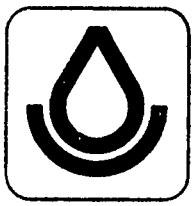
# SOIL SURVEY

# Craig County Oklahoma



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
OKLAHOMA AGRICULTURAL EXPERIMENT STATION
Issued April 1973

Major fieldwork for this soil survey was done in the period 1960–67. Soil names and descriptions were approved in 1968. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1967. This survey was made cooperatively by the Soil Conservation Service and the Oklahoma Agricultural Experiment Station. It is part of the technical assistance furnished to the Craig County Soil and Water Conservation District.

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

# HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

## Locating Soils

All the soils of Craig County are shown on the detailed map at the back of this survey. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

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

## Finding and Using Information

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

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

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

*Foresters and others* can refer to the section "Use of the Soils as Woodland," where the soils of the county are grouped according to their suitability for trees.

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

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

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

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

*Newcomers in Craig County* may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication and in the section "General Nature of the County."

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# Contents





Issued April 1973

# SOIL SURVEY OF CRAIG COUNTY, OKLAHOMA

BY CLAUDE T. NEWLAND

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

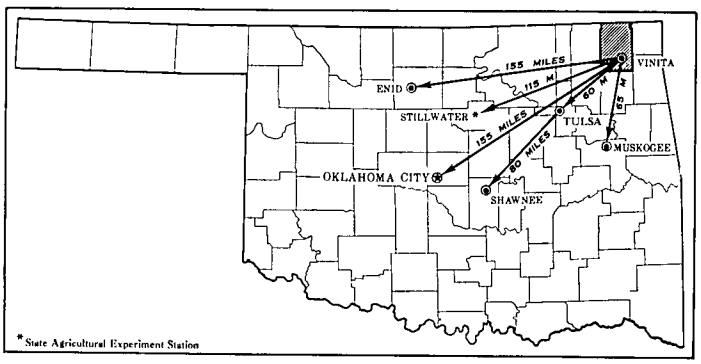


*Figure 1.*—**Location of Craig County in Oklahoma.**

CRAIG COUNTY is in the northeastern part of Oklahoma (fig. 1). The county is bounded on the north by the state of Kansas, on the east by Ottawa and Delaware Counties, on the west by Nowata and Rogers Counties, and on the south by Mayes and Rogers Counties. Vinita, the county seat, lies in the south-central part of the county.

The county has a land area of 488,960 acres, or 764 square miles. About 468,612 acres is in farms; of this, about 368,800 acres is suitable for cultivation. Farming has always been the leading occupation. Many of the farms are diversified, but there are a number of ranches where beef cattle are raised.

Most of the soils are deep and on nearly level to sloping areas. The soils are generally acid. Crops grown on these soils respond well when lime and fertilizer are added.

The principal crops are wheat, grain sorghum, and soybeans. Much of the acreage is tame pasture and native range.

## *How This Survey Was Made*

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

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey (*5*).[1]

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

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

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

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

Some mapping units are made up of soils of different series, or of different phases within one series. One such

[1] Italic numbers in parentheses refer to Literature Cited, page 63.

kind of mapping unit is shown on the soil map of Craig County—the soil complex.

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

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

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

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

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

## *General Soil Map*

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

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

Not all soil boundaries and names on the Craig County general soil map join with those on maps of Delaware, Ottawa, and Rogers Counties that were surveyed earlier. Most of the differences result from refinement in the current system of soil classification.

The eight soil associations in Craig County are discussed in the pages that follow. Unless otherwise specified, the terms for texture used in the title for each association apply to the surface layer. For example, in the title for association 1, the words "loamy soils" mean that the surface layer of the major soils is loamy.

### 1. Dennis-Parsons-Taloka Association

*Deep, nearly level to gently sloping, loamy soils that have a loamy and clayey subsoil over loamy sediment, shale, or clay; on uplands*

Dennis soils make up about 44 percent of this association, Parsons soils about 13 percent, Taloka soils about 6 percent, and minor soils about 37 percent. This association makes up about 56 percent of the county.

Dennis soils are deep, very gently sloping to gently sloping, and they are moderately well drained. They are loamy throughout.

Parsons soils are deep, nearly level, somewhat poorly drained to moderately well drained loamy soils that have a clayey subsoil.

Taloka soils are deep, nearly level, somewhat poorly drained to moderately well drained loamy soils that have a clayey subsoil.

Minor soils in this association are the Bates, Choteau, Collinsville, Okemah, Radley, Summit, Talpa, Verdigris, and Vinita.

Most soils in this association are cultivated. The main crops are wheat, grain sorghum, soybeans, oats, and pasture plants. Soils in this association respond well to good management. Maintenance of soil structure and fertility are the chief concerns.

### 2. Summit-Bonham-Lula Association

*Deep, nearly level to gently sloping, loamy soils that have a loamy and clayey subsoil over limestone or shale; on uplands*

Summit soils make up about 29 percent of this association, Bonham soils about 28 percent, Lula soils about 11 percent, and minor soils about 32 percent. This association makes up about 17 percent of the county.

Summit soils are deep, nearly level to gently sloping, moderately well drained loamy soils that have a clayey subsoil.

Bonham soils are deep, very gently sloping, moderately well drained loamy soils that have a clayey subsoil.

Lula soils are deep, very gently sloping to gently sloping, well-drained soils that are loamy throughout.

Minor soils in this association are Claremore, Osage (uplands), Lenapah, and Talpa.

About 50 percent of the soils in this association is used for cultivated crops, and the rest is used for pasture and range. The main crops are wheat, oats, grain sorghum, corn, soybeans, and alfalfa.

The principal concerns of management on soils in this association are the control of erosion caused by water and the maintenance of soil structure and fertility.

## 3. Verdigris-Radley-Lightning Association

*Deep, nearly level, loamy soils that are loamy throughout or have a clayey subsoil; over loamy or clayey sediment; on flood plains*

Verdigris soils make up about 60 percent of this association, Radley soils about 20 percent, Lightning soils about 13 percent, and minor soils about 7 percent. The association makes up about 6 percent of the county.

Verdigris soils are deep, nearly level, moderately well drained soils that are loamy throughout. They have very dark grayish-brown layers more than 20 inches thick.

Radley soils are deep, nearly level, moderately well drained soils that are loamy throughout. They have very dark grayish-brown layers less than 20 inches thick.

Lightning soils are deep, nearly level, poorly to somewhat poorly drained loamy soils that have a clayey subsoil.

Minor soils in this association are Carytown and Osage.

Most of the soils in this association are cultivated. The main crops grown are wheat, grain sorghum, alfalfa, corn, soybeans, and tame pasture plants. The principal concerns of management on soils in this association are maintaining soil structure and protecting against damaging overflows.

## 4. Hector-Linker Association

*Very shallow to moderately deep, very gently sloping to moderately steep soils that are loamy throughout and are over sandstone; on uplands*

Hector soils make up about 48 percent of this association, Linker soils about 36 percent, and minor soils about 16 percent. This association makes up about 5 percent of the county.

Hector soils are very shallow and shallow, very gently sloping to moderately steep, well-drained soils that are loamy throughout.

Linker soils are moderately deep, very gently sloping to moderately steep, well-drained soils that are loamy throughout.

Minor soils in this association are Bates, Collinsville, Radley, and Verdigris.

About 60 percent of this association is woodland used for grazing, and the rest is in small grains, grain sorghum, and tame pasture plants. The principal concerns of management on soils in this association are the control of erosion caused by water and the maintenance of soil fertility.

## 5. Craig-Eldorado Association

*Deep, very gently sloping to sloping, loamy soils that have a loamy and clayey subsoil over cherty limestone; on uplands*

Craig soils make up about 46 percent of this association, Eldorado soils about 42 percent, and minor soils about 12 percent. The association makes up about 3 percent of the county.

Craig soils are deep, very gently sloping, well-drained prairie soils that are loamy throughout.

Eldorado soils are deep, very gently sloping to sloping, well-drained soils that have a clayey or loamy subsoil.

Minor soils in this association are the Bates, Collinsville, and Cherokee.

About 65 percent of this association is used for native range, and the rest is used for cultivated crops and tame pasture. The main crops are wheat, grain sorghum, soybeans, and tame pasture plants. The principal concerns of management on soils in this association are the control of erosion caused by water and maintenance of soil fertility.

## 6. Clarksville-Nixa Association

*Deep, nearly level to strongly sloping, loamy soils that have a loamy and clayey subsoil over cherty limestone; on uplands*

Clarksville soils make up about 62 percent of this association, Nixa soils about 5 percent, and minor soils about 33 percent. This association makes up about 2 percent of the county.

Clarksville soils are deep, very gently sloping to strongly sloping, somewhat excessively drained loamy soils that have a loamy or clayey subsoil.

Nixa soils are deep, nearly level to very gently sloping, moderately well drained loamy soils that have a loamy or clayey subsoil.

Minor soils in this association are Sallisaw and Staser.

About 70 percent of this association is woodland and is used for grazing livestock. The rest is used for tame pasture, small grains, and grain sorghum. The principal concern of management on soils in this association is maintenance of soil fertility.

## 7. Bates-Collinsville-Vinita Association

*Moderately deep to very shallow, very gently sloping to steep, loamy soils that are loamy throughout or have a loamy or clayey subsoil; over sandstone or shale; on uplands*

Bates soils make up about 40 percent of this association, Collinsville soils about 30 percent, Vinita soils about 25 percent, and minor soils about 5 percent. This association makes up about 4 percent of the county.

Bates soils are moderately deep, very gently sloping and gently sloping, well-drained soils that are loamy throughout.

Collinsville soils are very shallow and shallow, very gently sloping to steep, well-drained and somewhat excessively drained soils that are loamy throughout.

Vinita soils are moderately deep, very gently sloping to steep, moderately well drained loamy soils that have a clayey or loamy subsoil.

Minor soils in this association are Summit and Talpa.

Because of the shallow soils and steep slopes, nearly all of this association is used for range. The principal concerns of management on soils in this association are shallowness and steep slopes.

## 8. Talpa-Summit Association

*Very shallow to moderately deep, nearly level to sloping, loamy soils that are loamy throughout or have a dominantly clayey subsoil; over limestone or shale; on uplands*

Talpa soils make up about 55 percent of this association, Summit soils about 38 percent, and minor soils about 7 percent. This association makes up about 7 percent of the county.

Talpa soils are very shallow and shallow, nearly level to sloping, well-drained soils that are loamy throughout.

Summit soils are moderately deep, very gently sloping to sloping, moderately well drained loamy soils that have a clayey subsoil.

Minor soils in this association are the Claremore, Lenapah, and Lula.

Soils in this association are used for range. The principal concerns of management on soils in this association are rockiness and shallowness to bedrock.

# *Descriptions of the Soils*

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

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

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. The land type Mine pits and dumps, for example, does not belong to a soil series; nevertheless, it is listed in alphabetic order along with the soil series.

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

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*5*).

Not all soil boundaries and names on the Craig County soil map join with those on maps of Delaware, Ottawa, and Rogers Counties that were surveyed and published earlier. Most of the differences result from refinement in the current system of soil classification.

## Bates Series

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

In a representative profile the surface layer is 11 inches of very dark grayish-brown loam. The upper part of the subsoil, to a depth of 16 inches, is dark-brown loam. The lower part, to a depth of 28 inches, is strong-brown clay loam. The subsoil is underlain by yellowish-brown, partly weathered sandstone.

Bates soils have moderate permeability. Available water capacity is moderate to high.

Representative profile of Bates loam, 3 to 5 percent slopes, 700 feet north of the SW. corner of sec. 23, T. 26 N., R. 20 E.:

A1—0 to 11 inches, very dark grayish-brown (10YR 3/2) loam, grayish-brown (10YR 5/2) dry; moderate, medium, granular structure; slightly hard, friable; medium acid; gradual, smooth boundary.

B1—11 to 16 inches, dark-brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate, medium, granular structure; slightly hard, friable; strongly acid; gradual, smooth boundary.

B2t—16 to 28 inches, strong-brown (7.5YR 5/6) clay loam, reddish yellow (7.5YR 6/6) dry; common, medium, prominent, red (2.5YR 4/6) mottles; weak, fine, subangular blocky structure; hard, friable; patchy clay films on ped surfaces; few sandstone fragments; strongly acid; gradual, smooth boundary.

R—28 inches, yellowish-brown sandstone; hard when dry.

The A horizon is very dark grayish brown, dark brown, or very dark brown in color. It generally is strongly acid or medium acid but in places is more alkaline in areas that have been limed. The B1 horizon is dark brown to yellowish brown. The reaction is strongly acid or medium acid. The B2t horizon is dark-brown, brown, strong-brown, dark yellowish-brown, or yellowish-brown clay loam or sandy clay loam. Mottling is in shades of brown and red. Sandstone is at a depth of 20 to 40 inches.

Soils in part of the acreage of mapping unit BaC2 are outside the defined range for the Bates series. The A horizon has been thinned by erosion, and the profile in less than half the acreage of the mapping unit is similar to that described as representative for the series. Soils in the remaining areas are enough like the Bates series in morphology, composition, and behavior to be included with this series.

Bates soils are coarser textured throughout than associated Dennis soils, and their solum is thinner than that of Dennis soils. Bates soils lack the gravelly B horizon of associated Sallisaw soils and are deeper to sandstone than associated Collinsville soils.

**Bates loam, 1 to 3 percent slopes** (BaB).—This soil is very gently sloping. Included with it in mapping are spots of Dennis and Collinsville soils. Also included are

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

| Soil | Acres | Percent | Soil | Acres | Percent |
|---|---|---|---|---|---|
| Bates loam, 1 to 3 percent slopes | 1,002 | 0.2 | Lightning-Carytown complex | 5,915 | 1.2 |
| Bates loam, 3 to 5 percent slopes | 15,629 | 3.2 | Linker fine sandy loam, 1 to 3 percent slopes | 1,237 | .3 |
| Bates loam, 2 to 5 percent slopes, eroded | 3,771 | .8 | Linker fine sandy loam, 3 to 5 percent slopes | 1,409 | .3 |
| Bates-Collinsville complex, 1 to 5 percent slopes | 9,919 | 2.0 | Linker fine sandy loam, 2 to 5 percent slopes, eroded | 486 | .1 |
| Bonham silt loam, limestone substratum, 1 to 3 percent slopes | 24,356 | 5.0 | Lula silt loam, 1 to 3 percent slopes | 9,856 | 2.0 |
| Carytown silt loam, thin surface | 904 | .2 | Lula silt loam, 3 to 5 percent slopes | 367 | .1 |
| Cherokee silt loam | 2,536 | .5 | Mine pits and dumps | 1,901 | .4 |
| Choteau silt loam, 0 to 1 percent slopes | 5,673 | 1.2 | Nixa cherty silt loam, 0 to 3 percent slopes | 508 | .1 |
| Choteau silt loam, 1 to 3 percent slopes | 5,609 | 1.2 | Okemah silt loam, limestone substratum | 1,914 | .4 |
| Claremore silt loam, moderately shallow variant 1 to 5 percent slopes | 5,416 | 1.1 | Osage silty clay loam | 2,668 | .6 |
| Clarksville stony silt loam, 5 to 12 percent slopes | 3,238 | .7 | Osage silty clay loam, uplands | 8,400 | 1.7 |
| Clarksville very cherty silt loam, 1 to 8 percent slopes | 3,119 | .6 | Parsons silt loam, 0 to 1 percent slopes | 36,286 | 7.4 |
| Collinsville-Vinita complex, 2 to 30 percent slopes | 41,935 | 8.6 | Radley silt loam | 9,730 | 2.0 |
| Craig silt loam, 1 to 3 percent slopes | 6,996 | 1.4 | Sallisaw silt loam, 0 to 3 percent slopes | 390 | .1 |
| Dennis silt loam, 1 to 3 percent slopes | 103,288 | 21.0 | Sallisaw silt loam, 3 to 8 percent slopes | 385 | .1 |
| Dennis silt loam, 3 to 5 percent slopes | 5,104 | 1.0 | Staser silt loam | 730 | .2 |
| Dennis silt loam, 2 to 5 percent slopes, eroded | 12,292 | 2.5 | Summit silty clay loam, 0 to 1 percent slopes | 2,876 | .6 |
| Dennis soils, 3 to 5 percent slopes, severely eroded | 950 | .2 | Summit silty clay loam, 1 to 3 percent slopes | 26,132 | 5.3 |
| Eldorado stony silt loam, 1 to 8 percent slopes | 3,729 | .8 | Summit silty clay loam, 3 to 5 percent slopes | 1,895 | .4 |
| Eldorado silt loam, 3 to 5 percent slopes | 2,619 | .5 | Summit silty clay loam, 2 to 5 percent slopes, eroded | 1,557 | .3 |
| Hector-Linker complex, 1 to 5 percent slopes | 7,960 | 1.6 | Taloka silt loam, 0 to 1 percent slopes | 17,023 | 3.5 |
| Hector-Linker complex, 5 to 20 percent slopes | 10,791 | 2.2 | Talpa soils, 0 to 3 percent slopes | 9,913 | 2.0 |
| Lenapah silty clay loam, 0 to 3 percent slopes | 5,448 | 1.1 | Talpa-Summit complex, 1 to 8 percent slopes | 28,764 | 5.9 |
| | | | Verdigris silty clay loam | 15,333 | 3.1 |
| | | | Verdigris soils, channeled | 3,342 | .7 |
| | | | Verdigris-Breaks complex | 17,659 | 3.6 |
| | | | Total | 488,960 | 100.0 |

a few small areas similar to Bates soils except that they have a fine sandy loam surface layer.

This Bates soil is used mostly for growing small grains, grain sorghum, soybeans, corn, alfalfa, and tame pasture plants. Some areas are in prairie grasses and are used for range or hay.

The main concerns of management are the hazard of erosion and maintenance of soil structure and fertility. Most of the adapted crops can be grown if the soil is well managed. Returning crop residue to the soil and fertilizing are good management practices. Terraces with protected outlets and contour farming are needed where row crops are grown. Capability unit IIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Bates loam, 3 to 5 percent slopes** (BaC).—This soil is gently sloping. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Dennis and Collinsville soils. Also mapped were a few areas of soils similar to Bates soils except that they have a fine sandy loam surface layer.

This Bates soil is used largely for growing wheat, grain sorghum, soybeans, corn, alfalfa, and tame pasture plants. A sizable acreage is in prairie grass and is used for range or hay.

The main concerns of management are the hazard of erosion and the maintenance of soil fertility and structure. Where row crops are grown, terraces and contour farming are needed. Large amounts of residue should be returned to the soil, and fertilizer should be added to help maintain organic-matter content and soil structure and to increase the intake rate of water. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops. This cropping system should include biennial or perennial vegetation at least half the time. Capability unit IIIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Bates loam, 2 to 5 percent slopes, eroded** (BaC2).—This soil is very gently sloping and gently sloping. Part of the original surface layer has been removed by erosion in about 75 percent of the area, and the present surface layer is about 6 inches thick. The present surface layer in about 30 percent of the area is a mixture of the original surface layer and subsoil brought to the surface by tillage. There are a few uncrossable gullies and rills about 100 feet apart in these more eroded areas.

Included with this soil in mapping are spots of Dennis and Collinsville soils. Also mapped were a few areas of soils similar to Bates soils except that they have a fine sandy loam surface layer.

Most of the acreage of this Bates soil has been or is cultivated and is used mostly for tame pasture, but some acreage is used for growing small grains, grain sorghum, soybeans, and corn.

The principal concerns of management are the hazard of erosion and the maintenance of soil structure and fertility. Returning large amounts of crop residue to the soil and growing green manure crops will help to increase the amount of water intake, improve tilth, and reduce the hazard of erosion. Terraces and contour farming are needed where row crops are grown. Capability unit IIIe–2; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Bates-Collinsville complex, 1 to 5 percent slopes** (BcC).—The soils in this complex are very gently sloping and gently sloping. Included with these soils in mapping are spots of Dennis soils and areas of soils that are similar to Bates soils except that they have a fine sandy loam surface layer. These inclusions make up about 10 percent of the mapped areas.

About 65 percent of the acreage is Bates loam, and 25 percent is Collinsville loam. The Bates profile is similar to the one described as representative for the series, but the depth to sandstone is 6 inches less. The Collinsville profile is similar to the one described as representative for the series, but the depth to sandstone is 5 inches more.

Most of the acreage of this complex is used for tame pasture or range, but in places areas are used for growing small grains and drilled sorghum.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. The regular use of crop residue, green manure crops, and fertilizers helps to control erosion and maintain soil structure and fertility. Because of the shallow Collinsville soils, terraces are difficult to construct and maintain. This complex is better suited to growing grass for livestock than to other uses. Both parts in capability unit IVe–1; Bates part in pasture and hay group 8A and Collinsville part in pasture and hay group 14A; Bates part in Loamy Prairie range site and Collinsville part in Shallow Prairie range site; both parts in woodland group 5o0.

## Bonham Series

The Bonham series consists of deep, moderately well drained, very gently sloping soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from limestone.

In a representative profile the surface layer and the subsurface layer are 14 inches of very dark grayish-brown and dark grayish-brown silt loam. The upper part of the subsoil, to a depth of 18 inches, is dark-brown silty clay loam. The lower part, to a depth of 33 inches, is dark-brown silty clay. The next layer, to a depth of 46 inches, is brown silty clay. It is underlain by hard limestone.

Bonham soils have slow permeability. Available water capacity is high.

A representative profile of Bonham silt loam, limestone substratum, 1 to 3 percent slopes, 2,000 feet east of the NW. corner of sec. 13, T. 29 N., R. 18 E.:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; hard, friable; slightly acid; clear, smooth boundary.

A1—6 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; strong, medium, granular structure; hard, friable; medium acid; gradual, smooth boundary.

A2—12 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; moderate, medium, granular structure; hard, friable; medium acid; gradual, smooth boundary.

B1—14 to 18 inches, dark-brown (7.5YR 3/3) silty clay loam, dark brown (7.5YR 4/3) dry; few, fine, distinct, yellowish-red mottles and common, fine, distinct, grayish-brown mottles; strong, medium, granular structure; hard, friable; common black concretions; medium acid; gradual, smooth boundary.

B2t—18 to 26 inches, dark-brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) dry; common, fine and medium, distinct, yellowish-red (5YR 5/6) and grayish-brown (10YR 5/2) mottles; strong, medium, granular structure and weak, medium, subangular blocky structure; very hard, firm; clay films on ped surfaces; few black concretions; few small chert fragments; slightly acid; gradual, smooth boundary.

B3—26 to 33 inches, dark-brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) dry; many, medium, prominent, red (2.5YR 4/6) mottles and many, medium, faint, brown (7.5YR 5/4) mottles; weak, fine, subangular blocky structure; very hard, very firm; many black concretions; few small chert fragments; slightly acid; diffuse, smooth boundary.

C—33 to 46 inches, brown (10YR 5/3) silty clay, pale brown (10YR 6/3) dry; many, coarse, faint, gray (10YR 5/1) and yellowish-brown (10YR 5/4) mottles; massive; very hard, very firm; many black concretions; neutral; abrupt, wavy boundary.

R—46 inches +, hard limestone.

Limestone is at a depth of 40 to 60 inches. The A1 horizon is very dark gray, black, dark brown, very dark brown, or very dark grayish brown and is slightly acid or medium acid. The A2 horizon is similar to the A1 horizon but has a moist color value of 1 unit higher. The B1 horizon is dark brown or very dark grayish brown in color. Mottles range from red to grayish brown. The B2t horizon is light brown to dark brown. Mottles range from red to grayish brown. Reaction is slightly acid or medium acid. The B3 horizon is brown, dark brown, or strong brown and is slightly acid to neutral. The C horizon is dark brown, brown, or strong brown. Generally, mottles are coarse and range from dark red to gray. In this horizon reaction is from slightly acid to neutral.

These soils are outside the defined range of the Bonham series, because limestone is at a depth of 40 to 60 inches. The soils, however, are similar enough to the Bonham series in morphology, composition, and behavior to be included with this series.

Bonham soils are more clayey and less red in the B2t horizon than associated Lula soils. They are less clayey in the A horizon than associated Summit soils, and they have mottles higher in the profile than associated Okemah soils.

**Bonham silt loam, limestone substratum, 1 to 3 percent slopes** (BoB).—This soil is very gently sloping. Included with it in mapping are spots of Claremore, Lula, Okemah, Summit, and Talpa soils. Also, in about 35 percent of the mapped areas the soils are similar to Bonham soils except that they have limestone at a depth of 20 to 40 inches. A few areas have a reddish subsoil.

This Bonham soil is used extensively for growing small grains, grain sorghum, soybeans, corn, and tame pasture plants. A large acreage is used for range.

The main concerns of management are the control of erosion and the maintenance of soil structure and fertility. Crops that produce large quantities of residue can be grown continuously where the soil is well managed and the crop residue is used for soil improvement. Terraces and contour farming are needed where row crops are grown. Capability unit IIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

## Breaks

This land type is mapped only as part of the Verdigris-Breaks complex. It is on gently sloping to steep uplands in areas 10 to 50 feet wide on the sides of ridges. Generally, the surface layer is loamy, but the

characteristics of the land type are variable. Sandstone, limestone, or shale is between depths of 10 to 60 inches or more. Permeability is slow to moderate.

## Carytown Series

The Carytown series consists of deep, poorly drained, nearly level soils on uplands and flood plains. These soils formed under a cover of mid and tall grasses in material weathered from clayey shale.

In a representative profile the surface layer and subsurface layer is 8 inches of dark-gray and dark grayish-brown silt loam. The upper part of the subsoil, to a depth of 16 inches, is very dark grayish-brown clay, high in sodium content. The lower part, to a depth of 60 inches, is clay mottled in shades of gray, brown, and yellow. The underlying material is yellowish-brown and gray mottled clay.

Carytown soils have very slow permeability. Available water capacity is high.

Representative profile of Carytown silt loam, thin surface, 66 feet east and 36 feet south of the NW. corner of sec. 1, T. 27 N., R. 20 E.:

Ap—0 to 5 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; weak, medium, granular structure; soft, friable; strongly acid; clear, smooth boundary.

A2—5 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; common, fine, distinct, yellowish-brown mottles; weak, thin, platy structure; soft, very friable; strongly acid; abrupt, smooth boundary.

B21t—8 to 16 inches, very dark grayish-brown (10YR 3/2) clay, dark grayish brown (10YR 4/2) dry; common, fine, distinct, yellowish-brown mottles; compound of moderate, coarse, prismatic structure and moderate, fine, blocky structure; extremely hard, very firm; prism tops are slightly rounded by thin gray silt coatings that extend 2 inches down prism faces; black (10YR 2/1) clay films on prism and block faces; medium acid; gradual, wavy boundary.

B22t—16 to 24 inches, medium-mottled, very dark gray (10YR 3/1) and yellowish-brown (10YR 5/6) clay; compound of moderate, coarse, prismatic structure and moderate, fine, blocky structure; extremely hard, very firm; thin, continuous, very dark gray (10YR 3/1) coatings and a few gray silt coatings on prisms; nearly continuous clay films on ped faces; slightly acid; gradual, smooth boundary.

B23t—24 to 34 inches, medium-mottled, dark-gray (10YR 4/1) and yellowish-brown (10YR 5/6) clay; compound of coarse prismatic structure and moderate, fine, blocky structure; extremely hard, very firm; thick, continuous, very dark gray (10YR 3/1) coatings on prisms; nearly continuous clay films on ped faces; few slickensides; neutral; gradual, wavy boundary.

B31—34 to 50 inches, gray (10YR 5/1) clay, light gray (10YR 7/1) dry; many, medium and coarse, prominent, yellowish-brown (10YR 5/6) mottles; moderate, coarse, prismatic structure; extremely hard, very firm; very dark gray (10YR 3/1) coatings on prisms; many gypsum crystals 1 to 5 millimeters in diameter; few slickensides; moderately alkaline; gradual, wavy boundary.

B32—50 to 60 inches, coarsely mottled, gray (2.5Y 6/1) and brownish-yellow (10YR 6/8) clay; weak, coarse, prismatic structure; extremely hard, very firm; common slickensides; many gypsum crystals 1 to 7 millimeters in diameter; moderately alkaline; gradual, smooth boundary.

C—60 to 73 inches, coarsely mottled, yellowish-brown (10YR 5/8) and gray (2.5Y 6/1) clay; massive; extremely hard, very firm; moderately alkaline.

Solum thickness ranges from 40 to more than 60 inches. The A1 or Ap horizon is dark grayish brown, dark gray, very dark gray, or very dark grayish brown. Reaction in this horizon is medium acid or strongly acid. In places the A2 horizon is indistinct. It is dark gray, grayish brown, dark grayish brown, or gray. Mottles are yellowish brown or dark yellowish brown. The B21t horizon is dark grayish brown, very dark brown, or very dark grayish brown. Reaction in this horizon is medium acid to neutral. Mottles range from dark gray to reddish brown. The B22t and B23t horizons are similar to B21t horizon, but they are grayer in color and more mottled. All of the B2t horizons have a high content of sodium. The B3 horizon is similar to the B2t horizon. Reaction in the B3 horizon is neutral to moderately alkaline.

Carytown soils have higher exchangeable sodium content than associated Cherokee and Parsons soils.

**Carytown silt loam, thin surface** (Ca).—This is a nearly level soil. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Cherokee and Parsons soils. Also included are a few areas of soils similar to Carytown soils, but they have limestone or shale at a depth of 36 to 60 inches.

This Carytown soil is used mostly for range, but some areas are cultivated, and the principal crops are small grains and grain sorghum.

The main concerns of management are slow intake of water and maintenance of soil structure and fertility. This soil is seasonally wet or droughty.

Small grains or grain sorghum can be grown continuously if large amounts of residue are returned to the soil and fertilizer is used. Capability unit IVs–2; pasture and hay group 8D; Shallow Claypan range site; woodland group 5o0.

## Cherokee Series

The Cherokee series consists of deep, somewhat poorly drained, nearly level soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from clayey shale.

In a representative profile the surface layer is 12 inches of dark-gray silt loam. The subsurface layer, to a depth of 17 inches, is grayish-brown silt loam. The upper part of the subsoil, to a depth of 27 inches, is dark grayish-brown clay. The lower part, to a depth of 42 inches, is grayish-brown clay. The underlying material is dark grayish-brown silty clay.

Cherokee soils have very slow permeability. Available water capacity is high.

Representative profile of Cherokee silt loam (0 to 1 percent slopes) 800 feet east of the NW. corner of sec. 35, T. 24 N., R. 21 E.:

A1—0 to 12 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; moderate, medium, granular structure; slightly hard, friable; strongly acid; gradual, smooth boundary.

A2—12 to 17 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; few, fine, faint, yellowish-brown mottles; weak, fine, granular structure; slightly hard, friable; strongly acid; abrupt, smooth boundary.

B2t—17 to 27 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; common, fine, faint, dark yellowish-brown and yellowish-brown mottles;

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moderate, medium, blocky structure; extremely hard, very firm; clay films on ped surfaces; gray silt siftings; few small chert fragments; medium acid; gradual, smooth boundary.

B3—27 to 42 inches, grayish-brown (10YR 5/2) clay, light brownish gray (10YR 6/2) dry; common, medium, faint, dark grayish-brown (10YR 4/2) and yellowish-brown (10YR 5/6) mottles; weak, coarse, blocky structure; extremely hard, very firm; gypsum crystals in lower part of horizon; medium acid; gradual, smooth boundary.

C—42 to 60 inches, dark grayish-brown (10YR 4/2) silty clay, pale brown (10YR 6/3) dry; many coarse, prominent, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) mottles; massive; extremely hard, very firm; neutral.

The A1 horizon ranges from very dark gray to grayish brown. Where it is very dark gray or very dark grayish brown, it is less than 6 inches thick. Reaction is medium or strongly acid. The A2 horizon is gray to light gray in color with mottles of gray to yellowish brown. The B2t horizon is very dark gray to dark grayish brown. Colors of the mottles range from dark grayish brown to yellowish brown. Reaction is medium acid or strongly acid. In places this horizon contains gypsum crystals or chert fragments. The B3 horizon is very dark gray to grayish brown in color. The mottled C horizon is clay to silty clay.

Cherokee soils differ from associated Parsons or Taloka soils in having an A1 horizon that is very dark gray or very dark grayish brown in color and less than 6 inches thick. They differ from associated Carytown soils in having a B2t horizon that is less than 15 percent exchangeable sodium.

**Cherokee silt loam** (Ce).—This is the only Cherokee soil mapped in the county. It is deep and nearly level. Included in mapping are spots of Carytown, Craig, and Parsons soils.

This Cherokee soil is used mostly for growing small grain, grain sorghum, and tame pasture plants, but in some places it is in native grasses that are used for hay or range.

The slow intake of water, seasonal wetness, and droughtiness are limitations on this soil. Maintaining good tilth and fertility is also a management concern.

Adding fertilizer, growing high-residue crops, and returning enough crop residue to the soil are practices that help to control erosion and improve tilth. Capability unit IIIw–3; pasture and hay group 8C; Claypan Prairie range site; woodland group 5o0.

## Choteau Series

The Choteau series consists of deep, moderately well drained, nearly level to very gently sloping soils on uplands. These soils formed under a cover of mid and tall grasses in loamy sediment.

In a representative profile the surface layer is 14 inches of very dark grayish-brown silt loam. The subsurface layer extends to a depth of 23 inches and is grayish-brown silt loam. The next layer is 4 inches of brown silt loam. The upper part of the subsoil, to a depth of 51 inches, is brown and yellowish-brown silty clay loam. The lower part, to a depth of 64 inches, is silty clay loam mottled in shades of brown, red, and gray. The underlying material is mottled gray, yellowish-brown, and yellowish-red silty clay loam.

