United States
Department of
Agriculture

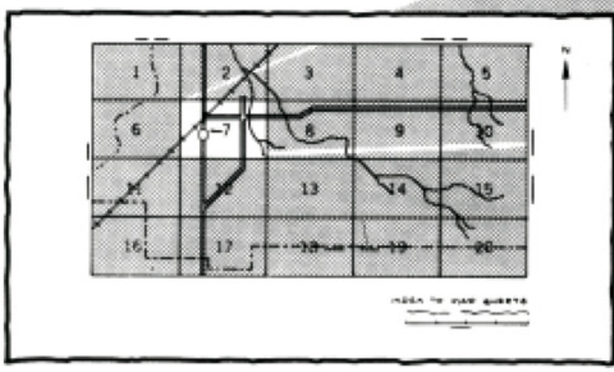
Soil
Conservation
Service

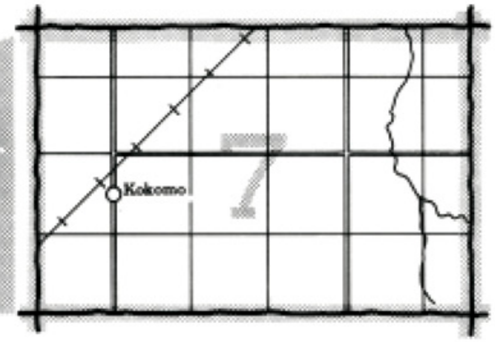
In cooperation with
Kansas Agricultural
Experiment Station

Soil Survey of Coffey County Kansas

HOW TO USE

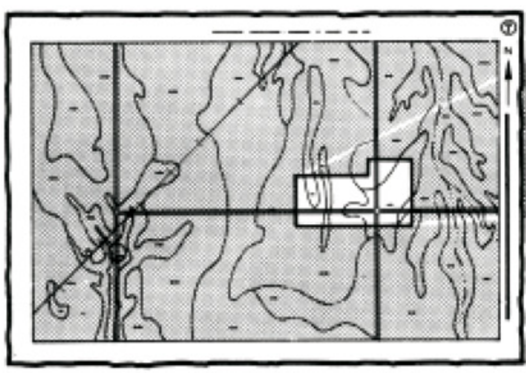
1. Locate your area of interest on the "Index to Map Sheets"

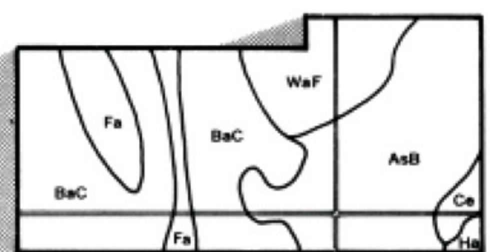




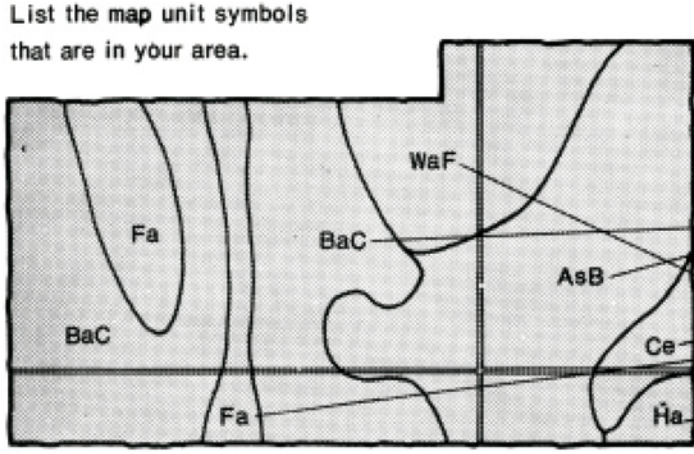
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the map unit symbols that are in your area.

