to 95	0. 2 to 0. 8	. 14	6. 6 to 7. 3	None	Moderate.
SM	A-2-4(0)	100	30 to 50			7. 4 to 7. 8	None	Low to moderate.

engineering properties of soils

Soil features affecting engineering practices[1]—					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment				
Soil features favorable.	Spillway stabilization a problem in places; slopes stable.	Steep slopes and narrow valleys; good natural drainage.	Steep slopes and narrow valleys; mostly nonarable.	Steep slopes and narrow valleys; mostly nonarable.	Steep slopes and narrow valleys.
Soil features favorable; in slickspots, water would be muddy.	Bethany soil fairly stable; slickspots unstable.	Slow internal drainage.	Unsuitable for irrigation because of slickspots.	Dispersed soil; fills not stable in slickspots.	Difficult to establish vegetation in slickspots.
Soil features favorable.	Soil features favorable.	Not needed; good natural drainage.	Soil features favorable; steeper slopes suitable for irrigation by sprinkler system only.	Soil features favorable.	Soil features favorable; some windblown deposits.
In slickspots, water would be muddy.	Dispersed material; strength and stability poor in slickspots.	Very slow to moderate internal drainage.	Unsuitable for irrigation because of slickspots.	Dispersed subsoil; fills not stable.	Dispersed subsoil; difficult to establish vegetation in slickspots.
Suitable for dug ponds only; banks not stable; water would be muddy.	Level; unstable	Very slow internal drainage; occasional overflow; many small depressed areas.	Very slow internal drainage; occasional overflow; saline soil.	Not needed; level topography.	Not needed; level topography.
Sandstone at a depth of 4 to 20 inches; unsuitable for reservoir.	High seepage; easily eroded.	Not needed; good natural drainage.	Steep, shallow soils over sandstone.	Steep, shallow soils over sandstone.	Steep, shallow soils; droughty.
High seepage	High seepage; easily eroded.	Not needed; good natural drainage.	High intake rate; suitable for irrigation by sprinkler system only.	Susceptible to wind erosion.	Susceptible to wind erosion; low fertility; gully erosion.

713-464—64——5

TABLE 5.—*Interpretation of*

Soil series and map symbols	Suitability as source of—				Soil features affecting highway location
	Topsoil	Sand and gravel	Select grading material	Road fill	
Eroded clayey land (Es)	Poor	Unsuitable	Poor	Poor; high shrink-swell potential.	High shrink-swell potential; very slow internal drainage.
Eroded loamy land (Et)	Good; amount limited as result of erosion.	Unsuitable	Good	Good	Soil features favorable.
Eufaula (EuC)	Fair; easily eroded	Unsuitable	Good	Good if slopes are stabilized.	Erodible in cut slopes.
Gowen (Go)	Good to a depth of 10 to 16 inches.	Unsuitable	Fair	Fair to poor	Soil features favorable; occasional overflow.
Kipp (Kk)	Good to a depth of 5 to 12 inches.	Unsuitable	Fair	Fair to poor	Soil features favorable.
Kipson (Kk)	Good to a depth of 4 to 12 inches.	Unsuitable	Fair	Fair; amount limited; bedrock at depth of 4 to 20 inches.	Bedrock at a depth of 4 to 20 inches.
Kirkland (KnA, KrB, RfB2).	Good to a depth of 8 to 14 inches.	Unsuitable	Fair to poor	Poor; high shrink-swell potential.	High shrink-swell potential at depth of 12 inches or more.
Lucien (Lz)	Good to a depth of 5 to 15 inches.	Unsuitable	Good; amount limited; bedrock at depth of 5 to 15 inches.	Good; amount limited; bedrock at depth of 5 to 15 inches.	Some rock outcrops; bedrock at a depth of 5 to 15 inches.
Miller (Mr, Ms)	Fair to a depth of 10 to 15 inches.	Unsuitable	Fair to poor	Poor; high shrink-swell potential.	High shrink-swell potential; overflow hazard.
Nash (NaB, NnC, NnD)	Good to a depth of 6 to 12 inches.	Unsuitable	Good	Good	Soft sandstone at a depth of 20 to 36 inches; easily eroded.
Noble (NnC, NnD)	Good to a depth of 6 to 12 inches.	Unsuitable	Good	Good	Soil features favorable; easily eroded.
Port (Pf, Po, Pr, Ps)	Good to a depth of 10 to 15 inches.	Unsuitable	Good, except for Port clay loam.	Fair to good	Overflow hazard

See footnotes at end of table.

engineering properties of soils—Continued

Soil features affecting engineering practices [1]—Continued					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment				
Soil features favorable.	Fairly stable	Not needed; good natural drainage.	Eroded soil; low fertility.	Soil features favorable for diversions; not favorable for terraces because of erosion.	Vegetation hard to establish.
Depth limited in eroded Nash soils.	Stable	Not needed; good natural drainage.	Eroded soil; low fertility.	Soil features favorable for diversions; not favorable for terraces, because of erosion.	Limited amount of topsoil to support vegetation.
High seepage	Unstable; easily eroded.	Not needed; good natural drainage.	High intake rate; susceptible to wind erosion; low water-holding capacity.	Susceptible to wind and gully erosion.	Very susceptible to gully erosion; droughty.
Soil features favorable.	Fairly stable	Moderately slow drainage; occasional overflow.	Soil factors favorable except an occasional overflow.	Nearly level topography.	Nearly level topography; occasional overflow.
Soil features favorable.	Fairly stable	Not needed; good natural drainage.	Slopes generally too steep for cultivation.	Soil features favorable for diversions; generally too steep for terracing.	Most slopes are 5 to 10 percent.
Bedrock at a depth of 4 to 20 inches; unsuitable for reservoir.	Stable; hard to establish vegetation.	Not needed; good natural drainage.	Shallow soil; steep slopes.	Shallowness limits suitability for diversions; too shallow and steep for terracing.	Shallow soil; steep topography.
Soil features favorable.	Fairly stable	Not needed; good natural drainage.	Slow intake rate	Soil features favorable.	Soil features favorable.
Bedrock at a depth of 5 to 15 inches; unsuitable for reservoir.	High seepage; easily eroded.	Not needed; good natural drainage.	Shallow soil; sandstone at depth of about 12 inches.	Shallow soil; sandstone at depth of about 12 inches; some rock outcrops.	Shallow soil; droughty.
Soil features favorable.	High shrink-swell potential.	Very slow surface and internal drainage; occasional overflow.	Slow intake rate; very slow internal drainage; occasional overflow.	Nearly level topography.	Nearly level topography; occasional overflow.
High seepage and limited depth to bedrock.	Easily eroded	Not needed; good natural drainage.	Suitable for irrigation by sprinkler system only, because of slope.	Soil features favorable.	Soil features favorable.
High seepage	Easily eroded	Not needed; good natural drainage.	Suitable for irrigation by sprinkler system only, because of slope.	Soil features favorable.	Soil features favorable.
Soil features favorable.	Level; soil features favorable.	Moderate to moderately slow drainage.	Soil features favorable except for occasional overflow.	Nearly level topography.	Nearly level topography.

TABLE 5.—*Interpretation*

Soil series and map symbols	Suitability as source of—				Soil features affecting highway location
	Topsoil	Sand and gravel	Select grading material	Road fill	
Renfrow (ReC, RfB2)	Good to a depth of 8 to 10 inches.	Unsuitable	Fair to poor	Poor; high shrink-swell potential.	High shrink-swell potential.
Rough broken land, clayey (Rg).	Poor	Unsuitable	Poor	Poor	Steep slopes and rock outcrops; poor location.
Rough broken land, sandy (Rs).	Poor	Unsuitable	Good, except on rock outcrops.	Good, except on rock outcrops.	Steep slopes and rock outcrops; poor location.
Sandy alluvial land (Sa)	Poor	Unsuitable	Good	Good	Frequent overflow
Stephenville (SbB, SbC, SbC2, SbD, SdE, Sw3).	Fair to a depth of 8 to 14 inches; low fertility.	Unsuitable; gradation too fine.	Good	Good	Drainageways easily eroded; sandstone at a depth of 3 to 6 feet.
Vernon (Lz)	Poor	Unsuitable; gradation too fine.	Fair to poor	Fair to poor; high shrink-swell potential.	Shallow; soil features favorable.
Windthorst (Sw3, WdB, WdB2, Wn).	Fair; low fertility	Unsuitable	Surface soil good; subsoil too clayey.	Good	Soil features favorable.
Zaneis (ZaB, ZaC, ZaC2, ZaD).	Good to a depth of 7 to 12 inches.	Unsuitable	Good	Good	Soil features favorable.

[1] "Not applicable" means that, because of some characteristic of the soil, the practice specified at the head of the column is not feasible.

Shrinkage ratio is the ratio of volume change resulting from drying to change in water content. Theoretically, it is also the apparent specific gravity of the dried soil pat.

The field moisture equivalent (FME) is the minimum moisture content at which a smooth soil surface will absorb no more water within 30 seconds when the water is added in individual drops. It is the moisture content required to fill all the pores in sands and to approach saturation in cohesive soils. The volume change from FME is the volume change, expressed as a percentage of the dry volume, of the soil mass when the moisture content is reduced from FME to the shrinkage limit.

The engineering classifications given in table 6 are based on data obtained by mechanical analysis and by tests to determine the liquid limit and the plastic limit. Mechanical analysis was made by combined sieve and hydrometer methods. Percentages of clay obtained by the hydrometer test are not suitable for determining USDA soil textural classes.

Genesis, Classification, and Morphology of the Soils

This section explains the factors that are involved in the formation of soils. It describes briefly the system of soil classification used in the United States, shows how the soils in Stephens County have been classified, and describes the outstanding morphological characteristics of these soils.

Factors of Soil Formation

Soil is the product of the action of climate and living organisms upon the parent material, as conditioned by time and relief. The interrelationships among the factors of soil formation are complex, and the effect of any one factor cannot be isolated and identified with certainty.[9]

[9] UNITED STATES DEPARTMENT OF AGRICULTURE. SOILS AND MEN. U.S. Dept. Agr. Ybk., 1232 pp., illus. 1938.

of engineering properties of soils—Continued

Soil features affecting engineering practices[1]					
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment				
Soil features favorable.	Fairly stable	Not needed; good natural drainage.	Suitable for irrigation by sprinkler system only, because of slope.	Soil features favorable.	Soil features favorable.
Not applicable	Not applicable	Not needed; good natural drainage.	Short, steep slopes; nonarable.	Short, steep slopes; nonarable.	Short, steep slopes.
Not applicable	Not applicable	Not needed; good natural drainage.	Short, steep slopes; nonarable.	Short, steep slopes; nonarable.	Short, steep slopes.
Soil features favorable for dug ponds.	Not applicable	Frequent overflow	Suitable for irrigation by sprinkler system only; frequent floods.	Nearly level topography; frequent overflow.	Nearly level topography; frequent overflow.
Soil features favorable.	Soil features favorable.	Not needed; good natural drainage.	Suitable for irrigation by sprinkler system only, because of topography.	Soil features favorable.	Low fertility; gully erosion.
Soil features favorable.	High shrink-swell potential; hard to establish vegetation.	Rapid surface runoff; very slow internal drainage.	Very slow intake rate; very slow internal drainage.	Not applicable, except for diversions at foot of slopes.	Low fertility; droughty.
Soil features favorable.	Soil features favorable.	Not needed; good natural drainage.	Depth of cuts limited; heavy clay subsoil at depth of about 12 inches.	Soil features favorable, except for high surface erosion.	Low fertility; gully erosion.
Soil features favorable.	Soil features favorable.	Not needed; good natural drainage.	Suitable for irrigation by sprinkler system only, because of slope.	Soil features favorable.	Soil features favorable.

Although all five factors influence the formation of any given soil, they do not necessarily play equal roles. In some cases, one or two determine most of the characteristics of the soil. Pronounced differences in any of the factors result in noticeable differences in soil characteristics. Consequently, soils can vary considerably within short distances on the landscape.