Choteau soils have slow permeability. Available water capacity is high.

Representative profile of Choteau silt loam, 1 to 3 percent slopes, 2,500 feet east of SW. corner of sec. 1, T. 25 N., R. 20 E.:

A1—0 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; hard, friable; strongly acid; gradual, smooth boundary.

A2—14 to 23 inches, grayish-brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; weak, fine, subangular blocky structure; hard, very friable; few black concretions; very strongly acid; gradual, smooth boundary.

A3—23 to 27 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; few, medium, faint, light brownish-gray (10YR 6/2) mottles; weak, fine, subangular blocky structure; hard, friable; many brown and black concretions; patchy coating of clean silt on and in peds; very strongly acid; clear, smooth boundary.

B1—27 to 31 inches, brown (10YR 5/3) silty clay loam, pale brown (10YR 6/3) dry; few, fine, prominent, yellowish-brown and yellowish-red mottles and few, fine, faint, light brownish-gray mottles; weak, fine, subangular blocky structure; hard, friable; few black concretions; very strongly acid; gradual, smooth boundary.

B2t—31 to 51 inches, yellowish-brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; common, medium, prominent, yellowish-red (5YR 4/6) mottles and few, fine, faint, grayish-brown mottles; moderate, medium, blocky structure; very hard, very firm; distinct clay films on ped surfaces; few black concretions; medium acid; diffuse, smooth boundary.

B3—51 to 64 inches, coarsely mottled, yellowish-brown (10YR 5/8), light brownish-gray (10YR 6/2), pale-brown (10YR 6/3), and yellowish-red (5YR 4/6) silty clay loam; weak, coarse, blocky structure; very hard, very firm; few black concretions; neutral; diffuse, smooth boundary.

C—64 to 70 inches, coarsely mottled gray (10YR 6/1), yellowish-brown (10YR 5/8), and yellowish-red (5YR 4/6) silty clay loam; massive; very hard, very firm; neutral.

The solum is more than 60 inches thick. The A1 horizon is very dark grayish brown or dark brown. Reaction in this horizon is strongly acid or medium acid. The A2 horizon is grayish brown, dark brown, brown, or dark grayish brown. The texture is dominantly silt loam, but a few areas are loam. The reaction is very strongly acid or strongly acid. The A3 horizon is brown, dark yellowish brown, dark brown, or yellowish brown in color. The reaction in the A3 horizon is very strongly acid or strongly acid. The A3 horizon is missing in places. The B1 horizon has the same colors as the A3 horizon. A few mottles have a chroma of 2 or less. Reaction in the B1 horizon is medium acid to very strongly acid. The B2t horizon is brown, dark brown, yellowish-brown, or dark yellowish brown. Mottles range from gray to red in color. Texture in the B2t horizon is dominantly silty clay loam but includes clay loam. The reaction is slightly acid to strongly acid. The B3 horizon has coarse mottles that range from gray to red when moist. Texture of this horizon is silty clay loam or clay loam, and reaction is slightly acid or neutral.

Choteau soils have a thicker A horizon than associated Dennis soils, and the B2t horizon in Choteau soils is less clayey than that in associated Taloka soils.

**Choteau silt loam, 0 to 1 percent slopes** (ChA).—Included with this soil in mapping are spots of Dennis and Taloka soils. Also, in about 10 percent of the mapped areas the soils have a solum less than 60 inches thick but are otherwise similar to Choteau soils.

This soil is used mostly for growing small grains, grain sorghum, soybeans, and tame pasture plants. Some areas are in native grass and are used for range or hay.

The main concern of management is the maintenance of soil structure and fertility. Most crops that produce large amounts of residue can be grown continuously if the soil is well managed and most of the crop residue is returned to the soil. These measures, and the addition of fertilizer, help to maintain organic-matter content, good structure, and fertility. Capability unit I–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Choteau silt loam, 1 to 3 percent slopes** (ChB).—This soil is very gently sloping. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Dennis, Parsons, and Taloka soils.

This soil is used mainly for growing small grains, grain sorghum, soybeans, and tame pasture plants. Small areas are in native grass and are used for range or hay.

The main concerns of management are erosion hazard and maintenance of soil structure and fertility. Most adapted crops can be grown if the soil is well managed and most of the crop residue returned to the soil. Contour farming and terraces are needed to help control erosion where row crops are grown. Capability unit IIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

## Claremore Series, Moderately Shallow Variant

These variants from the normal soils are deeper to bedrock than is defined for the series, and they are called moderately shallow variants. They consist of moderately deep, well-drained, very gently sloping and gently sloping soils on uplands. They formed in material weathered from limestone under a cover of mid and tall grasses.

In a representative profile the surface layer is 8 inches of dark-brown silt loam. The subsoil is dark reddish-brown silty clay loam. It is underlain, at a depth of 21 inches, by hard limestone.

These variants have moderate permeability. Available water capacity is moderate.

Representative profile of Claremore silt loam, moderately shallow variant, 1 to 5 percent slopes, 1,900 feet north of the SW. corner of sec. 36, T. 28 N., R. 18 E.:

A1—0 to 8 inches, dark-brown (7.5YR 3/2) silt loam, dark brown (7.5YR 4/2) dry; strong, medium, granular structure; hard, friable; medium acid; gradual, smooth boundary.

B1—8 to 14 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) dry; strong, medium, granular structure; hard, friable; few iron-manganese concretions; medium acid; gradual, smooth boundary.

B2t—14 to 21 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) dry; moderate, fine, subangular, blocky structure; hard, firm; clay films on ped faces; few fine chert fragments; medium acid; abrupt, wavy boundary.

R—21 inches +, hard limestone.

The A1 horizon is dark brown or very dark grayish brown. Reaction is slightly acid or medium acid. The B1 horizon is dark brown or dark reddish brown, and reaction is slightly acid or medium acid. The B2t horizon is dark-brown or dark reddish-brown. This horizon is silty clay loam or clay loam, and reaction is generally medium acid to neutral. Iron-manganese concretions are in most profiles. Limestone is at a depth of 20 to 25 inches.

Claremore soils are shallower to limestone than associated Lula soils, and their solum is thicker than associated Lenapah soils.

**Claremore silt loam, moderately shallow variant, 1 to 5 percent slopes** (ClC).—This soil is very gently sloping and gently sloping. It is the only Claremore, moderately shallow variant, mapped in the county.

Included with this soil in mapping are spots of Lenapah, Lula, Summit, and Talpa soils.

This soil is used mainly as range. Small areas are used for growing small grains, grain sorghum, soybeans, and tame pasture plants.

The main concerns of management are the control of erosion and the maintenance of soil structure and fertility. Droughtiness also is a management concern.

Where row crops are grown, terraces are needed, but in some areas terraces are difficult to build because limestone bedrock is near the surface. Regular use of large amounts of crop residue and fertilizer helps to maintain organic-matter content and soil structure, increases the intake of water, and helps to control erosion. A good cropping system does include biennial or perennial vegetation about half the time and does not include soil-depleting crops in areas that are not terraced. Capability unit IIIe–6; pasture and hay group 14A; Loamy Prairie range site; woodland group 5o0.

## Clarksville Series

The Clarksville series consists of deep, somewhat excessively drained, very gently sloping to strongly sloping soils on uplands. These soils formed under a cover of oaks and an understory of tall grasses in material weathered from cherty limestone.

In a representative profile the surface layer is 3 inches of very dark grayish-brown very cherty silt loam. The subsurface layer is 17 inches of light brownish-gray very cherty silt loam. The subsoil, which extends to a depth of 60 inches, is yellowish-red very cherty silty clay loam.

Clarksville soils have moderate to rapid permeability. Available water capacity is moderate.

Representative profile of Clarksville very cherty silt loam, 1 to 8 percent slopes, 1,800 feet east and 200 feet north of the SW. corner of sec. 11, T. 24 N., R. 21 E.:

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) very cherty silt loam, light brownish gray (10YR 6/2) dry; weak, fine, granular structure; slightly hard, very friable; about 50 percent chert fragments ¼ inch to 6 inches in diameter; strongly acid; clear, smooth boundary.

A2—3 to 20 inches, light brownish-gray (10YR 6/2) very cherty silt loam, white (10YR 8/2) dry; weak, fine and medium, granular structure; slightly hard, very friable; about 50 percent chert fragments ¼ inch to 6 inches in diameter; very strongly acid; gradual, wavy boundary.

B2t—20 to 60 inches, yellowish-red (5YR 4/6) very cherty silty clay loam, reddish yellow (5YR 6/6) dry; weak, fine, subangular blocky structure; hard, firm; clay films on ped faces and on chert fragments; about 60 percent chert fragments in upper part of horizon and 80 percent in lower part; very strongly acid.

The A1 horizon is very dark grayish-brown, brown, dark-brown, or dark grayish-brown silt loam or very stony silt

loam. In some places this horizon is 50 to 60 percent chert fragments.

In other places it is 15 to 30 percent stones, and chert fragments are on 30 to 60 percent of the surface area. Reaction in the A1 horizon is medium acid or strongly acid. The A2 horizon is pale brown, brown, dark grayish brown, or light brownish gray. It is 20 to 60 percent chert fragments. Reaction in the A2 horizon is strongly acid or very strongly acid. The B2t horizon is reddish-brown to reddish-yellow very cherty clay loam to very cherty silty clay loam that has a few small areas of very cherty clay. Reaction is strongly acid to very strongly acid. The solum is 6 to 10 feet thick.

Clarksville soils lack a Bx horizon that is in the associated Nixa soils. Clarksville soils have a thinner A1 horizon and have an A2 horizon that is lacking in similar Eldorado soils.

**Clarksville stony silt loam, 5 to 12 percent slopes** (CmE).—This soil is sloping to strongly sloping. The profile is similar to that described as representative for the series, but the chert fragments are larger. Chert fragments cover about 50 percent of the surface. They are 10 to 24 inches in diameter.

Included with this soil in mapping are spots of Clarksville and Sallisaw soils. In about 10 percent of the mapped areas, the soils are similar to Clarksville soils except that at a depth of 4 to 8 feet the subsoil is very cherty clay underlain by tripoli. Also included are spots of Clarksville soil that has slopes of 12 to 18 percent.

Most of this soil is woodland and is used for grazing livestock, but a small percentage of the acreage has been cleared and is used for tame pasture.

The main concerns of management are low fertility, droughtiness, steep slopes, and stoniness. If this soil is not properly managed, a brushy condition results, and intensive management is needed for woodland production or range. This soil is not suited to cultivation; however, if it is properly managed and fertilized and brush is controlled, it is fairly well suited to forage production in tame pasture. The quality of the native grasses can be maintained or improved by controlling brush, using suitable grazing practices, and protecting against fire. Capability unit VIs–1; pasture and hay group 8B; Smooth Chert Savannah range site; woodland group 4f8.

**Clarksville very cherty silt loam, 1 to 8 percent slopes** (CnD).—This soil is very gently sloping to sloping. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Clarksville, Nixa, and Sallisaw soils.

Most of this soil is woodland and is used for grazing livestock. Other areas have been cleared and are used for growing tame pasture plants and sorghums.

The main concerns of management are low fertility, droughtiness, and the large amounts of chert fragments that make tillage difficult. Sorghum or other crops that produce a large amount of residue can be grown if fertilizer is applied and residue is returned to the soil. Tame pasture needs to be fertilized and the brush needs to be controlled. Capability unit IVs–1; pasture and hay group 8B; Smooth Chert Savannah range site; woodland group 4f8.

## Collinsville Series

The Collinsville series consists of well-drained to somewhat excessively drained, very shallow to shallow, very gently sloping to steep soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from sandstone.

In a representative profile the surface layer is 8 inches of very dark grayish-brown loam. It is underlain by hard yellowish-brown sandstone (fig. 2).

Collinsville soils have moderately rapid permeability. Available water capacity is low.

Representative profile of Collinsville loam from an area of Collinsville-Vinita complex, 2 to 30 percent slopes, 2,600 feet east of the SW. corner of sec. 21, T. 27 N., R. 18 E.:

A1—0 to 8 inches, very dark grayish-brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; slightly hard, friable; few fine sandstone fragments; strongly acid; abrupt, wavy boundary.

R—8 inches, hard yellowish-brown sandstone.

This soil generally has 10 to 40 percent of its surface covered with sandstone fragments 3 to 16 inches in diameter. The A1 horizon is very dark grayish brown or dark brown and is medium acid to strongly acid. The dominant texture is loam, but in some places it is stony loam and fine sandy loam. In places there is a partly weathered sandstone C horizon. Sandstone bedrock is at a depth of 4 to 20 inches.

Collinsville soils have a thicker A1 horizon than similar Hector soils. They lack a B horizon and are shallower to sandstone than associated Bates soils, and they are shallower to bedrock than associated Vinita soils.

**Collinsville-Vinita complex, 2 to 30 percent slopes** (CoF).—These soils are very gently sloping to steep.


*Figure 2.*—**Representative profile of Collinsville loam in the Collinsville-Vinita complex, 2 to 30 percent slopes.**

About 45 percent of the mapped areas is Collinsville loam, and 40 percent is Vinita loam. The Collinsville soil and the Vinita soil have the profile described as representative for their series.

Included with this soil in mapping are spots of Dennis and Bates soils. In about 15 percent of the mapped areas the soils are similar to Collinsville soils except that they are clayey, and bedrock is at a depth of less than 20 inches.

This soil is used mostly for range. It is not suited to cultivation because of steep slopes, shallowness to rock, and droughtiness. Under good management, the soil will produce a fair amount of forage for livestock. The quality of native grasses can be maintained or improved by controlling brush, using suitable grazing practices, and protecting against fire. Both parts in capability unit VIIs–3; Collinsville part in Shallow Prairie range site and Vinita part in Loamy Prairie range site; both parts in woodland group 5o0.

## Craig Series

The Craig series consists of deep, very gently sloping soils on uplands. These soils (fig. 3) formed in material weathered from cherty limestone under a cover of mid and tall grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown silt loam to a depth of 12 inches. The subsurface layer extends to a depth of 16 inches and is dark grayish-brown silt loam. The next layer is 5 inches of brown silt loam. The upper part of the subsoil, to a depth of 25 inches, is dark yellowish-brown very cherty clay loam. The middle part, to a depth of 42 inches, is yellowish-red very cherty clay loam. The lower part of the subsoil, to a depth of 60 inches, is mainly chert fragments.

The Craig soils are well drained and have moderately slow permeability. Available water capacity is moderate.

Representative profile of Craig silt loam, 1 to 3 percent slopes, 2,100 feet north of the SW. corner of sec. 12, T. 24 N., R. 20 E.:

A11—0 to 7 inches, very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; moderate, medium and fine, granular structure; hard, friable; medium acid; gradual, smooth boundary.

A12—7 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak, fine, granular structure; hard, friable; few fine chert fragments; strongly acid; gradual, smooth boundary.

A2—12 to 16 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak, medium, granular structure; hard, friable; few fine chert fragments; strongly acid; gradual, wavy boundary.

A3—16 to 21 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; weak, medium, subangular blocky structure; hard, friable; 10 percent chert fragments; common dark concretions 2 to 8 millimeters in size; strongly acid; gradual, wavy boundary.

B21t—21 to 25 inches, dark yellowish-brown (10YR 4/4) very cherty clay loam, yellowish brown (10YR 5/4) dry; moderate, very fine, blocky structure; hard, friable; 60 to 70 percent chert fragments 2 millimeters to 4 inches in diameter; thin clay films on faces of peds and chert fragments; common concretions 2 to 5 millimeters in diameter; strongly acid; gradual, wavy boundary.

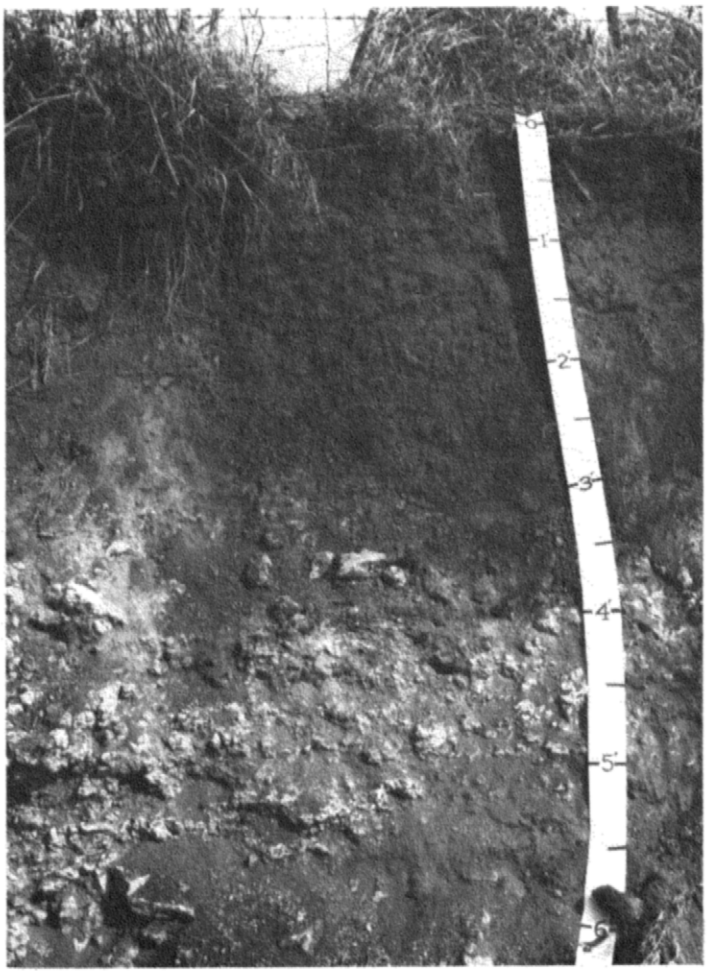

*Figure 3.*—**Profile of Craig silt loam, 1 to 3 percent slopes.**

B22t—25 to 42 inches, yellowish-red (5YR 4/6) very cherty clay loam, reddish yellow (5YR 6/6) dry; common, fine to coarse, reddish and brownish mottles on chert fragments; weak, very fine, blocky structure; hard, friable; few roots; clay films on faces of peds and chert fragments and in pores; 75 to 85 percent, by volume, chert fragments 2 millimeters to 4 inches in diameter; strongly acid; gradual, wavy boundary.

B3—42 to 60 inches, closely packed chert fragments 2 millimeters to 4 inches in diameter and about 10 to 15 percent yellowish-red (5YR 5/6) clay loam in interstices; massive; patchy clay films on fragments of chert and in pores; strongly acid.

The A1 horizon is dark brown, very dark grayish brown, or very dark brown in color, and in many areas it does not include an A12 horizon. The A2 horizon is brown, dark brown, grayish brown, or dark grayish brown. The A3 horizon is silt loam to cherty clay loam that is dark brown, brown, dark yellowish brown, or yellowish brown. The B2t horizon is very cherty and is at a depth of 18 to 28 inches. The B21t horizon is brown, dark-brown, or dark yellowish-brown cherty clay loam to very cherty clay loam. The B22t horizon is reddish brown or yellowish red in color. The B3 horizon is red, yellowish red, or strong brown and is 50 to 95 percent chert fragments. Reaction in all horizons ranges from medium acid to very strongly acid.

Craig soils are deeper to a very cherty horizon than associated Eldorado soils, and the very cherty B2t horizon in the Craig soils is lacking in similar Dennis soils.

**Craig silt loam, 1 to 3 percent slopes** (CrB).—This very gently sloping soil is the only Craig soil mapped in the county.

Included with this soil in mapping are spots of Dennis, Eldorado, and Summit soils. Also included in about 5 percent of the mapped areas are soils similar to those of the Craig series except that they have a reddish surface layer.

This soil is used mostly for growing small grains, grain sorghum, soybeans, and tame pasture plants. Some areas are in native grass and are used for range or hay.

The main concerns of management are erosion hazard and maintenance of soil structure and fertility. Most of the adapted crops can be grown if the soil is well managed, large amounts of crop residue are returned to it, and fertilizer is used. Terraces and contour farming are needed where row crops are grown. Capability unit IIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

## Dennis Series

The Dennis series consists of deep, moderately well drained, very gently sloping and gently sloping soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from shale.

In a representative profile the surface layer is 11 inches of very dark grayish-brown silt loam. The upper part of the subsoil, to a depth of 34 inches, is dark-brown and brown silty clay loam. The lower part, to a depth of 60 inches, is silty clay loam coarsely mottled in shades of brown, gray, and red.

Dennis soils have slow permeability. Available water capacity is high.

Representative profile of Dennis silt loam, 1 to 3 percent slopes, 1,800 feet south of the NE. corner of sec. 15, T. 29 N., R. 20 E.:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak, medium, granular structure; hard, friable; medium acid; clear, smooth boundary.

A1—6 to 11 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; hard, friable; medium acid; gradual, smooth boundary.

B1—11 to 16 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; few, fine, faint, gray mottles; weak, fine, subangular blocky structure; hard, friable; clean silt and very fine sand coatings on ped faces; strongly acid; gradual, smooth boundary.

B21t—16 to 24 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; common, fine, prominent, yellowish-red and yellowish-brown mottles and common, medium, grayish-brown (10YR 5/2) mottles; moderate, medium, blocky structure; very hard, very firm; clay films on ped faces, coating of clean silt on ped faces in upper part of horizon; strongly acid; gradual, smooth boundary.

B22t—24 to 34 inches, brown (10YR 5/3) silty clay loam, pale brown (10YR 6/3) dry; many, medium, faint, grayish-brown (10YR 5/2) and dark yellowish-brown (10YR 4/4) and many, fine, prominent, yellowish-red mottles; moderate, medium, blocky structure; very hard, very firm; clay films on ped faces; few brown and black concretions; strongly acid; gradual, smooth boundary.

B3—34 to 60 inches, coarsely mottled yellowish-brown (10YR 5/8), gray (10YR 6/1), brown (10YR 5/3), dark-gray (10YR 4/1), and yellowish-red (5YR 5/6) silty clay loam; weak, coarse, blocky structure; very hard, very firm; many black concretions and streaks; slightly acid.

The Ap and A1 horizons are very dark gray or very dark grayish-brown. Reaction in these horizons is medium acid to strongly acid. In places there is a thin A2 horizon that is dark grayish brown, brown, or dark brown. Reaction in the A2 horizon is medium acid to strongly acid. The B1 horizon is dark-brown, brown, or dark yellowish-brown silty clay loam or clay loam. Fine mottles that have a chroma of 1 or 2 are present in this horizon, and in most areas faces of peds are coated with clean silt and very fine sand. Reaction in the B1 horizon ranges from strongly acid to very strongly acid. The B2t horizon is dark brown, brown, yellowish brown, or dark yellowish brown. Mottles generally are coarser in this horizon than in others, and they range from gray to red. Texture in the B2t horizon is dominantly silty clay loam but ranges to clay loam. The reaction is medium acid or strongly acid. In the B3 horizon are many coarse mottles that have a chroma of 1 or 2 or of 6 to 8. Reaction in this horizon is medium acid or slightly acid. Black concretions in the B horizon range from none to many.

Soils in part of the acreage of mapping units DnC2 and DsC3 are outside the defined range for the Dennis series. The A horizon has been thinned by erosion, and the profile in less than one-half the acreage in those mapping units is similar to that described as representative for the series. The soils in the remaining areas are similar enough to the Dennis series in morphology, composition, and behavior to be included with this series.

Dennis soils are finer textured throughout than associated Bates soils, and their solum is thicker. They have a thinner A horizon than associated Choteau soils, and they lack the very cherty B2t horizon of similar Craig soils. Dennis soils are deeper over shale than associated Vinita soils.

**Dennis silt loam, 1 to 3 percent slopes** (DnB).—This soil is very gently sloping. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Choteau, Craig, Bates, Parsons, and Taloka soils. Also, in about 35 percent of the mapped areas, the soils are similar to Dennis soils but have a less clayey subsoil, and in about 10 percent of the areas, the soils are similar but have a thinner surface layer.

The soil is used mostly for growing small grains, grain sorghum, soybeans, and tame pasture plants. A sizable acreage is in native grass and is used for range or hay.

The main concerns of management are the hazard of erosion and the maintenance of soil structure and fertility. Most of the adapted crops can be grown continuously if the soil is well managed and crop residue is returned to the soil. Contour farming and terraces are needed where row crops are grown. Capability unit IIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Dennis silt loam, 3 to 5 percent slopes** (DnC).—This soil is gently sloping. It has a profile similar to that described as representative for the series, but the upper part of the subsoil is thicker and generally is less clayey in the upper 20 inches.

Included with this soil in mapping are spots of Bates, Collinsville, and Vinita soils. Also, in about 30 percent of the mapped areas, the soils are similar to Dennis soils except that they lack gray mottles in the upper 20 inches of the subsoil.

This soil is used mostly for range or hay, but in places it is used for growing small grains, grain sorghum, soybeans, and tame pasture plants.

The main concerns of management are hazard of ero-

sion and maintenance of soil structure and fertility. Where row crops are grown, contour farming and terraces are needed. Crops that produce large amounts of residue should be kept on the soil at least a third of the time, and the residue should be managed for soil improvement. If row crops are not grown and terraces are not used, all crops should be the kind that produce large amounts of residue. The residue should be managed for soil improvement. Annual reseeding should be provided, or biennial or perennial vegetation should be grown at least half the time. Capability unit IIIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Dennis silt loam, 2 to 5 percent slopes, eroded** (DnC2).—This is a gently sloping eroded soil. Part of the original surface layer has been removed by erosion in about 70 percent of the mapped areas. In about 20 percent of the mapped areas the surface layer is material from the subsoil and original surface layer that has been mixed by tillage. A few uncrossable gullies and rills are about 200 feet apart in these more eroded areas.

Included with this soil in mapping are areas of Bates and Collinsville soils. In about 30 percent of the mapped areas, the soils are similar to Dennis soils but have shale at a depth of less than 60 inches.

Most of this soil is cultivated or has been in the past. It is used mainly for growing tame pasture plants, but a limited acreage is used for small grains, grain sorghum, or soybeans. A sizable acreage is in poor grasses and weeds and is used as forage for livestock.

The main concerns of management are erosion hazard and maintenance of soil structure and fertility. Erosion should be controlled by a permanent cover of perennial grasses. Contour farming practices and terraces are required in cultivated areas. Large amounts of crop residue should be added to the soil to improve it. Applications of fertilizer help to increase the amount of residue and maintain fertility. Capability unit IIIe–2; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Dennis soils, 3 to 5 percent slopes, severely eroded** (DsC3).—These are gently sloping, severely eroded soils (fig. 4). Part of the original surface layer has been removed by erosion in about 70 percent of the acreage of this mapping unit. In about 40 percent of the areas, the original surface layer and the subsoil have been mixed by tillage. Uncrossable gullies as deep as 6 feet occur at intervals of 100 to 200 feet in the more severely eroded areas.

Included with this soil in mapping are areas of Bates loam that make up about 15 percent of the mapped areas, Collinsville loam that make up 5 percent, and Vinita loam that make up about 5 percent.

Most of this soil has been cultivated in the past, but it is now unsuitable for crops. The present vegetation is mostly poor grasses and weeds, and the soil is used for range. A small acreage is in tame pasture.

The quality of native grasses can be maintained or improved by controlling brush, using suitable grazing practices, and providing fire protection. Diversion terraces help to control the formation of gullies. Forage suitable for tame pasture can be produced if management is intensive and fertilizer is applied. Capability unit VIe–2; pasture and hay group 8F; Loamy Prairie range site; woodland group 5o0.

*Figure 4.*—Area of Dennis soils, 3 to 5 percent slopes, severely eroded.

## Eldorado Series

The Eldorado series consists of deep, well-drained, very gently sloping to sloping soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from cherty limestone.

In a representative profile (fig. 5) the surface layer is very dark grayish-brown silt loam to a depth of 10 inches and very dark grayish-brown, very cherty silt loam between depths of 10 and 22 inches. The upper part of the subsoil, to a depth of 33 inches, is dark-brown very cherty silty clay loam. The lower part of the subsoil, to a depth of 60 inches, is a dark-red very cherty clay.

Eldorado soils have moderate permeability. Available water capacity is moderate.

Representative profile of Eldorado stony silt loam, 1 to 8 percent slopes, 350 feet north of the SW. corner of sec. 15, T. 24 N., R. 21 E.:

A11—0 to 10 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate, medium and fine, granular structure; hard, friable; about 10 percent chert fragments and 10 percent stones; slightly acid; gradual, smooth boundary.

A12—10 to 22 inches, very dark grayish-brown (10YR 3/2) very cherty silt loam, grayish brown (10YR 5/2) dry; moderate, medium and fine, granular structure; hard, friable; about 60 percent chert fragments ½ inch to 3 inches in diameter; slightly acid; gradual, smooth boundary.

B1—22 to 33 inches, dark-brown (7.5YR 4/4) very cherty silty clay loam, brown (7.5YR 5/4) dry; moderate, medium and fine, granular structure; hard, friable; about 60 percent chert fragments 1 to 6 inches in diameter; medium acid; gradual, smooth boundary.

B2t—33 to 60 inches, dark-red (2.5YR 3/6) very cherty clay, red (2.5YR 4/6) dry; strong, very fine, blocky structure; very hard, firm; nearly continuous clay films on ped faces; 60 to 70 percent chert fragments 1 to 4 inches in diameter; medium acid.

*Figure 5.*—**Representative profile of Eldorado stony silt loam, 1 to 8 percent slopes.**

Stones or chert fragments are on 0 to 50 percent of the surface area. The A11 horizon is black to dark-brown stony silt loam or silt loam. Reaction in the A horizon is slightly acid or medium acid. The A12 horizon is black to dark-brown silt loam to very cherty silt loam. It is missing in places. The B1 horizon is dark-brown, dark yellowish-brown, or brown cherty silt loam to very cherty silty clay loam. Reaction is medium acid or strongly acid. The B2t horizon is dark-brown, red, brown, dark reddish-brown, reddish-brown, dark-red, or yellowish-red very cherty clay loam to very cherty clay. Reaction is medium acid or strongly acid. In places a B22t horizon that is similar in color to the B2t horizon but has a higher content of cherty fragments is present. In places there is a B3 horizon at a depth of 40 inches or more that is similar in color to the B2t horizon but has a higher content of chert fragments and has mottles ranging from gray to red in color. Cherty limestone is at a depth below 6 feet.

Eldorado soils are shallower to the very cherty horizon than associated Craig soils. They have a thicker A1 horizon and do not have the A2 horizon that is in similar Clarksville soils.

**Eldorado stony silt loam, 1 to 8 percent slopes** (EID).—This soil is very gently sloping to sloping. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Craig, Dennis, and Summit soils and a few areas of soils that have gray mottles in the upper part of the subsoil. Also included are a few areas where the subsoil is thin over chert fragments, but the soils are otherwise similar to those of the Eldorado series.

Most of the acreage of this soil has never been cultivated. The soil is not suited to cultivated crops and is used for range or hay.

This soil needs careful grazing control and fertilization. Where stones are not excessive, tame pasture plants can be grown. Quality native grasses can be maintained or improved by controlling brush, using suitable grazing practices, and providing fire protection. Capability unit VIs–2; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Eldorado silt loam, 3 to 5 percent slopes** (EoC).—This soil is gently sloping. It has a profile similar to that described as representative for the series, but the surface layer is about 3 inches thinner and is free of stones.

Included with this soil in mapping are spots of Craig and Dennis soils. Also, about 5 percent of the mapped areas is made up of soils similar to Eldorado soils except that they have a reddish surface layer.

Most of this Eldorado soil is in native grass and is used for range or hay, but in places it is used for tame pasture plants and grain sorghum.

The main concerns of management are the hazard of erosion and the maintenance of soil structure and fertility. Where row crops are grown, terraces and contour farming are needed. The cropping system needs high residue crops at least one-third of the time, and the residue should be managed for soil improvement. Where row crops are not grown and terraces are not used, all crops should be the kind that produce high residue. Again, the residue should be managed for soil improvement, and annual reseeding should be provided and biennial or perennial vegetation grown at least half of the time. Capability unit IIIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

## Hector Series

The Hector series consists of well-drained, very shallow or shallow, very gently sloping to moderately steep soils on uplands. These soils formed under a cover of oaks and an understory of tall grasses in material weathered from sandstone.

In a representative profile the surface layer is 3 inches of very dark grayish-brown fine sandy loam. The subsoil extends to a depth of 10 inches and is strong-brown fine sandy loam. It is underlain by hard sandstone.

Hector soils have rapid permeability. Available water capacity is low to moderate.

Representative profile of Hector fine sandy loam, in an area of Hector-Linker complex, 5 to 20 percent slopes, 500 feet east of the NW. corner of sec. 36, T. 25 N., R. 18 E.:

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak, medium, granular structure; slightly hard, very friable; slightly acid; gradual, smooth boundary.

B—3 to 10 inches, strong-brown (7.5YR 5/6) fine sandy loam, reddish yellow (7.5YR 6/6) dry; weak, fine, granular structure; slightly hard, very friable; 5 percent sandstone fragments; strongly acid; abrupt, wavy boundary.

R—10 inches +, sandstone bedrock; hard; massive.

Sandstone is at a depth of 8 to 20 inches. The A1 horizon is brown, very dark grayish brown, dark brown, or dark grayish brown in color. Reaction in this horizon is slightly acid or medium acid. The B horizon is yellowish-red or strong-brown fine sandy loam to sandy loam. In places stones are on the surface.

Hector soils are shallower to sandstone than associated Linker soils, and they have a thinner A1 horizon than similar Collinsville soils.