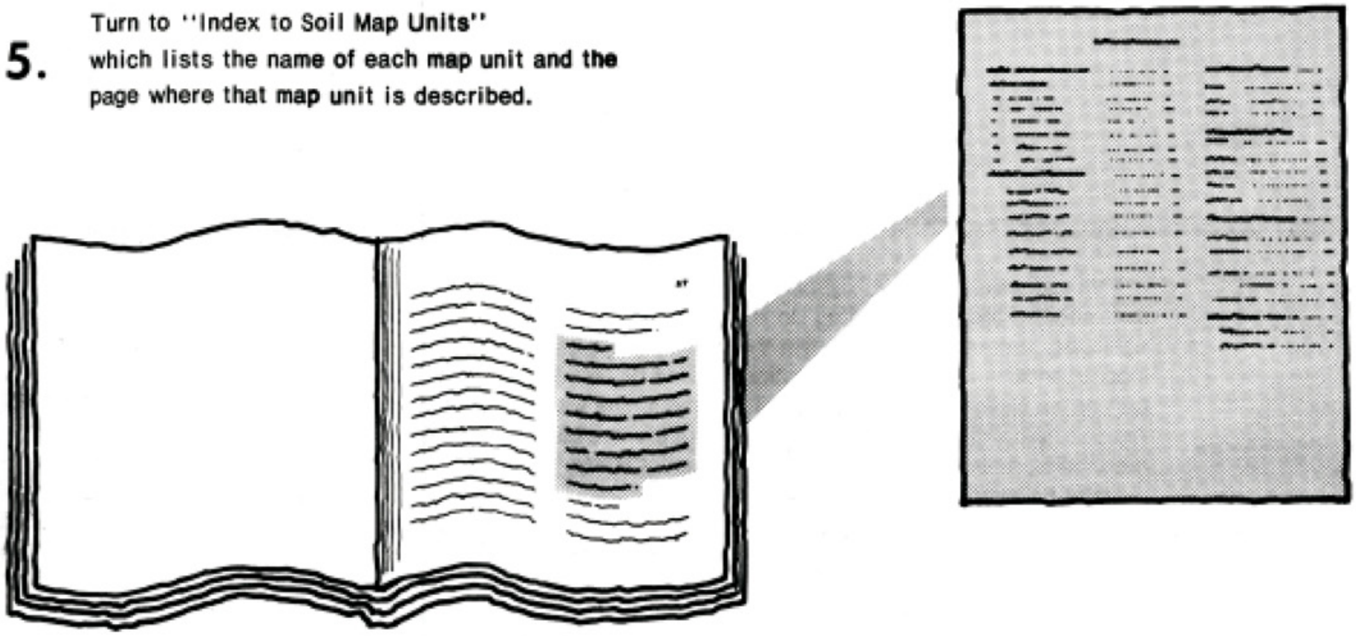


Symbols

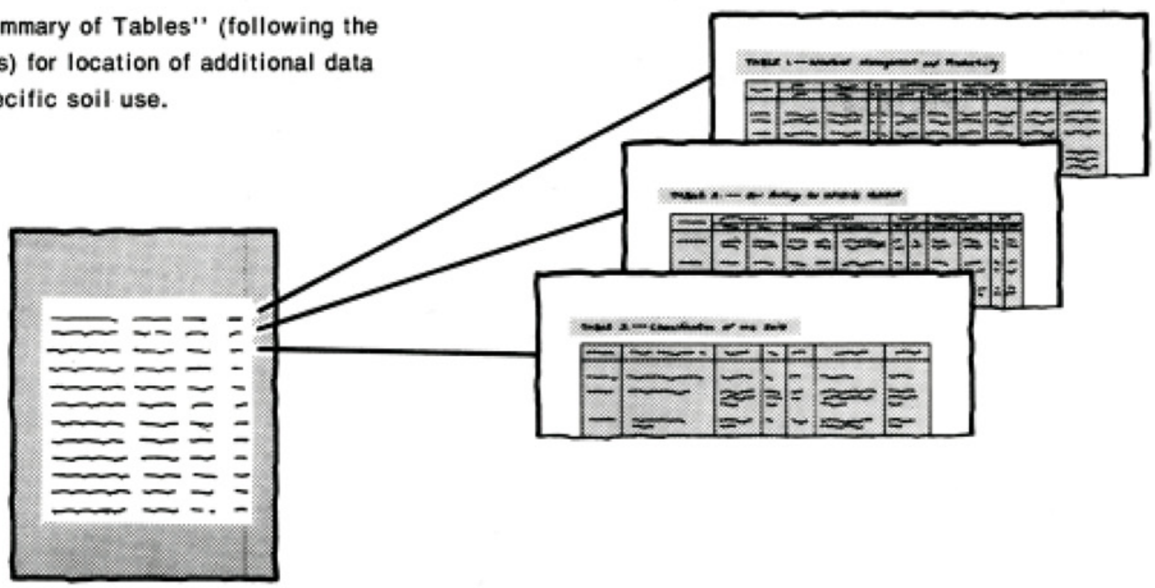
AsB
BaC
Ce
Fa
Ha
WaF

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1973-1979. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Coffey County Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Water is supplied to Coffey County from lakes of the Frog Creek Watershed.

contents

soil series

Issued June 1982

index to map units

summary of tables

foreword

This soil survey contains information that can be used in land-planning programs in Coffey County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie
State Conservationist
Soil Conservation Service

soil survey of
Coffey County, Kansas

By Deane W. Swanson, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
Kansas Agricultural Experiment Station.

Coffey County is in the east-central part of Kansas (fig. 1). It has a total area of 656 square miles, or 419,840 acres. In 1978, the population of the county was 8,888 and that of Burlington, the county seat, was 2,589.

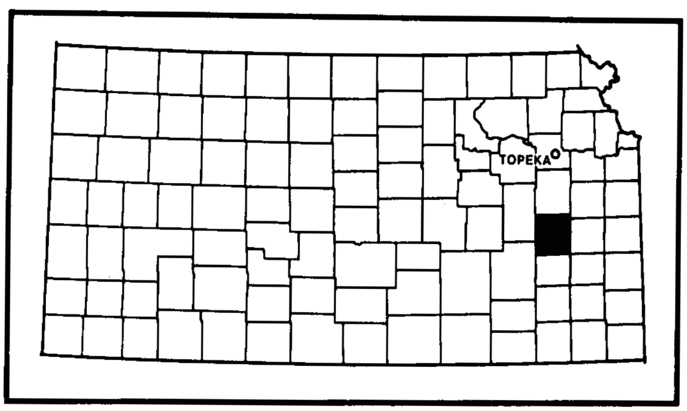


Figure 1.—Location of Coffey County in Kansas.

Farming and related services are the most important enterprises in Coffey County. Wheat, grain sorghum, and soybeans are the principal crops. Beef cattle are the most important kind of livestock.

Coffey County was organized in 1855. It is named in honor of Colonel A. M. Coffey, a resident of Miami County. He was an agent of the Confederate Tribe of Indians and Colonel of a Confederate Army regiment in the Indian territory.

Descriptions, names, and delineations in this soil survey do not fully agree with those on soil maps of adjacent counties. Differences are the result of better knowledge, modification in series concepts, intensity of mapping, or the extent of soils within the survey.

general nature of the survey area

This section gives general information concerning the county. It discusses climate; physiography, drainage, and relief; water supply; and natural resources.

climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Coffey County is a typical continental type, as would be expected from its location in the interior of a large land mass in the middle latitudes. Such climates are characterized by large daily and annual variations in temperature. Winters are cold because of the frequent flow of air from the Polar regions. Winter conditions prevail from December to February. Warm temperatures of summer last for about 6 months every year, and the transitional seasons of spring and fall are relatively short. The warm temperatures provide a long growing season for crops in the county.

Coffey County is in the path of a fairly dependable current of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest in late spring and early summer. A good part of it falls in late-evening, or nighttime, thunderstorms. Although the total precipitation is generally adequate for any crop, its distribution may cause problems in some years. Prolonged dry periods of several weeks duration are not uncommon during the growing season in this area. A surplus of precipitation often produces muddy fields that delay planting and harvesting.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Burlington in the period 1951 to 1976. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 32.8 degrees F, and the average daily minimum temperature is 21.6 degrees. The lowest temperature on record, which occurred at Burlington on February 12, 1899, is -27 degrees. In summer the average temperature is 77.3 degrees, and the average daily maximum temperature is 89.6 degrees. The highest recorded temperature, which occurred at Burlington on July 18, 1936, and August 14, 1936, is 117 degrees.

The total annual precipitation is 35.42 inches. Of this, 25.22 inches, or 71 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 18.94 inches. The heaviest 1-day rainfall during the period of record was 12.59 inches at Burlington on May 31, 1941.

Average seasonal snowfall is 17.5 inches. The greatest snowfall, 33.0 inches, occurred during the winter of 1911-1912. On an average of 20 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The sun shines 73 percent of the time possible in summer and 58 percent in winter. The prevailing wind is from the south. Average windspeed is highest in spring.

Tornadoes and severe thunderstorms occur occasionally in Coffey County. These storms are usually local in extent and of short duration so that risk is small. Hail occurs during the warmer part of the year, but again, it is infrequent and local. Crop damage by hail is less in this part of the state than it is in western Kansas.

physiography, drainage, and relief

Coffey County is centered in the Cherokee Prairies Land Resource Area. Generally, the upland landscape is made up of low hills; a few steep escarpments; broad, gentle slopes; and occasional broad flats. The Neosho River drains all of Coffey County, except the extreme north edge of the county. This northern edge drains toward the Marais Des Cygnes River (fig. 2).