Development of soil horizons results from four basic changes: additions, removals, transfers, and transformations of organic matter, soluble salts, carbonates, sesquioxides, and silicate clay minerals. All of these processes have been active, although not all to the same degree, in the development of each soil in Stephens County.

Parent material

Parent material can strongly influence the rate of soil development and the nature of the soil that is developed. For example, heavy clay is very resistant to weathering and may remain almost unweathered for a long time. Some parent material lacks, or contains little of, one or more of the mineral elements, and this fact is reflected in the kind of soil formed. In some places, the parent material consists of a mixture of clay, unweathered minerals, and rock fragments that vary considerably in composition. In these places, the characteristics of the soil depend almost entirely on the effects of living organisms, climate, relief, and time.

In this county the parent material is of two kinds—sedimentary material, derived from the Permian red beds, and Quaternary alluvium deposited during the Pleistocene and Recent epochs.

All of the surface rocks of the county belong to the Permian red beds, which extend from north Texas across central Oklahoma and Kansas and into eastern Nebraska. The deposits in this county are normally marine toward the south and west, but in its northern and eastern extensions there are vast sheets of red beds that contain thick deposits of gypsum and salt. This red-bed material

TABLE 6.—*Engineering*

[Tests performed by State of Oklahoma, Department of Highways, Materials and Research Department,

Soil name and location of sample	Depth	Horizon	Classification	
			Unified	AASHO
	In.			
Bethany silt loam (in Bethany-slickspot complex)	0 to 7	A1	ML-CL	A-4(7)
2,100 ft. E. of NW. corner sec. 1, T. 1 S., R. 5 W.	8 to 35	B1 and B2	ML	A-7-6(10)
	35 to 54	C	CL	A-6(11)
Chickasha fine sandy loam, 1 to 3 percent slopes	0 to 12	A1	SM	A-4(2)
1,800 ft. N. of SW. corner sec. 32, T. 2 N., R. 8 W.	16 to 34	B1 and B2	CL	A-6(6)
	40 to 50	C	CL	A-6(8)
Kipp silt loam (in Kipp-Kipson complex)	0 to 9	A1	ML-CL	A-4(8)
1,200 ft. W. of SE. corner sec. 35, T. 1 N., R. 5 W.	16 to 32	B	ML-CL	A-7-6(10)
Lucien fine sandy loam (in Lucien-Zaneis-Vernon complex)	0 to 8	A1	SM	A-4(2)
2,500 ft. E. of NW. corner sec. 6, T. 1 S., R. 4 W.	13 to 40	C	SM-SC	A-4(3)
Port fine sandy loam	0 to 12	A1	SM	A-4(0)
925 ft. E. and 50 ft. S. of NW. corner sec. 14, T. 2 N., R. 7 W.	15 to 60	C	CL	A-6(8)
Renfrow silt loam, 3 to 5 percent slopes	0 to 10	A1	ML-CL	A-4(8)
SE. corner sec. 23, T. 2 N., R. 9 W.	15 to 27	B1 and B2	ML-CL	A-7-6(12)
	30 to 50	C	ML-CL	A-4(8)
Slickspot (in Chickasha-slickspot complex)	0 to 10	A1	ML	A-4(3)
SE. corner sec. 21, T. 2 S., R. 7 W.	10 to 21	B2	CL	A-6(8)
	30 to 46	C	CL	A-6(4)
Stephenville fine sandy loam, 3 to 5 percent slopes (not a modal profile; red subsoil).	0 to 7	A1 and A2	SM	A-4(2)
	12 to 24	B2	SM-SC	A-4(2)
3,200 ft. S. of NW. corner sec. 33, T. 1 S., R. 7 W.	32 to 42	C	SM	A-4(0)
Stephenville fine sandy loam, 5 to 8 percent slopes	0 to 10	A1 and A2	SM	A-2-4(0)
2,240 ft. E. of SW. corner sec. 14, T. 1 N., R. 7 W.	12 to 30	B2	SC	A-4(0)
	34 to 54	C	SM-SC	A-2-4(0)
Zaneis loam, 3 to 5 percent slopes (not a modal profile; light-textured subsoil).	0 to 7	A1	ML	A-4(3)
	10 to 35	B2	SM	A-4(1)
990 ft. S. of NE. corner sec. 1, T. 1 S., R. 9 W.	39 to 53	C	SM	A-2-4(0)

[1] Mechanical analysis by procedure of the AASHO. Results by this procedure are likely to differ somewhat from results that would have been obtained by the procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is determined by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than

appears to have been derived from the rising ancestral Rocky Mountains in Colorado and New Mexico. The salts and gypsum were precipitated when a dry climate prevailed.[10]

The two geologic systems represented in Stephens County are the Permian and the Quaternary. Figure 15 shows the location and extent of the geologic formations in this county.

Six formations and four groups of the Permian system are represented in the county: the Rush Springs sandstone and the Marlow formation of the Whitehorse group; the Chickasha formations and the Duncan sandstone of the El Reno group; the Hennessey shale of the Clear Fork group; and the Wichita formation of the Wichita group.

[10] CHARLES SCHUCHERT. OUTLINES OF HISTORICAL GEOLOGY. Pt. 2, 693 pp., illus. New York, 1924.

RUSH SPRINGS SANDSTONE.—Rush Springs sandstone is the upper formation of the Whitehorse group. It is a good aquifer. It consists of very friable, fine, salmon-colored sandstone about 300 feet thick. Salmon-colored clay partings occur in places.

MARLOW FORMATION.—The Marlow formation is the lower member of the Whitehorse group. It consists of a layer of brick-colored clay shale about 100 feet thick with two thin beds of dolomite in the middle part.

CHICKASHA FORMATION.—This formation is the upper member of the El Reno group. It is a 400-foot layer of purple-maroon, lenticular mudstone and conglomeratic sandstone and clay shale.

DUNCAN FORMATION.—Duncan sandstone is the lower member of the El Reno group. This formation is less than 200 feet thick. It consists of sandstone and clay shale. The color normally is maroon, but in spots it

test data

in accordance with standard procedures of the American Association of State Highway Officials (AASHO)]

Liquid limit	Plasticity index	Shrinkage limit	Shrinkage ratio	Volumetric change from FME	Mechanical analysis [1]						
					Percentage passing sieve—				Percentage smaller than—		
					No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.
				Pct.							
33	9	21	1. 62	16	100	99	98	71	55	20	18
48	12	13	1. 90	35	----------	----------	100	88	75	46	41
37	17	13	1. 92	36	----------	100	99	80	76	37	34
22	3	18	1. 76	8	----------	100	97	47	35	15	12
34	13	15	1. 86	33	----------	100	98	59	46	30	26
33	13	14	1. 87	30	----------	100	98	63	52	30	28
36	10	20	1. 71	23	100	99	98	84	75	25	21
42	16	17	1. 77	35	100	99	99	96	92	40	29
24	2	22	1. 61	5	100	99	99	45	30	15	11
30	6	21	1. 63	14	100	99	99	49	42	20	17
22	3	18	1. 72	4	----------	100	99	36	31	12	10
32	12	17	1. 82	21	----------	100	99	73	55	35	30
25	5	16	1. 80	12	----------	100	99	86	80	25	20
44	18	12	1. 97	49	----------	----------	100	96	91	52	44
32	8	21	1. 66	13	----------	100	99	96	94	23	18
19	2	17	1. 78	3	----------	100	98	51	37	13	10
38	17	14	1. 88	36. 8	----------	100	99	61	54	33	33
30	12	17	1. 88	24. 3	----------	100	99	53	45	27	25
(2)	(2)	(2)	(2)	(2)	----------	100	97	43	28	9	6
25	5	17	1. 77	7	----------	100	98	45	32	21	20
(2)	(2)	(2)	(2)	(2)	100	99	96	37	22	11	10
(2)	(2)	(2)	(2)	(2)	100	99	91	22	19	13	11
29	9	17	1. 80	25	----------	100	93	40	35	25	24
24	5	18	1. 76	9	100	99	86	26	23	19	17
25	2	20	1. 69	9	----------	100	97	52	35	15	13
30	10	18	1. 77	13	----------	100	97	41	30	23	23
22	2	19	1. 74	7	----------	100	97	27	23	14	14

2 millimeters in diameter. In the procedure of the SCS, the fine material is determined by the pipette method and material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis used in this table, therefore, are not suitable for naming textural classes of soils in the USDA system.

[2] Nonplastic.

has been changed to gray by the iron-reducing action of water. Water seems to have circulated most freely in structure breaks and through fractures caused by folding of the rocks.

HENNESSEY SHALE.—This formation is about 400 feet thick. It consists of greenish-gray sandy clay shale, in which are lenticular beds of cross-bedded, greenish-gray, friable sandstone.

WICHITA FORMATION.—This formation is about 700 feet thick. It consists of layers of gray, massive sandstone separated by 40 to 60 feet of purplish-maroon shale. Near the center of the shale layer are beds of baritic concretions that are about 6 to 12 inches thick.

Sediments derived from red beds consist of sandstone, clay, and shale in various proportions. In some places, the sandstone is dominant, in others the clay. Most of the sandstone is noncalcareous, and most of the clay is calcareous.

Among the soils developed from the more clayey parent material are those of the Zaneis, Kirkland, and Renfrow series. These soils have a surface layer of loam or silt and a subsoil of clay loam to clay.

Some of the soils developed from the more sandy parent material are the Chickasha, Nash, Stephenville, and Dougherty, all of which have a surface layer of loam to loamy fine sand and a subsoil of fine sandy loam to sandy clay loam. The sandier soils are more permeable, but some are less fertile, than the soils developed from the clayey material.

Most of the soils that consist of recent alluvium are variable in texture. Port soils, for example, are loam, fine sandy loam, or clay loam. Miller soils are predomi-