**Hector-Linker complex, 1 to 5 percent slopes** (HIC).—These soils are very gently sloping to gently sloping. Included with this complex in mapping are spots of Collinsville and Dennis soils. These inclusions make up about 4 percent of the acreage.

About 54 percent of the mapped areas is Hector fine sandy loam, and about 42 percent is Linker fine sandy loam. The Hector and Linker profiles are similar to the ones described as representative for their series except that the subsoil of the Hector soil in this complex is 2 inches thicker, and the subsurface layer of the Linker soil is 8 inches thicker than that shown in the representative profile.

Most of the acreage in this complex is used for range. A small acreage has been cleared and is used for growing small grains, truck crops, and tame pasture plants.

The main concerns of management are the hazard of erosion, shallowness to bedrock, and maintenance of soil structure and fertility. Small grains or other high-residue crops can be grown continuously if fertilizer is used and all crop residue is returned to the soil. If crop residue is not returned to the soil, terraces and contour farming are needed to control erosion. Terraces are difficult to build and maintain on these soils. Both parts in capability unit IVe–2; Hector part in pasture and hay group 14A and Linker part in pasture and hay group 8B; Hector part in Shallow Savannah range site and Linker part in Sandy Savannah range site; both parts in woodland group 5d2.

**Hector-Linker complex, 5 to 20 percent slopes** (HIE).—These soils are sloping to moderately steep.

About 71 percent of the mapped areas is Hector fine sandy loam, and about 25 percent is Linker fine sandy loam. The Hector profile is the one described as representative for the Hector series. The Linker profile is similar to the one described as representative for the Linker series, but the combined surface layer and subsoil of this Linker soil is 4 inches thinner.

Included with this soil in mapping are spots of Collinsville soils and a few areas where the soils are moderately deep and have a clay to silty clay loam subsoil but are otherwise similar to Hector soils. Also included are a few areas of Hector soils that have a few stones on the surface. The included soils make up about 4 percent of the total mapped areas.

Most of this complex is used for range. A small acreage has been cleared and is used for pasture.

These soils are not suited to cultivation. They are suited to trees, native grasses, and food and cover for wildlife. Quality of the native grasses can be maintained or improved by controlling brush, using suitable grazing practices, and providing protection from fire. Both parts in capability unit VIIs–1; Hector part in pasture and hay group 14A and Linker part in pasture and hay group 8B; Hector part in Shallow Savannah range site and Linker part in Sandy Savannah range site; both parts in woodland group 5d2.

## Lenapah Series

The Lenapah series consists of shallow, moderately well drained to well drained, nearly level to very gently sloping soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from limestone.

In a representative profile the surface layer is 7 inches of black silty clay loam. The upper part of the subsoil, to a depth of 12 inches, is very dark gray silty clay loam. The lower part, to a depth of 18 inches, is very dark grayish-brown clay. The subsoil is underlain by hard limestone.

Lenapah soils have slow permeability. Available water capacity is moderate.

Representative profile of Lenapah silty clay loam, 0 to 3 percent slopes, 300 feet south and 100 feet west of the NE. corner of sec. 35, T. 28 N., R. 19 E.:

Ap—0 to 7 inches, black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate, medium, granular structure; very hard, friable; slightly acid; gradual, smooth boundary.

B1—7 to 12 inches, very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; strong, medium, granular structure; very hard, firm; slightly acid; gradual, smooth boundary.

B2t—12 to 18 inches, very dark grayish-brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; few, fine, prominent, olive-brown and reddish-brown mottles; moderate, medium, blocky structure; very hard, very firm; clay films on faces; a few cracks filled with material similar to that in the B1 horizon; few, cemented, calcium carbonate concretions; few black concretions; neutral; abrupt, wavy boundary.

R—18 inches +, limestone.

The A1 or Ap horizon is very dark grayish brown, black, very dark brown, or very dark gray. Reaction is slightly acid or medium acid. The B1 horizon colors are the same as those in the A1 horizon. In places there are a few iron-manganese concretions. The B2t horizon is black, dark brown, very dark brown, very dark gray, or very dark grayish brown. Reaction in this horizon is neutral to slightly acid. Limestone is at a depth of 16 to 20 inches.

Lenapah soils have a thinner solum than associated Claremore soils. Lenapah soils are shallower to limestone than associated Summit soils and have a B2t horizon that associated Talpa soils do not have.

**Lenapah silty clay loam, 0 to 3 percent slopes** (LeB).—This soil is nearly level and very gently sloping. It is the only Lenapah soil mapped in the county.

Included with this soil in mapping are spots of Bonham, Claremore, and Talpa soils. About 25 percent of the mapped area is soils that are similar to Lenapah soils except that they are deeper to limestone or have a redder subsoil.

This soil is used mostly for range, but some areas are used for growing wheat, grain sorghum, and tame pasture plants.

The droughtiness of the soil and the requirement for maintaining good tilth and fertility are the main concerns of management. Most adapted crops can be grown continuously if the soil is well managed and most of the crop residue is returned to the soil. Crops respond well

to fertilizer. Quality native grasses can be maintained or improved by controlling brush, using suitable grazing practices, and providing protection against fire. Capability unit IIIe–5; pasture and hay group 14A; Shallow Prairie range site; woodland group 5o0.

## Lightning Series

The Lightning series consists of deep, poorly drained to somewhat poorly drained, nearly level soils on flood plains. They formed under a cover of oaks and an understory of tall grasses in clayey sediment. These soils are subject to flooding.

In a representative profile the surface layer is 10 inches of dark-gray silt loam. The subsurface layer is 4 inches of gray silt loam. The subsoil extends to a depth of 54 inches and is dark grayish-brown clay mottled in shades of gray, brown, and red.

Lightning soils have very slow permeability. Available water capacity is high.

Representative profile of Lightning silt loam, in an area of Lightning-Carytown complex, 2,600 feet west of the NE. corner of sec. 25, T. 25 N., R. 20 E.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; weak, fine, granular structure; hard, friable; strongly acid; abrupt, smooth boundary.

A1—6 to 10 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; few, fine, faint, brown mottles; weak, medium, granular structure; hard, friable; medium acid; clear, smooth boundary.

A2—10 to 14 inches, gray (10YR 5/1) silt loam, light gray (10YR 7/1) dry; few, fine, faint, yellowish-brown mottles; weak, fine, granular structure; hard, very friable; medium acid; clear, wavy boundary.

B2t—14 to 40 inches, dark grayish-brown (10YR 4/2) clay, light brownish gray (10YR 6/2) dry; common, fine, distinct, brown and yellowish-red mottles and many, medium, gray (10YR 5/1) mottles; weak, fine, blocky structure; very hard, firm; patchy clay films on ped faces; strongly acid; gradual, smooth boundary.

B3—40 to 54 inches, dark grayish-brown (10YR 4/2) clay, light gray (10YR 6/1) dry; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine, blocky structure; very hard, very firm; few black concretions; few gypsum crystals; medium acid.

The Ap and A1 horizons are very dark gray, dark grayish brown, dark gray, or very dark grayish brown. Reaction in these horizons is medium acid or strongly acid. The A2 horizon is gray, grayish brown, or light brownish gray. Mottles in the A2 horizon are very dark grayish brown to brownish yellow. Reaction is very strongly acid to medium acid. The B horizon is dark-gray, grayish-brown, gray, or dark grayish-brown clay or silty clay. If the B2t horizon is dark grayish brown, it has gray mottles. Mottles in this horizon range from gray to yellowish red. Reaction is medium acid to very strongly acid. In the B3 horizon medium to coarse mottles range in color from gray to yellowish brown. Reaction is strongly acid to neutral.

Lightning soils have a thinner A1 horizon than associated Verdigris and Osage soils, and they have a B2t horizon that is lacking in associated Radley soils.

**Lightning-Carytown complex** (lg).—These are nearly level soils on flood plains. They flood once in 5 to 20 years.

Included with this unit in mapping are spots of Osage, Radley, and Verdigris soils that make up about 11 percent of the mapped area.

About 69 percent of the mapped areas is Lightning silt loam, and 20 percent is Carytown silt loam. The Lightning and Carytown soils have the profiles described as representative of their respective series.

The soils of this complex are used mostly for growing tame pasture plants, grain sorghum, wheat, and corn.

The main concerns of management are poor drainage, flooding, slow intake of water, and the maintenance of soil structure and fertility.

Crops can be grown continuously if the soil is well managed. Crop residue should be returned to the soil, and fertilizer should be used. A drainage system that includes drainage by row direction is also beneficial to most crops, but this soil should not be grazed or cultivated when it is wet. Both parts in capability unit IIIw–2; both parts in pasture and hay group 2B; Lightning part in Heavy Bottomland range site and Carytown part in Alkali Bottomland range site; both parts in woodland group 3w6.

## Linker Series

The Linker series consists of moderately deep, well-drained, very gently sloping to moderately steep soils on uplands. These soils formed under a cover of oaks and an understory of tall grasses in material weathered from sandstone.

In a representative profile the surface layer is 4 inches of dark-brown fine sandy loam. The subsurface layer is 8 inches of brown fine sandy loam. The subsoil extends to a depth of 32 inches and is yellowish-red sandy clay loam. It is underlain by sandstone.

Linker soils have moderate permeability. Available water capacity is high.

Representative profile of Linker fine sandy loam, 1 to 3 percent slopes, 1,300 feet east of the SW. corner of sec. 26, T. 25 N., R. 18 E.

Ap—0 to 4 inches, dark-brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak, medium, granular structure; slightly hard, friable; strongly acid; clear, smooth boundary.

A2—4 to 12 inches, brown (7.5YR 5/4) fine sandy loam, pink (7.5YR 7/4) dry; weak, fine, granular structure; slightly hard, friable; very strongly acid; clear, smooth boundary.

B21t—12 to 22 inches, yellowish-red (5YR 4/8) sandy clay loam, reddish yellow (5YR 6/8) dry; common, medium, distinct, light yellowish-brown (10YR 6/4) mottles; moderate, fine, subangular blocky structure; hard, friable; patchy clay films on ped faces; very strongly acid; gradual, smooth boundary.

B22t—22 to 32 inches, yellowish-red (5YR 4/8) sandy clay loam, reddish yellow (5YR 6/8) dry; common, medium, distinct, light yellowish-brown (10YR 6/4) and brownish-yellow (10YR 6/6) mottles; moderate, fine, subangular blocky structure; hard, friable; patchy clay films on ped faces; very strongly acid; abrupt, wavy boundary.

R—32 inches +, level-bedded sandstone.

The Ap horizon is dark grayish brown, dark yellowish brown, brown, or dark brown. Reaction in all horizons is strongly acid or very strongly acid. The A2 horizon is grayish brown, brown, or yellowish brown. The B2t horizon is reddish brown, yellowish red, or red. Sandstone is at a depth of 30 to 40 inches.

Linker soils are deeper to sandstone than the associated Hector soils.

**Linker fine sandy loam, 1 to 3 percent slopes** (LkB).—This soil is very gently sloping. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Bates, Dennis, and Hector soils. In a few areas there are soils similar to Linker soils except that sandstone is at a depth of 20 to 30 inches.

This soil is used mostly for growing tame pasture plants, but small grains, truck crops, and orchard crops are also grown. A sizable acreage has never been cleared and is used for grazing livestock.

The main concerns of management are the hazard of erosion and the maintenance of soil structure and fertility. Where row crops are grown, contour farming and terraces are needed. High-residue crops can be grown if enough of the crop residue is returned to the soil and fertilizer is used. Capability unit IIe–2; pasture and hay group 8B; Sandy Savannah range site; woodland group 4o1.

**Linker fine sandy loam, 3 to 5 percent slopes** (LkC).—This soil is gently sloping. It is similar to the one described as representative for the series.

Included with this soil in mapping are spots of Bates, Dennis, and Hector soils. Also included in a few areas are soils similar to Linker soils except that sandstone is at a depth of 20 to 30 inches.

This soil is used mostly for tame pasture, but small areas are used for truck and orchard crops.

The main concerns of management are the hazard of erosion and the maintenance of soil structure and fertility.

Where row crops are grown, terraces and contour farming are needed. Also, large amounts of crop residue and fertilizer should be returned to the soil to help maintain organic-matter content and soil structure and to increase the intake of water. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops. Biennial or perennial vegetation should be provided in this system at least half of the time. Capability unit IIIe–7; pasture and hay group 8B; Sandy Savannah range site; woodland group 4o1.

**Linker fine sandy loam, 2 to 5 percent slopes, eroded** (LkC2).—This is a very gently sloping to sloping eroded soil. Part of the original surface layer has been removed by erosion in about 75 percent of the mapped areas. In about 30 percent of the mapped areas, the present surface layer is material from the original surface layer and material from the subsoil mixed by tillage. A few uncrossable gullies and rills are about 100 feet apart in these more eroded areas.

Included with this soil in mapping are a few spots of Hector soils.

Nearly all of this Linker soil is or has been cultivated. It is used mostly for tame pasture or range.

The main concerns of management are the hazard of erosion and maintenance of soil structure and fertility.

Where this soil is cultivated, terraces and contour farming are needed. Most of the adapted crops can be grown if the soil is well managed and if large amounts of crop residue are returned to the soil. Fertilizer is needed in areas of crops and tame pasture. Capability unit IIIe–8; pasture and hay group 8B; Sandy Savannah range site; woodland group 4o1.

## Lula Series

The Lula series consists of deep, well-drained, very gently sloping and gently sloping soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from limestone.

In a representative profile the surface layer is 10 inches of very dark grayish-brown silt loam. The subsoil extends to a depth of 52 inches and is dark reddish-brown silty clay loam. It is underlain by hard limestone.

Lula soils have moderate permeability. Available water capacity is high.

Representative profile of Lula silt loam, 1 to 3 percent slopes, 2,000 feet east and 1,000 feet south of the NW. corner of sec. 19, T. 27 N., R. 18 E.:

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

B1—10 to 18 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) dry; strong, medium, granular structure; hard, friable; medium acid; gradual, smooth boundary.

B21t—18 to 32 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, reddish brown (2.5YR 4/4) dry; common, fine, faint, dark-red mottles; moderate, medium, blocky structure; hard, firm; clay films on ped faces; few, fine, black concretions; strongly acid; gradual, smooth boundary.

B22t—32 to 52 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, reddish brown (2.5YR 4/4) dry; few, fine, faint, dark-red mottles; moderate, medium, blocky structure; very hard, firm; clay films on ped faces; few, fine, black concretions; few chert and limestone fragments 2 to 25 millimeters in diameter; neutral; abrupt, wavy boundary.

R—52 inches +, hard limestone bedrock.

The A1 horizon is very dark grayish brown, dark reddish brown, very dark brown, or dark brown. Reaction is slightly acid or medium acid. The B1 horizon is brown, dark-reddish brown, dark-brown, or reddish-brown silt loam or silty clay loam. Reaction is slightly acid or medium acid. The B2t horizon is reddish brown, dark reddish brown, red, dark red, or yellowish red. Reaction is neutral to strongly acid. Limestone is at a depth of 40 to 60 inches.

Lula soils have a B2t horizon that contains less clay and is redder than that in associated Bonham soils. Lula soils are deeper to limestone than associated Claremore soils.

**Lula silt loam, 1 to 3 percent slopes** (LuB).—This soil is very gently sloping. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Bonham, Claremore, Summit, and Talpa soils. Also, about 25 percent of the mapped areas is made up of soils similar to Lula soils except that they are either shallower or deeper to limestone.

This soil is used mostly for growing wheat, grain sorghum, and soybeans. A sizable acreage is used for tame pasture and range.

The main concerns of management are the hazard of erosion and the maintenance of soil structure and fertility. Most of the adapted crops can be grown continuously if the soil is well managed. Most of the crop residue should be returned to the soil, and fertilizer should be used. Terraces and contour farming are needed where row crops are grown. Capability unit IIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Lula silt loam, 3 to 5 percent slopes** (LuC).—This soil is gently sloping. Included with it in mapping are spots of Claremore, Summit, and Talpa soils.

This soil is used for growing wheat, grain sorghum, soybeans, tame pasture plants, and native grasses.

The main concerns of management are the hazard of erosion and the maintenance of soil structure and fertility.

Where row crops are grown, terraces and contour farming are needed. Also, large amounts of crop residue and fertilizer should be returned to the soil to help maintain organic-matter content and soil structure and to increase the intake of water. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops and biennial or perennial vegetation at least half the time. Capability unit IIIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

## Mine Pits and Dumps

Mine pits and dumps (Mp) consists of mixed shale, sandstone, limestone, and soil of the original mantle that has been stripped from coalbeds.

In mining operations the removal of material above coal has left long pits and piles of material (fig. 6). Slopes are steep, runoff is rapid, and the hazard of erosion is severe. Included with this land type in mapping are gravel pits, borrow pits, and limestone quarries where no soil remains.

This land type is not suited to cultivation and is mostly idle. In places native grasses and trees have been established where there is a source of seed nearby. A few of the areas have been planted to tame or native grasses, but the results are generally poor. These areas can be used for wildlife habitat and recreation. Capability unit VIIs–4; not assigned to a pasture and hay group; Coal Strip Mines range site; woodland suitability group 5o0.

*Figure 6.*—Piles of excavated overburden surround inundated pit of coal strip mine.

## Nixa Series

The Nixa series consists of deep, moderately well drained, nearly level and very gently sloping soils on uplands. These soils formed under a cover of oaks and an understory of tall grasses in material weathered from cherty limestone.

In a representative profile the surface layer is 3 inches of very dark grayish-brown cherty silt loam. The subsurface layer extends to a depth of 14 inches and is light brownish-gray cherty silt loam. The upper part of the subsoil, to a depth of 21 inches, is brown cherty clay loam. Below this, to a depth of 27 inches, it is reddish-brown very cherty clay loam that is hard and brittle. The subsoil between depths of 27 and 54 inches is dark-red very cherty clay.

Nixa soils have very slow permeability. Available water capacity is moderate.

Representative profile of Nixa cherty silt loam, 0 to 3 percent slopes, 1,300 feet north of the SW. corner of sec. 19, T. 24 N., R. 21 E.:

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) cherty silt loam, grayish brown (10YR 5/2) dry; weak, fine, granular structure; slightly hard, very friable; about 15 percent chert fragments ½ inch to 3 inches in diameter; strongly acid; gradual, smooth boundary.

A2—3 to 14 inches, light brownish-gray (10YR 6/2) cherty silt loam, white (10YR 8/2) dry; weak, fine, granular structure; slightly hard, very friable; about 20 percent chert fragments ½ inch to 3 inches in diameter; very strongly acid; gradual, smooth boundary.

B1—14 to 21 inches, brown (7.5YR 5/4) cherty clay loam, light brown (7.5YR 6/4) dry; common, medium, distinct, grayish-brown (10YR 5/2) mottles; moderate, medium, granular and fine, subangular blocky structure; hard, friable; clay films on ped faces and fragments; about 30 percent chert fragments ½ inch to 3 inches in diameter; very strongly acid; gradual, smooth boundary.

Bx—21 to 27 inches, reddish-brown (5YR 5/4) very cherty clay loam, yellowish-red (5YR 5/6) dry; many, medium, prominent, light brownish-gray (10YR 6/2) mottles and vertical streaks; very coarse prismatic and weak, thin, platy structure; hard, brittle; about 60 percent chert fragments ½ inch to 4 inches in diameter; very strongly acid; gradual, smooth boundary.

B21t—27 to 47 inches, dark-red (2.5YR 3/6) very cherty clay, dark red (2.5YR 3/6) dry; moderate, medium, blocky structure; very hard, firm; clay films on ped faces and chert fragments; about 60 percent chert fragments ½ inch to 6 inches in diameter; very strongly acid; gradual, smooth boundary.

B22t—47 to 54 inches, dark-red (2.5YR 3/6) very cherty clay, dark red (2.5YR 3/6) dry; common, medium, prominent, red (2.5YR 4/8) and pale-brown (10YR 6/3) mottles; moderate, fine, blocky structure; very hard, firm; clay films on chert fragments; about 80 percent chert fragments ½ inch to 6 inches in diameter; very strongly acid.

The A1 horizon is dark grayish brown or very dark grayish brown. The A2 horizon is grayish brown, light brownish gray, brown, or pale brown. Reaction in these horizons is strongly acid or very strongly acid. The B1 horizon is brown, red, dark-brown, dark-red, reddish-brown, dark reddish-brown, strong-brown, or yellowish-red cherty silt loam to cherty clay loam. The content of chert fragments is as much as 30 percent. The Bx horizon is dominantly reddish-brown to brownish-yellow very cherty silt loam to very cherty clay loam. The content of chert fragments is 50 to 75 percent, by volume. Reaction in this horizon is strongly acid or very strongly acid. The

B21t horizon is dark reddish-brown, red, dark-red, reddish-brown, yellowish-red, brown, or dark-brown very cherty clay loam or very cherty clay. Chert fragments make up 60 to 80 percent of the mass. Reaction in the B21t horizon is strongly acid or very strongly acid. The B22t horizon is very cherty clay loam or very cherty clay. It has colors about the same as those in the B21t horizon. Reaction in the B22t horizon is strongly acid or very strongly acid.

These soils are outside the defined range for the Nixa series because they have mottles higher in the profile, and their B horizon is redder than is typical for the series. The soils are similar enough to the Nixa soils in morphology, composition, and behavior to be included in the series.

Nixa soils differ from associated Clarksville soils in having a Bx horizon. They have an A2 horizon and a Bx horizon, but these horizons are lacking in associated Sallisaw soils.

**Nixa cherty silt loam, 0 to 3 percent slopes** (NcB).—This soil is nearly level to very gently sloping. Included with it in mapping are spots of Clarksville very cherty silt loam. Also, about 45 percent of the mapped areas is made up of soils that are similar to Nixa soils except that they lack a fragipan.

This soil is used mostly for tame pasture. A small acreage is used for small grains and sweet sorghum or as wooded pasture.

The main concerns of management are droughtiness and maintenance of soil structure and fertility. Returning large amounts of crop residue to the soil helps to maintain organic-matter content and soil structure. The natural fertility of the soil is low, and fertilizer is needed for crops and tame pasture. Capability unit IIIs–1; pasture and hay group 8B; Smooth Chert Savannah range site; woodland group 4f8.

## Okemah Series

The Okemah series consists of deep, moderately well drained, nearly level soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from limestone and shale.

In a representative profile the surface layer is 15 inches of very dark grayish-brown and dark grayish-brown silt loam. The upper part of the subsoil, to a depth of 23 inches, is very dark grayish-brown silty clay loam. The lower part of the subsoil, to a depth of 50 inches, is dark-brown and yellowish-red silty clay. The subsoil is underlain by hard limestone.

Okemah soils have slow permeability. Available water capacity is high.

Representative profile of Okemah silt loam, limestone substratum, 1,500 feet east of the NW. corner of sec. 26, T. 28 N., R. 19 E.:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; hard, friable; medium acid; clear, smooth boundary.

A1—6 to 13 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; strong, medium, granular structure; hard, friable; medium acid; gradual, smooth boundary.

A2—13 to 15 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; moderate, medium, granular structure; hard, friable; medium acid; gradual, smooth boundary.

B1—15 to 23 inches, very dark grayish-brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak, fine, subangular blocky structure; hard, friable; medium acid; gradual, smooth boundary.

B2t—23 to 38 inches, dark-brown (7.5YR 4/2) silty clay, brown (7.5YR 5/2) dry; many, medium, prominent, yellowish-red (5YR 4/6) mottles; moderate, medium, blocky structure; very hard, very firm; clay films on ped faces; few black concretions; slightly acid; gradual, smooth boundary.

B3—38 to 50 inches, yellowish-red (5YR 4/6) silty clay, yellowish red (5YR 5/6) dry; many, medium, prominent, strong-brown (7.5YR 5/8) and grayish-brown (10YR 5/2) mottles; weak, medium, blocky structure; very hard, very firm; few black concretions; neutral; abrupt, wavy boundary.

R—50 inches +, hard limestone.

The A1 horizon is very dark brown, very dark grayish brown, black, or very dark gray. Reaction is slightly acid or medium acid. In places there is an A2 horizon that is dark gray or dark grayish brown in color. The B1 horizon is black, very dark grayish brown, very dark brown, or very dark gray. Reaction in this horizon is slightly acid or medium acid. The B2t horizon is dark-gray to yellowish-brown silty clay or clay. Reaction is slightly acid or medium acid. The B3 horizon is similar in color and texture to the B2t horizon.

Okemah soils have mottles lower in the profile than the associated Bonham soils.

These soils are outside the defined range for the Okemah series because they have limestone rock at a depth of 40 to 60 inches. They are enough like the Okemah series, however, in morphology, composition, and behavior to be included with this series.

**Okemah silt loam, limestone substratum** (Oe).—This soil is nearly level. Included with it in mapping are spots of Bonham, Claremore, Lenapah, Lula, Summit, and Talpa soils. Also, about 15 percent of the mapped areas are made up of soils that are similar to Okemah soils except that they are shallower to limestone.

This Okemah soil is used mostly for growing small grains, grain sorghum, and soybeans. A small acreage is in native grasses and is used for range.

The main concern of management is maintenance of soil structure and fertility. If the soil is well managed, crops can be grown continuously if most of the crop residue is returned to the soil to help maintain organic-matter content and improve soil structure. Capability unit I–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

## Osage Series

The Osage series consists of deep, poorly drained, nearly level soils on flood plains and on uplands. These soils formed in clayey sediment under a cover of hardwood trees and an understory of tall grasses. The soils on flood plains are subject to flooding.

In a representative profile the surface layer is 15 inches of very dark gray silty clay loam. The subsoil extends to a depth of 25 inches and is very dark gray clay. The underlying material is dark-gray clay.

Osage soils have very slow permeability. Available water capacity is high.

Representative profile of Osage silty clay loam, 1,320 feet north of the SE. corner of sec. 1, T. 28 N., R. 21 E.:

A1—0 to 15 inches, very dark-gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak, fine, subangular blocky structure; extremely hard, very firm; slightly acid; clear, smooth boundary.

B—15 to 25 inches, very dark gray (10YR 3/1) clay, gray (10YR 5/1) dry; few, fine, faint, strong-brown mottles; moderate, medium, blocky structure; extremely

hard, very firm; slightly acid; gradual, smooth boundary.

C—25 to 44 inches, dark-gray (10YR 4/1) clay, gray (10YR 5/1) dry; few, faint, strong-brown mottles; massive; extremely hard, extremely firm; a few slickensides that do not intersect; few calcium carbonate concretions; mildly alkaline.

The A1 horizon is black or very dark gray. In places it has few, fine, faint, dark-brown mottles. Reaction is medium acid to neutral in this horizon. The B horizon is very dark gray or dark gray. Mottles range from dark gray to dark yellowish brown in color. Reaction in the B horizon is medium acid to mildly alkaline. The C horizon ranges from black to grayish brown. Mottles are few to many, fine to coarse, and gray to light olive brown in color. Reaction in the C horizon is neutral or mildly alkaline.

Osage soils have a thicker A1 horizon than associated Lightning soils. They are more clayey in the lower part of the profile than associated Verdigris soils.

**Osage silty clay loam** (Os).—This is a nearly level soil on flood plains. It has the profile described as representative for the series. Flooding occurs on this soil once every 5 to 20 years.

Included with this soil in mapping are spots of Lightning, Radley, and Verdigris soils.

About half of this soil is used for growing corn, grain sorghum, and small grains. The other half is used for range or hay.

The main concerns of management in cultivated areas are surface wetness, flooding, surface crusting, slow water intake, and maintenance of soil structure. Most adapted crops can be grown continuously if crop residue is returned to the soil and the soil is well managed. When this soil is wet, tilling or grazing breaks down the soil structure and increases puddling. A drainage system that includes arranging row direction for drainage is beneficial to most crops. Capability unit IIIw–1; pasture and hay group 2B; Heavy Bottomland range site; woodland group 3w6.

**Osage silty clay loam, uplands** (Ot).—This is a nearly level soil on uplands. It has a profile similar to the one described as representative for the series except that the surface layer is 26 inches thicker.

Included with this soil in mapping are spots of Dennis, Parsons, and Summit soils.

About 50 percent of this soil is used for growing wheat and grain sorghum. The other 50 percent is used for range.

The main concerns of management are surface crusting, slow intake of water, seasonal wetness or droughtiness, and maintenance of soil structure and fertility.

This soil can be maintained by growing crops that produce large quantities of residue, which is returned to the soil for protection and improvement. Capability unit IIs–1; pasture and hay group 8C; Claypan Prairie range site; woodland group 5o0.

## Parsons Series

The Parsons series consists of deep, somewhat poorly drained to moderately well drained, nearly level soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from shale and clay.

In a representative profile the surface layer is 10 inches of very dark grayish-brown silt loam. The subsurface layer is about 3 inches of dark grayish-brown silt loam. The upper part of the subsoil, to a depth of 32 inches, is dark grayish-brown clay. The lower part extends to a depth of 60 inches and is clay mottled in shades of brown and gray.

Parsons soils have very slow permeability. Available water capacity is high.

Representative profile of Parsons silt loam, 0 to 1 percent slopes, 1,450 feet east of the SW. corner of sec. 35, T. 25 N., R. 19 E.:

A1—0 to 10 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; hard, friable; medium acid; gradual, smooth boundary.

A2—10 to 13 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; few, fine, faint, very dark grayish-brown and yellowish-brown mottles; weak, medium, granular structure; hard, friable, strongly acid; abrupt, wavy boundary.

B21t—13 to 21 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; many, fine, prominent, yellowish-red mottles; moderate, medium, blocky structure; extremely hard, very firm; clay films on ped faces; strongly acid; gradual, smooth boundary.

B22t—21 to 32 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; common, medium, prominent, red (2.5YR 4/6), dark-brown (10YR 4/3) and gray (10YR 5/1) mottles; moderate, medium, blocky structure; extremely hard, very firm; clay films on ped faces; few black concretions; strongly acid; gradual, smooth boundary.

B3—32 to 60 inches, coarsely mottled, dark-brown (10YR 4/3), gray (10YR 5/1), and yellowish-brown (10YR 5/4) clay; weak, coarse, blocky structure; extremely hard, very firm; many gypsum crystals in upper part of subsoil; many black concretions and streaks; medium acid.

The A1 horizon is very dark grayish brown or very dark gray. Reaction is strongly acid or medium acid but ranges to slightly acid where limed. The A2 horizon is gray, grayish brown, dark gray, or dark grayish brown. Reaction is medium acid or strongly acid. The B21t horizon is very dark grayish brown or dark grayish brown. Mottles range from shades of gray to shades of red. Reaction is strongly acid or medium acid. The B22t horizon is dark yellowish brown, dark grayish brown, yellowish brown, brown, dark brown, or grayish brown. Reaction is medium acid or strongly acid. The B3 horizon is mottled in shades of gray, red or brown. Texture generally is clay but ranges to silty clay. Reaction in the B3 horizon is slightly acid or medium acid.

Parsons soils have a thinner A horizon than associated Taloka soils, and they have a lower content of exchangeable sodium than associated Carytown soils. They have a very dark gray or very dark grayish brown A1 horizon more than 6 inches thick that is lacking in associated Cherokee soils.

**Parsons silt loam, 0 to 1 percent slopes** (PaA).—This is a nearly level soil. This is the only Parsons soil mapped in the county. Included with this soil in mapping are spots of Carytown, Dennis, Osage, and Taloka soils. Also, about 45 percent of the mapped areas is made up of soils similar to those of the Parsons series except that they have a surface layer that is dark grayish brown.

This soil is used mostly for growing small grains, grain sorghum, soybeans, and tame pasture plants. A fair percentage of the acreage is in native grass and is used for range or hay.

The main concerns of management are maintenance of soil structure and fertility, surface crusting, slow intake

of water, and seasonal wetness or droughtiness. Growing crops that produce residue and returning the crop residue along with fertilizer helps to maintain this soil. Drainage benefits most crops. Capability unit IIs–1; pasture and hay group 8C; Claypan Prairie range site; woodland group 5o0.

## Radley Series

The Radley series consists of deep, moderately well drained, nearly level soils on flood plains. These soils formed under a cover of hardwood trees and tall grass in loamy sediment. They are subject to flooding.

In a representative profile the surface layer is 14 inches of very dark grayish-brown silt loam. The subsoil, which extends to a depth of 23 inches, is dark grayish-brown silty clay loam. It is underlain by dark-brown silty clay loam.

Radley soils have moderate permeability. Available water capacity is high.

Representative profile of Radley silt loam, 2,100 feet west and 150 feet north of the SE. corner of sec. 21, T. 28 N., R. 18 E.:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak, medium, granular structure; hard, friable; neutral; clear, smooth boundary.

A1—7 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; hard, friable; slightly acid; gradual, smooth boundary.

B—14 to 23 inches, dark grayish-brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; weak, fine, subangular blocky structure; hard, friable; medium acid; gradual, smooth boundary.

C—23 to 60 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; few, fine, faint, yellowish-brown mottles; massive; hard, friable; few thin strata of coarser material; common black concretions in lower part of horizon; medium acid.

The A1 horizon is very dark grayish brown or dark brown. The B horizon is brown, dark-brown, or dark grayish-brown silt loam or silty clay loam. In places there are a few, fine, faint, very pale brown, dark-brown, or yellowish-brown mottles. The C horizon is grayish-brown, dark grayish-brown, brown, or dark-brown silt loam, silty clay loam, or clay loam. Reaction throughout the profile is neutral to medium acid. A few rounded pebbles are present in places.