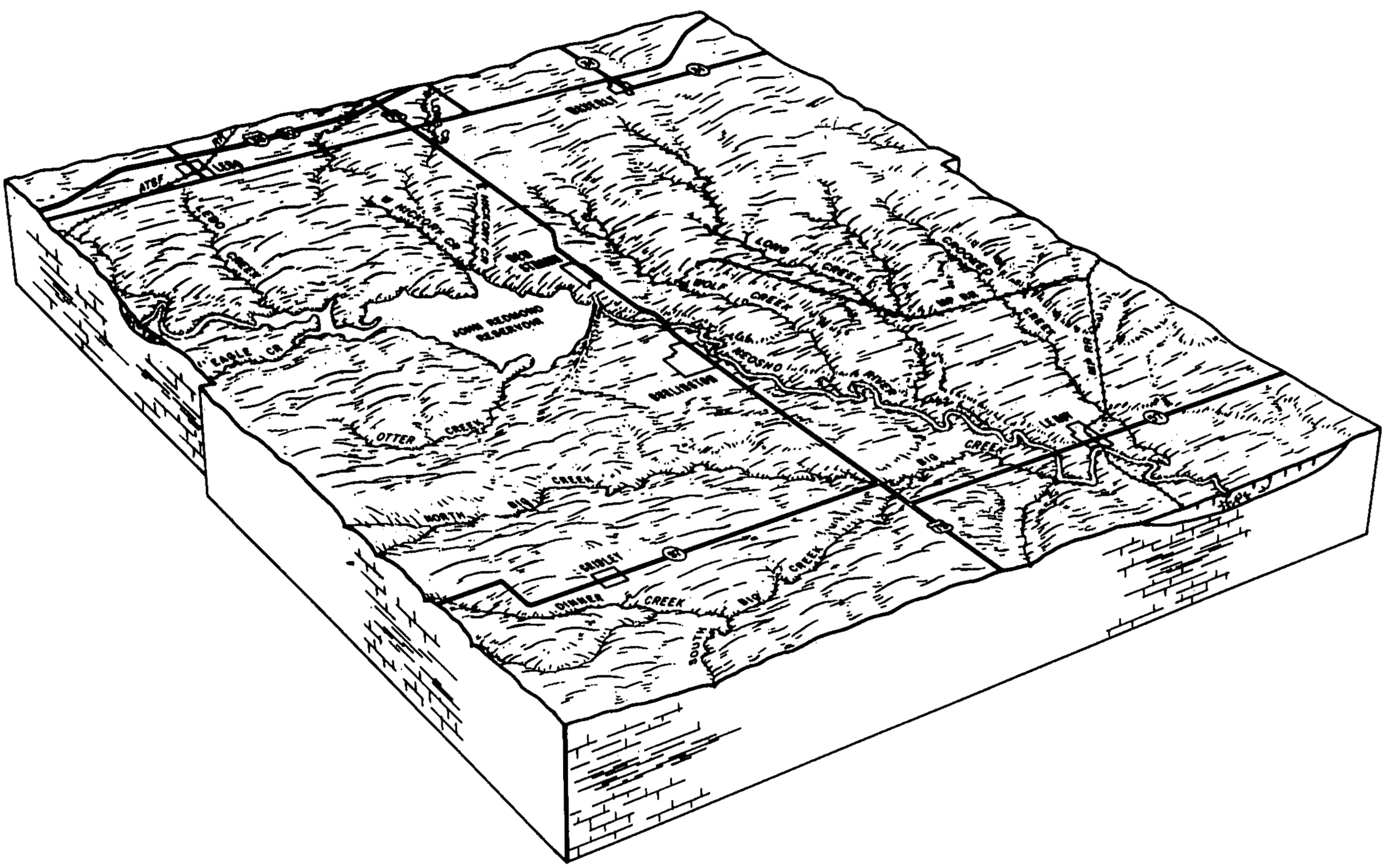


Figure 2.—Relief and drainage in Coffey County.

The highest elevation is about 1,250 feet above sea level and is northwest of Gridley. Several areas in the west and north are 1,230 feet above sea level. The lowest elevation is about 970 feet above sea level, where the Neosho River enters Woodson County.

water supply

The water supply in Coffey County comes from ground water, surface impoundments, and streams. Wells yield about 10 to 100 gallons of ground water per minute in the Neosho River Valley and along the eastern edge of the county. Wells in the remainder of the county yield about 1 to 10 gallons per minute. Wells south of the town of Waverly supply water for a rather large, rural water district that extends into Anderson County.

Rural water districts cover a major part of the county. Except for the wells in the Waverly area, the source of water is the Neosho River.

The principal source of water for livestock is surface water impoundments on intermittent streams.

The Neosho River is a dependable source of water, and the larger creeks are usually a dependable source. Creek beds commonly have rock ledges, usually limestone, and gravel bars that trap water in pools of various depths (fig. 3). During prolonged drought the upstream part of most creeks dries up.

Figure 3.—The pool of water is created by rock ledges and gravel bars in Big Creek, which supplies water to the county.

natural resources

Soil is the most important natural resource in the county. Cash crops and livestock are the marketable products affected by the soil.

Other mineral resources include oil, sand, gravel, coal, and limestone. A small area of shallow-veined coal has been strip mined in the vicinity of the town of Lebo. Limestone is quarried and crushed for various uses, such as, road surfacing and agricultural lime.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study 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, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows broad areas called soil associations that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one soil association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

soil descriptions

1. Woodson-Kenoma-Dennis association

Deep, nearly level and gently sloping, somewhat poorly drained and moderately well drained soils that have a dominantly silty clay subsoil; on uplands

This soil association consists of deep soils on ridgetops or side slopes. It is dissected by shallow drainageways. Slope ranges from 1 to 5 percent.

This association makes up about 20 percent of the county. It is about 36 percent Woodson soils, 34 percent Kenoma soils, and 11 percent Dennis soils. The remaining 19 percent is minor soils (fig. 4).

The somewhat poorly drained Woodson soils formed in old alluvial sediment. These soils are on the broad, nearly level ridgetops. The surface layer is very dark gray silt loam about 9 inches thick. The subsoil is extremely firm silty clay about 47 inches thick. It is black in the upper part and gray and dark gray in the lower part. The substratum is mottled, grayish brown silty clay to a depth of 60 inches.

The moderately well drained Kenoma soils formed in old alluvial sediment. These soils are on ridgetops and the upper part of side slopes. The surface layer is very dark grayish brown silt loam about 11 inches thick. The very firm subsoil is about 45 inches thick. The upper part is very dark grayish brown silty clay and the lower part dark brown, mottled silty clay. The substratum is yellowish brown, mottled silty clay to a depth of 60 inches.

The moderately well drained Dennis soils formed in residuum or colluvium weathered from shale. These soils are on side slopes. The surface layer is very dark grayish brown silt loam about 11 inches thick. The subsoil, which extends to a depth of 60 inches or more, is dark brown, friable silty clay loam in the upper part. The lower part is brown, yellowish brown, and strong brown silty clay that is mottled and very firm.