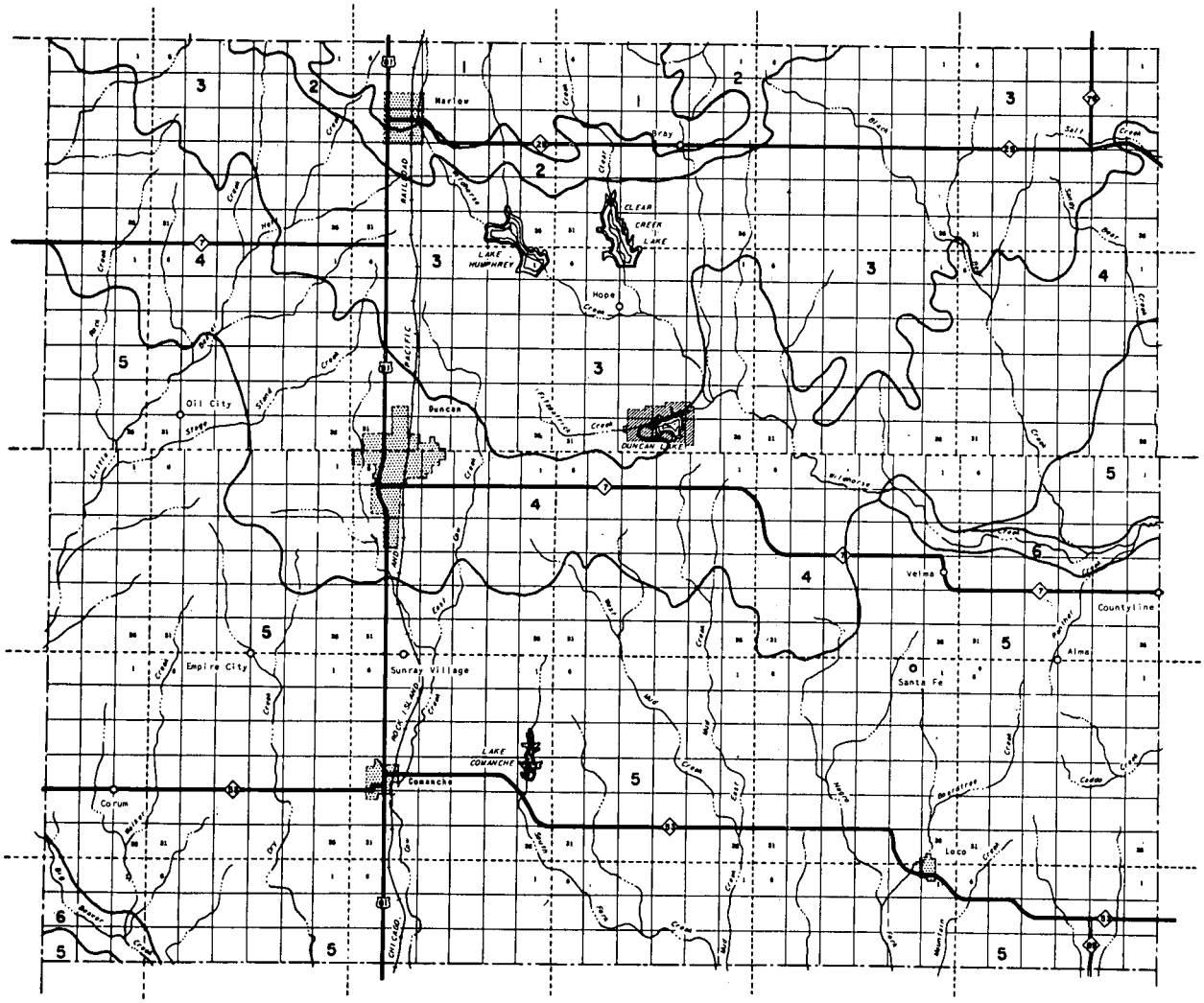

Figure 15.—**Geologic formations and drainage patterns: (1) Rush Springs sandstone; (2) Marlow formation; (3) Chickasha formation and Duncan sandstone; (4) Hennessey shale; (5) Wichita formation; (6) Alluvium of first and second terraces and low terraces.**

nantly clay throughout the profile. Gowen soils, which are of minor extent, are predominantly clay loam but in some areas are loam or fine sandy loam.

Climate

Stephens County has a warm-temperate, subhumid, continental climate. The average annual temperature is 62° F., and the average annual rainfall is 33 inches. Rainfall is 2 or 3 inches more in the eastern part of the county than in other parts. Otherwise, the climate is fairly uniform throughout the county. Consequently, few of the differences among soils in the county result directly from differences in climate. The climate is, however, directly or indirectly the cause of many variations in plant and animal life, which, in turn, result in differences in the soils.

The effect of climate on the development of soils in this county is intermediate between that in humid regions and that in arid regions. Compared to soils in the humid areas of the southeastern United States, the soils in this county are only moderately leached. They range from medium acid to calcareous, depending on the type of parent material and the length of time the forces of soil development have acted on the soil material. In the calcareous soils of this county, the calcareous layer generally is deeper than that in the soils of the southwestern States where the climate is arid. The Stephenville, Dougherty, and Nash soils are examples of neutral to medium acid soils. The Vernon, Kirkland, and Renfrow soils are calcareous. Some areas of Vernon soils are calcareous to the surface; in the Kirkland and Renfrow soils, the depth to calcareous material is about 30 inches.

Living organisms

The addition of organic matter is the most important effect of plants and animals on soil development. This is brought about by the return of plant residues to the soil and the decomposition of this material as a result of the action of micro-organisms.

In timbered areas, plant residues returned to the soil are usually strongly acid, and the acid from these residues is highly effective as a leaching agent. Thus, a leached

layer is one of the main distinguishing characteristics of soils formed under timber. It appears as a light-colored layer in the lower part of the surface layer. In Stephens County, the forest vegetation consists chiefly of blackjack oak and post oak on the ridges, and elm, pecan, and cottonwood on the bottom lands. Some mid and tall grasses grow beneath the trees. The Dougherty, Stephenville, and Windthorst soils are some soils in the county that formed under timber.

Generally, soils formed under a cover of grass do not have a leached layer. In this county the original vegetation on the permeable, loamy soils was mostly mid and tall grasses. Short and mid grasses were dominant on the slowly permeable, fine-textured soils. The Kirkland, Renfrow, Zaneis, Chickasha, and Nash soils are some soils in the county that formed under a cover of grass.

Relief

Relief, or topography, influences the soil-forming processes mostly through its effect on the movement of water. Variations in air drainage and in exposure to the sun and wind also have an effect.

The three broad classes of relief in Stephens County are normal relief, excessive relief, and flat or concave relief. Normal relief is dominant. In this class are sloping uplands where runoff is medium. The effect of slope varies, depending on the nature of the parent material. The slope range is ½ percent to 8 percent. The Chickasha, Nash, and Zaneis soils have normal relief.

In areas of excessive relief are shallow soils, rough broken land, and rocky and hilly areas. The slope range is 4 to 40 percent. Soils of the Vernon, Lucien, and Kipson series have excessive relief.

The bottom lands have flat or concave relief. The clayey soils of the Miller series occupy these areas.

Time

The length of time required for a soil to develop depends on the combined action and intensity of the other soil-forming factors. Soils that have clearly expressed horizons are considered mature; those that do not are considered immature.

The soils of the Kirkland, Chickasha, Stephenville, and Windthorst series are examples of mature soils in this county. They have well-developed profiles. They occur in areas little affected by geological erosion and formed from parent material that was easily altered by the processes of soil formation.

Examples of immature soils are the Port, Gowen, and Miller soils, which are developing in recent alluvium, and the Vernon, Lucien, and Kipson soils, which are shallow and very shallow soils that are forming either where the parent material is resistant to weathering or where active geologic erosion is continuously exposing fresh parent rock and parent material.

Classification and Morphology of the Soils

In the system of soil classification currently followed in the United States, soils are placed in six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great soil group, the family, the series, and the type. The suborder and family categories have not been fully developed, and, consequently, have been little used.

The highest categories of classification are the zonal, the intrazonal, and azonal orders. Only the zonal and azonal orders are represented in Stephens County.

The classification of the soils in Stephens County by order, great soil group, and series is outlined in the following list.

ZONAL ORDER:
- Chernozem great soil group—
  - Kipp series.
- Reddish Prairie great soil group—
  - Bethany series.
  - Chickasha series.
  - Kirkland series.
  - Renfrow series.
  - Zaneis series.
- Red-Yellow Podzolic great soil group—
  - Dougherty series.
  - Eufaula series.
  - Stephenville series.
  - Windthorst series.

AZONAL ORDER:
- Alluvial great soil group—
  - Gowen series.
  - Miller series.
  - Noble series.
  - Port series.
- Lithosol great soil group—
  - Darnell series.
  - Kipson series.
  - Lucien series.
  - Vernon series.
- Regosol great soil group—
  - Nash series.

Zonal soils

Zonal soils have well-developed horizons that reflect the predominant influence of climate and living organisms in their formation. The zonal order is represented in Stephens County by the Chernozem, Reddish Prairie, and Red-Yellow Podzolic great soil goups.

CHERNOZEM SOILS

Chernozem soils are dark-colored, silty soils that develop under a cover of grass in a subhumid, warm climate with average annual rainfall of about 35 inches.

Chernozem soils are not common as far south as Oklahoma. They are extensive in the central part of the United States.

The Kipp series represents this great soil group in Stephens County.

Kipp series.—The Kipp soils are moderately deep Chernozem soils developed, under a cover of grass, in material weathered from siltstone and calcareous, gray shale of the Permian system. They have a dark-colored loamy surface layer and a grayish-brown to olive, medium-textured subsoil. The lower part of the subsoil and the parent material are generally calcareous. Kipp soils are of minor extent in this county.

Profile of Kipp silt loam, 1,800 feet east of the southwest corner of sec. 18, T. 1 N., R. 5 W.:

A1—0 to 8 inches, grayish-brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, fine and medium, granular structure; friable when moist, hard when dry; numerous roots; few worm casts; neutral; gradual boundary.

B2—8 to 21 inches, light olive-brown (2.5Y 5/3) silty clay loam; dark grayish brown (2.5Y 4/2) when moist; moderate, fine, subangular blocky structure; friable when moist, hard when dry; few roots; neutral; clear boundary.

B2ca—21 to 25 inches, olive (5Y 5/3) silty clay loam; olive (5Y 4/3) when moist; moderate, fine, subangular blocky structure; friable when moist, hard when dry; few roots; calcareous; numerous $CaCO_3$ concretions; gradual boundary.

C—25 to 32 inches +, gray (5Y 6/1) weathered shale of silty clay loam texture; gray (5Y 5/1) when moist; distinctly mottled with light olive brown; massive; highly calcareous; very numerous $CaCO_3$ concretions.

Minor areas of this soil have a loam surface layer. The texture of the B2 horizon ranges from silty clay loam to heavy clay loam. In some places shale fragments

occur throughout the profile. In some areas these soils are calcareous in the surface layer. Drainage is moderate, both from the surface and internally. The vegetation consists principally of mid and tall native grasses. The slope range is 5 to 10 percent.

REDDISH PRAIRIE SOILS

This great soil group consists of normal soils that develop in material weathered from the Permian red beds, under a cover of mid and tall native grasses, in a subhumid, warm climate, with average annual rainfall of between 30 and 35 inches. The parent material ranges from sandstone to clay and from slightly acid to moderately alkaline.

The Reddish Prairie soils extend from south-central Kansas across central Oklahoma into north-central Texas.

The Bethany, Chickasha, Kirkland, Renfrow, and Zaneis series represent this great soil group in Stephens County.

Bethany Series.—The Bethany soils developed in calcareous clay and clayey shale. They have a dark-colored, loamy surface layer and a yellowish-brown, clay subsoil. They occur in the northeastern part of the county.

Profile of Bethany silt loam, 1,000 feet east and 400 feet north of the southwest corner of sec. 10, T. 1 N., R. 4 W.:

A1—0 to 5 inches, dark grayish-brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; friable when moist, slightly hard when dry; numerous small roots; slightly acid; clear boundary.

A3—5 to 10 inches, brown (10YR 4/3) silt loam; dark brown (10YR 3/3) when moist; weak, coarse, subangular blocky structure; faces of peds are slightly darkened; friable when moist, hard when dry; slightly acid; gradual boundary.

B1—10 to 18 inches, brown (10YR 4/3) light silty clay loam; dark brown (10YR 3/3) when moist; moderate, coarse, subangular blocky structure breaking to moderate, fine, granular; friable when moist, hard when dry; few worm casts; many insect channels; many small roots; slightly acid; gradual boundary.

B2—18 to 30 inches, yellowish-brown (10YR 5/4) clay; dark yellowish brown (10YR 4/4) when moist; moderate, coarse, prismatic structure breaking to moderate, fine, blocky; distinct, fine mottles of reddish brown (5YR 4/4) when moist; faces of prisms are darkened; continuous clay films; firm when moist, very hard when dry, very plastic when wet; few ferromanganese concretions; neutral; gradual boundary.

B3—30 to 40 inches, yellowish-brown (10YR 5/6) clay; yellowish brown (10YR 5/6) when moist; fine, distinct mottles of black, reddish brown, and light olive brown; nearly massive with a few weak structural planes; very firm when moist, very hard when dry; many small ferromanganese concretions; few lime concretions; gradual boundary.

C—40 to 50 inches +, yellowish-brown (10YR 5/6) clay; yellowish brown (10YR 5/6) when moist; fine, distinct mottles of black, reddish brown, and light olive brown; massive; many small ferromanganese concretions; many lime concretions and veinlets of soft lime material.

The texture of the A horizon is dominantly silt loam, but in places it is loam.

Depth to the B2 horizon ranges from 14 to 22 inches. The slope range is 1 to 3 percent. Drainage is moderate from the surface and slow to very slow internally. The vegetation consists principally of mid and tall native grasses.

Chickasha Series.—The Chickasha soils developed in material weathered from sandstone and sandy shale. They are deep, loamy soils that have a brown to yellowish-brown subsoil. They occur extensively in association with other Reddish Prairie soils.