Radley soils lack a B2t horizon, but a B2t horizon is in associated Lightning soils. They have a thinner A1 horizon than similar Staser soils. Radley soils differ from associated Verdigris soils by having a very dark grayish-brown A horizon that is less than 20 inches thick.

**Radley silt loam** (Ra).—This is a nearly level soil that is flooded about once every 5 to 20 years. It is the only Radley soil mapped in the county.

Included with this soil in mapping are spots of Lightning, Osage, and Verdigris soils.

This soil is used mostly for growing corn, small grains, soybeans, grain sorghum, and tame pasture plants.

The main concerns of management are flooding and maintenance of soil structure. Most crops that are generally grown produce large amounts of crop residue. Such crops can be grown continuously if the soil is well managed and crop residue is returned to the soil. Capability unit IIw–1; pasture and hay group 2A; Loamy Bottomland range site; woodland group 3w5.

## Sallisaw Series

The Sallisaw series consists of deep, well-drained, nearly level to sloping soils on terraces. These soils formed in loamy sediment under a cover of hardwood trees and an understory of tall grasses.

In a representative profile the surface layer is 8 inches of dark-brown silt loam. The upper part of the subsoil, to a depth of 18 inches, is reddish-brown silty clay loam. The middle part, to a depth of 30 inches, is yellowish-red gravelly clay loam. The lower part of the subsoil is yellowish-red and reddish-brown very gravelly clay loam. It extends to a depth of 60 inches.

Sallisaw soils have moderate permeability. Available water capacity is high.

Representative profile of Sallisaw silt loam, 0 to 3 percent slopes, 300 feet west of the SE. corner of sec. 36, T. 24 N., R. 20 E.:

A1—0 to 8 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak, fine, granular structure; slightly hard, friable; few pebbles; medium acid; gradual, smooth boundary.

B1—8 to 18 inches, reddish-brown (5YR 4/4) silty clay loam, light reddish brown (5YR 6/4) dry; moderate, medium, granular structure; slightly hard, friable; few pebbles ¼ inch to 1½ inches in diameter; strongly acid; gradual, smooth boundary.

B21t—18 to 30 inches, yellowish-red (5YR 4/6) gravelly clay loam, yellowish red (5YR 5/6) dry; moderate, medium, blocky structure; hard, firm; clay films on ped faces; about 35 percent pebbles ¼ inch to 2 inches in diameter; medium acid; gradual, wavy boundary.

B22t—30 to 42 inches, yellowish-red (5YR 4/6) very gravelly clay loam, yellowish red (5YR 5/6) dry; moderate, fine, blocky structure; hard, firm; clay films on ped and gravel faces; about 50 percent pebbles ¼ inch to 3 inches in diameter; medium acid; gradual, wavy boundary.

B3—42 to 60 inches, reddish-brown (5YR 4/4) very gravelly clay loam, reddish brown (5YR 5/4) dry; weak, fine, blocky structure; very hard, firm; patchy clay films and coatings of silt on gravel; 50 percent gravel; few black concretions; strongly acid.

The A1 horizon is grayish brown, dark grayish brown, yellowish brown, dark yellowish brown, brown, or dark brown. Reaction is slightly acid or medium acid.

The B1 horizon is brown, dark-brown, reddish-brown, strong-brown, or yellowish-red silt loam to gravelly clay loam and silty clay loam. Content of pebbles in this horizon ranges from a few to as much as 25 percent of the mass. Reaction in the B1 horizon is strongly acid to medium acid.

The B2t horizon is brown, dark brown, reddish brown, strong brown, red, or yellowish red. The B21t horizon ranges from clay loam to gravelly clay loam. Content of pebbles in this horizon ranges from a few to as much as 40 percent of the mass. Reaction is medium acid or strongly acid in the B21t horizon. The B22t horizon is gravelly clay loam or very gravelly clay loam. Content of pebbles ranges from a few to as much as 50 percent of the mass. Reaction in this horizon is medium acid or strongly acid. In places the B22t horizon is missing.

The B3 horizon is gravelly clay loam or very gravelly clay loam. The range of color is similar to that of the B2t horizon. In about 30 percent of the areas, the B3 horizon is coarsely mottled. Content of gravel ranges from 30 to 80 percent of the mass. Reaction is medium acid or strongly acid. Depth to very gravelly material ranges from 30 to 60 inches.

Sallisaw soils have a B2t horizon that is lacking in associated Staser soils. They have a gravelly B horizon that is lacking in associated Bates soils.

**Sallisaw silt loam, 0 to 3 percent slopes** (SaB).—This soil is nearly level and very gently sloping. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Clarksville and Staser soils. Also, there are a few areas of soils that are similar to Sallisaw soils except that their surface layer is about 15 to 20 percent gravel.

This soil is used mostly for tame pasture, but some areas are used for growing small grains and grain sorghum.

The main concerns of management are the hazard of erosion and maintenance of soil structure and fertility. Most of the adapted crops can be grown continuously if the soil is well managed, and large amounts of crop residue are returned to the soil. Terraces and contour farming are needed where row crops are grown. Tame pastures need brush control and fertilizer. Capability unit IIe–1; pasture and hay group 8A; Smooth Chert Savannah range site; woodland group 3o7.

**Sallisaw silt loam, 3 to 8 percent slopes** (SaD).—This soil is gently sloping to sloping. It has a profile similar to the one described as representative for the series, but the surface layer is 10 to 14 percent gravel.

Included with this soil in mapping are spots of Clarksville very cherty silt loam and Staser soils.

This soil is used mostly for growing tame pasture plants, but a small acreage is used for small grains and grain sorghum.

The main concerns of management are the hazard of erosion and maintenance of soil structure and fertility. Row crops are not recommended on this soil because of the hazard of erosion, even if terraces and contour farming practices are used. Soil-depleting crops should not be grown between soil-maintaining crops in the cropping system for more than one year. Terraces are needed unless all cultivated crops are soil-maintaining crops. In many areas terraces are needed to divert runoff from higher elevations. Tame pastures need fertilizer and brush control. Capability unit IVe–3; pasture and hay group 8A; Smooth Chert Savannah range site; woodland group 3o7.

## Staser Series

The Staser series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy sediment under a cover of hardwood trees and an understory of tall grasses. They are subject to flooding.

In a representative profile the surface layer is 6 inches of very dark grayish-brown silt loam. The next layer is very dark brown silt loam and extends to a depth of 16 inches. Below it, and extending to a depth of 28 inches, is very dark grayish-brown gravelly silt loam. The substratum is dark yellowish-brown gravelly clay loam to a depth of 38 inches and dark yellowish-brown very gravelly clay loam to a depth of 60 inches.

Staser soils have moderate permeability. Available water capacity is high.

Representative profile of Staser silt loam, 1,400 feet south of the NE. corner of sec. 23, T. 24 N., R. 20 E.:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak, medium, granular structure; hard, friable; few chert pebbles; slightly acid; clear, smooth boundary.

A11—6 to 16 inches, very dark brown (10YR 2/2) silt loam. dark grayish brown (10YR 4/2) dry; moderate, medium, granular structure; hard, friable; few chert pebbles; slightly acid; gradual, wavy boundary.

A12—16 to 28 inches, very dark grayish-brown (10YR 3/2) gravelly silt loam, grayish brown (10YR 5/2) dry; weak, medium, granular structure; hard, friable; about 25 percent chert pebbles ½ inch to 3 inches in diameter; medium acid; gradual, wavy boundary.

C1—28 to 38 inches, dark yellowish-brown (10YR 4/4) gravelly clay loam, yellowish-brown (10YR 5/4) dry; massive; hard, friable; about 35 percent chert pebbles 2 millimeters to 3 inches in diameter; medium acid; gradual, wavy boundary.

C2—38 to 60 inches, dark yellowish-brown (10YR 4/4) very gravelly clay loam, yellowish brown (10YR 5/4) dry; massive; hard, firm; about 60 percent chert pebbles 2 millimeters to 3 inches in diameter; medium acid.

The A horizon is very dark grayish brown, dark brown, or very dark brown and is more than 20 inches thick. Reaction is slightly acid or medium acid. The A horizon is silt loam, but gravelly silt loam is in the lower part. The lower part is 10 to 35 percent gravel, by volume. The C horizon is dark grayish-brown, very dark grayish-brown, dark yellowish-brown, brown, or dark-brown clay loam to very gravelly clay loam. It contains a few to 85 percent pebbles, by volume.

Staser soils lack the B2t horizon of associated Sallisaw soils, and they have a thicker A1 horizon than the similar Radley soils.

**Staser silt loam** (Sm).—This soil is nearly level. It is subject to flooding once every 5 to 20 years.

Included with this soil in mapping are spots of Sallisaw and Summit soils. Also, about 10 percent of the mapped areas is stream channels, and about 14 percent is made up of soils similar to Staser soils except that they have a gravelly silt loam surface layer.

This soil is used mostly for growing cultivated crops and tame pasture plants. A small amount of the acreage is woodland.

The main concerns of management are flooding and maintenance of soil structure and fertility. Most adapted crops can be grown if the soil is well managed, and crop residue is returned to the soil. Brush control is needed on tame pasture. Capability unit IIw–1; pasture and hay group 2A; Loamy Bottomland range site; woodland group 2o7.

## Summit Series

The Summit series consists of deep and moderately deep, moderately well drained, nearly level to sloping soils on uplands. These soils formed under a cover of mid and tall grass in material weathered from limestone and shale.

In a representative profile the surface layer is 11 inches of black silty clay loam. The upper part of the subsoil, to a depth of 15 inches, is very dark gray silty clay loam. The lower part, which extends to a depth of 36 inches, is dark grayish-brown clay. The underlying material is dark-gray clay. Hard limestone is at a depth of 48 inches.

Summit soils have slow permeability. Available water capacity is high.

Representative profile of Summit silty clay loam, 1 to 3 percent slopes, 2,100 feet east of the SW. corner of sec. 34, T. 24 N., R. 20 E.:

A1—0 to 11 inches, black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; strong, medium, granular

structure; hard, friable; slightly acid; gradual, smooth boundary.

B1—11 to 15 inches, very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate, medium and coarse, granular structure; hard, friable; slightly acid; gradual, smooth boundary.

B21t—15 to 24 inches, dark grayish-brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; common, fine, distinct, olive and yellowish-brown mottles; moderate, medium, blocky structure; extremely hard, very firm; nearly continuous clay films on ped faces; few black concretions; neutral; gradual, smooth boundary.

B22t—24 to 36 inches, dark grayish-brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; many, medium, distinct, light olive-brown (2.5Y 5/4) and yellowish-brown (10YR 5/4) and common, fine, gray mottles; moderate, medium, blocky structure; extremely hard, very firm; clay films on ped faces; common, black concretions; mildly alkaline; gradual, smooth boundary.

C—36 to 48 inches, dark-gray (10YR 4/1) clay, gray (10YR 5/1) dry; common, fine and medium, distinct, yellowish-brown (10YR 5/6) and common, fine, faint, brown mottles; massive; extremely hard, extremely firm; few, fine, black concretions; few calcium carbonate concretions; few fine limestone fragments; mildly alkaline; abrupt, wavy boundary.

R—48 inches +, limestone.

The A1 horizon is very dark gray, black, very dark grayish brown, or very dark brown. Reaction is slightly acid or medium acid. The B1 has the same range of colors as the A1 horizon. Texture in the B1 horizon ranges from dark brown silty clay loam to silty clay. The B21t horizon is dark grayish brown, very dark grayish brown, dark brown, or brown. Reaction is slightly acid to neutral.

The B22t horizon is very dark grayish brown, olive brown, or dark grayish brown in color and is slightly acid to mildly alkaline. The C horizon is very dark gray or dark gray. Limestone or shale is at a depth of 40 to 60 inches.

The Summit soil in mapping unit TsD (see Talpa series) is outside the defined range for the Summit series because it has limestone at a depth of less than 40 inches. It is enough like the Summit soils in morphology, composition, and behavior, however, to be included with this series.

Summit soils have a more clayey A horizon than associated Bonham soils, and they are deeper to limestone than associated Lenapah and Talpa soils.

**Summit silty clay loam, 0 to 1 percent slopes** (SuA).—Included with this nearly level soil in mapping are spots of Lenapah, Okemah, Osage, and Talpa soils. Also, about 10 percent of the mapped areas are made up of soils similar to Summit soils except that they are either shallower or deeper to limestone.

This soil is used mostly for growing small grains, grain sorghum, soybeans, and tame grasses. The main concerns of management are surface crusting and the maintenance of soil structure and fertility. Crops that produce large amounts of residue can be grown continuously if the soil is well managed, and if most of the residue is returned to the soil along with fertilizer. Capability unit I–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Summit silty clay loam, 1 to 3 percent slopes** (SuB).—This very gently sloping soil has the profile described as representative for the series.

Included with this soil in mapping are spots of Bonham, Claremore, Lenapah, Lula, Osage, and Talpa soils. Also, about 10 percent of the mapped areas is made up of soils similar to Summit soils except that they are either shallower or deeper to limestone.

This soil is used mostly for growing small grains, grain sorghum, soybeans, and tame pasture grass. A sizable acreage is in native grass and is used for range or hay.

The main concerns of management are the hazard of erosion and maintenance of soil structure and fertility. Most of the crops that produce large amounts of residue can be grown continuously if the soil is well managed and large amounts of residue are returned to the soil. Where row crops are grown, terraces and contour farming are needed to break up water concentration and reduce the hazard of erosion. Capability unit IIe–1; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Summit silty clay loam, 3 to 5 percent slopes** (SuC).—This is a gently sloping soil. Included with it in mapping are spots of Bonham, Lenapah, Lula, and Talpa soils. Also, about 10 percent of the mapped areas is made up of soils similar to Summit soils except that they are either shallower or deeper to limestone.

This soil is used mostly for range or hay. A fair percentage of the acreage is used for growing small grains and grain sorghum.

The principal concerns of management are the hazard of erosion and maintenance of soil structure and fertility. Where row crops are grown, terraces and contour farming are needed. Also, large amounts of crop residue should be returned to the soil along with fertilizer to help maintain organic-matter content and soil structure and to increase the intake of water. Where terraces are not used, a cropping system is needed that includes only soil-maintaining crops. This cropping system should include biennial or perennial vegetation at least half of the time. Capability unit IIIe–3; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

**Summit silty clay loam, 2 to 5 percent slopes, eroded** (SuC2).—This is a very gently sloping and gently sloping eroded soil. Part of the original surface layer has been removed by erosion in about 50 percent of the mapped areas. In about 30 percent of the mapped areas, the present surface layer is material from the subsoil and original surface layer that has been mixed by tillage. A few rills and a few uncrossable gullies are about 100 feet apart in these more eroded areas.

Most of the acreage is or has been cultivated. It is used mostly for tame pasture, but some is used for growing small grain and grain sorghum.

The main concerns of management are the hazard of erosion and maintenance of soil structure and fertility.

Terraces and contour farming are needed where this soil is cultivated. The return of large amounts of crop residue to the soil and use of fertilizer help to maintain organic-matter content and soil structure, increase the intake of water, and control the hazard of erosion. Capability unit IIIe–4; pasture and hay group 8A; Loamy Prairie range site; woodland group 5o0.

## Taloka Series

The Taloka series consists of deep, somewhat poorly drained to moderately well drained, nearly level soils on uplands. These soils formed under a cover of mid and tall grasses in loamy sediment.

In a representative profile the surface layer is 16 inches of very dark grayish-brown silt loam, and the subsurface layer is 4 inches of grayish-brown silt loam. The upper part of the subsoil, to a depth of 42 inches, is dark grayish-brown clay. The lower part of the subsoil extends to a depth of 60 inches and is clay mottled in shades of brown and gray.

Taloka soils have very slow permeability. Available water capacity is high.

Representative profile of Taloka silt loam, 0 to 1 percent slopes, 100 feet south of the NW. corner of sec. 20, T. 24 N., R. 20 E.:

A1—0 to 16 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak, medium, granular structure; hard, friable; medium acid; clear, smooth boundary.

A2—16 to 20 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; few, fine, faint, yellowish-brown mottles; weak, fine, granular structure; hard, friable; strongly acid; abrupt, wavy boundary.

B21t—20 to 33 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; common, medium, distinct, gray (10YR 6/1) and yellowish-brown (10YR 5/4) mottles and prominent reddish-brown (5YR 5/4) mottles; moderate or strong, medium, blocky structure; extremely hard, extremely firm; nearly continuous clay films on ped faces; strongly acid; gradual, smooth boundary.

B22t—33 to 42 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; common, medium, distinct, gray (10YR 6/1) and yellowish-brown (10YR 5/6) mottles and prominent dark reddish-brown (5YR 3/4) mottles; moderate, medium, blocky structure; extremely hard, extremely firm; clay films on ped faces; medium acid; gradual, smooth boundary.

B3—42 to 60 inches, coarsely mottled, dark grayish-brown (10YR 4/2), gray (10YR 6/1), and yellowish-brown (10YR 5/6) clay; weak, medium, blocky structure; extremely hard; extremely firm; slightly acid.

The A1 horizon is very dark grayish brown or very dark gray. The A2 horizon is dark grayish brown or grayish brown. Reaction is medium acid or strongly acid. The B21t horizon is very dark grayish brown or dark grayish brown. Mottles vary in number, size, and color within the horizon. They range from gray to reddish yellow. Reaction in the B21t horizon is slightly acid to strongly acid. The B22t horizon is dark grayish brown, brown, dark brown, or dark yellowish brown. Mottles range in color from gray to red. In places black concretions and gypsum crystals are in the B22t horizon. Reaction is slightly acid or medium acid. The B3 horizon is clay or silty clay. Coarse mottles in this horizon range in color from gray to yellowish red. Reaction is slightly acid and neutral.

Taloka soils are similar to associated Parsons soils but have a thicker A horizon. They have more clay in the B2t horizon than associated Choteau soils. Taloka soils have a very dark gray or very dark grayish-brown A1 horizon more than 6 inches thick that is lacking in associated Cherokee soils.

**Taloka silt loam, 0 to 1 percent slopes** (TaA).—Included with this nearly level soil in mapping are spots of Choteau, Dennis, and Parsons soils. Also, about 25 percent of the mapped areas is made up of soils similar to Taloka soil except that they have a dark grayish-brown surface layer.

This soil is used mostly for growing small grains, grain sorghum, soybeans, and tame pasture plants. A large acreage is used for range or native hay.

The main concerns of management are the slow infiltration rate and the maintenance of soil structure. Returning large amounts of crop residue to the soil helps to maintain soil structure. Capability unit IIs–2; pasture and hay group 8C; Loamy Prairie range site; woodland group 5o0.

## Talpa Series

The Talpa series consists of very shallow and shallow, well-drained, nearly level to sloping soils on uplands. These soils formed under a cover of mid and tall grass in material weathered from limestone.

In a representative profile the surface layer is 8 inches of very dark gray silty clay loam. It is underlain by hard limestone.

Talpa soils have moderate permeability. Available water capacity is low to moderate.

Representative profile of Talpa soils, 0 to 3 percent slopes, 100 feet south of the NW. corner of sec. 2, T. 26 N., R. 18 E.:

A1—0 to 8 inches, very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate, medium, granular structure; hard, friable; neutral; abrupt, wavy boundary.

R—8 inches +, hard limestone.

The A1 horizon is very dark gray, black, very dark grayish-brown, or very dark brown silty clay loam or clay loam. Reaction is slightly acid to mildly alkaline. Broken limestone generally is on the surface, covering from 0 to 40 percent of the surface area. Limestone bedrock is at a depth of 5 to 20 inches.

These soils are outside the defined range for the Talpa series because they are not calcareous. They are enough like the Talpa soils in morphology, composition, and behavior, however, to be included with this series.

Talpa soils are shallower and lack the B horizon of associated Summit and Lenapah soils.

**Talpa soils, 0 to 3 percent slopes** (TlB).—This soil is nearly level and very gently sloping. It has the profile described as representative for the series.

Included with this soil in mapping are spots of Bonham, Claremore, Lenapah, Lula, and Summit soils. Also, about 15 percent of the mapped areas is made up of soils that are similar to Talpa soils except that they have a clay loam surface layer, or they have a silt loam surface layer and are redder.

This soil is not suited to cultivation and is used for range and hay. Shallowness to bedrock and rockiness are the main concerns of management. This soil is best suited to range. Quality of the native grasses can be maintained or improved by controlling brush, using suitable grazing practices, and providing protection against fire. Capability unit VIIs–2; Very Shallow range site; woodland group 5o0.

**Talpa-Summit complex, 1 to 8 percent slopes** (TsD).—These soils are very gently sloping to sloping.

About 43 percent of the mapped areas is Talpa silty clay loam, and about 40 percent is Summit silty clay loam. The remaining 17 percent is minor soils.

Included with this complex in mapping are spots of Bonham, Claremore, Lenapah, and Lula soils and a few

areas of soils similar to Talpa soils except that the clay loam surface layer is redder.

Talpa and Summit soils have a profile similar to the one described as representative for their respective series, but the Summit soil in this complex is 18 inches thinner to limestone.

A large part of the mapped areas is drainageways. Talpa soils are on the sides of the drainageways, and Summit soils are on the bottom.

Most of the acreage in this complex is used for range. The main concerns of management are rockiness and shallowness to bedrock. This complex is not suited to cultivation, and it is not suited to tame pasture plants except in the deeper soils in drainageways. Quality of the native grasses can be maintained or improved by controlling brush, using suitable grazing practices, and protecting against fire. Both parts in capability unit VIs–3; Talpa part in Very Shallow range site and Summit part in Loamy Prairie range site; both parts in woodland group 5o0.

## Verdigris Series

The Verdigris series consists of deep, moderately well drained, nearly level soils on flood plains. These soils formed in loamy alluvium under a cover of hardwood trees and an understory of tall grasses. They are subject to flooding.

In a representative profile the surface layer is 18 inches of very dark grayish-brown silty clay loam. The next layer extends to a depth of 30 inches and is very dark grayish-brown silty clay loam. The underlying material is dark-brown clay loam.

Verdigris soils have moderate permeability. Available water capacity is high.

Representative profile of Verdigris silty clay loam in the SW. corner of sec. 13, T. 29 N., R. 20 E.:

A11—0 to 18 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; hard, friable; medium acid; gradual, smooth boundary.

A12—18 to 30 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak, fine, subangular blocky structure; hard, friable; many fine pores; medium acid; gradual, smooth boundary.

C—30 to 60 inches, dark-brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; massive; hard, friable; many fine pores; medium acid.

The A11 horizon is very dark brown, very dark grayish-brown, or dark-brown silt loam, silty clay loam, or clay loam. Reaction in the A horizon is slightly acid or medium acid. The A12 horizon is black, very dark grayish-brown, very dark gray, or very dark brown silty clay loam or clay loam. The C horizon is dark grayish-brown, grayish-brown, dark-brown, or brown silty clay loam or clay loam. In places there are fine to medium mottles ranging from reddish brown to grayish brown in color. Also present in the C horizon in places is water-worn gravel and stratified layers of sandier material.

Verdigris soils have a thicker A1 horizon than the associated Lightning soils, and they are less clayey in the lower part of the horizon than associated Osage soils. They differ from associated Radley soils in having a very dark grayish-brown A horizon more than 20 inches thick.

**Verdigris silty clay loam** (Ve).—This is a nearly level soil. It has the profile described as representative of the series. It floods about once in 5 to 20 years.

Included with this soil in mapping are spots of Lightning, Osage, and Radley soils. Also, about 35 percent of the mapped areas is made up of soils similar to Verdigris soils except that they are thinner or are dark grayish brown or brown in color.

This Verdigris soil is used mostly for growing corn, small grains, grain sorghum, soybeans, and tame pasture plants.

The main concerns of management are occasional flooding and the maintenance of soil structure and fertility. Most of the crops generally grown produce large amounts of residue and can be grown continuously where the crop residue is returned to the soil and fertilizer is used. Capability unit IIw–1; pasture and hay group 2A; Loamy Bottomland range site; woodland group 3w5.

**Verdigris soils, channeled** (Vs).—This soil is nearly level. Areas are along stream channels, and they are about 150 to 500 feet wide. They are flooded more than once every year. This soil has a profile similar to the one described as representative for the series, but the surface layer is silt loam or clay loam.

Included with this soil in mapping are spots of Osage and Radley soils. Also included are narrow stream channels and a few flooded areas where the surface layer is gravelly, but the soils are otherwise similar to Verdigris soils.

This soil is used mostly for tame pasture or woodland. It is not suited to cultivation.

The main concern of management is the frequent flooding. This soil produces high-quality hardwoods when the trees are thinned, weeded, and selectively harvested. A good mulch is desirable on tame pasture to prevent erosion by flooding. Brush control is needed. Capability unit Vw–1; pasture and hay group 2A; Loamy Bottomland range site; woodland group 3w5.

**Verdigris-Breaks complex** (Vt).—This complex of soil and land type includes the drainageways on prairie uplands. The Verdigris soil is nearly level and is on flood plains that are flooded more than once every year. Areas are 50 to 150 feet wide. Breaks are on gently sloping to steep uplands in areas 10 to 50 feet wide on the side of ridges.

About 65 percent of the acreage is Verdigris soil, and about 35 percent is Breaks. The profile of the Verdigris soil is similar to the one described as representative for the series, but the surface layer is a few inches thinner.

This complex is used mostly for range. Most of the acreage is in native grasses. Only a few small areas have been cultivated. Because of flooding and steep slopes, this mapped area is not suited to cultivation. It is suited to range, tame pasture, or wildlife. The quality of the native grasses can be maintained or improved by controlling brush, using suitable grazing practices, and providing fire protection. Both parts in capability unit VIe–1; Verdigris part in pasture and hay group 2A and Breaks part in pasture and hay group 11B; Verdigris part in Loamy Bottomland range site and Breaks part in Loamy Prairie range site; both parts in woodland group 5o0.

## Vinita Series

The Vinita series consists of moderately deep, moderately well drained, very gently sloping to steep soils on uplands. These soils formed under a cover of mid and tall grasses in material weathered from shale.

In a representative profile the surface layer is 8 inches of very dark grayish-brown loam. The upper part of the subsoil, to a depth of 16 inches, is mottled reddish-brown, yellowish-brown, and grayish-brown clay. The lower part of the subsoil extends to a depth of 28 inches and is a brown clay. It is underlain by brown shale with strata of mottled silty clay.

Vinita soils have slow permeability. Available water capacity is high.

Representative profile of Vinita loam, from an area of Collinsville-Vinita complex, 2 to 30 percent slopes, 1,320 feet south and 2,500 feet east of the NW. corner of sec. 22, T. 25 N., R. 19 E.:

A1—0 to 8 inches, very dark grayish-brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; hard, friable; 15 percent sandstone fragments ½ inch to 12 inches in diameter; very strongly acid; gradual, smooth boundary.

IIB2t—8 to 16 inches, finely mottled, reddish-brown, yellowish-brown, and grayish-brown clay; moderate, medium and fine, blocky structure; very hard, very firm; clay films on ped faces; very strongly acid; gradual, smooth boundary.

IIB3—16 to 28 inches, brown (10YR 5/3) clay, pale brown (10YR 6/3) dry; many, medium and fine, distinct, gray (10YR 6/1) light brownish-gray (10YR 6/2) mottles and prominent yellowish-red (5YR 4/6) and red (2.5YR 4/6) mottles; moderate, medium, blocky structure; extremely hard, very firm; clay films on ped faces; few shale fragments; very strongly acid; gradual, smooth boundary.

IIR—28 to 34 inches, brown (10YR 5/3) shale; strata of silty clay that have many, medium, distinct, gray (10YR 5/1) and yellowish-brown (10YR 5/6) mottles; extremely hard, very firm; very strongly acid.

The A1 horizon is very dark grayish brown or dark brown. Reaction is strongly acid or very strongly acid. The IIB2t horizon is clay loam or clay. Mottles are fine and range from dark grayish-brown to light reddish-brown, with no one color predominating. The IIB3 horizon is dark grayish-brown to light reddish-brown silty clay loam to clay. Shale is at a depth of 22 to 40 inches.

Vinita soils are shallower to shale than associated Dennis soils and they are deeper to bedrock than associated Collinsville soils.

Vinita soils in this county are mapped with Collinsville soils and are not mapped separately.

# *Use and Management of the Soils*

This section explains the system of capability classification used by the Soil Conservation Service and gives estimated yields of the principal crops grown in the county under two levels of management. The capability classification of each soil mapped in the county can be found by referring to the "Guide to Mapping Units." Information about management needs of a particular soil is given in the section "Descriptions of the Soils."

This section also contains information about management of the soils for cultivated crops and tame pasture, and about the use of the soils for range, woodland, wildlife habitat, and for engineering purposes.

## General Management of the Soils for Cultivated Crops [2]

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

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

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

Minimum tillage is accomplished by (1) using a long-term cropping system with perennial grasses or deep-rooted legumes, (2) using herbicides instead of cultivation for weed control, and (3) reducing the number of operations in preparing the seedbed, planting, and cultivating.

*Crop residue management.*—Leaving crop residue on the surface during winter and spring, or working it partly into the surface, is needed to protect soils from erosion. Organic matter, or humus, supplied in crop residue improves the tilth of the surface layer. The improved tilth then increases infiltration and storage of water, reduces the hazard of erosion, and helps to prevent crusting.

*Soil-improving crops.*—The main objectives in using soil-improving crops are to maintain or improve the physical condition and the productivity of the soil and to control erosion, weeds, insects, and diseases. A cropping system that improves the soil includes crops that produce large amounts of residue.

Crop residue and weeds are the largest source of organic material for maintenance of soil fertility and soil structure. This residue needs the addition of nitrogen fertilizer to prevent a shortage of this nutrient for the succeeding crop.

*Soil-depleting crops.*—Crops that do not help to control erosion, improve soil structure, or build up the organic-matter content are soil-depleting crops. Minimum use of these crops is made in a good cropping system. Clean-tilled crops, if the forage is removed for silage or cut low for bundle feed or hay, and soybeans cut for hay are soil depleting if most of the top growth is removed each year.

*Cover Crops.*—Cover crops usually consist of small grains with vetch or animal lespedeza grown to improve the soil and protect it from erosion. Small grains, overseeded with annual lespedeza, is an example of a warm-season cover crop. Small grains and vetch are suitable cool-season cover crops.

[2] By Ernest O. Hill, agronomist, Soil Conservation Service.

*Grassed waterways.*—Grassed waterways consist principally of broad, flat-bottomed channels seeded or sodded with perennial plants. Bermudagrass or native grasses are commonly used to provide vegetation. Grassed waterways are needed in terrace outlets to provide safe disposal of excess water. They also should be used on diversion terraces and in natural drainageways.

### *Capability grouping*

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

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

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. In class I are 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, so shallow, or otherwise so limited that they do not produce worthwhile yields of crops, forage, or wood products.

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

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

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–4 or IIIe–6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

The eight classes in the capability system and the subclasses and units in Craig County are described in the list that follows. The unit designation for each soil in the county can be found in the "Guide to Mapping Units."

Class I. Soils that have few limitations that restrict their use.
(No subclasses.)
Unit I–1. Deep, nearly level, moderately well drained loamy soils that have a loamy and clayey subsoil; on uplands.

Class II. Soils that have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
Subclass IIe. Soils that are subject to moderate erosion if they are not protected.
Unit IIe–1. Deep and moderately deep, nearly level to very gently sloping, well drained and moderately well drained loamy soils that have a loamy and clayey subsoil; on terraces and uplands.
Unit IIe–2. Moderately deep, very gently sloping, well-drained soils that are loamy throughout; on uplands.
Subclass IIw. Soils that have moderate limitations because of seasonal overflow.
Unit IIw–1. Deep, nearly level, well drained and moderately well drained soils that are loamy throughout; on flood plains.
Subclass IIs. Soils that have moderate limitations because of very slow permeability.
Unit IIs–1. Deep, nearly level, poorly drained to moderately well drained, loamy soils that have a clayey subsoil; on uplands.
Unit IIs–2. Deep, nearly level, somewhat poorly drained to moderately well drained, loamy soils that have a clayey subsoil; on uplands.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.
Subclass IIIe. Soils that are subject to severe erosion if they are not protected.
Unit IIIe–1. Deep and moderately deep, gently sloping, well drained and moderately well drained soils that are loamy throughout; on uplands.
Unit IIIe–2. Deep and moderately deep, very gently sloping to gently sloping, well drained and moderately well drained, eroded soils that are loamy throughout; on uplands.
Unit IIIe–3. Deep, gently sloping, moderately well drained, loamy soils that have a clayey subsoil; on uplands.

Unit IIIe–4. Deep, very gently sloping to gently sloping, moderately well drained, eroded, loamy soils that have a clayey subsoil; on uplands.

Unit IIIe–5. Shallow, nearly level to very gently sloping, well drained to moderately well drained loamy soils that have a clayey subsoil; on uplands.

Unit IIIe–6. Shallow, very gently sloping to gently sloping, well-drained soils that are loamy throughout; on uplands.

Unit IIIe–7. Moderately deep, gently sloping, well-drained soils that are loamy throughout; on uplands.

Unit IIIe–8. Moderately deep, very gently sloping to gently sloping, well-drained, eroded soils that are loamy throughout; on uplands.

Subclass IIIw. Soils that have severe limitations because of excess water.

Unit IIIw–1. Deep, nearly level, poorly drained, loamy soils that have a clayey subsoil; on flood plains.

Unit IIIw–2. Deep, nearly level, poorly drained and somewhat poorly drained, loamy soils that have a clayey subsoil; on flood plains.

Unit IIIw–3. Deep, nearly level, somewhat poorly drained, loamy soils that have a clayey subsoil; on uplands.

Subclass IIIs. Soils that have severe limitations because of very slow permeability.