The minor soils in this association are in the Eram and Verdigris series. The moderately deep Eram soils are steep and on side slopes. The deep, loamy Verdigris soils are along narrow drainageways on flood plains.

This association is used mainly for cultivated crops. Some small areas are used for rangeland and pasture. Soybeans, wheat, and grain sorghum are the main crops.

The main concerns of management are controlling water erosion and maintaining good soil tilth and fertility. Some areas of the Woodson soils need surface drainage.

2. Summit-Kenoma-Lula association

Deep, nearly level to moderately sloping, moderately well drained and well drained soils that have a silty clay and silty clay loam subsoil; on uplands

This association consists of deep soils on ridgetops, side slopes, and foot slopes. It is dissected by drainageways and creeks. Slope ranges from 0 to 7 percent.

This association makes up about 41 percent of the county. It is about 28 percent Summit soils, 19 percent Kenoma soils, and 16 percent Lula soils. The remaining 37 percent is minor soils (fig. 5).

The moderately well drained Summit soils formed in residual or colluvial material weathered from shale. These soils are on side slopes and foot slopes. The surface layer is black silty clay loam about 9 inches thick. The subsoil, which extends to a depth of 60 inches or more, is black, very firm silty clay loam in the upper part. The lower part is black, very dark gray, and dark gray silty clay that is mottled and very firm.

The moderately well drained Kenoma soils formed in old alluvial sediment. These soils are on ridgetops and the lower part of side slopes. The surface layer is very dark grayish brown silt loam about 11 inches thick. The very firm subsoil is about 45 inches thick. The upper part is very dark grayish brown silty clay, and the lower part is

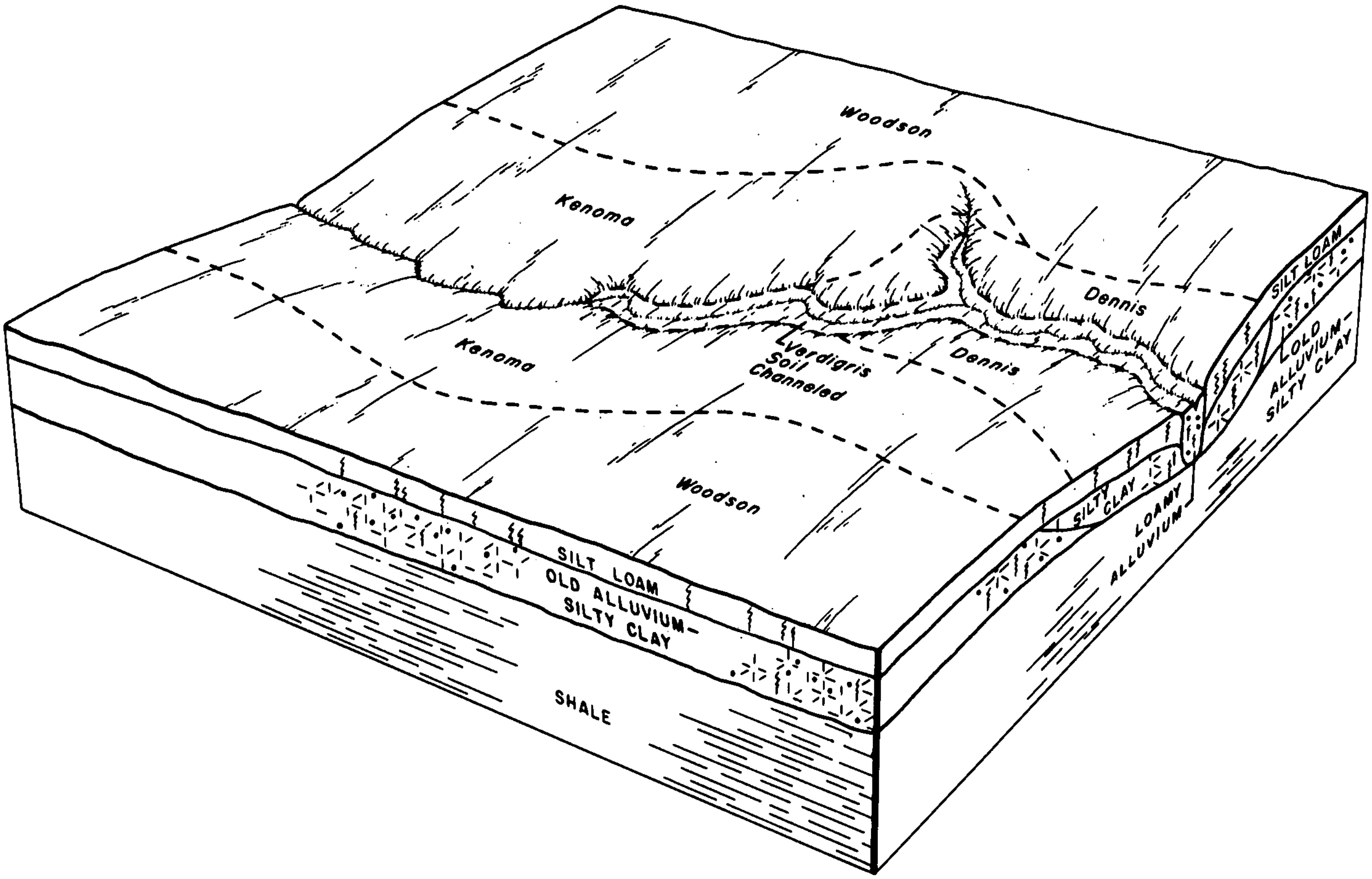


Figure 4.—Typical pattern of soils in Woodson-Kenoma-Dennis association.

dark brown, mottled silty clay. The substratum is yellowish brown, mottled silty clay to a depth of 60 inches.

The well drained Lula soils formed in material weathered from limestone. They are on ridgetops. The surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is about 39 inches thick. The upper part is dark reddish brown, firm silty clay loam, and the lower part is reddish brown, firm and very firm silty clay loam. Limestone bedrock is at a depth of about 48 inches.

The minor soils in this association are in the Apperson, Eram, Shidler, Verdigris, and Woodson series. The Apperson soils are on the ridgetops and the upper part of side slopes. They are 40 to 60 inches deep to limestone. The shallow Shidler soils are on the rim of the ridgetops. The moderately deep Eram soils are on the upper part of side slopes. The loamy Verdigris soils are along the drainageways on flood plains. The somewhat poorly drained Woodson soils are on ridgetops and the lower part of foot slopes.

About one-half of this association is cultivated. The other half is in rangeland or pasture. Soybeans, grain sorghum, wheat, and legumes are the main crops.

Management concerns are controlling water erosion and maintaining good soil tilth and fertility. Good pasture and range management practices help retain plant vigor and growth and reduce invasion of undesirable grasses, bushes, and trees.

3. Kenoma-Eram-Dennis association

Deep and moderately deep, gently sloping to strongly sloping, moderately well drained soils that have a dominantly silty clay subsoil; on uplands

This association consists of ridgetops, side slopes, and foot slopes. It is dissected by drainageways. Slope ranges from 1 to 15 percent.