Profile of Chickasha loam, 2,150 feet south and 100 feet east of the northwest corner of sec. 8, T. 3 S., R. 8 W.:

A1—0 to 10 inches, brown (10YR 5/3) loam; dark brown (10YR 3/3) when moist; weak, fine, granular structure; friable when moist, hard when dry; many roots; few worm casts; slightly acid; gradual boundary.

B1—10 to 20 inches, brown (7.5YR 5/4) clay loam, high in sand; dark brown (7.5YR 3/3) when moist; weak, fine, subangular blocky structure; friable when moist, hard when dry; slightly acid; gradual boundary.

B2—20 to 34 inches, yellowish-brown (10YR 5/4) clay loam; dark yellowish brown (10YR 4/4) when moist; moderate, fine and medium, subangular blocky structure; friable when moist, hard when dry; few distinct mottles of strong brown (7.5YR 5/8) when moist; few ferromanganese concretions; slightly acid; gradual boundary.

B3—34 to 45 inches, yellowish-brown (10YR 5/4), partly weathered red beds of clay loam texture; dark yellowish brown (10YR 4/4) when moist; distinct mottles of reddish yellow (7.5YR 6/8) and strong brown (7.5YR 5/8) when moist make up about half of the mass; massive; slightly acid; gradual boundary.

C—45 to 60 inches +, reddish-yellow (5YR 6/8) intermixed with pale-yellow (2.5Y 7/4), partly weathered red beds of sandy clay loam texture; yellowish red (5YR 5/8) intermixed with light yellowish brown (2.5Y 6/4) when moist; massive; few ferromanganese concretions; neutral.

The solum is 30 to 55 inches thick. Depth to the B2 horizon ranges from 10 to 22 inches. The slope range is 0 to 8 percent, but slopes of 1 to 3 percent are the most common. Drainage is moderate, both from the surface and internally.

Kirkland Series.—The Kirkland soils developed from the more clayey areas of the Permian red beds. Their surface layer is grayish silt loam, and the subsoil is dark-colored compact clay. They occur on the more gentle slopes in association with the Chickasha, Zaneis, and Renfrow soils in the western half of the county.

Profile of Kirkland silt loam, 2,540 feet south and 100 feet east of the northwest corner of sec. 26, T. 2 S., R. 9 W.:

A1—0 to 11 inches, grayish-brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; friable when moist, hard when dry; numerous roots; few worm casts; slightly acid; clear boundary.

B2—11 to 38 inches, dark grayish-brown (10YR 4/2) clay; very dark grayish brown (10YR 3/2) when moist; weak, blocky structure; few roots; a little cherty gravel; neutral; gradual boundary.

C—38 to 52 inches +, very dark grayish-brown (10YR 3/2) clay; very dark brown (10YR 2/2) when moist; mottled with yellowish red (5YR 5/8 and 5YR 4/8) when moist; yellowish red becomes predominant at depth of 48 inches; massive; few ferromanganese concretions; calcareous; contains a few $CaCO_3$ concretions and a small amount of interbedded calcareous shale.

The solum is 32 to 40 inches thick. The depth to the B2 horizon is 8 to 14 inches. In some places the peds in the upper part of the B2 horizon have a gray surface coating or film. In some areas there is a 1- to 2-inch layer of clay loam between the A and B horizons. The slope range is 0 to 3 percent. Drainage is moderate from the surface and very slow internally. The vegetation consists mostly of short and mid native grasses.

Renfrow Series.—The Renfrow soils developed from clay or clay and shale of the Permian red beds. They are redder than the closely associated Kirkland soils, and they have a clay loam B1 horizon over a clay B2

horizon. They occur principally in the western half of the county.

Profile of Renfrow silt loam, 1,300 feet north and 100 feet east of the southwest corner of sec. 18, T. 1 S., R. 8 W.:

A1—0 to 8 inches, dark-brown (7.5YR 4/2) silt loam; dark brown (7.5YR 3/2) when moist; moderate, fine and medium, granular structure; friable when moist, hard when dry; numerous roots, few worm casts; neutral; gradual boundary.

B1—8 to 12 inches, dark reddish-brown (5YR 3/4) clay loam; dark reddish brown (5YR 3/3) when moist; moderate, medium, subangular blocky structure; friable when moist, hard when dry; neutral; clear boundary.

B2—12 to 30 inches, reddish-brown (5YR 4/3) clay; dark reddish brown (5YR 3/3) when moist; moderate, medium, blocky structure; very firm when moist, very hard when dry; few roots; few ferromanganese concretions; clay films numerous but not continuous; lower 10 inches is alkaline but noncalcareous; gradual boundary.

C—30 to 60 inches, yellowish-red (5YR 4/6) clay; yellowish red (5YR 4/8) when moist; massive; very firm when moist, very hard when dry; few ferromanganese concretions; calcareous; $CaCO_3$ concretions common.

The solum is 28 to 38 inches thick. In some areas the B1 horizon is lacking. Depth to the B2 horizon ranges from 6 to 14 inches. The reaction is slightly acid to mildly alkaline. The parent material is interbedded red and gray clay and shale. The slope range is 1 to 5 percent. Drainage is moderate from the surface and very slow internally. The vegetation consists of buffalograss, grama grasses, and some little bluestem.

Zaneis Series.—The Zaneis series consists of deep soils developed in material weathered from shale, siltstone, and some clay. These soils have a surface layer of loam and a subsoil of reddish-brown clay loam. They are most extensive in the western half of the county.

Profile of Zaneis loam, 1,800 feet east and 100 feet north of the southwest corner of sec. 32, T. 2 N., R. 8 W.:

A1—0 to 9 inches, brown (7.5YR 5/4) loam; dark brown (7.5YR 3/2) when moist; weak, fine and medium, granular structure; friable when moist, hard when dry; numerous roots; few worm casts; neutral; gradual boundary.

B1—9 to 13 inches, reddish-brown (5YR 4/4) light clay loam; dark reddish brown (5YR 3/4) when moist; weak, fine and medium, granular structure; friable when moist, hard when dry; numerous roots; numerous worm casts; neutral; gradual boundary.

B2—13 to 32 inches, reddish-brown (5YR 4/4) clay loam; dark reddish brown (5YR 3/4) when moist; moderate, fine and medium, subangular blocky structure; firm when moist, hard when dry; few roots; few ferromanganese concretions; neutral; gradual boundary.

B3—32 to 42 inches, yellowish-red (5YR 5/8) clay loam; yellowish red (5YR 4/8) when moist; weak, subangular blocky structure; soil material is noncalcareous but contains $CaCO_3$ concretions; few ferromanganese concretions; clear boundary.

C—42 to 60 inches +, interbedded red siltstone and calcareous, olive-gray shale.

The solum ranges from 28 to 42 inches in thickness. Depth to the B2 horizon is 10 to 16 inches. The texture of the B2 horizon ranges from silty clay loam to heavy clay loam. The substratum is neutral and, in places, calcareous. The slope range is 1 to 8 percent. Drainage is moderate from the surface and moderate to slow internally.

RED-YELLOW PODZOLIC SOILS

Red-Yellow Podzolic soils in Stephens County have a light-colored, leached A2 horizon and a B horizon of yellowish-red or red loamy fine sand, sandy clay loam, or clay. The Red-Yellow Podzolic soils in Stephens County developed in a warm-temperate, subhumid, continental climate, under a cover of post oak and blackjack oak. The parent material was sandy alluvium, clay, and weathered and unweathered sandstone. The A2 horizon is less strongly leached than that in Red-Yellow Podzolic soils farther east where rainfall is heavier.

The Dougherty, Eufaula, Stephenville, and Windthorst series represent this great soil group in Stephens County.

Dougherty Series.—The Dougherty soils developed in sandy alluvium. They are inextensive in this county.

Profile of Dougherty loamy fine sand, 1,600 feet north and 50 feet west of the southeast corner of sec. 11, T. 3 S., R. 9 W.:

A1—0 to 6 inches, brown (10YR 5/3) loamy fine sand; dark brown (10YR 3/3) when moist; single grain; loose when moist or dry; slightly acid; gradual boundary.

A2—6 to 21 inches, pale-brown (10YR 6/3) loamy fine sand; yellowish brown (10YR 5/4) when moist; single grain; loose when moist or dry; slightly acid; gradual boundary.

B2—21 to 43 inches, yellowish-red (5YR 4/6) sandy clay loam; yellowish red (5YR 3/6) when moist; massive; friable when moist, hard when dry; medium acid in the upper part, slightly acid in the lower part; gradual boundary.

C—43 to 72 inches +, brownish-yellow (10YR 6/8) fine sand; yellowish brown (10YR 5/8) when moist; a few streaks of pale brown that increase in number with depth; single grain; loose when moist or dry; slightly acid.

In uncultivated areas the A horizon ranges from 16 to 28 inches in thickness. In color, the A1 horizon ranges from grayish brown to brown, and the B2 horizon from reddish yellow to yellowish red. The parent material, which is at a depth of 36 to 55 inches, ranges in texture from fine sandy loam to sand. The topography is irregular, consisting of mounds, narrow ridges, and small nearly level areas. Drainage is moderate to slow from the surface and moderate internally. The vegetation consists of post oak, blackjack oak, and mid and tall native grasses.

Eufaula Series.—Eufaula soils developed in old alluvium or eolian material. They are more sandy than the other Red-Yellow Podzolic soils in the county. The surface layer is browner than the subsoil. These soils are inextensive in this county.

Profile of Eufaula fine sand, 175 feet west and 30 feet north of the southeast corner of sec. 14, T. 3 S., R. 8 W.:

A1—0 to 9 inches, brown (10YR 5/3) fine sand; brown (10YR 4/3) when moist; single grain; loose when moist and when dry; many roots; slightly acid; clear boundary.

A2—9 to 35 inches, light-brown (7.5YR 6/4) fine sand; brown (7.5YR 4/4) when moist; single grain; loose when moist and when dry; few roots; slightly acid; gradual boundary.

B2—35 to 65 inches +, yellowish-red (5YR 5/8) fine sand; yellowish red (5YR 4/8) when moist; single grain; contains streaks 1/8 to 1/4 inch thick of red (2.5YR 4/6) loamy fine sand, red (2.5YR 4/6) when moist, comprising 10 to 20 percent of the horizon; massive; medium acid.

The A1 horizon is neutral to slightly acid. The rest of the profile is slightly acid to medium acid. The A2 horizon ranges from light brown to light yellowish brown in color. The topography consists of mounds and long,

narrow ridges that have short, irregular slopes of 3 to 8 percent. Surface runoff is very slow, and internal drainage is rapid.

Stephenville Series.—Stephenville soils developed in noncalcareous, sandy formations of the Permian red beds. Their surface layer is fine sandy loam, and their subsoil is yellowish-red to red sandy clay loam. Stephens County is on the western edge of the Stephenville soil area. These soils are extensive in this county.

Profile of Stephenville fine sandy loam, in the NW¼NE¼ sec. 21, T. 2 N., R. 8 W.:

A1—0 to 6 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; very dark brown (10YR 2/2) when moist; weak, fine and medium, granular structure; very friable when moist, hard when dry; few roots; slightly acid; gradual boundary.

A2—6 to 12 inches, brown (10YR 5/3) fine sandy loam; brown (10YR 4/3) when moist; weak, fine, granular structure to massive; very friable when moist, slightly hard when dry; few roots; slightly acid; gradual boundary.

B2—12 to 33 inches, yellowish-red (5YR 5/6) sandy clay loam; yellowish red (5YR 4/6) when moist; weak, fine and medium, subangular blocky structure; friable when moist, hard when dry; slightly acid; gradual boundary.

B3—33 to 41 inches, red (2.5YR 5/8) sandy clay loam; red (2.5YR 4/8) when moist; slightly higher in sand than the B2 horizon; massive; friable when moist, hard when dry; slightly acid; gradual boundary.