Unit IIIs–1. Deep, nearly level to very gently sloping, moderately well drained, loamy soils that have a cherty clay subsoil; on uplands.

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

Subclass IVe. Soils that are subject to very severe erosion if they are cultivated and not protected.

Unit IVe–1. Moderately deep to very shallow, very gently sloping to gently sloping, well-drained to somewhat excessively drained soils that are loamy throughout; on uplands.

Unit IVe–2. Very shallow to moderately deep, very gently sloping to gently sloping, well-drained soils that are loamy throughout; on uplands.

Unit IVe–3. Deep, gently sloping to sloping, well-drained soils that are loamy throughout; on terraces.

Subclass IVs. Soils that have very severe limitations because of high sodium content, low available water capacity, or other soil features.

Unit IVs–1. Deep, very gently sloping to sloping, somewhat excessively drained, loamy soils that have a very cherty clay loam and cherty clay subsoil; on uplands.

Unit IVs–2. Deep, nearly level, poorly drained, loamy soils that are high in content of sodium and have a clayey subsoil; on uplands.

Class V. Soils that are not likely to be eroded but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.

Subclass Vw. Soils subject to flooding.

Unit Vw–1. Deep, nearly level, moderately well drained soils that are loamy throughout; on flood plains.

Class VI. Soils that have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, woodland, or wildlife habitat.

Subclass VIe. Soils that are limited chiefly by hazards of erosion and flooding and by steep slopes.

Unit VIe–1. Deep, nearly level to steep, somewhat poorly drained to excessively drained, loamy and clayey soils; on flood plains and uplands.

Unit VIe–2. Deep, gently sloping, moderately well drained, severely eroded soils that are loamy throughout; on uplands.

Subclass VIs. Soils that have severe limitations because of depth to hard underlying material and slope.

Unit VIs–1. Deep, sloping to strongly sloping, somewhat excessively drained soils that are loamy and stony throughout; on uplands.

Unit VIs–2. Deep, very gently sloping to sloping, well-drained, loamy soils that have a very cherty clay loam and cherty clay subsoil; on uplands.

Unit VIs–3. Very shallow and deep, very gently sloping to sloping, well drained and moderately well drained soils; on uplands.

Class VII. Soils that have very severe limitations that make them unsuited for cultivation and that restrict their use largely to pasture, range, woodland, or wildlife habitat.

Subclass VIIs. Soils very severely limited by low available water capacity, shallowness, stones, or other characteristics.

Unit VIIs–1. Very shallow to moderately deep, sloping to moderately steep, well-drained soils that are loamy throughout; on uplands.

Unit VIIs–2. Very shallow, nearly level to very gently sloping, well-drained soils that are loamy throughout; on uplands.

Unit VIIs–3. Very shallow to moderately deep, very gently sloping to steep, well drained to moderately well drained, loamy soils that have a loamy or clayey subsoil; on uplands.

Unit VIIs–4. This land type consists of mixed shale, sandstone, limestone, and the original mantle of soil stripped from coal beds.

Class VIII. Soils and land types that have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or to esthetic purposes. (None in Craig County.)

## Management of the Soils for Pasture and Hay

General guidelines for managing soils for pasture and hay are described in this subsection. Following this, the soils are placed in nine pasture and hay groups, and each group is described. Those who wish to know the pasture and hay group of a soil can refer to the "Guide to

Mapping Units" at the back of this survey. Those desiring detailed information about the management of soils can refer to the section "Descriptions of the Soils."

Much of the acreage in Craig County is in pasture. Pasture plants are grown on soils that vary from Class I through Class VI. The trend is to convert cropland to pasture. Because of high land values, extensive acreages of Classes IV and VI woodland soils also are being cleared and planted to tame pasture plants.

The principal base grass is improved bermudagrass for warm-season pasture and fescue and bromegrass for cool-season pasture. The base grass is usually overseeded in a mixture with legumes. A bermudagrass-legume mixture is the main summer pasture (fig. 7) vegetation. Improved varieties of bermudagrass under good management will produce more forage than common bermudagrass. Bermudagrass is well suited for most of the soils in Classes I through VI. Winter rye and vetch, when overseeded on bermudagrass, provide grazing late in fall and early in spring. Annual lespedeza is grown with bermudagrass primarily to provide more palatable forage in July and August. Sudan and sorghum hybrids are used for summer temporary pasture where perennial forages are in short supply. Fall-sown small grains, such as winter rye, are sometimes used for fall, winter, and spring grazing as a supplement to native and perennial tame-pasture plants.

Tall fescue and bromegrass pasture plants also provide grazing early in spring and late in fall. Tall fescue is better suited to the wetter, more clayey soils. Tall fescue can be grown successfully on upland soils, but intensive management is required if it is to survive dry seasons. On bottom-land soils management need not be so intensive. Bromegrass is better suited to the better drained bottom-land soils. Ladino and big hop clovers are frequently grown with both fescue and bromegrass.

### *Management and maintenance*

Proper grazing helps to lengthen the life of most pastures. When bromegrass is grazed with other species, it is likely to be killed by excessive use, since it is more palatable than bermudagrass or fescue. Fescue and bromegrass pasture should not be grazed in July and August. This rest permits the plants to grow enough to shade the ground and regain plant vigor.

Brush control is essential, especially on soils that grow trees. Applying moderate amounts of fertilizer that contains the proper elements provides for more vigorous plants and more palatable forage. This helps to increase production and lengthen the lifespan of the pasture. Some legumes, such as Ladino clover, require more phosphate and lime than others, such as yellow hop clover and lespedeza. Commonly, where grass is grown without legumes, larger amounts of nitrogen fertilizer are needed.

*Figure 7.*—**Bermudagrass pasture on Parsons silt loam, 0 to 1 percent slopes.**

### *Pasture and hay groups*

Pasture and hay groupings of soil have been made in this county to assist farmers in selecting suitable forage plants for grazing livestock. These groups are described in the following pages. The soils of each group will grow similar pasture plants and require similar treatment and management. Forage production for one soil in the group is essentially the same as other soils when management and treatment is the same for all soils. Soils that formed under woodland will require brush control. Failure to control brush will result in the regrowth of trees and reduction of pasture forage.

Yields of pasture and hay under two levels of management are given in the section "Estimated Yields." Grazing data is estimated in terms of animal-unit months. An animal-unit month (A.U.M.) is the amount of forage or feed required to maintain one animal unit—one cow, one horse, one mule, five sheep, or five goats—for a period of 30 days. Dry hay production is given in terms of tons per acre.

#### PASTURE AND HAY GROUP 2A

In this group are deep loamy soils that have a rapidly permeable to moderately permeable subsoil. These soils are on bottom lands and are subject to flooding. Management includes brush control, reduction of surface compaction, and use of fertilizers.

#### PASTURE AND HAY GROUP 2B

In this group are deep loamy soils that have a very slowly permeable subsoil. These soils are on bottom lands and are poorly drained to somewhat poorly drained. They are subject to flooding. Management includes brush control, the use of drainage practices and fertilizers, and reduction of surface compaction. Application of lime is generally needed.

#### PASTURE AND HAY GROUP 8A

In this group are deep loamy soils that have a slowly permeable to moderately permeable subsoil. These soils are on uplands and terraces. Management includes brush control, reduction of surface compaction, and use of fertilizers.

#### PASTURE AND HAY GROUP 8B

In this group are deep to moderately deep loamy soils that have very slow to rapid permeability and are low in natural fertility. These soils are on uplands. Management includes brush control, reduction of surface compaction, liming of acid soils, and use of fertilizers.

Fertilizer that has a high content of nitrogen needs to be applied in split applications.

#### PASTURE AND HAY GROUP 8C

In this group are deep loamy soils that have a very slowly permeable dense subsoil of clay. They are somewhat droughty. These soils are on uplands. Greatest crop growth can be expected in spring and early in summer. Management includes the use of drainage practices on the more nearly level soils, brush control, the use of fertilizer, and the reduction of surface compaction.

#### PASTURE AND HAY GROUP 8D

In this group are loamy soils that have a very slowly permeable dense subsoil of clay. These soils are high in sodium, have a thin surface layer, and are droughty. They are on uplands. Bermudagrass and locally adapted legumes respond to good management. Management includes good seedbed preparation, use of fertilizer and drainage practices, and improvement of soil structure.

#### PASTURE AND HAY GROUP 8F

In this group are deep loamy soils that have a slowly permeable subsoil. They are severely eroded and are low in fertility. These soils are on uplands. Management includes brush control, the use of fertilizers, and reduction of surface compaction. Gully shaping is needed in some areas.

#### PASTURE AND HAY GROUP 11B

In this group are loamy soils that have a slowly permeable to moderately permeable subsoil. These soils are in areas of uplands and bottom lands. Management includes brush control, the use of fertilizers, gully shaping, and reduction of surface compaction.

#### PASTURE AND HAY GROUP 14A

In this group are very shallow to moderately deep loamy soils that have rapid permeability. These soils are on uplands. Management includes brush control, use of fertilizer, and reduction of surface compaction. The shallowness of the soils is a limitation to good plant growth.

## Estimated Yields

Table 2 shows estimated long-term average yields of important crops and of pasture and hay plants. The crops are wheat, oats, corn, sorghum, soybeans, alfalfa, fescue, and bermudagrass. Yields are given for two levels of management. Estimates are averages for a period long enough to include both dry and wet years. When the moisture supply is favorable, yields are generally higher than those predicted. They are lower when moisture conditions are unfavorable.

The yields in table 2 are based partly on records kept by the Oklahoma Agricultural Experiment Station on fertility studies, crop variety tests, and crop rotation and tillage trials. These experiments have been conducted for many years on both permanent and experimental sites and on farmers' plots. The records provide an excellent source of information for estimating long-term average yields on a number of soils.

The soil scientists who made this survey obtained other data on yields at specific levels of management when they interviewed farmers and observed fields of crops. If enough data for a certain soil were not obtained, estimates were made by comparing the soil with similar soils for which ample data were available.

## Use of the Soils for Range [3]

Range in Craig County consists of native grassland that includes wooded areas used primarily for grazing. Rangeland makes up about 236,000 acres, or 50 percent of the farmland in the county. Each year the sale of livestock and livestock products accounts for more than half of the gross farm income. The production of cattle is the chief livestock operation. The number of cattle in the county, including calves, varies from year to year but generally ranges from 58,000 to 77,000.

The main objectives of range management are maintaining range that is in good and excellent condition and improving range that is in fair and poor condition. Efficient management is accomplished through a knowledge of the basic resources—soil and native vegetation.

Potential forage production depends upon the range site. Current forage production depends upon the range condition and the moisture condition.

Conservation treatment of rangeland involves planning and applying range management and conservation practices in three broad groups: plant management practices, accelerating practices, and livestock control practices. Such range practices as proper grazing use, deferred grazing, and rotation-deferred grazing relate to plant management. Range seeding, brush control, and other practices specifically designed to speed up improvement of range cover, in addition to grazing management alone, are accelerating practices. The third group, livestock control practices, facilitate handling livestock and include such practices as fencing, stock watering facilities, and others that obtain better livestock distribution.

Grazing systems should be scheduled so that enough cover remains to protect the soil and maintain the quantity and quality of desirable plants. Repeated or prolonged overuse of a range reduces the ability of the plants to produce deep rooting, seeds, and new shoots necessary for reproduction and maintenance of the stand.

Operators who are familiar with their sites and the main grasses generally understand signs of improvement or decline in range condition and adjust management to fit the condition.

One of the main objectives of good range management is to keep the rangeland in excellent condition or at least in good condition. When this is done, moisture is conserved, yields are maintained or improved, and the soils are protected from deterioration. A major concern is being able to recognize important changes in the kind of cover on a range site. The changes are so gradual that they are often overlooked or misunderstood. Lush

[3] By HARLAND E. DEITZ, range conservationist, Soil Conservation Service.

growth, encouraged by heavy rainfall, can lead to the conclusion that the range is in good condition and improving. Actually, this type of cover is often weedy and the long trend is toward a poorer condition that will provide less production.

Some rangeland in excellent condition that is being closely grazed, but for a short time under the supervision of a careful manager, may have a degraded appearance that conceals its good quality.

Specific information about the stocking of rangeland is not included in this survey. Technical personnel of the local agricultural agencies help ranchers to classify range sites and to estimate the condition of the range and the number of animals to stock.

### *Trends in range condition*

Range condition classifies the vegetation of a range site, but it does not indicate whether the range is improving or deteriorating. Some factors that indicate trend are plant vigor, abundance and type of seedlings, plant composition, accumulation of residue, and soil crusting.

Plant vigor is reflected primarily by the size of the plant in relation to its age and the environment in which it is growing. Evidence of increased vigor of decreaser plants indicates that the range is improving.

An abundance of seedlings of the species most palatable to livestock is evidence of improvement. Few seedlings are able to establish themselves, however, on ranges in excellent condition.

A change in composition of the plants on a range indicates a trend. Weakening or dying out of some of the decreaser plants indicates a decline in condition. An increase in the number of decreaser plants usually indicates an improvement of condition. Generally, the invasion of plants not native to the site indicates that a decline has already taken place.

An accumulation of plant residue is an indication of improving range conditions. Plant residue reduces the hazard of erosion caused by raindrops and makes the surface of the soil more favorable for seedlings and for the intake and conservation of moisture.

The condition of the soil surface affects the trend in condition and rate of recovery. Evidence of an increase in bare ground, soil crusting, compaction from trampling, and erosion indicates a declining trend in range condition.

A system for inventorying and evaluating range resources is discussed in the following paragraphs.

### *Range sites and condition classes*

The successful management of rangeland requires that (1) the manager knows the capability of different rangeland in terms of the kind and quantity of herbage they can be expected to produce, and (2) is able to appraise the native vegetation in its present condition in relation to its potential for production.

Range sites are a basic means of classifying rangeland resources. A range site is a local area of land, without respect to size, in which the physical environment is sufficiently alike so that it has the potential for the development of a distinctive climax vegetation. This vegetation is the stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change. Different range sites are distinctive rangelands that have various potentials for producing native plants. They are recognized separately because of their different abilities to produce significantly different kinds or amounts of native vegetation when in the same range condition.

A significant difference means one large enough to require different management to maintain the soil and plant resource. The site is stable, and it retains its ability to reproduce its potential plant community unless the seed source of the decreaser and increaser plants are destroyed or the soil is materially altered by physical deterioration.

Range condition is the existing state of the vegetation in relation to the potential plant community for that site. Range condition has been called "range health." Like health, condition is relative and when a particular range is said to be in "good condition" or "poor condition," the description is always relative to a standard that has been established for that range site. This standard is the kind and amount of native vegetation the site is capable of producing.

The kind and amount of vegetation on a site generally reflects the grazing practices. The components of vegetation on any specific range site are grouped according to their response to grazing. The categories used are decreaser plants, increaser plants, and invader plants.

Decreaser plants are species present in the potential plant community that decrease in relative abundance in response to continued heavy grazing. They usually are the most palatable and most productive perennial plants.

Increaser plants are species present in the potential plant community that normally increase as the decreaser plants decline. These are usually the shorter, less productive, subdominant members of the potential vegetation. Under prolonged heavy use of the decreasers, the less palatable plants dominate the site.

Invader plants are species that are not members of the potential plant community for the specific range site. They may be plants from an adjoining site or from a great distance. Although most invaders are woody plants, they can be herbaceous perennials or annuals.

Range condition is expressed in terms of condition classes. It mainly represents the degree to which the existing composition has departed from that of the native potential plant community. On this basis, the distinction between the four range condition classes is as follows:

| *Condition class* | *Percent of present composition that is potential for the site* |
|---|---|
| Excellent | 76 to 100 |
| Good | 51 to 75 |
| Fair | 26 to 50 |
| Poor | 0 to 25 |

Plant composition can be determined by estimating the relative production, by weight, of the species that make up the plant community. Condition classes can be satisfactorily determined any day of the year.

TABLE 2.—*Estimated average acre yields*

[Yields in column 5A can be expected under customary management; yields in columns B can be expected under improved

| Soil | Alfalfa | | Corn | | Grain sorghum | | Oats | |
|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B |
| | *Tons* | *Tons* | *Bu.* | *Bu.* | *Bu.* | *Bu.* | *Bu.* | *Bu.* |
| Bates loam, 1 to 3 percent slopes | 2. 2 | 3. 5 | 31 | 48 | 36 | 48 | 36 | 56 |
| Bates loam, 3 to 5 percent slopes | 1. 8 | 2. 8 | 30 | 42 | 30 | 42 | 28 | 47 |
| Bates loam, 2 to 5 percent slopes, eroded | | | 25 | 36 | 26 | 36 | 25 | 40 |
| Bates-Collinsville complex, 1 to 5 percent slopes | | | | | 21 | 27 | 24 | 40 |
| Bonham silt loam, limestone substratum, 1 to 3 percent slopes | 2. 6 | 4. 2 | 40 | 52 | 42 | 62 | 38 | 60 |
| Carytown silt loam, thin surface | | | | | 14 | 21 | 19 | 29 |
| Cherokee silt loam | 1. 5 | 2. 5 | 25 | 36 | 33 | 50 | 33 | 43 |
| Choteau silt loam, 0 to 1 percent slopes | 2. 5 | 4. 0 | 35 | 54 | 48 | 64 | 36 | 56 |
| Choteau silt loam, 1 to 3 percent slopes | 2. 0 | 3. 5 | 33 | 52 | 40 | 60 | 42 | 60 |
| Claremore silt loam, moderately shallow variant, 1 to 5 percent slopes | | | | | 25 | 36 | 20 | 33 |
| Clarksville stony silt loam, 5 to 12 percent slopes | | | | | | | | |
| Clarksville very cherty silt loam, 1 to 8 percent slopes | | | | | | | | |
| Collinsville-Vinita complex, 2 to 30 percent slopes | | | | | | | | |
| Craig silt loam, 1 to 3 percent slopes | 2. 0 | 2. 8 | 32 | 44 | 36 | 54 | 35 | 55 |
| Dennis silt loam, 1 to 3 percent slopes | 2. 5 | 4. 0 | 40 | 52 | 40 | 60 | 38 | 59 |
| Dennis silt loam, 3 to 5 percent slopes | 2. 0 | 3. 2 | 35 | 45 | 35 | 54 | 33 | 48 |
| Dennis silt loam, 2 to 5 percent slopes, eroded | | | 30 | 40 | 30 | 48 | 28 | 42 |
| Dennis soils, 3 to 5 percent slopes, severely eroded | | | | | | | | |
| Eldorado stony silt loam, 1 to 8 percent slopes | | | | | | | | |
| Eldorado silt loam, 3 to 5 percent slopes | | | 28 | 38 | 26 | 43 | 26 | 40 |
| Hector-Linker complex, 1 to 5 percent slopes | | | | | 18 | 24 | 21 | 36 |
| Hector-Linker complex, 5 to 20 percent slopes | | | | | | | | |
| Lenapah silty clay loam, 0 to 3 percent slopes | | | | | 25 | 35 | 20 | 33 |
| Lightning-Carytown complex | | | 20 | 30 | 30 | 42 | 21 | 35 |
| Linker fine sandy loam, 1 to 3 percent slopes | 1. 5 | 2. 5 | 22 | 32 | 29 | 41 | 29 | 42 |
| Linker fine sandy loam, 3 to 5 percent slopes | | | 18 | 27 | 24 | 37 | 24 | 42 |
| Linker fine sandy loam, 2 to 5 percent slopes, eroded | | | | | 18 | 32 | 17 | 31 |
| Lula silt loam, 1 to 3 percent slopes | 2. 8 | 4. 2 | 40 | 52 | 42 | 62 | 40 | 60 |
| Lula silt loam, 3 to 5 percent slopes | 2. 0 | 3. 0 | 36 | 48 | 35 | 57 | 34 | 55 |
| Mine pits and dumps | | | | | | | | |
| Nixa cherty silt loam, 0 to 3 percent slopes | | | 25 | 40 | 24 | 30 | 31 | 49 |
| Okemah silt loam, limestone substratum | 2. 8 | 4. 4 | 42 | 54 | 48 | 64 | 36 | 56 |
| Osage silty clay loam | | 3. 0 | 25 | 36 | 35 | 47 | 23 | 35 |
| Osage silty clay loam, uplands | 1. 5 | 2. 5 | 23 | 32 | 29 | 45 | 24 | 43 |
| Parsons silt loam, 0 to 1 percent slopes | | 2. 5 | 25 | 36 | 33 | 50 | 33 | 43 |
| Radley silt loam | 3. 0 | 4. 5 | 50 | 70 | 50 | 70 | 43 | 66 |
| Sallisaw silt loam, 0 to 3 percent slopes | 2. 3 | 4. 0 | 38 | 52 | 36 | 50 | 36 | 59 |
| Sallisaw silt loam, 3 to 8 percent slopes | 1. 2 | 2. 8 | 30 | 46 | 30 | 42 | 35 | 57 |
| Staser silt loam | 2. 3 | 3. 3 | 44 | 60 | 45 | 65 | 42 | 62 |
| Summit silty clay loam, 0 to 1 percent slopes | 2. 6 | 4. 2 | 40 | 52 | 48 | 62 | 36 | 56 |
| Summit silty clay loam, 1 to 3 percent slopes | 2. 4 | 4. 0 | 38 | 48 | 46 | 60 | 36 | 56 |
| Summit silty clay loam, 3 to 5 percent slopes | 2. 0 | 3. 5 | 36 | 43 | 37 | 52 | 30 | 46 |
| Summit silty clay loam, 2 to 5 percent slopes, eroded | | | 20 | 30 | 24 | 42 | 22 | 38 |
| Taloka silt loam, 0 to 1 percent slopes | | 2. 8 | 32 | 50 | 40 | 58 | 36 | 48 |
| Talpa soils, 0 to 3 percent slopes | | | | | | | | |
| Talpa-Summit complex, 1 to 8 percent slopes | | | | | | | | |
| Verdigris silty clay loam | 3. 0 | 4. 5 | 50 | 70 | 48 | 68 | 43 | 66 |
| Verdigris soils, channeled | | | | | | | | |
| Verdigris-Breaks complex | | | | | | | | |

[1] Animal-unit month. The amount of forage or feed required to maintain one animal unit—one cow, one horse, one mule, five sheep, or five goats—for a period of 30 days.

*of cultivated crops, pasture, and hay*

management. Absence of a yield figure indicates the crop is seldom grown or is not suited, or that the soil is not arable]

| Soybeans | | Wheat | | Pasture | | | | Hay | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Improved bermudagrass | | Fescue | | Improved bermudagrass | | Fescue | |
| A | B | A | B | A | B | A | B | A | B | A | B |
| *Bu.* | *Bu.* | *Bu.* | *Bu.* | *A.U.M.*[1] | *A.U.M.*[1] | *A.U.M.*[1] | *A.U.M.*[1] | *Tons* | *Tons* | *Tons* | *Tons* |
| 16 | 24 | 22 | 31 | 4.0 | 6.5 | 3.5 | 5.0 | 1.5 | 3.0 | 1.5 | 2.0 |
| 16 | 22 | 19 | 27 | 4.0 | 6.5 | 3.5 | 5.0 | 1.5 | 3.0 | 1.5 | 2.0 |
| 14 | 18 | 15 | 23 | 3.0 | 5.5 | 2.5 | 4.0 | 1.0 | 2.5 | 1.0 | 1.5 |
| | | 13 | 19 | 2.0 | 4.0 | 2.0 | 3.5 | 1.0 | 2.0 | 1.0 | 1.5 |
| 22 | 32 | 25 | 37 | 4.0 | 6.5 | 3.5 | 5.0 | 1.5 | 3.0 | 1.5 | 2.0 |
| | | 12 | 19 | 1.5 | 3.0 | | | 1.0 | 1.5 | | |
| 18 | 24 | 22 | 33 | 3.5 | 5.5 | 3.5 | 5.0 | 1.5 | 2.5 | 1.5 | 2.0 |
| 18 | 30 | 27 | 36 | 4.0 | 7.0 | 3.5 | 5.5 | 2.0 | 3.0 | 1.5 | 2.5 |
| 17 | 25 | 25 | 33 | 4.0 | 7.0 | 3.5 | 5.5 | 2.0 | 3.5 | 1.5 | 2.5 |
| 10 | 16 | 18 | 29 | 2.5 | 4.5 | | | 1.0 | 2.0 | | |
| | | | | 2.0 | 4.0 | 2.0 | 3.5 | | | | |
| | | | | 2.5 | 4.5 | 2.5 | 4.0 | | | | |
| 14 | 22 | 19 | 30 | 3.5 | 5.5 | 3.0 | 5.0 | 1.5 | 2.5 | 1.5 | 2.5 |
| 20 | 30 | 25 | 36 | 4.0 | 7.0 | 3.5 | 5.5 | 2.0 | 3.5 | 1.5 | 2.5 |
| 17 | 23 | 22 | 30 | 4.0 | 7.0 | 3.5 | 5.5 | 2.0 | 3.5 | 1.5 | 2.5 |
| 15 | 20 | 17 | 24 | 3.0 | 5.5 | 2.5 | 4.0 | 1.0 | 2.5 | 1.0 | 1.5 |
| | | | | 2.0 | 4.0 | 2.0 | 3.5 | 1.0 | 2.0 | | 1.5 |
| | | | | 3.0 | 4.5 | 2.5 | 4.0 | | | | |
| 10 | 17 | 13 | 22 | 3.5 | 5.5 | 3.0 | 4.5 | 1.5 | 2.5 | 1.5 | 2.0 |
| | | 11 | 16 | 2.5 | 4.5 | 2.0 | 4.0 | 1.0 | 2.0 | 1.0 | 2.0 |
| | | | | 2.0 | 4.0 | | | 1.0 | 2.0 | | |
| 10 | 16 | 18 | 29 | 2.5 | 4.5 | 3.0 | 4.5 | 1.0 | 2.0 | 1.5 | 2.0 |
| 16 | 22 | 12 | 19 | 2.0 | 4.5 | 1.5 | 3.0 | 1.0 | 2.0 | 1.0 | 1.5 |
| 11 | 19 | 17 | 23 | 2.5 | 5.0 | 2.5 | 4.0 | 1.0 | 2.0 | 1.0 | 2.0 |
| 11 | 17 | 17 | 23 | 2.5 | 5.0 | 2.5 | 4.0 | 1.0 | 2.0 | 1.0 | 2.0 |
| | | 13 | 19 | 2.0 | 4.0 | 2.0 | 3.5 | 1.0 | 2.0 | 1.0 | 1.5 |
| 21 | 31 | 28 | 38 | 4.5 | 6.5 | 3.5 | 5.0 | 1.5 | 3.0 | 1.5 | 2.0 |
| 17 | 26 | 24 | 33 | 4.5 | 6.5 | 3.5 | 5.0 | 1.5 | 3.0 | 1.5 | 2.0 |
| 12 | 20 | 13 | 21 | 2.5 | 5.5 | 2.5 | 4.0 | 1.0 | 2.0 | 1.0 | 2.0 |
| 24 | 34 | 27 | 39 | 4.0 | 7.0 | 3.5 | 5.5 | 2.0 | 3.0 | 1.5 | 2.5 |
| 14 | 22 | 15 | 25 | 3.0 | 6.0 | 4.0 | 6.5 | 1.5 | 2.5 | 1.5 | 2.5 |
| 16 | 22 | 18 | 27 | 3.5 | 5.5 | 3.5 | 5.0 | 1.5 | 2.5 | 1.5 | 2.0 |
| 18 | 24 | 22 | 33 | 3.5 | 5.5 | 3.5 | 5.0 | 1.5 | 2.5 | 1.5 | 2.0 |
| 26 | 36 | 30 | 40 | 6.0 | 8.0 | 6.0 | 7.5 | 2.5 | 3.0 | 2.5 | 3.0 |
| 20 | 28 | 23 | 35 | 4.5 | 6.5 | 3.5 | 5.0 | 1.5 | 3.0 | 1.5 | 2.0 |
| 16 | 24 | 18 | 26 | 4.0 | 6.0 | 3.0 | 4.5 | 1.5 | 2.5 | 1.0 | 2.0 |
| 21 | 30 | 23 | 39 | 6.0 | 8.0 | 6.0 | 7.5 | 2.5 | 3.0 | 2.5 | 3.0 |
| 22 | 30 | 26 | 37 | 4.0 | 7.0 | 3.5 | 5.5 | 2.0 | 3.0 | 1.5 | 2.5 |
| 20 | 30 | 24 | 35 | 4.0 | 7.0 | 3.5 | 5.5 | 2.0 | 3.0 | 1.5 | 2.5 |
| 18 | 28 | 22 | 30 | 3.5 | 6.5 | 3.0 | 5.0 | 1.5 | 2.5 | 1.5 | 2.5 |
| 12 | 18 | 16 | 24 | 3.0 | 5.5 | 2.5 | 4.5 | 1.0 | 2.0 | 1.0 | 2.0 |
| 18 | 25 | 23 | 34 | 4.0 | 6.0 | 3.0 | 5.0 | 1.5 | 2.5 | 1.5 | 2.5 |
| 26 | 36 | 30 | 40 | 6.0 | 8.0 | 6.0 | 7.5 | 2.5 | 3.0 | 2.5 | 3.0 |
| | | | | 4.0 | 6.0 | 4.0 | 6.0 | 2.0 | 2.5 | 2.0 | 2.5 |
| | | | | 3.0 | 4.5 | 2.5 | 4.5 | 1.0 | 2.0 | 1.0 | 2.0 |

Range sites in excellent condition are producing near their maximum. The plant cover adequately protects the soil, encourages intake of moisture, and maintains soil fertility. Continuous good management will maintain its high productivity.

Range sites in good condition have lost a few decreaser plants, but production is still good. Grazing management that favors the better plants will maintain and improve the condition. Range sites in fair condition are unsatisfactory for grazing. The plant cover has been altered severely, increasers dominate, and invaders are becoming prominent in the mixture. The litter is inadequate in most places, and the soil is exposed to compaction and erosion. A rest from grazing during the entire growing season is generally required for rapid improvement.

A site in poor condition has lost almost all of the desirable forage plants. Few, if any, of the original species remain, and many of the existing plants have moved into the spaces left vacant as the decreasers thinned out of the stand.

### *Descriptions of range sites*

In this subsection the 12 range sites in Craig County are described, the approximate percentage of climax vegetation is given, and the principal invaders are named. Estimated annual herbage yields are in each site description.

Actual records for the entire list of range sites are limited. Some of the range sites, especially the better bottom-land sites, have been severely disturbed or cultivated, and relict areas are not available for collecting data. The annual herbage estimates are based upon clippings made near the end of the growing season on sites in excellent condition. The weights given are for air-dry herbage clipped at ground level. Shrub and tree yields were not included. Yields shown in the range site descriptions are annual herbage yields and are not intended to reflect usable or grazeable forage.

Weights for the Savannah sites are yields of grasses and forbs and do not include leaf, flower, or fruit and stem production of woody plants.

#### ALKALI BOTTOMLAND RANGE SITE

This range site consists of nearly level loamy soils on flood plains. These soils have a clayey subsoil that is high in content of sodium. The soils are poorly drained and subject to flooding.

The principal decreasers on this site are switchgrass, little bluestem, Virginia wildrye, and Illinois bundleflower. The increasers include meadow dropseed, knotroot bristlegrass, tall dropseed, and heath aster. Where this site is overgrazed, it is invaded by annuals, predominantly seacoast sumpweed.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 4,000 pounds per acre in years of favorable moisture and about 2,000 pounds per acre in years of unfavorable moisture.

#### CLAYPAN PRAIRIE RANGE SITE

This range site consists of nearly level soils that have a loamy surface layer and a clayey subsoil. The soils are on uplands. The clayey subsoil restricts the penetration of water and roots.

Climax vegetation consists primarily of big bluestem, switchgrass, little bluestem, and indiangrass. Overgrazing, especially during prolonged droughts, causes depletion of the more palatable vegetation. Tall grasses are gradually replaced by less productive plants, such as meadow dropseed, tall dropseed, knotroot, bristlegrass, silver bluestem, heath aster, dotted gayfeather, and goldenrod.

Plants that commonly invade the site following continuous overgrazing are western ragweed, lanceleaf ragweed, ironweed, bitter sneezeweed, common bromeweed, seacoast sumpweed, broomsedge bluestem, three-awn, and annual bromes.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 5,000 pounds per acre in years of favorable moisture and about 2,500 pounds per acre in years of unfavorable moisture.

#### COAL STRIP MINES RANGE SITE

This range site consists of areas that have been strip mined for coal by heavy machinery. The mine dumps are mixtures of shales, limestone, sandstone, and the original mantle of soil. In most places dump materials have been left in rough, steep, parallel ridges.

Revegetation of the site following mining operations is slow unless it is encouraged. Land owners have been successful in sowing a mixture of native grass seed and sweetclover seed from airplanes during favorable seasons. Proper grazing management is essential in restoring a vegetative cover on the mine dumps. Areas that are seeded and properly managed have been restored to a good cover of native grasses similar to the adjacent prairies.

Because none of this site in Craig County is in excellent or good condition, yield data is not available.

Where this site is in fair condition, the estimated annual yield of air-dry herbage is about 2,000 pounds per acre in years of favorable moisture and about 1,000 pounds per acre in years of unfavorable moisture.

#### HEAVY BOTTOMLAND RANGE SITE

This range site consists of nearly level loamy soils that have a clayey subsoil. The soils are on flood plains. They have a subsoil that absorbs water slowly, and they are subject to flooding.