This association makes up about 18 percent of the county. It is about 35 percent Kenoma soils, 31 percent Eram soils, and 13 percent Dennis soils. The remaining 21 percent is minor soils (fig. 6 and fig. 7).

The deep Kenoma soils formed in old alluvial sediment. These soils are on ridgetops, side slopes, and foot slopes. The surface layer is very dark grayish brown silt loam about 11 inches thick. The very firm subsoil is about 45 inches thick. The upper part is very dark grayish brown silty clay, and the lower part is dark brown, mottled silty clay. The substratum is yellowish brown, mottled silty clay to a depth of 60 inches.

The moderately deep Eram soils formed in residuum weathered from shale. These soils are on narrow ridgetops and side slopes. The surface layer is very dark brown silt loam or silty clay loam about 10 inches thick. The subsoil is mottled, very firm silty clay about 18 inches thick. The upper part is very dark grayish brown, and the lower part is dark grayish brown. Olive brown, soft shale bedrock is at a depth of about 28 inches.

The deep Dennis soils formed in residuum or colluvium weathered from shale. These soils are on side slopes and foot slopes. The surface layer is very dark grayish brown silt loam about 11 inches thick. The subsoil, which extends to a depth of 60 inches, is dark brown, friable silty clay loam in the upper part. The lower part is brown, yellowish brown, and strong brown silty clay that is mottled and very firm.

The minor soils in this association are in the Bates, Collinsville, Shidler, and Verdigris series. The shallow Collinsville soils and the moderately deep Bates soils are on ridgetops and the upper part of side slopes. The shallow Shidler soils are on ridgetops. The loamy Verdigris soils are on flood plains.

About one-half of this association is in native grass. This rangeland is used for grazing livestock and for hay. The other half is in cultivated crops or pasture. Soybeans, wheat, and grain sorghum are the main crops.

Good pasture and range management practices are needed to prevent invasion of undesirable grasses, bushes, and trees and to help keep the grass in good condition. Good management is needed in cultivated areas to control water erosion and maintain good soil tilth and fertility.

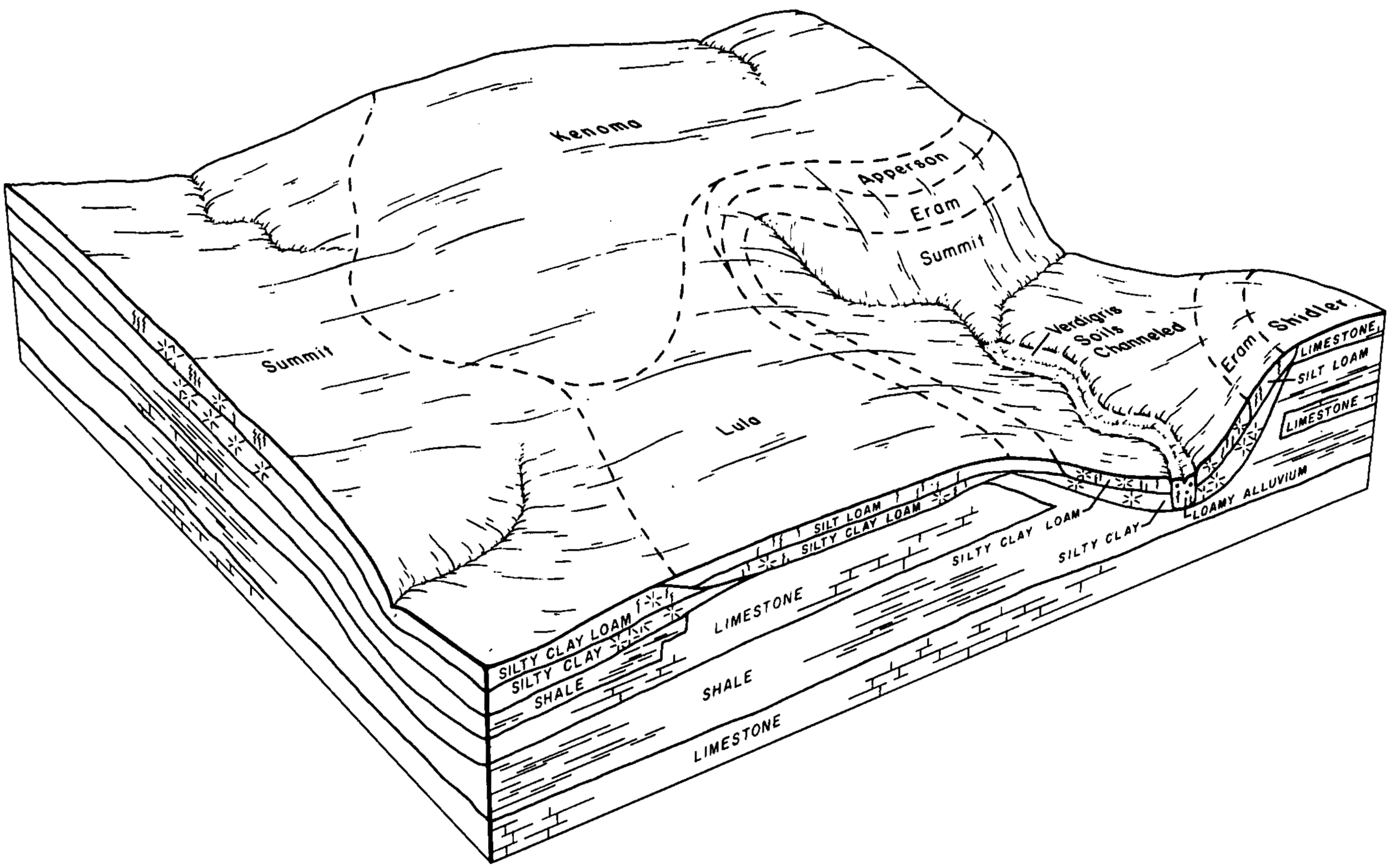


Figure 5.—Typical pattern of soils in Summit-Kenoma-Lula association.