C—41 to 58 inches +, red (2.5YR 4/8) partly weathered sandstone; dark red (2.5YR 3/8) when moist; contains streaks of very pale brown; slightly acid.

The solum ranges from 30 to 55 inches in thickness. The A1 horizon, when dry, ranges in color from very dark grayish brown (10YR 3/2) to dark yellowish brown (10YR 4/4). The B2 horizon is yellowish red to red. Depth to the B2 horizon ranges from 8 to 14 inches. The reaction is medium acid to neutral. In some places the parent material contains small amounts of shale. The slope range is 1 to 8 percent. Drainage is moderate, both from the surface and internally. The vegetation consists of post oak, blackjack oak, big bluestem, little bluestem, Indiangrass, and switchgrass.

Windthorst Series.—Windthorst soils developed in a more clayey parent material than the other Red-Yellow Podzolic soils in the county. They have a moderately thin surface layer of fine sandy loam and a reddish, fine-textured subsoil. The Windthorst soils are extensive in the more gently sloping areas in association with the Stephenville soils.

Profile of Windthorst fine sandy loam, 200 feet south and 50 feet west of the northeast corner of sec. 34, T. 2 N., R. 6 W.:

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

A2—4 to 9 inches, yellowish-brown (10YR 5/4) fine sandy loam; dark yellowish brown (10YR 3/4) when moist; moderate, fine and medium, granular structure; very friable when moist, slightly hard when dry; medium acid; abrupt boundary.

B21—9 to 15 inches, dark reddish-brown (2.5YR 3/4) sandy clay; dark red (2.5YR 3/6) when moist; moderate, fine and medium, subangular blocky structure; very firm when moist, very hard when dry; few ferromanganese concretions present; clay films present but not continuous; medium acid; gradual boundary.

B22—15 to 36 inches, dark-red (2.5YR 3/6) heavy sandy clay; dark red (2.5YR 2/6) when moist; strong, medium, subangular blocky structure; very firm when moist, very hard when dry; clay films present but not continuous; contains a little cherty gravel and a few ferromanganese concretions; slightly acid; gradual boundary.

C—36 to 42 inches +, red (2.5YR 4/6) sandy clay; dark red (2.5YR 3/6) when moist; massive; contains strata of soft red sandstone; slightly acid.

The solum ranges from 30 to 45 inches in thickness. Depth to the B horizon is 6 to 10 inches. The parent material consists of sandy clay, clay, or interbedded clay, sandstone, and a small amount of shale. In some areas there are yellowish-red and reddish-yellow mottles below a depth of 15 inches. In some places the parent material is calcareous. The reaction is commonly slightly acid or neutral. Reaction throughout the solum ranges from medium to slightly acid. Drainage is moderate from the surface and slow to very slow internally. The original vegetation consists of an open growth of post oak and blackjack oak, and mid and tall native grasses.

Azonal soils

Azonal soils are without well-developed soil characteristics, either because of their youth or because conditions of parent material or relief have prevented the development of definite soil characteristics. The azonal order is represented in Stephens County by the Alluvial soils, the Lithosols, and the Regosols.

ALLUVIAL SOILS

Alluvial soils consist of transported and relatively recently deposited material. They are varied in color, texture, reaction, and drainage. They reflect the characteristics of the soils from which the sediments were derived.

Alluvial soils occur along streams throughout the United States. The size of a given area is generally proportionate to the size of the stream.

The Gowen, Miller, Noble, and Port series represent this great soil group in Stephens County.

Gowen Series.—The Gowen soils consist of sediments washed from the Kipp, Kipson, and Bethany soils. They are commonly grayish to brownish clay loam throughout the profile. They occur in the northeastern part of the county and are of minor extent.

Profile of Gowen clay loam, 2,300 feet east and 175 feet north of the southwest corner of sec. 2, T. 1 S., R. 5 W.:

A1p—0 to 5 inches, grayish-brown (2.5Y 5/2) clay loam; dark grayish brown (2.5Y 4/2) when moist; weak, fine, subangular blocky structure; friable when moist; hard when dry; few worm casts; neutral; plowed boundary.

A12—5 to 16 inches, grayish-brown (10YR 5/2) clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; friable when moist, hard when dry; few worm casts; neutral; clear boundary.

AC—16 to 21 inches, dark-gray (10YR 4/1) silty clay loam; very dark gray (10YR 3/1) when moist; weak, medium and coarse, subangular blocky structure; firm when moist, very hard when dry; slightly alkaline but noncalcareous; gradual boundary.

C1—21 to 35 inches, brown (10YR 5/3) clay loam; dark grayish brown (10YR 4/2) when moist; massive; friable when moist, hard when dry; contains faint mottlings of light gray; slightly alkaline but noncalcareous; clear boundary.

C2—35 to 48 inches, dark-gray (10YR 4/1) silty clay loam; very dark gray (10YR 3/1) when moist; massive; few distinct mottles of reddish brown and streaks of yellowish brown; firm when moist, very hard when

dry; slightly alkaline but noncalcareous; gradual boundary.

C3—48 to 65 inches +, dark-gray (10YR 4/1) silty clay loam; very dark gray (10YR 3/1) when moist; massive; few distinct mottles of reddish brown; firm when moist, very hard when dry; calcareous; contains $CaCO_3$ concretions that become more numerous with depth.

The surface layer is brown to grayish brown. The AC and C horizons are generally dark-colored clay loam and silty clay loam. In some places there are layers of light silty clay below a depth of 36 inches. These soils are calcareous below a depth of 36 to 48 inches in some places. Drainage is moderate from the surface and moderate to slow internally.

Miller Series.—The Miller soils are reddish-brown, slightly calcareous, clayey soils. They consist of alluvial sediments washed from the red-bed areas in western Texas, Kansas, and Oklahoma.

Profile of Miller clay, 660 feet north and 50 feet west of the southeast corner of sec. 3, T. 3 S., R. 9 W.:

A1—0 to 7 inches, reddish-brown (5YR 4/3) clay; dark reddish brown (5YR 3/3) when moist; weak, subangular blocky structure; very firm when moist, very hard when dry; mildly calcareous; pH 7.5; gradual boundary.

C—7 to 60 inches +, dark reddish-brown (5YR 3/4) clay; dark reddish brown (5YR 2/4) when moist; moderate to strong, subangular blocky structure changing to massive in the lower part of the horizon; very firm when moist, very hard when dry; calcareous.

The color of the A horizon ranges from brown to reddish brown, and the reaction from neutral to moderately alkaline. In some places layers of various colors and textures occur throughout the profile. Drainage is very slow, both from the surface and internally.

Noble series.—The Noble soils occur on foot slopes below areas of Rough broken land and of Nash, Vernon, and Lucien soils. They consist of medium-textured local alluvium. They lack a textural B horizon.

Profile of Noble fine sandy loam, 1,000 feet north and 350 feet west of the southeast corner of sec. 3, T. 2 N., R. 8 W.:

A1—0 to 6 inches, brown (7.5YR 5/4) fine sandy loam; dark brown (7.5YR 4/4) when moist; moderate, fine and medium, granular structure; very friable when moist, slightly hard when dry; porous; neutral; gradual boundary.

AC—6 to 38 inches, reddish-brown (5YR 4/4) loam; dark reddish brown (5YR 3/4) when moist; moderate, fine and medium, granular structure; friable when moist; hard when dry; porous; numerous worm casts; neutral; gradual boundary.

C1—38 to 44 inches, yellowish-red (5YR 5/6) light clay loam, yellowish red (5YR 4/6) when moist; massive; friable when moist; hard when dry; faintly mottled with gray; neutral in the upper part; calcareous in the lower part; gradual boundary.

C2—44 to 50 inches +, interbedded, weathered, massive, red sandstone and calcareous gray shale of loam texture.

In some places the texture of the A horizon is loam. The A1 horizon ranges from brown to reddish brown in color. Depth to sandstone and shale ranges from 36 to 70 inches. In areas near the bottom of the foot slopes, this material may not be within measurable depth. In about one-third of the acreage, the C1 horizon is loam.

Drainage is moderate, both from the surface and internally. The slope range is 3 to 8 percent.

Port Series.—The Port soils in Stephens County consist of brown to reddish-brown loamy sediments derived from the Red-Yellow Podzolic soils and the Reddish Prairie soils. They are generally noncalcareous to a depth of 12 to 24 inches, but in many places they are calcareous below a depth of 36 inches. They are extensive on the flood plains throughout the county. Three soil types, clay loam, loam, and fine sandy loam, have been mapped in this county.

Profile of Port clay loam, 600 feet south and 50 feet east of the northwest corner of sec. 21, T. 1 N., R. 8 W.:

A1—0 to 5 inches, brown (7.5YR 5/4) clay loam; dark brown (7.5YR 3/2) when moist; strong, fine and medium, granular structure; friable when moist, hard when dry; neutral; gradual boundary.

AC—5 to 25 inches, reddish-brown (5YR 4/3) clay loam; dark reddish brown (5YR 3/3) when moist; moderate, fine and medium, subangular blocky structure; friable when moist, hard when dry; neutral; gradual boundary.

C—25 to 42 inches +, yellowish-red (5YR 4/6) silty clay loam; yellowish red (5YR 4/6) when moist; massive; calcareous.

Layers of various colors and textures are common throughout the profile. Layers of clay occur only in Port clay loam. Drainage of Port clay loam is moderate to slow, both from the surface and internally. Drainage of Port loam and Port fine sandy loam is moderate from the surface and internally.

LITHOSOLS

Lithosols have an incomplete solum or no clearly expressed soil morphology; they consist of a freshly and imperfectly weathered mass of rock fragments and are largely confined to steeply sloping land.

The Lithosols in Stephens County are shallow or very shallow soils. The factors responsible for their shallow development are resistant parent material and geologic erosion. The parent material is sandstone, shale, and clay. The topography is irregular, and the slope range is 5 to 35 percent. The native vegetation consists of both trees and grasses.

The Darnell, Kipson, Lucien, and Vernon series represent this great soil group in this county.

Darnell Series.—Darnell soils developed, under timber, in material weathered from noncalcareous sandstone. They have a thin surface layer of fine sandy loam over solid or fragmented sandstone. Outcrops of sandstone are common. Slopes are steeper than those of other Lithosols in Stephens County.

Profile of Darnell fine sandy loam, 2,300 feet north and 500 feet east of the southwest corner of sec. 7, T. 1 N., R. 6 W.:

A1—0 to 5 inches, grayish-brown (10YR 5/2) fine sandy loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; very friable when moist, slightly hard when dry; numerous roots; slightly acid; gradual boundary.

A2—5 to 12 inches, brown (7.5YR 5/2) fine sandy loam; brown (7.5YR 4/2) when moist; massive; friable when moist; slightly hard when dry; many roots; slightly acid; clear boundary.

C—12 to 18 inches +, reddish-brown (5YR 5/3) soft sandstone; reddish brown (5YR 4/3) when moist; medium acid.

The surface layer ranges from 4 to 20 inches in thickness. In many places the range in thickness occurs within short distances. In many places the A2 horizon is a very pale brown. The sandstone ranges from yellowish red to brown. The topography is irregular. The slope range is 5 to 35 percent. Drainage is rapid, both from the surface and internally.

Kipson Series.—The Kipson soils developed, under grass, in material weathered from Permian siltstone, sandstone, and calcareous, gray shale. They have a 5- to 15-inch grayish-brown loamy surface layer. These soils are inextensive in Stephens County. They are most extensive in east-central Kansas.

Profile of Kipson silt loam, 660 feet east of the southwest corner of sec. 18, T. 1 N., R. 5 W.:

A1—0 to 6 inches, grayish-brown (2.5Y 5/2) silt loam; very dark grayish brown (2.5Y 3/2) when moist; moderate, fine and medium, granular structure; friable when moist, hard when dry; contains a few fragments of hard, yellowish-brown sandstone; few roots; few worm casts; calcareous; few $CaCO_3$ concretions; clear boundary.