Climax vegetation consists of prairie cordgrass, big bluestem, eastern gamagrass, switchgrass, Canada wildrye, and Virginia wildrye. The principal increasers are tall dropseed, meadow dropseed, knotroot bristlegrass, and carex. Woody plants, such as hackberry, pecan, walnut, and elm, are common on the site, and they increase when the site is abused by overgrazing. Plants that invade the site are broomsedge, bluestem, seacoast sumpweed, giant ragweed, coralberry, and ironweed.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 7,000 pounds per acre in years of favorable moisture and about 3,500 pounds per acre in years of unfavorable moisture.

#### LOAMY BOTTOMLAND RANGE SITE

This range site consists of nearly level loamy soils on flood plains. These soils are subject to flooding.

Where this range site is in excellent condition, it is dominated by tall productive grasses that grow in warm seasons. These grasses consist of big bluestem, indiangrass, eastern gamagrass, prairie cordgrass, and switchgrass. Continuous overgrazing causes an increase in purpletop, little bluestem, tall dropseed, knotroot bristlegrass, longspike tridens, and woody plants. The common invaders include coralberry, ironweed, white snakeroot, broomsedge bluestem, and blackberry.

The trees on this site, predominantly walnut, pecan, elm, sycamore, and hackberry, grow naturally along streambanks. Beneath the canopy of these trees are Canada wildrye, Virginia wildrye, and other shade-tolerant, cool-season grasses.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 10,000 pounds per acre in years of favorable moisture and about 6,500 pounds per acre in years of unfavorable moisture.

#### LOAMY PRAIRIE RANGE SITE

This range site consists of nearly level to steep loamy soils on uplands. The texture and depth are such that moisture relations are favorable for the growth of highly productive tall grasses. This site, the most extensive in the county, is generally fertile and productive.

Climax vegetation is composed primarily of big bluestem, indiangrass, little bluestem, and switchgrass. Eastern gamagrass is frequently on the lower slopes and near the heads of prairie drainageways. Important legumes and forbs that decrease when overgrazed include leadplant, Illinois bundleflower, catclaw sensitivebrier, compass plant, and perennial sunflower. If the site is continually overgrazed, decreaser plants are replaced by meadow dropseed, knotroot bristlegrass, side-oats grama, heath aster, goldenrod, and prairie sagewort. Weeds that commonly invade heavily grazed areas are western ragweed, lanceleaf ragweed, ironweed, bitter sneezeweed, silver bluestem, broomsedge bluestem, and three-awns.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 7,000 pounds per acre in years of favorable moisture and about 3,500 pounds per acre in years of unfavorable moisture.

#### SANDY SAVANNAH RANGE SITE

This range site consists of very gently sloping to moderately steep loamy soils on uplands. These soils have good capacity for root development and moisture storage.

The original vegetation consists of tall grasses and scattered trees (fig. 8).

Big bluestem, little bluestem, indiangrass, switchgrass, Virginia tephrosia, and hairy sunflower are the main decreasers. Hardwoods make up about 25 percent of the climax vegetation. The major species of trees are post oak, red oak, blackjack oak, and hickory.

The stands of trees have gradually thickened on much of this site as a result of annual burning and heavy grazing. Forage production is severely limited in some areas where a dense stand of brush has developed. Other increasers, in addition to the trees, are purpletop, purple lovegrass, beaked panicum, tall dropseed, and Scribner panicum. Principal invaders include broomsedge bluestem, splitbeard bluestem, coralberry, ironweed, pokeberry, and marestail. Brush control is usually necessary to reduce the tree canopy and to speed recovery of the better grasses.

*Figure 8.*—**Original (climax) vegetation on Sandy Savannah range site. The soil is a Linker fine sandy loam.**

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 5,500 pounds per acre in years of favorable moisture and about 3,500 pounds per acre in years of unfavorable moisture.

#### SHALLOW CLAYPAN RANGE SITE

This range site consists of nearly level loamy soils on uplands. The loamy surface layer is about 8 inches thick. The subsoil, an abrupt change from the surface layer, is material that is high in content of sodium.

Where this site is in excellent condition, the vegetation is approximately 60 percent decreasers. The dominant decreasers are little bluestem, switchgrass, big bluestem, and Illinois bundleflower. Overgrazing causes rapid depletion of the taller grasses. The principal increasers are meadow dropseed, silver bluestem, fall witchgrass, heath aster, and dotted gayfeather. Common invaders in areas where the site is in poor condition are western ragweed, common broomweed, pricklypear, bitter sneezeweed, tumblegrass, windmillgrass, and three-awns. This site is the least productive of all range sites in the county.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 3,000 pounds per acre in years of favorable moisture and about 1,500 pounds per acre in years of unfavorable moisture.

#### SHALLOW PRAIRIE RANGE SITE

This range site consists of shallow, very gently sloping to steep, loamy soils on uplands. (fig. 9).

465-345—73——4

*Figure 9.*—**Shallow Prairie range site in excellent condition on Collinsville part of Bates-Collinsville complex, 1 to 5 percent slopes (background).**

Where this site is in excellent condition, the most abundant decreaser plants are little bluestem, big bluestem, indiangrass, switchgrass, leadplant, catclaw sensitivebrier, black samson, and ashy sunflower. The more common invaders include tall dropseed, purpletop, Scribner panicum, heath aster, and Missouri goldenrod. Principal invaders are broomsedge bluestem, three-awn, ironweed, lanceleaf ragweed, western ragweed, and common broomweed. Several woody plants, such as sumac, blackberry, hawthorne, coralberry, and persimmon, are common, and they thicken if overgrazing continues. It often becomes necessary to spray for brush control to speed recovery of the desirable native forage plants.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 4,500 pounds per acre in years of favorable moisture and about 2,500 pounds per acre in years of unfavorable moisture.

#### SHALLOW SAVANNAH RANGE SITE

This range site consists of very shallow to shallow, very gently sloping to moderately steep loamy soils on uplands.

The climax vegetation consists of an open stand of post oak, blackjack oak, and hickory and a ground cover of tall grasses. Where in excellent condition, this site produces about 70 percent grasses and forbs and 30 percent woody species. Little bluestem is the most abundant decreaser grass on the site. Other decreaser plants include big bluestem, indiangrass, slender lespedeza, Illinois tickclover, and hairy sunflower. Heavy grazing and annual burning cause a gradual increase of trees. Other plants that increase are purpletop, Scribner panicum, purple lovegrass, flameleaf sumac, heath aster, and goldenrod. The dominant invader plants are broomsedge bluestem, splitbeard bluestem, coralberry, ironweed, black-eyed susan, ragweed, and marestail. Brush control followed by deferment of grazing is usually necessary for improvement of areas in fair or poor condition.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 3,500 pounds per acre in years of favorable moisture and about 2,000 pounds per acre in years of unfavorable moisture.

#### SMOOTH CHERT SAVANNAH RANGE SITE

This range site consists of deep, nearly level to strongly sloping loamy soils that have a very cherty to gravelly, loamy and clayey subsoil.

Climax vegetation consists of post oak, blackjack oak, black oak, red oak, hickory, and a ground cover of tall grasses.

When well managed this site produces good yields of big bluestem, little bluestem, and indiangrass. Other decreaser plants include catclaw sensitivebrier, Virginia tephrosia, trailing lespedeza, and hairy sunflower. Poor management results in thickened stands of trees and increased amounts of low brush, such as flameleaf sumac, dogwood, and huckleberry. Invaders common on this site are broomsedge bluestem, poverty oatgrass, persimmon, sassafras, and ragweed. Brush control is usually necessary to reduce tree stands and speed recovery of desirable forage plants.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 4,200 pounds per acre in years of favorable moisture and about 2,100 pounds per acre in years of unfavorable moisture.

#### VERY SHALLOW RANGE SITE

This range site consists of shallow to very shallow, nearly level to sloping, loamy soils on uplands. Generally, limestone bedrock is at a depth of 10 inches or less but in places is as deep as 20 inches. Space for root growth and moisture storage is limited.

Grasses requiring less moisture for growth and reproduction dominate the site. These grasses consist of sideoats grama, hairy grama, and small amounts of little bluestem. Under good management this site grows numerous native legumes. These include catclaw sensitivebrier, prairie acacia, Illinois bundleflower, purple prairie clover, and white prairie clover. Willowleaf sunflower is an important decreaser forb on this site.

Overgrazing results in increased amounts of prickly pear, tumblegrass, windmillgrass, silver bluestem, fall witchgrass, dotted gayfeather, and noseburn.

In a few places, deep crevices or pockets in the limestone bedrock contain soil material that supports the taller grasses that are generally on the Loamy Prairie range site. These grasses are mainly big bluestem, indiangrass, little bluestem, and switchgrass.

Where this site is in excellent condition, the estimated annual yield of air-dry herbage is about 2,500 pounds per acre in years of favorable moisture and about 1,000 pounds per acre in years of unfavorable moisture.

### *Woodlands suitable for grazing*

Wooded areas used primarily for the production of shortleaf pine are also economically important to live-

stock operations. The ground vegetation under the canopy consists of grasses, forbs, and browse plants that are palatable to livestock. The kinds and amounts of understory plants and their production depends on the soils, percent of timber canopy, and on grazing management.

Proper grazing management is needed to improve and maintain the desired forage plants. Vegetation in wooded areas is classified as decreasers, increasers, or invaders according to response to continuous overgrazing. The important decreaser plants are big bluestem, little bluestem, indiangrass, Virginia tephrosia, slender lespedeza, hairy sunflower, and tickclover. Plants that increase when these areas are overgrazed include purpletop, Scribner panicum, goldenrod, and aster. Overgrazing also results in increased amounts of such low brush as sumac, blackjack oak, post oak, persimmon, and sassafras. Excessive overgrazing causes an invasion of undesirable plants, including broomsedge bluestem, poverty oatgrass, puffsheath dropseed, ironweed, black-eyed susan, and marestail.

## Use of the Soils as Woodland [4]

This section contains information concerning the relationship between soils in the county and trees. The material presented will be helpful to woodland owners and operators in farming and carrying out plans for establishing and maintaining tree resources.

Native woodland makes up about 5 percent of Craig County. It is confined mostly to areas along the Neosho River in the northeastern part of the county adjacent to Big Cabin Creek and its tributaries. The principal commercial trees on bottom lands are water oak, willow oak, pin oak, elm, hackberry, scaly bark hickory, sycamore, ash, swamp white oak, and pecan. The principal commercial trees on uplands are red oak and white oak.

### *Rating soils for woodland use*

The soils of Craig County have been rated on the basis of their performance when used to produce wood crops. The ratings are a means of expressing information useful in managing wood crops according to kinds of soils. Items rated in this soil survey and their importance to woodland use and management in Craig County are discussed in the following paragraphs.

Potential productivity is expressed as site index for a given tree species. This is the average height in feet of dominant or codominant trees at age 30 for cottonwood, age 35 for sycamore, and age 50 for all other species.

Species suitability is shown by listing the principal commercial tree species that should be favored in existing stands and by denoting the tree species suitable for planting. The selection of preferred species is influenced by their growth rates and by the quality, value, and general marketability of the products obtained from each species.

Important soil-related hazards or limitations in woodland use and management are a part of the definition of each woodland suitability group. The limitations or hazards are (1) potential hazard of erosion, (2) equipment limitations, and (3) seedling mortality. The evaluation of these management items for the soils of each woodland suitability group are rated according to the concern they impose on management. The ratings are *slight*, *moderate*, and *severe*.

Hazard of erosion is the potential erodibility of the soil and the hazard it causes when the area is managed according to recognized acceptable standards. There are three rating classes. A rating of *slight* indicates that no special techniques in management are required. A rating of *moderate* indicates that some provision in management must be made to prevent accelerated erosion. Roads, skid trails, fire lanes, land development, and maintenance require some special techniques. A rating of *severe* indicates that special techniques in management and special attention to roads, skid trails, fire lanes, land development, and maintenance are necessary to minimize accelerated erosion.

In developing equipment limitation ratings, the use of mechanical equipment generally used for woodland operation was assumed. The dominant factors that limit the use of equipment are steepness of slope, wetness of the soil, rough terrain, unfavorable texture, and obstacles such as rocks. A soil rating of *slight* indicates that there are no particular limitations in the use of equipment. A rating of *moderate* indicates that not all types of equipment can be used, that there are periods not in excess of 3 months when equipment cannot be used because of soil wetness, or that the soils are unstable. A rating of *severe* indicates that some equipment use may be limited and special equipment may be needed, that the soil is wet more than 3 months during the year, or that soil texture limits equipment use.

Seedling mortality refers to the expected degree of mortality of naturally occurring or planted tree seedlings as influenced by the soils when plant competition is not a factor. The rating is *slight* where seedling survival ordinarily will exceed 75 percent. Under these circumstances natural regeneration is suitable, or an original planting can be expected to produce a satisfactory stand. The rating is *moderate* where seedling survival is between 50 to 75 percent. In this case natural regeneration cannot always be relied upon for adequate and immediate restocking, and planting may be a desirable alternative. The rating is *severe* where seedling survival is less than 50 percent, and adequate restocking is not expected without additional management attention.

### *Woodland groups*

The ratings of individual soils provide a basis for grouping soils according to their suitability for woodland use and management. Groupings simplify the presentation of information. A woodland group consists of soils that have comparable potential productivity and comparable limitations, produce similar wood crops, and require similar management practices or treatment.

Each group symbol consists of three elements. The first element in the symbol indicates the relative production potential of the soils in the group for growing wood crops. It expresses the site quality based on the site index

[4] By NORMAN E. SMOLA, woodland conservationist, Soil Conservation Service.

of one or more important forest types or species. The site index is a numerical means of expressing the quality of a forest site that is based on the height of the dominant stand at a certain age; for example, the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years.

The numeral *1* indicates very high production potential.

The numeral *2* indicates that potential production is high.

The numeral *3* indicates moderately high.

The numeral *4* indicates moderate.

The numeral *5* indicates a low potential.

Numeral *1* is not applicable in this soil survey area.

The second element in the symbol indicates the soil or physiographic characteristic that is the primary cause of hazards, limitations, or restrictions for woodland use or management as follows:

w---------- excessive wetness.
d---------- restricted rooting depth.
f---------- fragmental or skeletal.
o---------- no significant soil-related problem.

Some soils have more than one limiting characteristic; in this case, priority was assigned in the order that the characteristics are listed here.

The third element in the symbol indicates the degree of hazard or limitation and the general suitability of the soil for certain kinds of trees.

The numeral *1* indicates the soils have no significant management limitations and are best suited to needleleaf trees.

The numeral *2* indicates that soils have one or more moderate limitations and are best suited to needleleaf trees.

The numeral *3* indicates one or more severe limitations; soils are best suited to needleleaf trees.

The numeral *4* indicates the soils have no significant limitations and are best suited to broadleaf trees.

The numeral *5* indicates one or more moderate limitations; soils are best suited to broadleaf trees.

The numeral *6* indicates one or more severe limitations; soils are best suited to broadleaf trees.

The numeral *7* indicates that soils have no significant management concerns and are well suited to either needleleaf or broadleaf trees.

The numeral *8* indicates one or more moderate limitations; soils are well suited to needleleaf or broadleaf trees.

The numeral *9* indicates one or more severe limitations; soils are suited to needleleaf or broadleaf trees.

The numeral *0* indicates the soils are not suitable for the production of major commercial wood products.

In Craig County the numerals 3, 4, and 9 were not used.

The woodland group to which each mapping unit is assigned can be determined by referring to the "Guide to Mapping Units" at the back of this survey.

Table 3 includes a brief description of each woodland group of soils in Craig County. The table also includes a summary of information concerning potential wood productivity, major hazards, limitations, and preferred tree species.

## Use of the Soils for Wildlife Habitat [5]

The wildlife population of any area depends upon the availability of food, cover, and water in a suitable combination. Habitat is created, improved, or maintained by establishing desirable vegetation and developing water supplies in suitable places.

In table 4 each of the soils in Craig County is rated as to its suitability for the elements of wildlife habitat and also for three classes of wildlife. These ratings refer only to the suitability of the soil and do not take into account the climate, the present use of the soil, or the distribution of wildlife and human populations. The suitability of individual sites has to be determined by onsite inspection. The meanings of the ratings used in table 4 are as follows:

*Well suited* means that habitat generally is easily created, improved, or maintained; that the soil has few or no limitations that affect management; and that satisfactory results can be expected.

*Suited* means that habitat can be created, improved, or maintained in most places; that the soil has moderate limitations that affect management; and that moderate intensity of management and fairly frequent attention may be required for satisfactory results.

*Poorly suited* means that habitat can be created, improved, or maintained in most places; that the soil has rather severe limitations; that habitat management is difficult, expensive, and requires intensive effort; and that results are not always satisfactory.

*Unsuited* means that it is impractical or impossible to establish, improve, or maintain habitat; and that unsatisfactory results are probable.

The column heading "Grain and seed crops" refers to grain-producing or seed-producing annual plants, such as corn, sorghum, millet, and soybeans.

"Grasses and legumes" refers to domestic grasses and legumes that are established by planting and that furnish food and cover for wildlife. Examples of grass species are weeping love, johnsongrass, ryegrass, and fescue grasses. Legumes include species such as clover, annual lespedeza, and bush lespedeza.

"Wild herbaceous upland plants" refers to native or introduced perennial grasses, forbs, and weeds that provide food and cover for wildlife on uplands. Beggarweed, perennial lespedeza, wild bean, pokeberry, and cheat are examples of these.

"Hardwood woody plants" refers to nonconiferous trees, shrubs, and woody vines that produce fruits, nuts, buds, catkins, or foliage (browse) used extensively as food by wildlife. These plants can be planted but commonly become established through natural processes. They include such species as oak, cherry, dogwood, viburnum, black locust, sand plum, sumac, Osage-orange, grape, honeysuckle, greenbrier, mulberry, hackberry, pecan, and hickory.

"Coniferous woody plants" refers to cone-bearing trees and shrubs mainly used as cover, but also, in places, as a source of food in the form of browse, seed, or fruit-

[5] By JEROME F. SYKORA, biologist, Soil Conservation Service.

like cones. These plants may be planted or established through natural processes. Included are pines, cedars, and ornamentals.

"Wetland food and cover plants" are annual and perennial wild herbaceous plants that grow on moist to wet sites. (They do not include submersed or floating aquatics.) These plants furnish food or cover mostly for wetland wildlife. Smartweed, wild millet, spikerush and other rushes, sedges, and burreed are examples.

"Waterfowl shallow-water developments" are those where low dikes and water control structures are established to create habitat, principally for waterfowl. They can be designed to be drained, planted, and flooded, or they can be used as permanent impoundments to grow submersed aquatics. Such developments are in both freshwater and brackish water areas.

"Ponds" are locations where water of suitable depth and quality can be impounded for fish production as one of the primary uses.

"Open-land wildlife" are quail, dove, cottontail rabbit, fox, meadowlark, field sparrow, and other birds and mammals that normally live on cropland, pasture, meadow, lawn, and in other open-land areas where grasses, herbs, and shrubby plants grow.

TABLE 3.—*Woodland groups and factors in woodland management*

[Absence of an entry in a column means information was not available]

| Woodland group and descriptions of soils | Management concerns | | | Potential productivity | | Preferred species for planting |
|---|---|---|---|---|---|---|
| | Erosion hazard | Equipment limitations | Seedling mortality | Selected species | Site index | |
| Group 2o7: Loamy soils that have high productivity potential; suited to southern pines or southern hardwoods; on flood plains. | Slight | Slight | Slight | Shortleaf pine, black walnut, red oak. | 80 | Loblolly pine, shortleaf pine, black walnut, northern red oak. |
| Group 3o7: Loamy soils that have moderately high productivity potential; suited to southern pines or hardwoods; on uplands. | Slight | Slight | Slight | Shortleaf pine, red oak, black walnut. | 70 | Loblolly pine, shortleaf pine, black walnut, northern red oak. |
| Group 3w5: Seasonally wet soils that have moderately high productivity potential; suited to southern hardwoods; on flood plains. | | Moderate | Moderate | Cottonwood, sycamore, green ash, water oak. | 90 | Cottonwood, sycamore, sweetgum, green ash, water oak. |
| Group 3w6: Excessively wet soils that have moderately high productivity potential; suited to water-tolerant hardwoods; on flood plains. | | Severe | Moderate to severe. | Water oak, green ash, hackberry. | 80 | Water oak, green ash. |
| Group 4o1: Loamy soils that have moderate productivity potential; suited to southern pines and eastern redcedar; on uplands. | Slight | Slight | Slight | Shortleaf pine, eastern redcedar. | 60 | Shortleaf pine, loblolly pine, eastern redcedar. |
| Group 4f8: Loamy soils that have coarse fragments in the profile; moderate productivity potential; suited to southern pines, upland hardwoods, and eastern redcedar; on uplands. | Moderate to severe. | Moderate to severe. | Moderate to severe. | Shortleaf pine | 60 | Shortleaf pine, eastern redcedar, northern red oak. |
| Group 5d2: Loamy soils that are very shallow to moderately deep with low productivity potential; on uplands. | Moderate to severe. | Moderate to severe. | Moderate to severe. | Shortleaf pine | 55 | [1]. |
| Group 5o0: Soils that are not suitable for the production of major commercial wood products. | | | | | | |

[1] Not recommended.

TABLE 4.—*Suitability of the soils for*

[Soil symbols BcC, CoF, HIC, HIE, Lg, TsD, and Vt identify soil

| Soil series and map symbols | Elements of wildlife habitat— | | | |
|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous upland plants | Hardwood woody plants |
| Bates: | | | | |
| BaB, BaC | Suited | Well suited | Well suited | Suited |
| BaC2, BcC | Suited | Suited | Well suited | Suited |
| Bonham: BoB | Well suited | Well suited | Well suited | Suited |
| Carytown: Ca | Poorly suited | Suited | Suited | Suited |
| Cherokee: Ce | Suited | Well suited | Well suited | Suited |
| Choteau: ChA, ChB | Well suited | Well suited | Well suited | Suited |
| Claremore, moderately shallow variant: ClC | Suited | Suited | Suited | Suited |
| Clarksville: CmE, CnD | Poorly suited | Suited | Suited | Well suited |
| Collinsville: CoF | Unsuited | Poorly suited | Poorly suited | Poorly suited |
| Craig: CrB | Well suited | Well suited | Well suited | Well suited |
| Dennis: | | | | |
| DnB, DnC | Well suited | Well suited | Well suited | Suited |
| DnC2 | Well suited | Well suited | Well suited | Suited |
| DsC3 | Poorly suited | Suited | Suited | Suited |
| Eldorado: | | | | |
| EoC | Poorly suited | Suited | Suited | Suited |
| ElD | Suited | Well suited | Well suited | Suited |
| Hector: | | | | |
| HIC | Poorly suited | Poorly suited | Poorly suited | Suited |
| HIE | Unsuited | Poorly suited | Poorly suited | Suited |
| Lenapah: LeB | Suited | Suited | Suited | Suited |
| Lightning: Lg | Poorly suited | Suited | Suited | Suited |
| Linker: LkB, LkC, LkC2 | Suited | Well suited | Well suited | Well suited |
| Lula: LuB, LuC | Well suited | Well suited | Well suited | Suited |
| Mine pits and dumps: Mp | Unsuited | Poorly suited | Poorly suited | Suited |
| Nixa: NcB | Suited | Well suited | Well suited | Well suited |
| Okemah: Oe | Well suited | Well suited | Well suited | Suited |
| Osage: Os, Ot | Poorly suited | Suited | Suited | Well suited |
| Parsons: PaA | Well suited | Well suited | Well suited | Suited |
| Radley: Ra | Well suited | Well suited | Well suited | Well suited |
| Sallisaw: SaB, SaD | Well suited | Well suited | Well suited | Well suited |
| Staser: Sm | Well suited | Well suited | Well suited | Well suited |

See footnote at end of table.

*elements of wildlife and kinds of wildlife*

complexes, both components of which have the same suitability for wildlife]

| Elements of wildlife habitat—Continued | | | | Kinds of wildlife | | |
|---|---|---|---|---|---|---|
| Coniferous woody plants | Wetland food and cover plants | Waterfowl shallow-water developments | Ponds | Open-land wildlife | Woodland wildlife | Wetland wildlife |
| Suited | Unsuited | Uusuited | Poorly suited | Well suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Poorly suited | Suited | Suited | Unsuited. |
| Suited | Unsuited | Poorly suited | Suited | Well suited | Suited | Unsuited. |
| Suited | Suited | Well suited | Poorly suited [1] | Suited | Suited | Suited. |
| Suited | Suited | Suited | Suited [1] | Well suited | Suited | Suited. |
| Suited | Poorly suited | Poorly suited | Suited [1] | Well suited | Suited | Poorly suited. |
| Suited | Unsuited | Unsuited | Unsuited | Suited | Suited | Unsuited. |
| Poorly suited | Unsuited | Unsuited | Unsuited | Suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Poorly suited | Poorly suited | Poorly suited | Unsuited. |
| Suited | Poorly suited | Poorly suited | Poorly suited | Well suited | Well suited | Poorly suited. |
| Suited | Poorly suited; slopes greater than 3 percent unsuited. | Unsuited | Suited | Well suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Suited | Well suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Poorly suited | Suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Unsuited | Suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Unsuited | Well suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Poorly suited | Suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Poorly suited | Suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Unsuited | Suited | Suited | Unsuited. |
| Suited | Suited | Well suited | Suited [1] | Suited | Suited | Suited. |
| Poorly suited | Unsuited | Unsuited | Poorly suited | Well suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Poorly suited | Well suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Poorly suited | Poorly suited | Suited | Unsuited. |
| Poorly suited | Unsuited | Unsuited | Poorly suited | Well suited | Suited | Unsuited. |
| Suited | Poorly suited | Suited | Suited [1] | Well suited | Suited | Poorly suited. |
| Suited | Suited | Well suited | Suited [1] | Suited | Suited | Suited. |
| Suited | Suited | Suited | Suited [1] | Well suited | Suited | Suited. |
| Poorly suited | Unsuited | Unsuited | Unsuited | Well suited | Suited | Unsuited. |
| Poorly suited | Unsuited | Unsuited | Unsuited | Wel suited | Suited | Unsuited. |
| Poorly suited | Unsuited | Unsuited | Unsuited | Well suited | Suited | Unsuited. |

TABLE 4.—*Suitability of the soils for elements*

| Soil series and map symbols | Elements of wildlife habitat— | | | |
|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous upland plants | Hardwood woody plants |
| Summit: | | | | |
| SuA | Well suited | Well suited | Well suited | Suited |
| SuB, SuC, SuC2 | Well suited | Well suited | Well suited | Suited |
| Taloka: TaA | Well suited | Well suited | Well suited | Suited |
| Talpa: | | | | |
| TlB | Unsuited | Poorly suited | Poorly suited | Poorly suited |
| TsD | Poorly suited | Poorly suited | Suited | Suited |
| Verdigris: | | | | |
| Ve | Well suited | Well suited | Well suited | Well suited |
| Vs | Poorly suited | Suited | Suited | Well suited |
| Vt | Poorly suited | Suited | Suited | Suited |

[1] This suitability rating refers to pond reservoirs.

"Woodland wildlife" are woodcock, thrush, vireo, squirrel, deer, raccoon, wild turkey, and other birds and mammals that normally live in wooded areas where hardwood trees and shrubs and coniferous trees grow.

"Wetland wildlife" are duck, geese, rail, heron, shore birds, mink, muskrat, and other birds and mammals that normally live in wet areas, marshes, and swamps.

## Engineering Uses of the Soils [6]

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

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

Information in this section can be helpful to those who—

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

Most of the information in this section is presented in tables 5, 6, and 7. Tables 5 and 6 show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses. Table 7 gives the results of the engineering laboratory tests for seven representative soils. This information, along with the soil map and other parts of this survey, can be used to make interpretations in addition to those given in the tables. It also can be used to make other useful maps.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where excavations are deeper than the depths of layers here reported. Estimates generally are made to a depth of about 6 feet, and interpretations do not apply to greater depths. Also, engineers should not apply specific values to the estimates for bearing capacity and traffic-supporting capacity given in this survey. Investigation of each site is needed because many delineated areas of a given mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineer-

[6] By ROBERT F. HEIDLAGE, area engineer, and W. E. HARDESTY, civil engineer, Soil Conservation Service.

*of wildlife and kinds of wildlife*—Continued

| Elements of wildlife habitat—Continued | | | | Kinds of wildlife | | |
|---|---|---|---|---|---|---|
| Coniferous woody plants | Wetland food and cover plants | Waterfowl shallow-water developments | Ponds | Open-land wildlife | Woodland wildlife | Wetland wildlife |
| Suited | Poorly suited | Poorly suited | Suited [1] | Well suited | Suited | Poorly suited. |
| Suited | Slopes of 1 to 3 percent poorly suited; slopes greater than 3 percent unsuited. | Unsuited | Suited | Well suited | Suited | Unsuited. |
| Suited | Suited | Suited | Suited [1] | Well suited | Suited | Suited. |
| Well suited | Unsuited | Unsuited | Unsuited | Poorly suited | Suited | Unsuited. |
| Suited | Unsuited | Unsuited | Poorly suited | Poorly suited | Suited | Unsuited. |
| Poorly suited | Poorly suited | Poorly suited | Suited [1] | Well suited | Suited | Poorly suited. |
| Poorly suited | Poorly suited | Poorly suited | Unsuited | Suited | Suited | Poorly suited. |
| Poorly suited | Unsuited | Unsuited | Suited [1] | Suited | Suited | Unsuited. |

ing. Even in these situations, the soil map is useful in planning more detailed field investigations and for indicating the kinds of limitations that can be expected.

Some of the terms used in this survey have special meaning to soil scientists not known to all engineers. Many of the terms commonly used in soil science are defined in the Glossary at the back of this survey.

### *Engineering classification systems*

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*7*) used by the SCS engineers, Department of Defense, and others, and the AASHO system (*1*) adopted by the American Association of State Highway Officials.

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

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

### *Estimated properties*

In table 5 the soil series of the county and their mapping symbols are listed, and certain properties significant in engineering are described. The estimates are based on a modal profile, or a profile typical for the series or soil type. For the soils in the county that were tested, estimates in table 5 are based on the test data listed in table 7. For other soils, estimates are based on test data obtained from similar soils in the county and other counties, and on past experience in engineering. Since the estimates are for typical profiles, variations from the estimates may be considerable. The following are explanations of the columns in table 5.

*Permeability*, as used in the table, refers only to the downward movement of water through undisturbed soil. The estimates are based on structure and porosity of the soil as it is in place. Such features as plowpans and surface crust were not considered.

*Available water capacity*, given in terms of inches per inch of soil, is the capacity of the soil to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. When the amount of moisture in the soil is at the wilting point of plants, the amount of water shown in the table will wet the soil material described to a depth of 1 inch without further percolation.

465-345—73——5

TABLE 5.—*Estimated engineering*

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

| Soil series and map symbols | Hydrologic soil group | Depth to— | | Depth from surface of typical profile | Classification | |
|---|---|---|---|---|---|---|
| | | Bedrock | Seasonal high water table | | USDA texture | Unified |
| | | *Inches* | *Feet* | *Inches* | | |
| *Bates: BaB, BaC, BaC2, BcC— For Collinsville part of unit BcC, see Collinsville series. | B | 20–40 | >6 | 0–16<br>16–28<br>28 | Loam<br>Clay loam<br>Sandstone. | ML–CL<br>CL, ML–CL |
| Bonham: BoB | C | 40–60 | 1–2 | 0–14<br>14–18<br>18–46<br>46 | Silt loam<br>Silty clay loam<br>Silty clay<br>Limestone. | ML, ML-CL<br>CL, ML-CL<br>CL, CH |
| Carytown: Ca | D | >72 | 0–1 | 0–8<br>8–73 | Silt loam<br>Clay | ML, ML-CL<br>MH, CH |
| Cherokee: Ce | D | >72 | 0–1 | 0–17<br>17–42<br>42–60 | Silt loam<br>Clay<br>Silty clay | ML, ML-CL<br>CL, CH<br>CL, CH |
| Choteau: ChA, ChB | C | >72 | 2–3 | 0–27<br>27–70 | Silt loam<br>Silty clay loam | ML, ML-CL<br>CL, ML-CL |
| Claremore, moderately shallow variant: ClC. | D | 20–25 | >6 | 0–8<br>8–21<br>21 | Silt loam<br>Silty clay loam<br>Limestone. | ML, ML-CL<br>CL, ML-CL |
| Clarksville: CmE, CnD | B | >72 | >6 | 0–20<br>20–60 | Very cherty silt loam<br>Very cherty silty clay loam. | GM<br>GM, GC |
| *Collinsville: CoF— For Vinita part of unit CoF see Vinita series. | C | 4–20 | >6 | 0–8<br>8 | Loam<br>Sandstone. | ML-CL |
| Craig: CrB | C | >72 | >6 | 0–21<br>21–60 | Silt loam<br>Very cherty clay loam | ML, ML-CL<br>GM, GC |
| Dennis: DnB, DnC, DnC2, DsC3 | C | >72 | 1–2 | 0–11<br>11–60 | Silt loam<br>Silty clay loam | ML, ML-CL<br>CL, ML-CL |
| Eldorado: ElD, EoC | C | >72 | >6 | 0–10<br>10–22<br>22–33<br>33–60 | Silt loam<br>Very cherty silt loam<br>Very cherty silty clay loam<br>Very cherty clay | ML, ML-CL<br>GM<br>GM, GC<br>GC |
| *Hector: HlC, HlE— For Linker part of units HlC, HlE, see Linker series. | D | 8–20 | >6 | 0–10<br>10 | Fine sandy loam<br>Sandstone. | SM, ML |
| Lenapah: LeB | D | 16–20 | 1–2 | 0–12<br>12–18<br>18 | Silty clay loam<br>Clay<br>Limestone. | CL, ML-CL<br>CL, CH |
| *Lightning: Lg— For Carytown part of unit Lg, see Carytown series. | D | >72 | 0–1 | 0–14<br>14–54 | Silt loam<br>Clay | ML, ML-CL<br>CL, CH |
| Linker: LkB, LkC, LkC2 | B | 30–40 | >6 | 0–12<br>12–32<br>32 | Fine sandy loam<br>Sandy clay loam<br>Sandstone. | SM, ML-CL<br>SC, CL |
| Lula: LuB, LuC | B | 40–60 | >6 | 0–10<br>10–52<br>52 | Silt loam<br>Silty clay loam<br>Limestone. | ML, ML-CL<br>CL, ML-CL |

See footnotes at end of table.