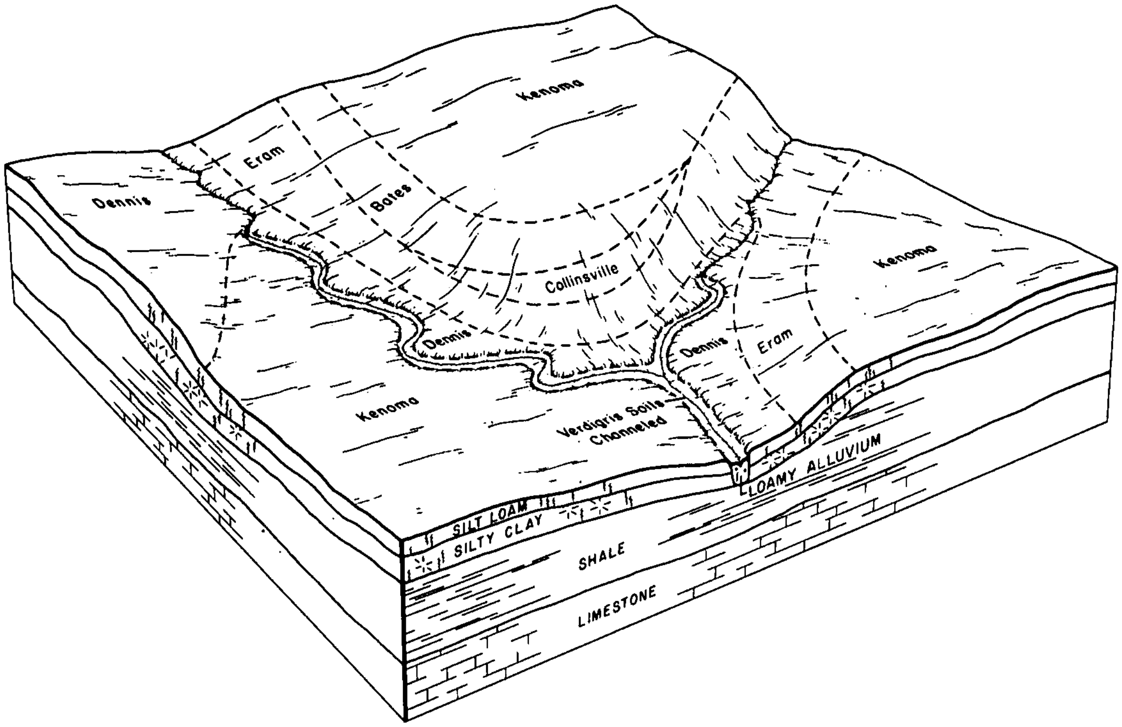


Figure 6.—Typical pattern of soils in Kenoma-Eram-Dennis association.

Figure 7.—Native grass in an area of Eram and Dennis soils.

4. Kenoma-Olpe association

Deep, gently sloping to strongly sloping, moderately well drained and well drained soils that have a silty clay subsoil or a very gravelly silty clay and very gravelly silty clay loam subsoil; on uplands

This soil association consists of deep soils on knolls, ridges, and foot slopes. Slope ranges from 1 to 15 percent.

This soil association makes up about 10 percent of the county. It is about 46 percent Kenoma soils, 23 percent Olpe soils, and 31 percent minor soils (fig. 8).

The moderately well drained Kenoma soils formed in old alluvial sediment. These soils are on the broad ridgetops and foot slopes. The surface layer typically is very dark grayish brown silt loam about 11 inches thick. The very firm subsoil is about 45 inches thick. The upper part is very dark grayish brown silty clay, and the lower part is dark brown, mottled silty clay. The substratum is yellowish brown, mottled silty clay to a depth of 60 inches.

The well drained Olpe soils formed in old, gravelly alluvial sediment. These soils are on narrow ridgetops and side slopes. The surface layer typically is very dark brown gravelly silt loam about 10 inches thick. The subsoil, which extends to a depth of 60 inches, is dark brown, firm gravelly silty clay loam in the upper part; dark brown or dark reddish brown, very firm very gravelly silty clay or silty clay loam in the middle part; and mixed yellowish red and strong brown, very firm very gravelly silty clay in the lower part.

The minor soils in this association are in the Dennis, Eram, Summit, and Verdigris series. Moderately well drained Dennis and Summit soils are on the lower part of foot slopes. The moderately deep Eram soils are on the upper part of side slopes. The loamy Verdigris soils are along narrow drainageways on flood plains.

This association is used mainly for rangeland and pasture. The rest is used for cultivated crops. Soybeans, grain sorghum, and wheat are the main crops.

The main concerns of management are controlling water erosion and maintaining good soil tilth and fertility.

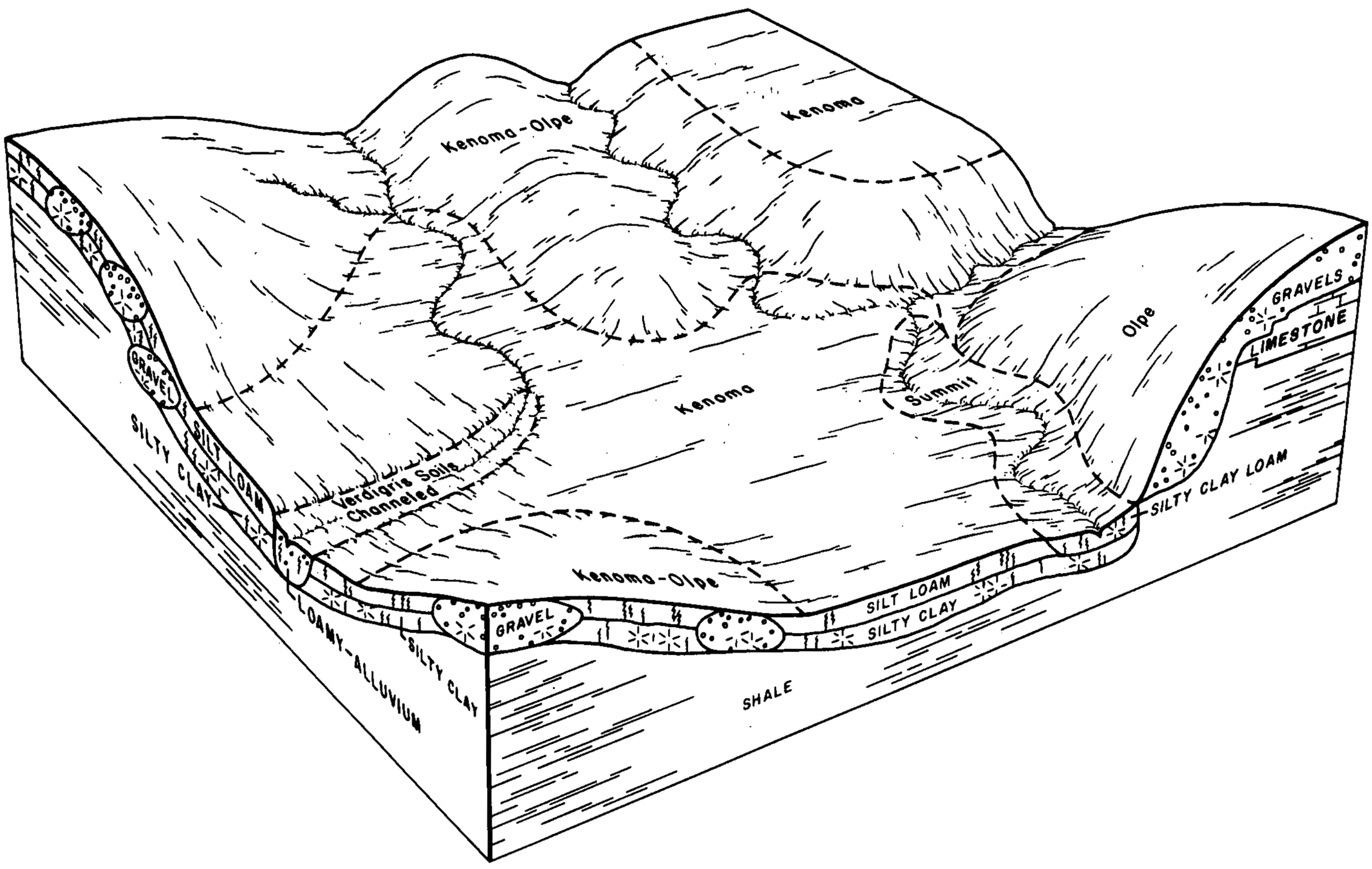


Figure 8.—Typical pattern of soils in Kenoma-Olpe association.