AC—6 to 12 inches, grayish-brown (2.5Y 5/2) heavy silt loam; dark grayish brown (2.5Y 4/2) when moist; moderate, fine and medium, granular structure; friable when moist, hard when dry; few roots; many fragments of hard, yellowish-brown sandstone and a few flakes of silty shale; calcareous; many $CaCO_3$ concretions; clear boundary.

C—12 to 20 inches, light olive-gray (5Y 6/2) heavy silt loam; olive gray (5Y 4/2) when moist; about 30 percent of the horizon is light olive-gray heavy silt loam intermixed with soft, gray, calcareous, silty shale and yellowish-brown sandstone fragments; clear boundary.

Dr—20 to 40 inches +, interbedded olive-gray, calcareous shale and gray and brown siltstone and sandstone that is calcareous in the seams.

The texture of the A horizon is dominantly silt loam, but in some places it is loam.

The topography is irregular. The slope range is 5 to 10 percent. Permeability is moderate, but the water-holding capacity is limited because of the shallow profile.

Lucien Series.—The Lucien soils developed, under grass, in material weathered from reddish Permian sandstone and sandy shale. They have a 5- to 15-inch surface layer of brown or reddish-brown fine sandy loam directly over the parent material. They are extensive in the western half of Stephens County.

Profile of Lucien fine sandy loam, 600 feet north and 50 feet east of the southwest corner of sec. 15, T. 1 S., R. 8 W.:

A1—0 to 5 inches, brown (7.5YR 5/4) fine sandy loam; dark brown (7.5YR 4/2) when moist; weak, fine and medium, granular structure; very friable when moist, slightly hard when dry; numerous roots; numerous worm casts; slightly acid; gradual boundary.

AC—5 to 12 inches, reddish-brown (5YR 4/4) fine sandy loam; dark reddish brown (5YR 3/4) when moist; weak, fine and medium, granular structure; very friable when moist, slightly hard when dry; numerous roots; numerous worm casts; slightly acid; clear boundary.

C—12 to 16 inches +, yellowish-red (5YR 5/6), soft, fine-grained sandstone; yellowish red (5YR 4/6) when moist; contains small ferromanganese concretions; slightly acid.

The texture of the solum is principally fine sandy loam, but in some areas it is loam. The substratum is yellowish-red to red and gray sandstone interbedded with shale and a small amount of clay. In some places the substratum is calcareous in the seams. Outcrops of rock occur in some areas. The slope range is 5 to 10 percent. Drainage is moderate to rapid from the surface and moderate internally. The water-holding capacity is limited because of the shallow profile.

Vernon Series.—The Vernon soils developed, under grass, in material weathered from calcareous Permian red-bed clay and shale. They have a 3- to 10-inch surface layer of clay loam or clay. This layer grades to the parent material. These soils are extensive in the area of the Reddish Prairie soils, which includes a large part of the western half of Stephens County.

Profile of Vernon clay loam, 50 feet north and 20 feet west of the southeast corner of sec. 34, T. 2 N., R. 8 W.:

A1—0 to 6 inches, reddish-brown (2.5YR 4/4) clay loam; dark reddish brown (2.5YR 3/4) when moist; moderate, fine and medium, granular structure; friable when moist, hard when dry; numerous roots; calcareous; clear boundary.

C—6 to 15 inches, red (2.5YR 4/6) clay; dark red (2.5YR 3/6) when moist; strong, fine and medium, subangular blocky structure; friable when moist, hard when dry; calcareous; numerous roots; 5 percent of the upper part of the layer is partly weathered shale; the proportion of partly weathered shale increases with depth, and near the bottom of the layer it makes up about 20 percent of the mass; gradual boundary.

Dr—15 to 20 inches +, red (10R 5/8), unweathered, raw clay and shale; red (10R 4/8) when moist; massive; calcareous.

In some places the surface layer is noncalcareous. The C and D horizons are red or red and gray clay, clayey shale, or interbedded clay and shale. Surface runoff is rapid, but internal drainage is very slow. The topography is irregular. The slope range is 5 to 10 percent.

REGOSOLS

Regosols are soils that have little morphological development. They consist of soils developed in unconsolidated rock or soft, rocky deposits. The Nash series represents this great soil group in Stephens County.

Nash Series.—The Nash soils developed, under grass, in material weathered from soft, red, Permian sandstone. They have a fine sandy loam solum over a noncalcareous substratum. They are extensive in the north-central part of the county.

Profile of Nash fine sandy loam, 350 feet north and 100 feet east of the southwest corner of sec. 7, T. 2 N., R. 6 W.:

Alp—0 to 6 inches, yellowish-red (5YR 5/6) fine sandy loam; yellowish red (5YR 4/6) when moist; massive; friable when moist, slightly hard when dry; few roots; slightly acid; plowed boundary.

A12—6 to 10 inches, yellowish-red (5YR 4/6) fine sandy loam; yellowish red (5YR 3/6) when moist; massive; friable when moist, slightly hard when dry; slightly acid; gradual boundary.

AC—10 to 32 inches, red (2.5YR 4/6) fine sandy loam; dark red (2.5YR 3/6) when moist; massive; friable when moist, slightly hard when dry; 5 percent of the layer consists of fragments of soft, red sandstone; slightly acid; clear boundary.

C—32 to 38 inches +, red (2.5YR 4/6), soft sandstone; dark red (2.5YR 3/6) when moist; slightly acid.

The color of the A horizon ranges from yellowish red to brown, and the color of the AC layer from reddish brown to red. The depth of the layer containing sandstone fragments varies from 10 to 30 inches. The depth to parent material ranges from 20 to 36 inches. The slope range is 1 to 8 percent. Drainage is moderate, both from the surface and internally.

Additional Facts About the County

Additional information about Stephens County is given in this section. It will be useful mainly to persons not familiar with the county. It tells about the relief and

drainage, climate, water supply, settlement, cultural facilities, transportation and markets, industries, and the agriculture of the county.

Relief and Drainage

Most of Stephens County is undulating and rolling, but throughout the county are small areas that are steep, rocky, rough, and broken. Meandering natural drainageways are numerous.

The slope ranges from nearly level to steep but is dominantly of less than 8 percent gradient. The steeper slopes commonly are next to the natural drainageways. Most of the nearly level and gently sloping areas are in the western two-thirds of the county. Natural drainageways are less numerous in these areas than where the slopes are steeper. In the eastern third of the county, relief is mostly moderately sloping to steep; areas of steep, rocky, rough, broken land are more numerous; and drainageways are more deeply entrenched.

Generally, the difference in elevation between the drainage channels and the ridgetops between the channels is 25 to 100 feet. The two extremes are commonly no more than half a mile apart. The highest elevations—about 1,400 feet—are in the northern and northwestern parts of the county. The lowest—about 800 feet—are in the southern part of the county. Natural drainage is generally to the south and east, but a small area in the northeastern part of the county drains to the north.

The western and central parts of the county are drained by tributaries of the Red River. Little Beaver Creek, Big Beaver Creek, and their tributaries drain the western part, and Cow Creek, Mud Creek, and their tributaries drain the central part. The northeastern and east-central parts of the county are drained by Wildhorse Creek, Caddo Creek, and their tributaries. Wildhorse Creek and Caddo Creek flow into the Washita River. The drainage pattern in the county is shown in figure 15, page 50.

All of the streams in the county flow intermittently. The major streams usually flow continuously except during the dry season of the year, which is normally from July to September. The smaller streams flow for only short periods after rains. The major streams overflow frequently, except those in areas protected by detention dams.

There are no natural lakes in the county. Lake Humphreys, which has a surface area of about 1,300 acres, and Clear Creek Lake, which has a surface area of about 900 acres, are the two largest manmade lakes.

The water supply is adequate throughout the county, even during periods of severe drought. Wells and farm ponds furnish water for livestock and domestic use. Until the middle 1930's, water for municipal and industrial use was furnished by wells, but now lakes supply water to municipalities.

Climate [11]

Stephens County has the temperate, continental climate typical of the southwestern Great Plains. Masses of air from the north and warm, moist air from the Gulf of Mexico alternately influence the weather. Seasonal changes are gradual. Spring is a season of variable weather and rains of high intensity. Severe local storms and tornadoes are most likely in spring. Summer is long, hot, and occasionally dry. The heat is not oppressive, however, because of low humidity and prevailing breezes. Autumn has long periods of pleasant weather interspersed with long, soaking rains. Winter is short and mild. Long periods of heavy snow and severe cold are infrequent.

Stephens County has wide variations in temperature. The temperature has fallen as low as −10° F., and has risen as high as 110°. Readings of zero or below have been recorded only one winter in eight. On the average, there are only 5 days each year when the temperature does not rise above freezing. The longest recorded period in which the temperature did not rise above freezing is 9 consecutive days. Temperatures of 90° occur as early as February and as late as November. Temperatures of 90° or higher occur on an average of 90 days per year, and temperatures of 100° or higher on 20 days per year.

Precipitation ranges from 17 to 54 inches a year (fig. 16). The average is near 33 inches. The amount and distribution are favorable for agriculture (fig. 17). Dry periods seldom last long enough to cause complete crop failure. Only once since weather records have been kept in the county has there been a period of 2 consecutive months without measurable precipitation. Occasional heavy rains cause floods, erosion, and damage to crops. Once a year in 1 year out of 2, and twice a year in 1 year out of 8, between 3 and 5 inches of rain will fall in 1 day. The greatest amount that has been recorded in 1 day at Marlow is 6.14 inches, and the greatest amount at Duncan is 9.85 inches.

On the average, 4 to 6 inches of snow falls each year, and occasionally as much as 6 to 8 inches in one fall. Snow seldom stays on the ground more than 3 or 4 days.

The prevailing winds are from the north in winter and from the south the rest of the year. The average wind speed is 13 miles an hour. Strong winds associated with violent line squalls are most common in spring. Only 25 tornadoes have struck in Stephens County in the last 86 years.

In the last 37 years, 17 hailstorms have caused damage in the county. Probability computations show that in 63 percent of the years no hailstorms will occur, that in 92 percent of the years no more than 1 hailstorm will occur, and that in 99 percent of the years no more than 2 hailstorms will occur. Most hailstorms cover a small area, and the chance that a destructive storm will hit any one farm in a given year is slight.

The freeze-free season ordinarily lasts about 217 days. This is ample time for the crops grown in the county to mature. April 30 is the latest date in spring on which a freezing temperature has been recorded, and October 7 the earliest date in fall. Only occasionally does a freeze late in spring cause serious damage to grain and other early-growing crops, or a freeze early in fall cause damage to cotton and other late-maturing crops.

Table 7 gives the probable dates of freezing temperatures in spring and in fall. In the southern part of the county, the probable dates are about 2 days earlier in spring and 2 days later in autumn.

[11] By Hugo V. Lehrer, state climatologist, U.S. Weather Bureau.