*properties of the soils*

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions in the first column of the table]

| Classification—Con. | Percentage passing sieve— | | | | Permeability | Available water capacity | Reaction | Shrink-swell potential |
|---|---|---|---|---|---|---|---|---|
| AASHO | No. 4 (4.7 mm.) | No. 10 (2.0 mm.) | No. 40 (0.42 mm.) | No. 200 (0.074 mm.) | | | | |
| | | | | | *Inches per hour* | *Inches per inch of soil* | *pH value* | |
| A–4 | 100 | 100 | 95–100 | 55–80 | 0.63–2.0 | 0.12–0.16 | 5.1–6.0 | Low. |
| A–6, A–7 | 95–100 | 95–100 | 90–100 | 75–95 | 0.63–2.0 | 0.15–0.19 | 5.1–5.5 | Moderate. |
| A–4 | 100 | 100 | 90–100 | 75–90 | 0.63–2.0 | 0.14–0.18 | 5.6–6.5 | Low. |
| A–6 | 100 | 100 | 90–100 | 85–95 | 0.63–2.0 | 0.15–0.19 | 5.6–6.0 | Moderate. |
| A–7 | 95–100 | 95–100 | 80–95 | 75–95 | 0.06–0.20 | 0.14–0.18 | 5.6–7.3 | High. |
| A–4 | 100 | 100 | 90–100 | 75–95 | 0.63–2.0 | 0.14–0.18 | 5.1–6.0 | Low. |
| A–7 | 100 | 100 | 90–100 | 85–95 | <0.06 | 0.14–0.18 | 5.6–8.4 | High. |
| A–4 | 100 | 100 | 100 | 75–90 | 0.63–2.0 | 0.14–0.18 | 5.1–6.0 | Low. |
| A–7 | 95–100 | 95–100 | 95–100 | 90–98 | <0.06 | 0.14–0.18 | 5.1–6.0 | High. |
| A–7 | 100 | 100 | 100 | 90–98 | 0.06–0.20 | 0.14–0.18 | 6.6–7.3 | High. |
| A–4 | 100 | 100 | 100 | 75–90 | 0.63–2.0 | 0.14–0.18 | 4.5–6.0 | Low. |
| A–6 | 100 | 100 | 100 | 85–95 | 0.06–0.20 | 0.15–0.19 | 4.5–7.3 | Moderate. |
| A–4 | 100 | 100 | 90–100 | 75–90 | 0.63–2.0 | 0.14–0.18 | 5.6–6.5 | Low. |
| A–6 | 95–100 | 95–100 | 90–100 | 85–95 | 0.63–2.0 | 0.15–0.19 | 5.6–7.3 | Moderate. |
| A–2, A–4 | 50–85 | 40–60 | 30–50 | 30–50 | 0.63–20.0 | 0.06–0.09 | 4.5–6.0 | Low. |
| A–2 | 30–60 | 20–50 | 20–30 | 15–30 | 0.63–20.0 | 0.06–0.09 | 4.5–5.5 | Low. |
| A–4 | 100 | 100 | 85–95 | 55–85 | 2.0–6.3 | 0.12–0.16 | 5.1–6.0 | Low. |
| A–4, A–6 | 80–95 | 80–95 | 70–90 | 70–90 | 0.63–2.0 | 0.14–0.18 | 4.5–6.0 | Low. |
| A–2, A–7 | 30–70 | 20–55 | 20–50 | 15–45 | 0.20–0.63 | 0.04–0.06 | 4.5–6.0 | Low. |
| A–4 | 90–100 | 90–100 | 90–100 | 75–90 | 0.63–2.0 | 0.14–0.18 | 5.1–6.0 | Low. |
| A–6 | 90–100 | 90–100 | 90–100 | 85–95 | 0.06–0.20 | 0.15–0.19 | 4.5–6.5 | Moderate. |
| A–4 | 85–95 | 85–95 | 85–95 | 70–85 | 0.63–2.0 | 0.14–0.18 | 5.6–6.5 | Low. |
| A–2, A–4 | 40–90 | 30–80 | 30–60 | 20–40 | 0.63–2.0 | 0.09–0.13 | 5.6–6.5 | Low. |
| A–2 | 35–60 | 30–50 | 30–40 | 20–30 | 0.63–2.0 | 0.06–0.09 | 5.1–6.0 | Low. |
| A–2 | 30–40 | 20–30 | 20–30 | 12–20 | 0.63–2.0 | 0.04–0.06 | 5.1–6.0 | Low. |
| A–2, A–4 | 85–100 | 95–100 | 80–90 | 30–60 | 6.3–20.0 | 0.09–0.13 | 5.1–6.5 | Low. |
| A–6 | 100 | 100 | 100 | 90–100 | 0.63–2.0 | 0.15–0.19 | 5.6–6.5 | Moderate. |
| A–7 | 100 | 100 | 100 | 90–100 | 0.06–0.20 | 0.14–0.18 | 6.1–7.3 | High. |
| A–4 | 100 | 100 | 95–100 | 75–95 | 0.63–2.0 | 0.14–0.18 | 4.5–6.0 | Low. |
| A–7 | 100 | 100 | 95–100 | 85–98 | <0.06 | 0.14–0.18 | 4.5–7.3 | High. |
| A–2, A–4 | 95–100 | 90–100 | 80–90 | 30–60 | 2.0–6.3 | 0.09–0.13 | 4.5–5.5 | Low. |
| A–4 | 85–100 | 75–95 | 70–85 | 45–65 | 0.63–2.0 | 0.12–0.16 | 4.5–5.5 | Low. |
| A–4 | 100 | 100 | 90–100 | 75–95 | 0.63–2.0 | 0.14–0.18 | 5.6–6.5 | Low. |
| A–6 | 95–100 | 95–100 | 90–100 | 80–95 | 0.63–2.0 | 0.15–0.19 | 5.1–7.3 | Moderate. |

TABLE 5.—*Estimated engineering*

| Soil series and map symbols | Hydrologic soil group | Depth to— | | Depth from surface of typical profile | Classification | |
|---|---|---|---|---|---|---|
| | | Bedrock | Seasonal high water table | | USDA texture | Unified |
| | | *Inches* | *Feet* | *Inches* | | |
| Mine pits and dumps: Mp[1]. | | | | | | |
| Nixa: NcB | C | >72 | 1–2 | 0–14 | Cherty silt loam | ML |
| | | | | 14–21 | Cherty clay loam | GC |
| | | | | 21–27 | Very cherty clay loam (fragipan). | GC |
| | | | | 27–54 | Very cherty clay | GC |
| Okemah: Oe | C | 40–60 | 2–3 | 0–15 | Silt loam | ML, ML–CL |
| | | | | 15–23 | Silty clay loam | CL, ML–CL |
| | | | | 23–50 | Silty clay | CL, CH |
| | | | | 50 | Limestone. | |
| Osage: Os, Ot | D | >72 | 1–2 | 0–15 | Silty clay loam | MH, CH |
| | | | | 15–44 | Clay | MH, CH |
| Parsons: PaA | D | >72 | 0–1 | 0–13 | Silt loam | ML, ML–CL |
| | | | | 13–60 | Clay | CL, CH |
| Radley: Ra | C | >72 | >6 | 0–14 | Silt loam | ML, ML–CL |
| | | | | 14–60 | Silty clay loam | CL, ML–CL |
| Sallisaw: SaB, SaD | B | >72 | >6 | 0–8 | Silt loam | ML, ML–CL |
| | | | | 8–18 | Silty clay loam | CL, ML–CL |
| | | | | 18–30 | Gravelly clay loam | CL, GC |
| | | | | 30–60 | Very gravelly clay loam | GC |
| Staser: Sm | B | >72 | >6 | 0–16 | Silt loam | ML, ML–CL |
| | | | | 16–28 | Gravelly silt loam | GM |
| | | | | 28–38 | Gravelly clay loam | GC |
| | | | | 38–60 | Very gravelly clay loam | GC |
| Summit: SuA, SuB, SuC, SuC2 | C | 40–60 | 1–2 | 0–15 | Silty clay loam | CL, ML–CL |
| | | | | 15–48 | Clay | CH |
| | | | | 48 | Limestone. | |
| Taloka: TaA | D | >72 | 1–2 | 0–20 | Silt loam | ML, ML–CL |
| | | | | 20–60 | Clay | CH, MH |
| *Talpa: TlB, TsD<br>For Summit part of unit TsD, see Summit series, which is similar except Summit soil in this unit has an average depth to bedrock of 30 inches. | D | 5–20 | >6 | 0–8 | Silty clay loam | ML, ML–CL |
| | | | | 8 | Limestone. | |
| Verdigris[2]: Ve, Vs, Vt | B | >72 | >6 | 0–30 | Silty clay loam | CL, ML–CL |
| | | | | 30–60 | Clay loam | CL, ML–CL |
| *Vinita<br>Mapped only in complex with Collinsville series. | C | 22–40 | 1–2 | 0–8 | Loam | ML–CL |
| | | | | 8–28 | Clay | CL, CH |
| | | | | 28–34 | Shale with strata of silty clay. | |

[1] Properties not estimated because the material is too variable.

*properties of the soils*—Continued

| Classification—Con. | Percentage passing sieve— | | | | Permeability | Available water capacity | Reaction | Shrink-swell potential |
|---|---|---|---|---|---|---|---|---|
| AASHO | No. 4 (4. 7 mm.) | No. 10 (2. 0 mm.) | No. 40 (0. 42 mm.) | No. 200 (0.074 mm.) | | | | |
| | | | | | *Inches per hour* | *Inches per inch of soil* | *pH vaule* | |
| A–4 | 75–85 | 75–85 | 75–85 | 65–75 | 0. 63–2. 0 | 0. 09–0. 13 | 4. 5–5. 5 | Low. |
| A–2, A–6 | 70–85 | 65–80 | 40–60 | 15–50 | <0. 06 | 0. 06–0. 09 | 4. 5–5. 0 | Low. |
| A–2 | 20–50 | 20–50 | 20–50 | 15–35 | 0. 63–2. 0 | 0. 06–0. 09 | 4. 5–5. 5 | Low. |
| A–2 | 20–50 | 20–50 | 20–50 | 15–35 | 0. 63–2. 0 | 0. 06–0. 09 | 4. 5–5. 5 | Low. |
| A–4 | 100 | 100 | 100 | 75–95 | 0. 63–2. 0 | 0. 14–0. 18 | 5. 6–6. 5 | Low. |
| A–6 | 100 | 100 | 100 | 85–95 | 0. 63–2. 0 | 0. 15–0. 19 | 5. 6–6. 5 | Moderate. |
| A–7 | 100 | 100 | 100 | 90–98 | 0. 06–0. 20 | 0. 14–0. 18 | 5. 6–7. 3 | High. |
| A–7 | 100 | 100 | 95–100 | 85–100 | 0. 63–2. 0 | 0. 15–0. 19 | 5. 6–7. 3 | Moderate. |
| A–7 | 100 | 100 | 95–100 | 85–100 | <0. 06 | 0. 14–0. 18 | 5. 6–7. 8 | High. |
| A–4 | 100 | 100 | 95–100 | 85–95 | 0. 63–2. 0 | 0. 14–0. 18 | 5. 1–6. 0 | Low. |
| A–7 | 100 | 100 | 95–100 | 85–98 | <0. 06 | 0. 14–0. 18 | 5. 1–6. 5 | High. |
| A–4 | 100 | 100 | 95–100 | 85–95 | 0. 63–2. 0 | 0. 14–0. 18 | 5. 6–7. 3 | Low. |
| A–6, A–7 | 95–100 | 95–100 | 90–100 | 90–100 | 0. 63–2. 0 | 0. 15–0. 19 | 5. 6–7. 3 | Moderate. |
| A–4 | 95–100 | 95–100 | 90–100 | 75–90 | 0. 63–2. 0 | 0. 14–0. 18 | 5. 6–6. 5 | Low. |
| A–6 | 85–95 | 70–90 | 65–85 | 60–80 | 0. 63–2. 0 | 0. 15–0. 19 | 5. 1–6. 0 | Moderate. |
| A–6 | 60–85 | 50–80 | 40–60 | 40–60 | 0. 63–2. 0 | 0. 09–0. 13 | 5. 1–6. 0 | Low. |
| A–2 | 20–70 | 20–60 | 15–50 | 15–35 | 2. 0–6. 3 | 0. 06–0. 09 | 5. 1–6. 0 | Low. |
| A–4 | 95–100 | 95–100 | 95–100 | 85–95 | 0. 63–2. 0 | 0. 14–0. 18 | 5. 6–6. 5 | Low. |
| A–4 | 65–90 | 50–70 | 40–70 | 40–50 | 0. 63–20. 0 | 0. 06–0. 09 | 5. 6–6. 5 | Low. |
| A–6, A–2 | 65–90 | 50–70 | 40–70 | 30–50 | 0. 63–6. 3 | 0. 06–0. 09 | 5. 6–6. 0 | Low. |
| A–2 | 20–60 | 15–40 | 15–40 | 15–35 | 0. 63–6. 3 | 0. 06–0. 09 | 5. 6–6. 0 | Low. |
| A–6, A–7 | 100 | 100 | 95–100 | 85–95 | 0. 63–2. 0 | 0. 15–0. 19 | 5. 6–6. 5 | Moderate. |
| A–7 | 100 | 100 | 95–100 | 85–100 | 0. 06–0. 20 | 0. 14–0. 18 | 6. 1–7. 8 | High. |
| A–4 | 100 | 100 | 100 | 85–100 | 0. 63–2. 0 | 0. 14–0. 18 | 5. 1–6. 0 | Low. |
| A–7 | 100 | 100 | 100 | 85–100 | <0. 06 | 0. 14–0. 18 | 5. 1–7. 3 | High. |
| A–6 | 100 | 100 | 95–100 | 75–90 | 0. 63–2. 0 | 0. 15–0. 19 | 6. 1–7. 8 | Moderate. |
| A–6 | 100 | 100 | 100 | 85–95 | 0. 63–2. 0 | 0. 15–0. 19 | 5. 6–6. 5 | Moderate. |
| A–6, A–7 | 100 | 100 | 100 | 75–95 | 0. 63–2. 0 | 0. 15–0. 19 | 5. 6–6. 0 | Moderate. |
| A–4 | 85–100 | 80–100 | 70–95 | 55–85 | 0. 63–2. 0 | 0. 12–0. 16 | 4. 5–5. 5 | Low. |
| A–7 | 95–100 | 95–100 | 90–100 | 90–100 | 0. 06–0. 20 | 0. 14–0. 18 | 4. 5–5. 0 | High. |

[2] Properties not estimated for Breaks part of unit Vt because the material is too variable.

TABLE 6.—*Engineering*

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

| Soil series and map symbols | Suitability as a source of— | | | Soil features affecting— | | |
|---|---|---|---|---|---|---|
| | Topsoil | Sand and gravel | Road fill | Highway location | Farm ponds | |
| | | | | | Reservoir areas | Embankments |
| *Bates: BaB, BaC, BaC2, BcC. For Collinsville part of BcC, see Collinsville series. | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Fair: moderate traffic-supporting capacity. | Bedrock is at a depth of 20 to 40 inches. | Bedrock is at a depth of 20 to 40 inches. | Limited volume of material. |
| Bonham: BoB | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Poor: high shrink-swell potential. | High shrink-swell potential; low traffic-supporting capacity. | All features favorable. | Clayey material; high volume change; poor compaction. |
| Carytown: Ca | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Poor: low traffic-supporting capacity. | High shrink-swell potential; poorly drained. | All features favorable. | Clayey material; high volume change; poor compaction. |
| Cherokee: Ce | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Poor: low traffic-supporting capacity. | High shrink-swell potential; low traffic-supporting capacity. | All features favorable. | Clayey material; high volume change; poor compaction. |
| Choteau: ChA, ChB | Good | Unsuitable: fine-grained material. | Fair: moderate traffic-supporting capacity. | Moderate shrink-swell potential; moderate traffic supporting capacity. | All features favorable. | Fair slope stability; medium compressibility. |
| Claremore, moderately shallow variant: ClC. | Fair: limited quantity of suitable material. | Unsuitable: possible source of limestone for crushing. | Poor: limited quantity of suitable material. | Bedrock is at a depth of 20 to 25 inches; moderate shrink-swell potential. | Bedrock is at a depth of 20 to 25 inches. | Limited volume of material. |
| Clarksville: CmE, CnD. | Poor: chert fragments. | Fair: gravel only; possible source of chert for crushing. | Good | Slopes of 5 to 12 percent. | High seepage potential. | High seepage potential. |
| *Collinsville: CoF. For Vinita part of unit CoF, see the Vinita series. | Fair: limited quantity of suitable material. | Unsuitable: sandstone at a depth of 4 to 20 inches. | Poor: limited quantity of suitable material. | Bedrock is at a depth of 4 to 20 inches; slopes of 2 to 30 percent. | Bedrock is at a depth of 4 to 20 inches. | Limited volume of material. |

See footnotes at end of table.

*interpretations of the soils*

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instruc-
appear in the first column of the table]

| Soil features affecting—Continued | | | | | Degree and kind of soil limitations for sewage disposal— | |
|---|---|---|---|---|---|---|
| Agricultural drainage | Irrigation | Terraces and diversions | Waterways | Foundations for low buildings | Septic tank filter fields | Sewage lagoons |
| Well drained | Limited root zone. | All features favorable. | All features favorable. | Moderate shrink-swell potential; bedrock at a depth of 20 to 40 inches. | Severe: bedrock at a depth of 20 to 40 inches. | Severe: bedrock is at a depth of 20 to 40 inches. |
| Moderately well drained; slow permeability. | Slow permeability; high available water capacity. | All features favorable. | All features favorable. | High shrink-swell potential; water table at a depth of 1 to 2 feet. | Severe: slow permeability; water table at a depth of 1 to 2 feet. | Moderate: bedrock at a depth of 40 to 60 inches. |
| Poorly drained; very slow permeability. | Very slow permeability; high sodium content; high available water capacity. | Very slow permeability; high sodium content. | Very slow permeability; high sodium content. | Poorly drained; high shrink-swell potential; water table at a depth of 0 to 1 foot. | Severe: water table at a depth of 0 to 1 foot; very slow permeability. | Slight. |
| Somewhat poorly drained; very slow permeability. | Very slow permeability; high available water capacity. | All features favorable. | All features favorable. | Water table at a depth of 0 to 1 foot; high shrink-swell potential. | Severe: water table at a depth of 0 to 1 foot; very slow permeability. | Slight. |
| Moderately well drained; slow permeability. | Slow permeability; high available water capacity. | All features favorable. | All features favorable. | Moderate shrink-swell potential. | Severe: slow permeability. | Slight. |
| Well drained | Limited root zone; moderate available water capacity. | Bedrock is at a depth of 20 to 25 inches. | Bedrock is at a depth of 20 to 25 inches. | Moderate shrink-swell potential; bedrock at a depth of 20 to 25 inches. | Severe: bedrock at a depth of 20 to 25 inches. | Severe: bedrock at a depth of 20 to 25 inches. |
| Somewhat excessively drained. | Moderate to rapid permeability; moderate available water capacity. | Somewhat excessively drained; chert fragments; slopes of 5 to 12 percent. | Somewhat excessively drained. | Slopes of 5 to 12 percent. | Slight if slopes are 0 to 5 percent; moderate if slopes are 5 to 12 percent. | Severe: moderate to rapid permeability. |
| Well drained to somewhat excessively drained. | Limited root zone; low available water capacity; moderately rapid permeability. | Bedrock is at a depth of 4 to 20 inches; slopes of 2 to 30 percent. | Bedrock is at a depth of 4 to 20 inches; low available water capacity. | Bedrock at a depth of 4 to 20 inches. | Severe: bedrock at a depth of 4 to 20 inches. | Severe: bedrock at a depth of 4 to 20 inches. |

TABLE 6.—*Engineering interpretations*

| Soil series and map symbols | Suitability as a source of— | | | Soil features affecting— | | |
|---|---|---|---|---|---|---|
| | Topsoil | Sand and gravel | Road fill | Highway location | Farm ponds | |
| | | | | | Reservoir areas | Embankments |
| Craig: CrB | Fair: chert fragments. | Fair: gravel at a depth below 21 inches only; possible source of chert for crushing. | Fair: moderate traffic-supporting capacity. | All features favorable. | Chert fragments; moderate seepage potential. | Fair slope stability; high seepage potential. |
| Dennis: DnB, DnC, DnC2, DsC3. | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Fair: moderate shrink-swell potential. | Moderate: shrink-swell potential; moderate traffic-supporting capacity. | All features favorable. | Fair slope stability; moderate compressibility. |
| Eldorado: EID, EoC | Poor: chert fragments. | Fair: gravel at a depth below 10 inches only; possible source of chert for crushing. | Good | All features favorable. | Chert fragments; moderate seepage potential. | Subject to piping. |
| *Hector: HIC, HIE— For Linker part of HIC and HIE, see Linker series. | Fair: limited quantity of suitable material. | Unsuitable: sandstone at a depth of less than 20 inches. | Poor: limited quantity of suitable material. | Bedrock is at a depth of 8 to 20 inches. | Bedrock is at a depth of 8 to 20 inches. | Limited volume of material. |
| Lenapah: LeB | Fair: silty clay loam. | Unsuitable: possible source of limestone for crushing. | Poor: limited quantity of suitable material. | Bedrock is at a depth of 16 to 20 inches. | Bedrock is at a depth of 16 to 20 inches. | Limited volume of material. |
| *Lightning: Lg— For the Carytown part of unit Lg, see Carytown series. | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Poor: wetness; high shrink-swell potential. | Poorly to somewhat poorly drained; high shrink-swell potential. | All features favorable. | Fair slope stability; high compressibility. |
| Linker: LkB, LkC, LkC2. | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Fair: limited quantity of suitable material. | Bedrock is at a depth of 30 to 40 inches. | Bedrock is at a depth of 30 to 40 inches. | Limited volume of material. |

See footnotes at end of table.

*of the soils*—Continued

| Soil features affecting—Continued | | | | | Degree and kind of soil limitations for sewage disposal | |
|---|---|---|---|---|---|---|
| Agricultural drainage | Irrigation | Terraces and diversions | Waterways | Foundations for low buildings | Septic tank filter fields | Sewage lagoons |
| Well drained | Moderate available water capacity; moderately slow permeability. | All features favorable. | All features favorable. | All features favorable. | Slight | Slight. |
| Moderately well drained; slow permeability. | Slow permeability; high available water capacity. | All features favorable. | All features favorable. | Moderate shrink-swell potential; water table at a depth of 1 to 2 feet. | Severe: slow permeability; water table at a depth of 1 to 2 feet. | Slight if slopes are 1 to 2 percent; moderate if slopes are 2 to 5 percent. |
| Well drained | Moderate permeability; moderate available water capacity. | Rocks or stones. | Rocks or stones. | All features favorable. | Slight | Moderate: slope. |
| Well drained | Limited root zone; low to moderate available water capacity; rapid permeability. | Bedrock is at a depth of 8 to 20 inches; slopes of 1 to 20 percent. | Bedrock is at a depth of 8 to 20 inches; slopes of 1 to 20 percent. | Bedrock at a depth of 8 to 20 inches. | Severe: bedrock at a depth of 8 to 20 inches. | Severe: bedrock at a depth of 8 to 20 inches. |
| Well drained to moderately well drained; slow permeability. | Limited root zone; slow permeability; moderate available water capacity. | Bedrock is at a depth of 16 to 20 inches. | Bedrock is at a depth of 16 to 20 inches. | Bedrock at a depth of 16 to 20 inches. | Severe: bedrock at a depth of 16 to 20 inches; slow permeability; water table at a depth of 1 to 2 feet. | Severe: bedrock at a depth of 16 to 20 inches. |
| Poorly drained to somewhat poorly drained; very slow permeability. | Very slow permeability; high available water capacity; subject to flooding. | Depressed areas. | Depressed areas. | Subject to flooding; high shrink-swell potential; poorly drained to somewhat poorly drained. | Severe: very slow permeability; water table at a depth of 0 to 1 foot. | Slight. |
| Well drained | Limited root zone; moderately rapid permeability; high available water capacity. | All features favorable. | All features favorable. | All features favorable. | Severe: bedrock at a depth of 30 to 40 inches. | Severe: bedrock at a depth of 30 to 40 inches. |

TABLE 6.—*Engineering interpretations*

| Soil series and map symbols | Suitability as a source of— | | | Soil features affecting— | | |
|---|---|---|---|---|---|---|
| | Topsoil | Sand and gravel | Road fill | Highway location | Farm ponds | |
| | | | | | Reservoir areas | Embankments |
| Lula: LuB, LuC | Fair: limited quantity of suitable material. | Unsuitable: possible source of limestone for crushing. | Fair: moderate shrink-swell potential. | Bedrock is at a depth of 40 to 60 inches; moderate shrink-swell potential. | Bedrock is at a depth of 40 to 60 inches; moderate seepage potential. | Limited volume of material; fair slope stability; medium compressibility. |
| Mine pits and dumps: Mp [1]. | | | | | | |
| Nixa: NcB | Poor: chert fragments. | Unsuitable: possible source of chert for crushing. | Good | All features favorable. | Chert; high seepage potential. | Subject to piping. |
| Okemah: Oe | Fair: Limited quantity of suitable material. | Unsuitable: fine-grained material. | Poor: high shrink-swell potential. | High shrink-swell potential; moderately well drained. | All features favorable. | Limited volume of material. |
| Osage: Os | Fair: silty clay loam. | Unsuitable: fine-grained material. | Poor: high shrink-swell potential. | High shrink-swell potential; poorly drained. | All features favorable. | Clayey material; high volume change; poor compaction. |
| Ot | Fair: silty clay loam. | Unsuitable: fine-grained material. | Poor: high shrink-swell potential. | High shrink-swell potential; poorly drained. | All features favorable. | Clayey material; high volume change; poor compaction. |
| Parsons: PaA | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Poor: high shrink-swell potential. | High shrink-swell potential; low traffic-supporting capacity. | All features favorable. | Clayey material; high volume change; poor compaction. |
| Radley: Ra | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Fair: moderate shrink-swell potential. | Moderate shrink-swell potential; subject to flooding. | Moderate seepage potential. | Fair slope stability; subject to piping. |
| Sallisaw: SaB, SaD | Fair: limited quantity of suitable material. | Fair: gravel at a depth below 30 inches only. | Good | All features favorable. | Moderate seepage potential. | Fair slope stability; subject to piping. |

See footnotes at end of table.

*of the soils*—Continued

| Soil features affecting—Continued | | | | | Degree and kind of soil limitations for sewage disposal | |
|---|---|---|---|---|---|---|
| Agricultural drainage | Irrigation | Terraces and diversions | Waterways | Foundations for low buildings | Septic tank filter fields | Sewage lagoons |
| Well drained | Moderate permeability; high available water capacity. | All features favorable. | All features favorable. | Moderate shrink-swell potential. | Moderate: bedrock at a depth of 40 to 60 inches; moderate permeability. | Moderate: bedrock at a depth of 40 to 60 inches; moderate permeability. |
| Moderately well drained; very slow permeability. | Very slow permeability; moderate available water capacity; fragipan at a depth of 21 to 27 inches. | Short slopes | All features favorable. | All features favorable. | Severe: very slow permeability in upper 21 inches; slight at a depth below 21 inches. | Severe: subject to seepage at a depth below 21 inches. |
| Moderately well drained; slow permeability. | Slow permeability; high available water capacity. | All features favorable. | All features favorable. | High shrink-swell potential. | Severe: water table at a depth of 2 to 3 feet; slow permeability. | Slight. |
| Poorly drained; very slow permeability; subject to flooding. | Very slow permeability; high available water capacity; subject to flooding. | Depressed areas | All features favorable; subject to flooding. | Subject to flooding; poorly drained; high shrink-swell potential. | Severe: very slow permeability; water table at a depth of 1 to 2 feet; subject to flooding. | Slight. |
| Poorly drained; very slow permeability. | Very slow permeability; high available water capacity. | All features favorable. | All features favorable. | High shrink-swell potential; poorly drained. | Severe: very slow permeability; water table at a depth of 1 to 2 feet. | Slight. |
| Somewhat poorly drained to moderately well drained; very slow permeability. | Very slow permeability; high available water capacity. | All features favorable. | All features favorable. | Water table at a depth of 0 to 1 foot; high shrink-swell potential. | Severe: very slow permeability; water table at a depth of 0 to 1 foot. | Slight. |
| Moderately well drained; moderate permeability; subject to flooding. | Moderate permeability; high available water capacity; subject to flooding. | All features favorable; subject to flooding. | All features favorable; subject to flooding. | Subject to flooding. | Moderate: subject to flooding. | Moderate: moderate permeability. |
| Well drained | Moderate permeability; high available water capacity. | All features favorable. | All features favorable. | Moderate shrink-swell potential. | Slight if slopes are 1 to 5 percent; moderate if slopes are 5 to 8 percent. | Moderate: moderate permeability. |

TABLE 6.—*Engineering interpretations*

| Soil series and map symbols | Suitability as a source of— | | | Soil features affecting— | | |
|---|---|---|---|---|---|---|
| | Topsoil | Sand and gravel | Road fill | Highway location | Farm ponds | |
| | | | | | Reservoir areas | Embankments |
| Staser: Sm | Fair: chert fragments. | Fair: gravel at a depth below 16 inches only. | Good | Subject to flooding. | High seepage potential at a depth below 28 inches. | Subject to piping; high seepage potential. |
| Summit: SuA, SuB, SuC, SuC2. | Fair: silty clay loam. | Unsuitable: fine-grained material. | Poor: high shrink-swell potential. | High shrink-swell potential; low traffic-supporting capacity. | All features favorable. | Clayey material; high volume change; poor compaction. |
| Taloka: TaA | Good | Unsuitable: fine-grained material. | Poor: high shrink-swell potential. | High shrink-swell potential; low traffic-supporting capacity. | All features favorable. | Clayey material; high volume change; poor compaction. |
| *Talpa: TlB, TsD. For the Summit part of unit TsD, see Summit series, which is similar except in the Summit soil in unit TsD depth to bedrock averages 30 inches. | Fair: silty clay loam. | Unsuitable: possible source of limestone for crushing. | Poor: limited quantity of suitable material. | Bedrock is at a depth of 5 to 20 inches. | Bedrock is at a depth of 5 to 20 inches. | Limited volume of material. |
| Verdigris [2]: Ve, Vs, Vt | Fair: silty clay loam. | Unsuitable: fine-grained material. | Fair: moderate shrink-swell potential. | Moderate shrink-swell potential; subject to flooding. | Moderate seepage potential. | Fair slope stability; moderate permeability. |
| Vinita. Mapped only in complex with Collinsville soil. | Fair: limited quantity of suitable material. | Unsuitable: fine-grained material. | Poor: high shrink-swell potential. | Bedrock is at a depth of 22 to 40 inches; high shrink-swell potential. | Bedrock is at a depth of 22 to 40 inches. | Limited volume of material; clayey material; poor compaction. |

[1] Interpretations not made because the material is too variable.

*of the soils*—Continued

| Soil features affecting—Continued | | | | | Degree and kind of soil limitations for sewage disposal | |
|---|---|---|---|---|---|---|
| Agricultural drainage | Irrigation | Terraces and diversions | Waterways | Foundations for low buildings | Septic tank filter fields | Sewage lagoons |
| Well drained; subject to flooding. | Moderate to rapid permeability; high available water capacity; subject to flooding. | All features favorable; subject to flooding. | All features favorable; subject to flooding. | Subject to flooding. | Moderate: subject to flooding. | Moderate to severe: moderate to very rapid permeability. |
| Moderately well drained; slow permeability. | Slow permeability; high available water capacity. | All features favorable. | All features favorable. | High shrink-swell potential; water table at a depth of 1 to 2 feet. | Severe: water table at a depth of 1 to 2 feet; slow permeability. | Slight if slopes are 0 to 2 percent; moderate if slopes are 2 to 8 percent. |
| Somewhat poorly drained and moderately well drained; very slow permeability. | Very slow permeability; high available water capacity. | All features favorable. | All features favorable. | High shrink-swell potential; water table at a depth of 1 to 2 feet. | Severe: very slow permeability; water table at a depth of 1 to 2 feet. | Slight. |
| Well drained----- | Limited root zone; low to moderate available water capacity; moderate permeability. | Bedrock is at a depth of 5 to 20 inches. | Bedrock is at a depth of 5 to 20 inches. | Bedrock is at a depth of 5 to 20 inches. | Severe: bedrock is at a depth of 5 to 20 inches. | Severe: bedrock is at a depth of 5 to 20 inches. |
| Moderately well drained; subject to flooding; moderate permeability. | Moderate permeability; high available water capacity; subject to flooding. | All features favorable; subject to flooding. | All features favorable; subject to flooding. | Subject to flooding. | Moderate: subject to flooding. | Moderate: moderate permeability. |
| Moderately well drained; slow permeability. | Slow permeability; high available water capacity. | Slopes of 2 to 30 percent. | Slopes of 2 to 30 percent. | Slopes of 2 to 30 percent; high shrink-swell potential. | Severe: bedrock at a depth of 22 to 40 inches; slow permeability; water table at a depth of 1 to to 2 feet. | Severe: bedrock at a depth of 22 to 40 inches. |

[2] Interpretations not made for Breaks part of mapping unit Vt because the material is too variable.