Good pasture and range management is needed to prevent invasion of undesirable grasses, bushes, and trees.

5. Osage-Verdigris-Lanton association

Deep, nearly level, poorly drained to moderately well drained soils that have a silty clay, silt loam, and silty clay loam subsoil; on flood plains

This soil association consists of deep soils on flood plains. It is in valleys along major streams and larger drainageways. The soils are occasionally or frequently flooded. Slope is 0 to 1 percent.

This association makes up about 11 percent of the county. It is about 35 percent Osage soils, 34 percent Verdigris soils, and 17 percent Lanton soils. The remaining 14 percent is minor soils.

The poorly drained Osage soils formed in clayey alluvium. They are on broad flats of flood plains. The surface layer is black silty clay or silty clay loam about 7 inches thick. The subsurface layer is black, very firm silty clay about 8 inches thick. The subsoil, which extends to a depth of 60 inches, is mottled, extremely firm silty clay. The upper part is very dark gray, and the lower part is dark gray.

The moderately well drained Verdigris soils, formed in silty alluvium, are along the stream channel. The surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is friable silt loam about 17 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The next layer is dark brown, friable silty clay loam about 18 inches thick. The substratum is dark brown, mottled silty clay loam to a depth of 60 inches.

The somewhat poorly drained Lanton soils formed in silty alluvium. The surface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 22 inches thick. It has mottles in the lower 14 inches. The next layer is dark gray, very firm silty clay loam about 19 inches thick. It is mottled throughout. The substratum is dark gray silty clay loam to a depth of 60 inches.

The minor soils in this association are in the Leanna and Mason series. The somewhat poorly drained Leanna soils are mainly along the smaller drainageways. The well drained Mason soils are on stream terraces.

Most of this association is used for cultivated crops, but some small areas are in grass or trees. All locally adapted crops are grown, but soybeans, wheat, grain sorghum, and corn are the main crops.

The main concerns of management are flooding and maintaining good tilth and fertility. Osage soils are seasonally wet and occasionally need surface drainage.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Eram silt loam, 3 to 7 percent slopes, is one of several phases in the Eram series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Kenoma-Olpe complex, 2 to 7 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

Ae—Apperson-Eram silty clay loams, 1 to 4 percent slopes. This map unit consists of deep and moderately deep, gently sloping soils that are moderately well drained. These soils are on ridgetops and side slopes. Individual areas are irregular in shape and range from 10 to 400 acres in size.

This map unit consists of about 50 percent Apperson soils and about 30 percent Eram soils. The Apperson soils are on ridgetops and the upper part of side slopes above thin limestone ledges. Eram soils are below the limestone ledges on the lower part of side slopes.

Typically, the Apperson soil has a surface layer of black silty clay loam about 9 inches thick. The subsoil is about 33 inches thick. The upper part is very dark grayish brown, firm silty clay loam. The middle part is very dark grayish brown and dark brown, very firm silty clay. The lower part is dark yellowish brown, very firm silty clay. Limestone bedrock is at a depth of about 42 inches. In some places bedrock is more than 60 inches deep or is less than 40 inches deep.

Typically, the Eram soil has a surface layer of black silty clay loam about 10 inches thick. The subsoil is about 24 inches thick. The upper part is dark brown, very firm silty clay loam; the middle part is olive brown, mottled, very firm silty clay; and the lower part is light olive brown, mottled, very firm silty clay. Shale bedrock is at a depth of about 34 inches and has a few lime accumulations in the seams. In some places the surface layer is silt loam. In places clayey shale is at a depth of more than 40 inches.

Included with these soils in mapping are small areas of Lula soils, Shidler soils, and limestone rock outcrop. Lula soils have a redder subsoil than the Apperson and Eram soils and are on ridgetops. The shallow, well drained Shidler soils are along the rim of the ridgetops and are above thin limestone ledges. These included soils make up about 10 percent of the map unit.

Apperson and Eram soils are slowly permeable. Available water capacity is moderate in the Apperson soil and low in the Eram soil. Natural fertility is high in the Apperson soil and medium in the Eram soil. Surface runoff is medium on both soils. These soils have moderate organic matter content. A perched seasonal high water table is at a depth of 1.5 to 3 feet. The subsoil in these soils has high shrink-swell potential. When unlimed, the surface layer of these soils is medium acid or slightly acid.

About 60 percent of this unit is used as rangeland or pasture, and the unit is well suited to these uses. Forty percent is used for cultivated crops. These soils are used mostly for grazing livestock but are also used for hay. Overgrazing reduces the vigor and retards the growth of the grasses. Proper stocking rates, timely deferment of grazing, and uniform grazing distribution are management practices that help keep the range and pasture in good condition. Native grasses used for hay should be cut early enough to allow for regrowth before frost. Timely cutting of tame grasses for hay is dependent on the plant species.

This unit is suited to wheat, grain sorghum, soybeans, and other adapted crops. Erosion is a hazard, however, if cultivated crops are grown. Cultivation also exposes rock in a few places. Grassed waterways, terraces, contour farming, and minimum tillage help prevent excessive soil loss and conserve moisture. Returning crop residue to the surface or incorporating it into the plow layer increases the content of organic matter, helps maintain good tilth, and increases the infiltration rate.

The shrink-swell potential is a severe limitation if these soils are used as a site for dwellings. Wetness is an additional severe limitation if these soils are used for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling and wetness. The low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

These soils are severely limited as sites for septic tank absorption fields. The slow permeability and the wetness are severe limitations. Depth to rock is an additional severe limitation in the Eram soil. If the soils are used as sites for sewage lagoons, slope is a moderate limitation in the Apperson soil and depth to rock is a severe limitation in the Eram soil. The deep, less sloping included soils are better sites for these uses.

The capability subclass is IIIe.