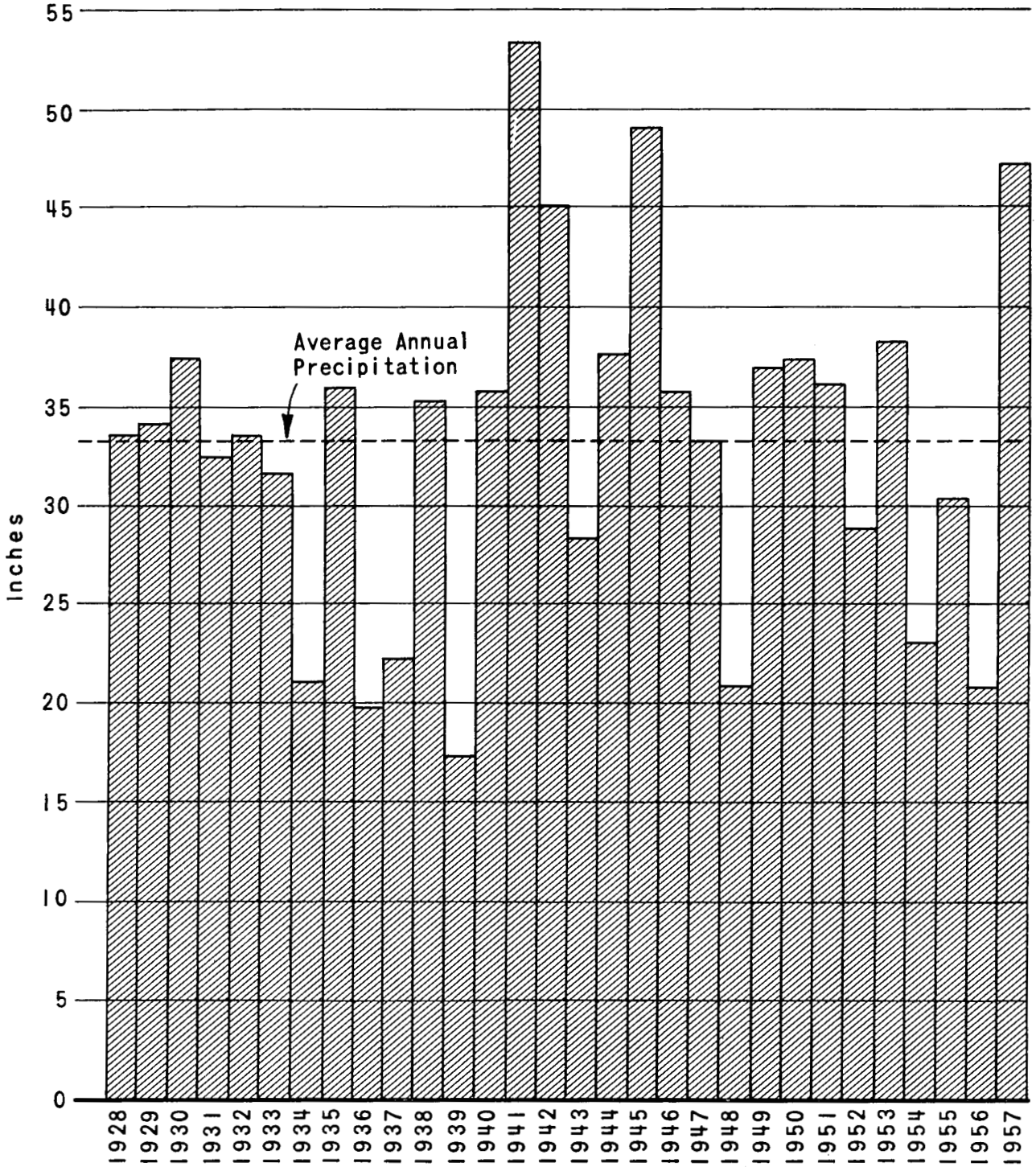

Figure 16.—Annual precipitation at Marlow for a 30-year period.

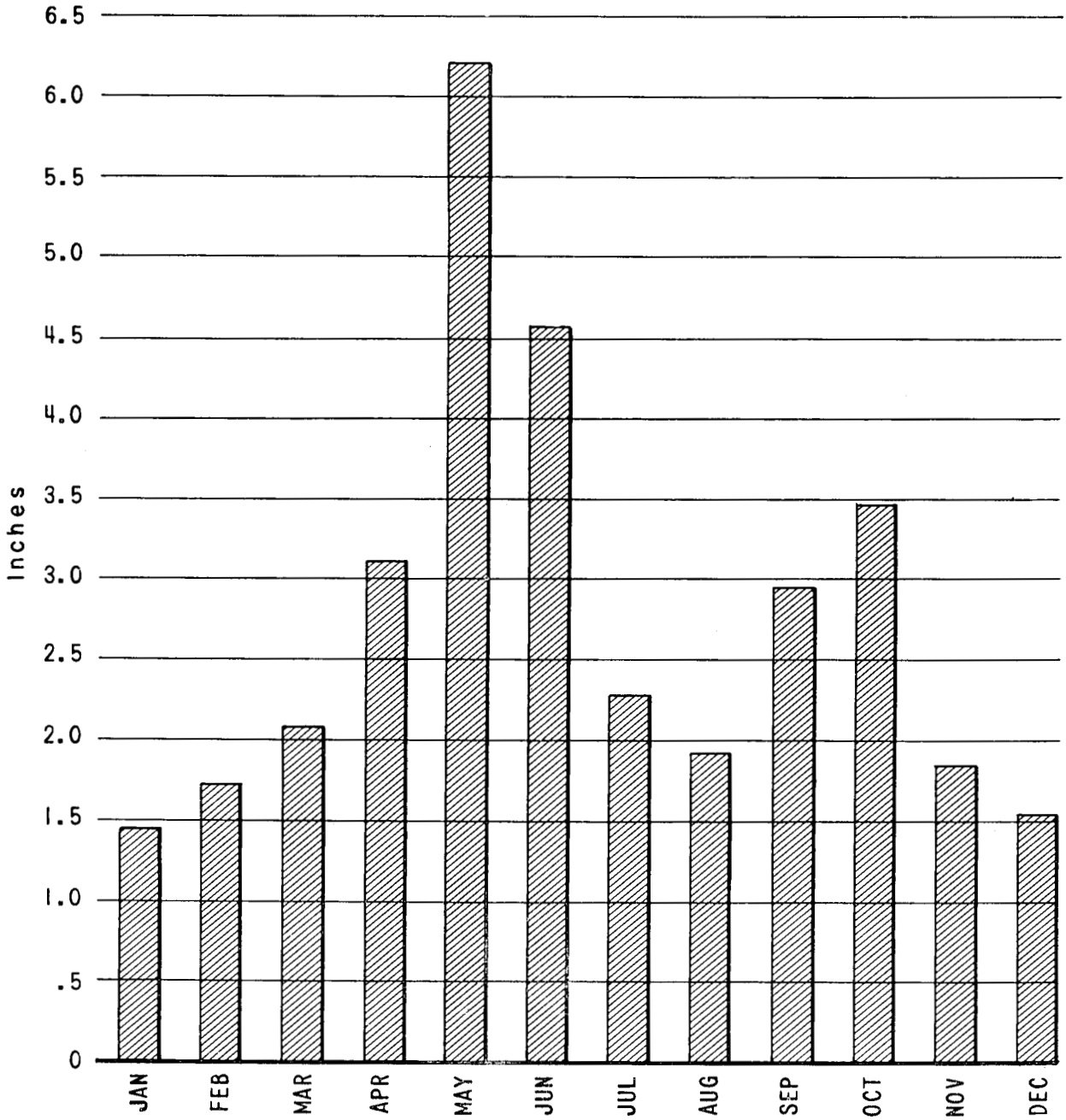

Figure 17.—Average monthly precipitation at Marlow, based on 30-year period.

TABLE 7.—*Probabilities of freezing temperatures in spring and in fall*

[Based on data from records kept at Marlow, Stephens County, Okla. for the years 1921–50]

Probability	Dates for given probability at temperature levels shown				
	16° F.	20° F.	24° F.	28° F.	32° F.
Spring:					
1 year in 10, later than	Mar. 12	Mar. 22	Mar. 30	Apr. 10	Apr. 20.
2 years in 10, later than	Mar. 3	Mar. 15	Mar. 24	Apr. 4	Apr. 13.
5 years in 10, later than	Feb. 15	Mar. 2	Mar. 11	Mar. 22	Apr. 1.
Fall:					
1 year in 10, earlier than	Nov. 25	Nov. 19	Nov. 8	Oct. 28	Oct. 20.
2 years in 10, earlier than	Dec. 3	Nov. 26	Nov. 15	Nov. 6	Oct. 25.
5 years in 10, earlier than	Dec. 19	Dec. 10	Nov. 30	Nov. 16	Nov. 3.

In autumn, the precipitation and temperature are generally favorable for the preparation of seedbeds and for seeding, germination, and development of wheat, oats, and barley, which normally are planted in autumn. Generally, the weather through October and November is such that plants become well enough established to withstand the winter, to protect the soil against erosion, and to provide winter pasture.

Table 8 shows, by months, the average daily maximum temperature, the average daily minimum temperature, and average precipitation at Marlow for the period 1928–57.

Settlement and Development [12]

Stephens County, named for John W. Stephens, a Congressman from Texas, was formed in 1907. At that time it had a population of 20,148. In 1960 the population of the county was 37,990, and that of Duncan, the county seat, was 20,009.

The first recorded exploration by white men of the territory that is now Stephens County was in 1834. In that

[12] The information about the settlement of Stephens County was given by J. G. CLIFT, Oklahoma Historical Society. The rest of this subsection was prepared by ROBERT R. BROWN, work unit conservationist, Soil Conservation Service.

TABLE 8.—*Temperature and precipitation at Marlow, Stephens County, Okla.*

[Based on data from records kept for the years 1928–57]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	2 years in 10 will have at least 4 days with—		Average monthly total	1 year in 10 will have—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Number	Inches
January	52	29	71	10	1.45	0.1	2.7	1	3
February	57	33	74	16	1.72	.2	3.1	(1)	3
March	66	39	83	22	2.09	.4	4.0	(1)	4
April	75	50	88	35	3.10	.6	5.9	(1)	2
May	81	58	92	47	6.21	1.6	10.9	0	----------
June	90	67	98	58	4.58	1.3	8.2	0	----------
July	95	70	104	65	2.29	.2	5.7	0	----------
August	96	70	106	62	1.92	.1	4.0	0	----------
September	89	62	101	50	2.95	.2	5.4	0	----------
October	78	52	92	38	3.48	.6	7.9	0	----------
November	63	39	79	24	1.83	0	3.8	0	----------
December	55	32	72	19	1.55	.2	2.7	(1)	2
Year [2]	75	50	[3] 106	[4] 5	33.17	21.1	45.0	1	3

[1] Less than half a day.

[2] Average daily maximum and minimum for the year computed for all years for which records were kept; maximum and minimum temperatures for year are highest and lowest ever recorded; average total precipitation for year is average computed from all years for which records were kept; precipitation of less than 21.1 inches is lowest probable for 1 year in 10; and 45.0 inches is highest probable for 1 year in 10.

[3] Average highest maximum for 29 years.

[4] Average lowest minimum for 29 years.

year Colonel Dodge led a military expedition to the North Fork of the Red River to make a treaty with the Indians. About 1865 the first permanent white settlement was established. It was on the north side of the present site of Duncan Lake. The historic Chisholm Trail, traces of which can still be seen, extended across the area that is now Stephens County. Between 1868 and 1890, several million cattle were driven over this trail to a shipping point at Abilene, Kans.

In 1892, a railroad, the Rock Island Lines, was built across the county, and the towns of Marlow, Duncan, and Comanche were established.

The first post office, established in 1884, was on the site that is now Duncan. The first schoolhouse, built in 1886, was at Panther Branch, about 2 miles northeast of Velma.

A number of new school plants have been constructed in the county recently. Most of the rural schools have been consolidated.

Numerous churches of various denominations are located throughout the county, and many new church buildings have been constructed.

There are hospitals in the larger towns, and a new county health clinic has just been completed.

Facilities for golfing, hunting, water skiing, boating, and fishing are available to the public.

The Rock Island Lines, a freight and passenger line of the Chicago, Rock Island, and Pacific Railroad, crosses the county from north to south, connecting Marlow, Duncan, and Comanche. An airport at Duncan is served by an airline which operates regularly scheduled passenger and freight flights. Duncan is the headquarters for a company that operates a freight and air service to all parts of the world.

State and U.S. highways crisscross the county and are used by regularly scheduled bus, motor freight, and motor express lines. U.S. Highway 81 crosses the county from north to south. State Highways 29, 7, and 53 cross the county from east to west and intersect U.S. Highway 81.

Livestock are shipped to markets in Oklahoma City. Wheat is transported by truck to Houston, Tex.

The principal industry in Stephens County is the production of refined petroleum and of petro-chemical products. Crude petroleum and natural gas are produced in the county, and they are processed by three major refineries and several smaller independent refineries.