TABLE 7—*Engineering*

[Tests performed by the Oklahoma Department of Highways in accordance with standard

| Soil name and location | Parent material | Oklahoma report No. | Depth from surface | Shrinkage | | Volume change from field moisture equivalent |
|---|---|---|---|---|---|---|
| | | | | Limit | Ratio | |
| | | *SO–* | *Inches* | *Percent* | | *Percent* |
| Craig silt loam: | | | | | | |
| 0.4 mile S. of NE. corner of sec. 11, T. 24 N., R. 21 E. (modal). | Cherty limestone. | 9452 | 0–14 | 19 | 1. 72 | 21 |
| | | 9453 | 14–20 | 12 | 1. 81 | 36 |
| | | 9454 | 40–50 | 14 | 1. 88 | 60 |
| Lightning silt loam: | | | | | | |
| 2,600 feet W. of NE. corner of sec. 25, T. 25 N., R. 20 E. (modal). | Clayey sediment. | 9440 | 0–6 | 23 | 1. 68 | 19 |
| | | 9441 | 14–40 | 14 | 1. 87 | 48 |
| | | 9442 | 40–54 | 11 | 2. 01 | 54 |
| Linker fine sandy loam: | | | | | | |
| SE. corner of sec. 30, T. 24 N., R. 19 E. (modal). | Sandstone. | 9446 | 0–4 | 21 | 1. 72 | 4 |
| | | 9447 | 9–24 | 15 | 1. 90 | 22 |
| | | 9448 | 24–28 | 19 | 1. 73 | 19 |
| Osage silty clay loam, uplands: | | | | | | |
| 150 yards W. of SE. corner of sec. 14, T. 25 N., R. 21 E. (modal). | Clayey sediment. | 9443 | 0–7 | 11 | 1. 95 | 68 |
| | | 9444 | 7–28 | 10 | 2. 02 | 81 |
| | | 9445 | 28–40 | 8 | 2. 06 | 84 |
| Radley silt loam: | | | | | | |
| 850 feet S. of NW. corner of sec. 27, T. 29 N., R. 18 E. (modal). | Loamy sediment. | 9461 | 0–6 | 19 | 1. 70 | 10 |
| | | 9462 | 24–48 | 12 | 1. 93 | 48 |
| Summit silty clay loam: | | | | | | |
| 0.4 mile E. of SW. corner of sec. 34, T. 24 N., R. 20 E. (modal). | Limestone and shale. | 9449 | 0–11 | 16 | 1. 79 | 46 |
| | | 9450 | 15–24 | 11 | 1. 99 | 69 |
| | | 9451 | 24–36 | 10 | 2. 05 | 71 |
| Taloka silt loam: | | | | | | |
| 1,320 feet S. of NE. corner of sec. 17, T. 24 N., R. 20 E. (modal). | Loamy sediment. | 9455 | 0–16 | 24 | 1. 58 | 14 |
| | | 9456 | 20–33 | 11 | 1. 94 | 65 |
| | | 9457 | 33–42 | 10 | 2. 00 | 72 |

[1] Mechanical analyses according to the AASHO Designation T 88–57 (*1*). Results by this procedure frequently may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes for soil.

*test data*

procedures of the American Association of State Highway Officials (AASHO) (*1*)]

| Mechanical analyses [1] | | | | | | | Liquid limit | Plasticity index | Classification | |
|---|---|---|---|---|---|---|---|---|---|---|
| Percentage passing sieve— [2] | | | | Percentage smaller than— | | | | | AASHO [3] | Unified |
| No. 4 (4.7 mm.) | No. 10 (2.0 mm.) | No. 40 (0.42 mm.) | No. 200 (0.074 mm.) | 0.05 mm. | 0.005 mm. | 0.002 mm. | | | | |
| 94 | 92 | 89 | 82 | 75 | 21 | 16 | 32 | 9 | A–4(8) | ML–CL |
| 94 | 90 | 88 | 81 | 76 | 28 | 22 | 33 | 11 | A–6(8) | ML–CL |
| 63 | 52 | 48 | 43 | 37 | 20 | 17 | 49 | 20 | A–7–6(5) | GM–GC |
| 100 | 100 | 98 | 94 | 85 | 25 | 14 | 35 | 10 | A–4(8) | ML–CL |
| 100 | 100 | 98 | 96 | 93 | 49 | 39 | 48 | 23 | A–7–6(15) | CL |
| 100 | 100 | 100 | 98 | 90 | 46 | 36 | 57 | 34 | A–7–6(19) | CH |
| 97 | 94 | 86 | 59 | 51 | 12 | 7 | 26 | 4 | A–4(5) | ML–CL |
| 97 | 92 | 85 | 60 | 53 | 22 | 18 | 27 | 9 | A–4(5) | CL |
| 87 | 79 | 71 | 47 | 42 | 20 | 17 | 29 | 9 | A–4(2) | SC |
| 100 | 100 | 98 | 97 | 90 | 46 | 38 | 56 | 29 | A–7–6(19) | CH |
| 100 | 100 | 100 | 97 | 92 | 55 | 48 | 70 | 41 | A–7–6(20) | CH |
| 100 | 100 | 100 | 98 | 93 | 54 | 50 | 74 | 45 | A–7–6(20) | CH |
| 100 | 100 | 99 | 95 | 85 | 18 | 10 | 29 | 6 | A–4(8) | ML–CL |
| 100 | 100 | 100 | 99 | 92 | 38 | 30 | 43 | 22 | A–7–6(13) | CL |
| 100 | 100 | 99 | 95 | 83 | 29 | 23 | 45 | 19 | A–7–6(13) | ML–CL |
| 100 | 100 | 98 | 96 | 88 | 45 | 41 | 55 | 30 | A–7–6(19) | CH |
| 100 | 100 | 99 | 97 | 90 | 50 | 45 | 60 | 35 | A–7–6(20) | CH |
| 100 | 100 | 100 | 96 | 87 | 19 | 11 | 34 | 6 | A–4(8) | ML |
| 100 | 100 | 100 | 97 | 87 | 49 | 41 | 66 | 35 | A–7–5(20) | MH–CH |
| 100 | 100 | 100 | 97 | 87 | 52 | 44 | 65 | 38 | A–7–6(20) | CH |

[2] Material more than 3 inches in diameter was excluded in the estimates.

[3] Based on AASHO Designation M 145–49 (*1*). Oklahoma Department of Highways classification procedure further subdivides the AASHO A–2–4 subgroup as follows: A–2–3(0) if plasticity index=nonplastic; A–2(0) if plasticity index=nonplastic to 5; and A–2–4(0) if plasticity index=5 to 10.

*Reaction* is expressed in terms of pH value. A pH of 4.5 to 5.0 indicates very strong acidity, and a pH of 9.1 or higher indicates very strong alkalinity.

The *shrink-swell potential* indicates the change in volume to be expected when the moisture content changes. It is estimated primarily on the amount and kind of clay in a soil.

For the *hydrologic soil group*, the entire thickness of the soil profile shown in the table is considered. The soils are classified in four hydrologic groups—A, B, C, and D. The basis of the grouping is intake of water at the end of a long-duration storm, after prior wetting and opportunity for swelling, without consideration of the protective effect of vegetation. Group A consists mostly of sandy soils that have the lowest runoff potential. None of the soils of Craig County is in group A. Group D consists mostly of clays that have the highest runoff potential.

### *Engineering interpretations*

Table 6 gives engineering interpretations of the soils and estimates of their suitability for engineering uses. The data applies to the soil considered representative of the series. A detailed profile typical of each series is described in the section "Descriptions of the Soils." Some soil features are favorable for certain kinds of engineering work but unfavorable for others. The following are explanations of the columns in table 6.

*Topsoil* is the soil material used to cover or resurface an area where vegetation is to be established and maintained. Properties considered are those that affect the productivity and workability of the soil material and the amount of suitable material available.

*Sand and Gravel* ratings are based on the probability that delineated areas of the soil contain deposits of sand and gravel. Depending on their quality, these materials are commonly used for filters, drains, aggregate for concrete, or granular subbase. The property considered is the sieve size of soil material within the soil and to a predictable depth below the soil.

*Roadfill*, or subgrade, is the soil material on which a subbase is laid and the pavement is built. Suitability ratings are based on the performance of the soil material as subgrade when excavated and compacted or compacted and used in place.

*Highway location* refers to trafficways that consist of the underlying local soil material called the subgrade, the base material of gravel; crushed rock, or cement-stabilized soil called the subbase; and the actual road surface or pavement, either flexible or rigid.

Farm-pond *reservoir areas* are areas behind a dam or embankment where water is collected and stored for use. The floor of the reservoir area is normally undisturbed except where soil material can be borrowed for embankment construction.

Farm-pond *embankments* are raised structures of soil material constructed across drainageways to impound water. These embankments are generally less than 20 feet high, are constructed of "homogeneous" soil material, and are compacted to medium density.

*Agricultural drainage* is the removal of excess water by means of landforming, ditching, or land smoothing. In the case of subsurface drainage, underground tile is used.

*Irrigation* is the artificial application of water to cropland by a sprinkler system or by overland flow.

*Terraces* are low ridges or channels constructed on the approximate contour to divert runoff water to a safe disposal area.

A *waterway* is a constructed or natural drainageway established to a suitable vegetation for the purpose of conveying excess water.

*Foundations for low buildings* are footings and shallow piers for houses and other low buildings no higher than three stories.

*Septic tank filter fields* are the subsurface tile systems that distribute effluent from a septic tank into the natural soil. The properties that affect absorption are permeability, depth to water table or rock, and flooding.

*Sewage Lagoons* are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet for the time required for bacterial decomposition of solids. The lagoon consists of a nearly level floor and an embankment or dike that forms the sides of the pond.

### *Engineering test data*

Table 7 gives test data for samples of seven of the soil series of the county. Selected layers of the soils were sampled and tested by the Oklahoma Department of Highways. The samples tested were from profiles considered modal for the series. They do not represent all of the soils of Craig County, or even the maximum range of characteristics of each series sampled.

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

*Shrinkage limit* is the percent moisture at which a soil ceases to decrease in volume, even though additional moisture is removed.

*Shrinkage ratio* is the volume change, expressed as the percentage of the volume of dry soil material, divided by the loss of moisture caused by drying. This ratio is expressed numerically.

*Mechanical analyses* show the percentages, by weight, of soil particles that would pass through sieves of specified sizes. Sand and other coarser materials do not pass through the No. 200 sieve. Silt and clay do pass through the No. 200 sieve. Silt is that material larger than 0.002 millimeter in diameter that passes through the No. 200 sieve, and clay is that fraction passing through the No. 200 sieve that is smaller than 0.002 millimeter in diameter. The clay fraction was determined by the hydrometer method, rather than the pipette method, which most soil scientists use in determining the clay in soil samples.

*Liquid limit and plasticity index* indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a

dry state, the material changes from solid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from solid to plastic. The liquid limit is the moisture content at which the material changes from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material remains plastic.

# *Formation and Classification of Soils*

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

## Factors of Soil Formation

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

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

Soils on the uplands of Craig County formed from material weathered from sandstone, limestone, and shale laid down during the Pennsylvanian geologic period. Soils of the Bates, Collinsville, Hector, and Linker series are examples of soils that formed in material weathered from sandstone. The Talpa, Summit, and Lula series are examples of soils that formed in material weathered from limestone. Carytown, Cherokee, and Vinita series are examples of soils that formed in material weathered from shale.

Alluvial sediment is extensive along the streams and rivers of the county. The kind of sediment deposited and the kinds of soil that formed in it depend largely on the source of the sediment and the velocity of the floodwaters. Verdigris soils formed from the loamy sediment dropped near the streambed when these streams overflowed. Osage soils formed in clayey sediment dropped from slow-moving water at the outer edges of the flood plains.

*Climate.*—Craig County has a warm, temperate climate. Precipitation is adequate for rapid leaching and plant growth. The climate is fairly uniform throughout the county, and differences among the soils cannot be attributed to differences in climate.

*Plants and animals.*—Plants, burrowing animals, insects, and soil micro-organisms have a direct influence on the formation of soils. The native grasses and the trees in the county have had different effects on the losses and gains of organic matter and plant nutrients, and on soil structure and porosity. Soils that formed under prairie vegetation, such as those of the Summit series, have a dark-colored surface layer and moderately high organic-matter content. Soils that formed under trees, such as those of the Linker series, have a lighter colored surface layer and moderate organic-matter content.

*Relief.*—Relief has influenced the formation of the soils mainly through its effect on the movement of water, erosion, soil temperature, and the kind of plant cover. In Craig County relief is determined largely by the resistance of underlying formations to weathering and geological erosion. About 11 percent of the acreage in Craig County is nearly level soils on bottom lands, and about 89 percent of the soil is nearly level to steep soils on uplands.

Hector and Linker soils formed from similar sandstone parent material, but their development has been controlled to a large extent by relief. The moderately deep Linker soils are less sloping than the shallow and very shallow Hector soils.

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

The soils of Craig County range from young to old. Some of the old, mature soils are Cherokee, Parsons, and Taloka soils on uplands. The Bates and Linker soils are younger, but they have well-expressed soil horizons. The Collinsville, Hector, and Talpa soils are considered young soils. They have had sufficient time to develop well-expressed horizons, but because they are sloping, geological erosion has taken away soil material almost as fast as it formed. The Osage, Staser, and Verdigris soils are on bottom lands and have been developing for such a short time that they show little horizon development.

## Processes of Soil Formation

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

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

The A horizon is the surface layer. The A1 horizon is a division of the surface layer in which there is an accumulation of organic matter. The A2 horizon is a division that is lighter colored and strongly leached of bases. Many of the soils of this county, such as those of the Parsons series, have both A1 and A2 horizons.

The B horizon is the mineral horizon below the A horizon, generally called the subsoil. In the older soils of the county, such as those of the Parsons series, this is the horizon of maximum accumulation of silicate clay. The younger soils of the county, such as those of the Verdigris series, do not have a B horizon.

The C horizon is weathered rock material. It has been little affected by soil-forming processes but may have been modified by reduction of iron or accumulation of calcium carbonates.

The R layer is consolidated bedrock.

## Classification of Soils

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

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and later revised (*4*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in development of this system should search the latest literature available (*3*, *6*). In table 8 the soil series represented in Craig County are placed in higher categories of the current system. The classes of the current system are briefly defined in the paragraphs that follow.

ORDER: Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groups. The two exceptions, Entisols and Histosols, occur in many different climates.

Table 8 lists the four soil orders represented in Craig County—Ultisols, Inceptisols, Mollisols, and Alfisols.

SUBORDER: Each order is divided into suborders, primarily on the basis of those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborder narrows the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation.

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans interfering with growth of roots or movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown in table 8, because it is the last word in the name of the subgroup.

SUBGROUP: Great groups are divided into subgroups, one that represents the central (typic) segment of the group and others, called intergrades, that have properties of one group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Argiudolls (typical Argiudolls).

FAMILY: Families are separated within the subgroup primarily on the basis of properties important to growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

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

# *General Nature of the County*

Additional information about the county is given in this section. This information will be useful to persons not familiar with Craig County. Briefly discussed are settlement and development of the county, transportation and industry, natural resources, climate, relief and drainage, and farming.

The first permanent residents of the area now known as Craig County were the Cherokee Indians who came over the Trail of Tears to their part of Indian Territory. Indians of other tribes came later. Until the railroads were built in 1871, there were few white men except those men who drove their cattle to markets in Kansas and Missouri.

The land was allotted to the Indians. The sale of allotted land was restricted during the time it remained the property of the original allottee, but the land could be leased subject to the supervision of the Indian Agency, and this helped to increase the number of white settlers. Most of the early settlers were cattlemen whose cattle grazed on the lush grass. In the prairies the grass was said to be so tall it hid small animals and often hid men on horseback.

As the population increased, the farming became more intensive. Cultivated crops have been grown on about 50 percent of the acreage in the county. The other 50 percent remains in native grass.

Vinita is the county seat of Craig County. Other towns are Welch, Bluejacket, Centralia, Big Cabin, and Ketchum.

TABLE 8.—*Classification of the soil series of Craig County*

| Series | Family | Subgroup | Order |
|---|---|---|---|
| Bates [1] | Fine-loamy, siliceous, mixed, thermic | Typic Argiudolls | Mollisols. |
| Bonham [2] | Fine, mixed, thermic | Aquic Argiudolls | Mollisols. |
| Carytown | Fine, mixed, thermic | Albic Natraqualfs | Alfisols. |
| Cherokee | Fine, mixed, thermic | Typic Albaqualfs | Alfisols. |
| Choteau | Fine, mixed, thermic | Aquic Paleudolls | Mollisols. |
| Claremore, moderately shallow variant. | Fine-silty, mixed, thermic | Typic Argiudolls | Mollisols. |
| Clarksville | Loamy-skeletal, siliceous, mixed, mesic | Typic Paleudults | Ultisols. |
| Collinsville | Loamy, siliceous, thermic | Lithic Hapludolls | Mollisols. |
| Craig | Clayey-skeletal, mixed, thermic | Mollic Paleudalfs | Alfisols. |
| Dennis [3] | Fine, mixed, thermic | Aquic Paleudolls | Mollisols. |
| Eldorado | Loamy-skeletal, mixed, thermic | Typic Paleudolls | Mollisols. |
| Hector | Loamy, siliceous, thermic | Lithic Dystrochrepts | Inceptisols. |
| Lenapah | Clayey, montmorillonitic, thermic | Lithic Vertic, Argiustolls | Mollisols. |
| Lightning | Fine, mixed, thermic | Typic Ochraqualfs | Alfisols. |
| Linker | Fine-loamy, siliceous, thermic | Typic Hapludults | Ultisols. |
| Lula | Fine-silty, mixed, thermic | Typic Argiudolls | Mollisols. |
| Nixa [4] | Loamy-skeletal, siliceous, mesic | Ochreptic Fragiudults | Ultisols. |
| Okemah [5] | Fine, mixed, thermic | Aquic Paleudolls | Mollisols. |
| Osage | Fine, montmorillonitic, noncalcareous, thermic. | Vertic Haplaquolls | Mollisols. |
| Parsons | Fine, mixed, thermic | Mollic Albaqualfs | Alfisols. |
| Radley | Fine-silty, mixed, thermic | Fluventic Hapludolls | Mollisols. |
| Sallisaw | Fine-loamy, mixed, thermic | Typic Paleudalfs | Alfisols. |
| Staser | Fine-loamy, mixed, thermic | Cumulic Hapludolls | Mollisols. |
| Summit [6] | Fine, montmorillonitic, thermic | Vertic Argiudolls | Mollisols. |
| Taloka | Fine, mixed, thermic | Mollic Albaqualfs | Alfisols. |
| Talpa [7] | Loamy, mixed, thermic | Lithic Haplustolls | Mollisols. |
| Verdigris | Fine-silty, mixed, thermic | Cumulic Hapludolls | Mollisols. |
| Vinita | Clayey, mixed, thermic | Aquic Hapludults | Ultisols. |

[1] Mapping unit BaC2 is a taxadjunct to the Bates Series. Less than one-half of the mapping unit has color and thickness requirements necessary for mollic epipedon because of thinning of the A horizon by erosion. The soil is enough like the Bates series in morphology, composition, and behavior so that a new series is not warranted.

[2] These soils differ from the Bonham series because they have limestone rock at a depth of 40 to 60 inches. They are similar to the Bonham series in morphology, composition, and behavior.

[3] Mapping units DnC2 and DsC3 are taxadjuncts to the Dennis series. Less than one-half of the mapping units have color and thickness requirements necessary for mollic epipedons because of thinning of the A horizon by erosion. These soils are enough like the Dennis series in morphology, composition, and behavior so that a new series is not warranted.

[4] These soils are taxadjuncts to the Nixa series. They differ by having mottles that are higher in the profile and redder B horizons than is typical for the Nixa series. They are enough like the Nixa series in morphology, composition, and behavior so that a new series is not warranted.

[5] These soils are taxadjuncts to the Okemah series. They differ by having limestone rock at a depth of 40 to 60 inches. These soils are enough like the Okemah series in morphology, composition, and behavior so that a new series is not warranted.

[6] The Summit soils in mapping unit TsD are taxadjuncts to the Summit series. They differ by having limestone at a depth of less than 40 inches. They are enough like the Summit series in morphology, composition, and behavior so that a new series is not warranted.

[7] These soils are taxadjuncts to the Talpa series. They differ by not being calcareous. They are enough like the Talpa series in morphology, composition, and behavior so that a new series is not warranted.

Two railroads serve the county. One is an east-west line; the other runs north and south. Passenger bus service and freight trucking facilities are also available in the county, and a landing strip for private planes is near Vinita. A network of Federal and State highways gives access to all parts of the country. In farm areas all-weather roads, mainly on section lines, provide access to highways.

Farming is the county's leading industry. Coal strip mining is also important. There is a furniture manufacturing plant, and there are other small industries.

Important natural resources of Craig County include water, coal, gravel, timber, and limestone. The water supply for Vinita and Big Cabin is from the Lake of the Cherokees. Water for the other towns comes from wells. Much of the well water in the county is hard and contains sulphur or other minerals that give it a disagreeable taste. Water for livestock is furnished by wells, streams, or farm ponds.

Coal is taken from strip pits mostly in the western part of the county. Most of it is shipped out by rail or truck to manufacturing areas. Most of the timber on the uplands has been cut over, and little is harvested. Most of the sawtimber is hardwoods such as walnut, taken from bottom lands. Gravel is taken from the southeast part of the county. It is used mostly for roads. Limestone is plentiful. There are several small quarries where limestone has been taken for use in surfacing roads. This material is not being processed for use as lime for farm use in Craig County.

## Climate [7]

The location of Craig County in the Prairie Plains region of northeast Oklahoma provides a temperate, continental climate. Gradual changes between the definite seasons are often marked by significant variations in daily and seasonal weather. The mild winters provide several brief periods of low temperatures and moderate snow cover. Spring is a season of variable weather, as noted by the greatest amounts and intensities of precipitation and the most frequent occurrences of severe local storms and tornadoes. Summers are long and hot. Moderate winds and showers or thunderstorms help to make the hot summer days more pleasant. A secondary maximum of precipitation occurs early in fall and is followed by many pleasant, sunny days and cool nights. Table 9 summarizes the records of temperature and precipitation at Vinita.

Vinita records show January as the coldest month. Average daily minimum temperature is below freezing 1 year out of 5. The coldest day each year averages slightly above zero and has ranged from 13°F. in 1952 and 1921 down to the record low for the State, −27° in February 1905. Summer temperatures reach 90° and above 77 days a year, and they reach 100° or above on an average of 17 days a year. The hottest day each year averages 105°. In only 1 year out of 7, the temperature fails to reach the 100° mark.

Table 10 gives probabilities, by specified dates, for the last freezing temperature in spring and the first freezing temperature in fall. The freeze-free season averages from 195 days in the southeast corner of the county to 205 days along the southwest border. Last spring freezes have varied from March 21 in 1943 to May 8 in 1923; first fall freezes have varied from September 20 in 1938 to November 21 in 1944.

The seasonal distribution of precipitation provides about 13 percent of the moisture in winter, 32 percent in spring, 30 percent in summer, and 25 percent in fall. Records dating back to 1895 show that annual precipitation has ranged from 20.76 inches in 1963 to 75.36 inches in 1941. The greatest monthly total was 20.95 inches in May 1943. Daily totals of a half inch or more occur on an average of 28 days per year; 1 inch or more is recorded 12 days a year. In 2 years out of 3, there is a wet day on which 3 to 6 inches of rain is recorded. Four such days were recorded in 1941. The wettest day was June 6, 1935, on which 7.17 inches were recorded.

Six to nine days of snow each winter provides a seasonal average of 8.7 inches and accounts for 8 percent of the winter moisture. In 1 year out of 8 over 10 inches of snow falls during the winter months. The greatest amount was 17.5 inches in February 1905. Snow cover usually melts within 2 to 5 days. In January 1930 a total of 16 inches of snow fell in 6 days and required 25 days to melt. This snow maintained a record 14-inch depth for 4 days, and 8 days of subzero temperatures froze the soil to a depth of 9.5 inches. A low of −26° was recorded in this period.

[7] By STANLEY HOLBROOK, climatologist for Oklahoma, National Weather Service, U.S. Department of Commerce.

Winds are generally from the south except late in winter when northerly winds predominate. The possibility of sunshine ranges from about 52 percent in January to 73 percent in August. An average year has 126 clear days, 103 partly cloudy days, and 136 cloudy days. Annual lake evaporation averages 49 inches; 72 percent of this total occurs in the period May through October.

Thunderstorms number about 54 a year, and a few of these include damaging surface winds of 60 to 80 miles per hour. Severe hailstorms hit in the county on an average of 1 year out of 3. The width of the hail paths averages 4 miles. Paths as long as 15 to 35 miles were noted for only half of these storms. The past 94 years of record show that 29 tornadoes have struck in the county in 13 different years. Damages have exceeded $20,000 in only seven of these, no deaths have occurred, and very few persons have been injured.

## Relief and Drainage

The topography of Craig County is nearly level to steep. The general slope is from north to south. Most of the county is drained by Big Cabin Creek and its tributaries. This creek flows to the south into Mayes County where it empties into Grand River. A small part of the west side of the county drains into Big Creek, which flows to the Verdigris River in Nowata County.

Craig County has three general types of areas: the prairie area, the timbered sandstone area, and the cherty limestone area, which is partly prairie and partly timbered. The main part of the county is prairie. In this area the soils were formed from shale, sandstone, or limestone.

Slopes in the prairie areas are dominantly very gently sloping, but smaller acreages of soils in these areas are nearly level to steep. Flood plains along the creeks are nearly level and range from 200 feet to 1 mile wide. A sizable acreage in the flood plain is moderately well drained.

## Farming

About 75 percent of the acreage in Craig County is suited to farming. In 1964 about 88 percent of the county, or 431,819 acres, was in farms. Of this acreage, 97,886 acres was harvested cropland and 260,453 was pasture, including woodland pasture.

The trend is toward fewer and larger farms. In 1959 there were 1,336 farms, and the average size was 314 acres. In 1964 there were 1,324 farms, and the average size was 326 acres.

Reports from farmers in the county in 1964 showed 137 cash-grain farms, 89 dairy farms, 432 livestock farms other than poultry and dairy, 94 livestock ranches, 82 general farms, and 572 miscellaneous and unclassified farms.

The main farming enterprises are the raising of livestock and production crops. The main cash crops are wheat, grain sorghum, and soybeans. A large acreage of native hay is harvested each year. According to the U.S. Census

TABLE 9.—*Temperature and precipitation data*

[All data from Vinita; period of record, 1938–67]

| Month | Temperature | | | | Precipitation | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average daily maximum | Average daily minimum | Average maximum | Average minimum | Average total | One year in 10 will have— | | Days with snow cover of 1 inch or more | Average depth of snow on days with snow cover |
| | | | | | | Less than— | More than— | | |
| | °F. | °F. | °F. | °F. | *Inches* | *Inches* | *Inches* | *Number* | *Number* |
| January | 48 | 25 | 69 | 4 | 1.6 | 0.7 | 3.5 | 3 | 2 |
| February | 53 | 29 | 73 | 11 | 2.1 | .9 | 3.9 | 3 | 2 |
| March | 61 | 36 | 81 | 16 | 2.9 | 1.0 | 6.2 | 1 | 3 |
| April | 72 | 48 | 87 | 29 | 4.5 | 1.4 | 9.2 | (1) | 2 |
| May | 80 | 56 | 90 | 39 | 6.2 | 2.6 | 14.2 | 0 | |
| June | 88 | 65 | 96 | 52 | 5.9 | 1.4 | 11.8 | 0 | |
| July | 94 | 68 | 102 | 57 | 3.4 | .9 | 9.4 | 0 | |
| August | 94 | 67 | 104 | 54 | 3.8 | 1.3 | 7.1 | 0 | |
| September | 87 | 59 | 99 | 41 | 4.8 | .2 | 11.3 | 0 | |
| October | 77 | 48 | 90 | 30 | 3.5 | .2 | 7.0 | 0 | |
| November | 61 | 36 | 79 | 17 | 2.4 | .3 | 5.3 | (1) | 2 |
| December | 51 | 28 | 70 | 9 | 1.9 | .6 | 3.4 | 1 | 2 |
| Year | 72 | 47 | [2] 105 | [3] 0 | 43.0 | 28.1 | 58.0 | 8 | 2 |

[1] Less than one-half day. [2] Average annual maximum. [3] Average annual minimum.

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

[All Data from Vinita; period of record, 1921–50]

| Probability | Dates for given probability and temperature | | | | |
|---|---|---|---|---|---|
| | 16°F. | 20°F. | 24°F. | 28°F. | 32°F. |
| Spring: | | | | | |
| 1 year in 10, later than | March 8 | March 22 | April 6 | April 12 | April 24 |
| 2 years in 10, later than | March 1 | March 16 | March 31 | April 8 | April 19 |
| 5 years in 10, later than | February 15 | March 5 | March 19 | March 29 | April 9 |
| Fall: | | | | | |
| 1 year in 10, earlier than | November 21 | November 11 | October 24 | October 19 | October 6 |
| 2 years in 10, earlier than | November 28 | November 17 | October 31 | October 24 | October 13 |
| 5 years in 10, earlier than | December 11 | November 28 | November 13 | November 1 | October 25 |

of Agriculture, the acreage of principal crops in 1964 was as follows:

| *Crops* | *Acres* |
|---|---|
| Small grain harvested: | |
| Wheat | 14,367 |
| Oats | 5,538 |
| Barley | 706 |
| Rye | 410 |
| Sorghum, all purpose | 16,084 |
| Corn, all purpose | 4,507 |
| Soybeans, all purpose | 14,197 |
| Hay crops: | |
| Native hay cut | 30,839 |
| Lespedeza cut for hay | 4,666 |
| Small grain cut for hay | 721 |
| Alfalfa and alfalfa mixture | 633 |

In 1964 the sale of livestock and livestock products in the county provided 81 percent of the farm income. According to the U.S. Census of Agriculture, the number of livestock in 1964 was as follows:

| *Livestock* | *Total No.* |
|---|---|
| All cattle and calves | 76,991 |
| Milk cows | 3,673 |
| Hogs and pigs | 4,525 |
| Sheep and lambs | 2,079 |
| Chickens 4 months old or older | 39,135 |

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# Glossary

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

**Alkali soil.** Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

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

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

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

**Channery soil.** A soil that contains thin, flat fragments of sandstone, limestone, or schist, as much as 6 inches in length along the longer axis. A single piece is called a fragment.

**Chiseling.** Tillage of soil with an implement having one or more soil penetrating points that loosen the subsoil and brings *clods* to the surface. A form of emerging tillage to control soil blowing.

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

**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.

**Colluvium.** Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

*Loose.*—Noncoherent when dry or moist; does not hold together in a mass.

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

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

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

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

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

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

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

**Contour farming.** Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

**Erosion.** The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

**Erosion pavement.** A layer of gravel or stones on the ground surface that remains after the fine particles are removed by wind or water. Desert pavements result from exposure to dry winds.

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

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

**Forb.** Any herbaceous plant, neither a grass nor a sedge, that is grazed on western ranges.

**Gleization.** The reduction, translocation, and segregation of soil compounds, notably of iron, usually in the lower horizons, as a result of water-logging with poor aeration and drainage; expressed in the soil by mottled colors dominated by gray. The soil-forming processes leading to the development of a gley soil.

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

**Gypsum.** Calcium suphate.

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

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

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

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

*C horizon.*—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

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

**Humus.** The well-decomposed, more or less stable part of the organic matter in mineral soils.

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

**Ped.** An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

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

**pH value.** A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

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

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

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

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

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

**Residual material.** Unconsolidated, partly weathered material that accumulates over disintegrating solid rock. Residual material is not soil but is frequently the material in which a soil has formed.

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

**Silt.** Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

**Slickensides.** Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

**Slick spots.** Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

**Slope, soil.** The amount of rise or fall in feet for each 100 feet of horizontal distance, expressed as follows:

| | *Percent* |
|---|---|
| Nearly level | 0 to 1 |
| Very gently sloping | 1 to 3 |
| Gently sloping | 3 to 5 |
| Sloping | 5 to 8 |
| Strongly sloping | 8 to 12 |
| Moderately steep | 12 to 20 |
| Steep | 20+ |

**Soil.** A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

**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).

**Soil variant.** A soil having properties sufficiently different from those other known soils to suggest establishing a new soil series, but a soil of such limited known area that creation of a new series is not believed to be justified.

**Solum.** The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

**Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Substratum.** Technically, the part of the soil below the solum.

**Subsurface layer.** That part of the A horizon below the surface layer. In soils of weak profile development the subsurface layer can be defined only in terms of arbitrary 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.

**Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoffs so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

**Terrace** (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Tilth, soil.** The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

**Trace elements.** The chemical elements found in soils in extremely small amounts, yet which are essential to plant growth. Some of the trace elements are zinc, cobalt, manganese, copper, and iron.

**Type, soil.** A subdivision of the soil series that is made on the basis of differences in the texture of the surface layer.

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