A company that manufactures portable scales is located at Duncan.

Agriculture

In the last 30 years, the trend in agriculture in Stephens County has been toward livestock farming. In 1929 crops were harvested from 183,605 acres; in 1954, from 67,244 acres; and in 1959, from 61,669 acres. Most of the acreage now in cultivation is in the western half of the county.

Since the formation of Stephens County, the average size of farms has increased and the number of farm units has decreased.

Table 9 shows the number and average size of farms in the county for stated years.

Table 10 shows the acreage of selected crops grown in the county for stated years. Wheat, cotton, sorghum, and oats are the most important crops. Wheat is the principal cash crop (fig. 18).

TABLE 9.—*Number and size of farms*

Size of farms	1940		1950		1959	
	Number	*Acres*	*Number*	*Acres*	*Number*	*Acres*
All farms	2, 592	451, 373	1, 931	472, 458	1, 330	462, 170
Less than 10 acres	62	336	118	526	59	222
10 to 99 acres	788	46, 780	524	27, 309	270	14, 118
100 to 179 acres	1, 116	157, 436	543	77, 953	328	46, 920
180 to 259 acres	284	60, 116	246	52, 882	177	38, 640
260 to 499 acres	263	89, 756	334	115, 695	267	95, 999
500 to 999 acres	53	34, 631	112	76, 921	142	98, 026
1,000 acres or more	26	62, 318	54	121, 172	87	168, 245

TABLE 10.—*Acreage of principal crops*

Corn	1929	1939	1949	1959
	Acres	*Acres*	*Acres*	*Acres*
Wheat threshed or combined	2, 562	2, 893	15, 887	14, 304
Cottor harvested	78, 559	32, 117	13, 043	4, 280
Oats threshed or combined	10, 708	21, 688	5, 473	7, 123
Barley threshed or combined	749	2, 303	592	3, 357
Sorghum for all purposes except sirup	27, 033	21, 306	20, 068	11, 805
Corn for all purposes	43, 373	26, 729	14, 917	1, 116
Peanuts for all purposes	2, 179	783	3, 152	1, 775
Broomcorn	3, 696	4, 569	4, 370	3, 154
Hay crops, total	9, 201	11, 130	13, 299	12, 894

In this county, much of the farm income is derived from the sale of livestock. There has been a large increase in the number of cattle and calves in the last 30 years, but all other types of livestock have decreased in number.

The number and kinds of livestock in the county in stated years are shown in table 11.

Flood Prevention Program

During and after World War I, a large acreage in Stephens County that had till then been in native grass was plowed and used for row crops. When the natural cover was removed, runoff increased and the larger streams overflowed so frequently that their bottom lands were no longer suitable for cultivation.

Figure 18.—**A wheatfield on Kirkland silt loam, 0 to 1 percent slopes.**

TABLE 11.—*Livestock on farms in stated years*

Livestock	1930	1940	1950	1959
	Number	*Number*	*Number*	*Number*
Cattle and calves	35, 187	[1] 28, 092	39, 424	49, 191
Milk cows	7, 227	9, 525	6, 518	2, 116
Horses and mules	11, 665	[1] 8, 651	2, 872	1, 136
Sheep and lambs	1, 672	[2] 1, 978	1, 292	1, 584
Hogs and pigs	14, 397	[3] 10, 122	11, 471	8, 035
Chickens	[1] 150, 548	[3] 116, 662	[3] 112, 836	[3] 57, 602

[1] Over 3 months old.
[2] Over 6 months old.
[3] Over 4 months old.

In the 1930's the Works Progress Administration, in cooperation with the City of Duncan, constructed Duncan Lake, but the watershed was not treated to prevent silting. Later Clear Creek Lake (also known as Chisholm Trail Lake) was built and a part of the watershed was seeded to native grasses, but silting again caused excessive damage. In 1955, the Board of Supervisors of the Stephens County Soil Conservation District, in cooperation with the Soil Conservation Service, constructed Lake Humphreys, a floodwater retarding structure that could also supply water to Duncan. Several hundred acres of the 20,000-acre watershed was seeded to grass before the lake was built.

The Wildhorse Creek Flood Prevention Association was organized and a watershed plan was developed for Wildhorse Creek and its tributaries. By 1957, 25 detention structures had been built and the rest of the program for protection of the watershed was in effect. Twenty-four structures were built along the tributaries of Wildhorse Creek, in addition to the one on the main stream that formed Lake Humphreys, the municipal lake. More than half of the acreage of the entire watershed was above these lakes. This program has been so successful that flood-prevention plans are now being developed for other areas of Stephens County. Work is now progressing on about 130,000 acres in a flood-plain area adjacent to the developed area. Plans have also been made to control flooding along Cow Creek and Beaver Creek.

Although the reduction of flood damage is the principal purpose of the flood prevention program, additional benefits are derived. The bottom lands are now being used for cultivated crops, water from the reservoirs is used for irrigating crops, the economy of the county has been improved, and Duncan now has a permanent water-supply system.

Glossary

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

Calcareous soil. A soil containing calcium carbonate, or a soil that is alkaline in reaction because of the presence of calcium carbonate.

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

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

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; will not hold together in a mass.

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

Firm.—When moist, can be crushed 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; 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.

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

A horizon. The mineral horizon at the surface. It has an accumulation of organic matter, has been leached of soluble minerals and clay, or shows the effects of both.

B horizon. A horizon in which clay minerals or other material has accumulated, that has developed a characteristic blocky or prismatic structure, or that shows the effects of both processes.

C horizon. The unconsolidated material immediately under the true soil. In chemical, physical, and mineral composition it is presumed to be similar to the material from which at least part of the overlying solum has developed.

D horizon. Any layer, or stratum, underlying the C horizon, or the B horizon if no C horizon is present. If this stratum is rock that presumably was the source of material in the C horizon, it is designated Dr.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

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.*

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

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely

neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

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

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

Sand. As a soil separate, individual rock or mineral fragments 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but they may be any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

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 without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

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."

GUIDE TO MAPPING UNITS

[See table 1, p. 7, for approximate acreage and proportionate extent of the soils; table 2, p. 29, for predicted yields of principal crops; table 3, p. 33, for estimated yields of range vegetation; and tables 4, 5, and 6, pp. 36, 44, and 48, for soil properties affecting engineering and for interpretations of these properties]

Map symbol	Mapping unit	Page	Capability unit		Range site	
			Symbol	Page	Name	Page
Ba	Breaks-alluvial land complex	7	VIe-5	27	----------	
Bc	Bethany-slickspot complex	7	IVe-3	25	Loamy Prairie; Slickspot	31; 32
CaA	Chickasha fine sandy loam, 0 to 1 percent slopes	8	IIe-1	21	Loamy Prairie	31
CaB	Chicasha fine sandy loam, 1 to 3 percent slopes	8	IIe-2	22	Loamy Prairie	31
CaC	Chickasha fine sandy loam, 3 to 5 percent slopes	8	IIIe-4	23	Loamy Prairie	31
ChA	Chickasha loam, 0 to 1 percent slopes	8	I-3	21	Loamy Prairie	31
ChB	Chickasha loam, 1 to 3 percent slopes	8	IIe-3	22	Loamy Prairie	31
ChC	Chickasha loam, 3 to 5 percent slopes	8	IIIe-2	23	Loamy Prairie	31
ChD	Chickasha loam, 5 to 8 percent slopes	8	IVe-4	25	Loamy Prairie	31
Ck	Chickasha-slickspot complex	8	IVe-3	25	Loamy Prairie; Slickspot	31; 32
Cs	Clayey saline alluvial land	9	Vs-1	26	Alkali Bottom Land	30
DoB	Dougherty loamy fine sand, undulating	9	IIIe-5	24	Deep Sand Savannah	30
DoC	Dougherty loamy fine sand, hummocky	9	IVe-6	25	Deep Sand Savannah	30
DuB2	Dougherty soils, 1 to 5 percent slopes, eroded	9	IVe-6	25	Deep Sand Savannah	30
Es	Eroded clayey land	10	VIe-1	26	Eroded Clay	30
Et	Eroded loamy land	10	VIe-2	26	Loamy Prairie	31
EuC	Eufaula fine sand, hummocky	10	VIs-1	27	Deep Sand Savannah	30
Go	Gowen clay loam	10	I-1	21	Loamy Bottom Land	31
	Gravel pits	10	VIIIs-1	27	----------	
Kk	Kipp-Kipson complex	11	VIs-3	27	Loamy Prairie	31
KnA	Kirkland silt loam, 0 to 1 percent slopes	11	IIs-1	22	Claypan Prairie	30
KrB	Kirkland-Renfrow silt loams, 1 to 3 percent slopes	11	IIIe-1	22	Claypan Prairie	30
Lz	Lucien-Zaneis-Vernon complex	12	VIs-2	27	Loamy Prairie; Red Clay Prairie; Shallow Prairie	31; 32
Mr	Miller clay	12	IIIw-1	24	Heavy Bottom Land	31
Ms	Miller soils, frequently flooded	12	Vw-1	26	Heavy Bottom Land	31
NaB	Nash fine sandy loam, 1 to 3 percent slopes	12	IIe-2	22	Loamy Prairie	31
NnC	Nash and Noble fine sandy loams, 3 to 5 percent slopes	12	IIIe-3	23	Loamy Prairie	31
NnD	Nash and Noble fine sandy loams, 5 to 8 percent slopes	13	IVe-4	25	Loamy Prairie	31
Ow	Oil waste land	13	VIIIs-1	27	----------	
Pf	Port fine sandy loam	13	I-2	21	Loamy Bottom Land	31
Po	Port clay loam	13	I-1	21	Loamy Bottom Land	31
Pr	Port loam	13	I-2	21	Loamy Bottom Land	31
Ps	Port soils, frequently flooded	14	Vw-2	26	Loamy Bottom Land	31
ReC	Renfrow silt loam, 3 to 5 percent slopes	14	IVe-1	24	Claypan Prairie	30
RfB2	Renfrow and Kirkland soils, 1 to 5 percent slopes, eroded	14	IVe-2	24	Claypan Prairie	30
Rg	Rough broken land, clayey	14	VIIs-2	27	Breaks	30
Rs	Rough broken land, sandy	14	VIIe-1	27	Sandy Savannah	32
Sa	Sandy alluvial land	15	Vw-3	26	----------	
SbB	Stephenville fine sandy loam, 1 to 3 percent slopes	15	IIe-2	22	Sandy Savannah	32
SbC	Stephenville fine sandy loam, 3 to 5 percent slopes	15	IIIe-4	23	Sandy Savannah	32
SbC2	Stephenville fine sandy loam, 3 to 5 percent slopes, eroded	15	IVe-5	25	Sandy Savannah	32
SbD	Stephenville fine sandy loam, 5 to 8 percent slopes	16	IVe-5	25	Sandy Savannah	32
SdE	Stephenville-Darnell complex, 5 to 12 percent slopes	15	VIe-4	27	Sandy Savannah; Shallow Savannah	32
Sw3	Stephenville and Windthorst soils, severely eroded	15	VIe-3	26	Sandy Savannah	32
WdB	Windthorst fine sandy loam, 1 to 5 percent slopes	16	IIIe-6	24	Sandy Savannah	32
WdB2	Windthorst fine sandy loam, 1 to 5 percent slopes, eroded	16	IVe-7	26	Sandy Savannah	32
Wn	Windthorst-Darnell complex	16	VIIs-1	27	Shallow Savannah	32
ZaB	Zaneis loam, 1 to 3 percent slopes	17	IIe-3	22	Loamy Prairie	31
ZaC	Zaneis loam, 3 to 5 percent slopes	17	IIIe-2	23	Loamy Prairie	31
ZaC2	Zaneis loam, 3 to 5 percent slopes, eroded	17	IVe-4	25	Loamy Prairie	31
ZaD	Zaneis loam, 5 to 8 percent slopes	17	IVe-4	25	Loamy Prairie	31

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