Bb—Bates loam, 1 to 4 percent slopes. This moderately deep, gently sloping soil is well drained. It is on narrow ridgetops or along the upper part of side slopes in uplands. Individual areas of this unit are mainly long and narrow in shape and range from 10 to 150 acres in size.

Typically, the surface layer is very dark brown loam about 11 inches thick. The subsoil is about 15 inches thick. It is very dark grayish brown, friable loam in the upper part and dark brown, firm clay loam in the lower part. Bedrock is at a depth of about 26 inches. In a few small eroded areas the surface layer is clay loam and occasional small sandstone and shale fragments. In some places the subsoil is silty clay loam. Sandstone bedrock is at a depth of 15 to 20 inches in a few areas.

Included with this soil in mapping are small areas of Dennis and Dwight soils. Dennis soils are on the lower part of side slopes and have a thicker, more clayey subsoil than this Bates soil. Dwight soils have a subsoil that has a higher sodium content, and they are on the ridgetops. These included soils make up about 10 percent of the map unit.

Permeability is moderate in this Bates soil, and the available water capacity is low. Surface runoff is medium. Natural fertility is medium, and the organic matter content is moderate. The surface layer is friable and easily tilled. When unlimed, it is strongly acid to slightly acid. The root zone is restricted by the bedrock at a depth of about 26 inches.

About one-half of this soil is used for cultivated crops, and the other half is in range or pasture. This soil is suited to growing grain sorghum, wheat, and soybeans. Water erosion is a hazard when this soil is cultivated. Grassed waterways, terraces, conservation cropping systems, and minimum tillage reduce erosion. Using crop residue in or on top of the plow layer increases water infiltration, improves tilth, and improves fertility.

This soil is well suited to rangeland and pasture. It is used for grazing livestock and for hay. Overgrazing reduces vigor and retards growth of grasses. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the range in good condition. Properly placing salt and water evenly distributes livestock. If the soil is used for hay, native grasses should be mowed early enough to allow for recovery before frost. Proper timing for mowing tame grasses depends on the species grown. Pastures of tame grasses also benefit from deferment of grazing and from fertilization.

This soil is moderately limited as a site for dwellings with basements by depth to rock. The deeper included soils are suitable sites for dwellings with basements. This soil is suitable, however, as a site for dwellings without basements. The low strength is a moderate limitation for local roads and streets. Strengthening or replacing the base material helps overcome this limitation.

This soil is generally unsuitable as a site for septic tank absorption fields and sewage lagoons. The moderate depth to bedrock is a severe limitation. Sewage lagoons can usually be located in the deeper included soils.

The capability subclass is IIe.

Bc—Bates loam, 4 to 7 percent slopes. This moderately deep, moderately sloping soil is well drained. It is on convex side slopes. Individual areas of this unit are in long, narrow patterns and range from about 10 to 200 acres in size.

Typically, the surface layer is very dark brown loam about 10 inches thick. The subsoil is about 15 inches thick. It is very dark grayish brown, friable loam in the upper part and dark brown, firm clay loam in the lower part. Sandstone bedrock is at a depth of about 25 inches. In a few small eroded areas the surface layer is clay loam and a few sandstone rocks and shale fragments. In some places the subsoil is more clayey.

Included with this soil in mapping are small areas of deep, moderately well drained Dennis soils on the lower part of foot slopes. This included soil makes up 5 percent of the map unit.

Permeability is moderate in this Bates soil, and the available water capacity is low. Surface runoff is rapid. Natural fertility is medium, and the organic matter content is moderate. The surface layer is friable and easily tilled. If unlimed, it ranges from strongly acid to slightly acid. The root zone is restricted by bedrock at a depth of about 25 inches.

Most of this soil is in range or pasture, and the rest is used for cultivated crops. This soil is moderately well suited to grain sorghum, wheat, and soybeans. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, and minimum tillage help to prevent excessive soil loss. Using crop residue in or on top of the plow layer increases the infiltration rate, improves tilth, and increases the content of organic matter.

This soil is well suited to rangeland and pasture and is used for grazing livestock and for hay. Overgrazing reduces the vigor and retards the normal growth of grasses. Proper stocking rates, timely deferment of grazing, rotation grazing, and brush control help keep the range in good condition. Properly placing salt and water improves the grazing patterns. Pastures of cool-season tame grasses benefit from deferment of grazing and from fertilization. If the soil is used for hay, native grass should be mowed early enough to allow the plants to recover and store food before frost.

Depth to rock is a moderate limitation if this soil is used as sites for dwellings with basements. The deeper included soils are more suitable as sites for dwellings with basements. This soil is suitable, however, as a site for dwellings without basements. The low strength is a moderate limitation for local roads and streets. Strengthening or replacing the base material helps overcome this limitation.

This soil is generally unsuitable as sites for septic tank absorption fields and sewage lagoons. It is severely limited by depth to bedrock. Sewage lagoons can usually be located in the deeper included soils.

The capability subclass is IIIe.

Cs—Clareson-Shidler silty clay loams, 1 to 8 percent slopes. This map unit consists of moderately deep and shallow, (fig. 9) gently sloping and moderately sloping soils that are well drained. These soils are on ridgetops and along some drainageways. Individual areas of this unit are irregular in shape and range from about 10 to 160 acres in size.

Areas are of 50 percent Clareson soils and 30 percent Shidler soils. The Clareson soil is on ridgetops and along some drainageways. The Shidler soil is mainly along the rim of ridgetops.

Typically, the Clareson soil has a surface soil of very dark brown silty clay loam about 12 inches thick. The subsoil is about 12 inches thick. It is dark brown, firm silty clay loam in the upper part. The lower part is dark reddish brown, very firm very flaggy silty clay. Limestone bedrock is at a depth of about 24 inches. In places the subsoil does not have coarse fragments. In a few places the subsoil is gravelly silty clay.

Typically, the Shidler soil has a surface soil of black silty clay loam about 12 inches thick. Below this is limestone bedrock. In some places shale is at a depth of less than 20 inches.

Included with these soils in mapping are small areas of Eram and Summit soils. Eram soils are underlain by shale. They are below the rim of the ridgetop on side slopes. Summit soils are deep, do not have rock fragments in the subsoil, and are on foot slopes. These included soils make up about 10 percent of the map unit.

Permeability is moderately slow in the Clareson soil and is moderate in the Shidler soil. Available water capacity is low in the Clareson soil and very low in the Shidler soil. Root development is restricted at a depth of about 24 inches in the Clareson soil and at a depth of about 12 inches in the Shidler soil. Surface runoff is medium or rapid depending on slope. These soils have medium natural fertility and moderate organic matter content. The subsoil in these soils has moderate shrink-swell potential.

Almost all of the acreage is used as rangeland, and this map unit is better suited to this use. These soils are not suited to cultivated crops because of droughtiness and a severe hazard of erosion. The main concern of managing range is droughtiness caused by low and very low available water capacity. An adequate plant cover and ground mulch reduce the runoff rate and increase the available water capacity. Overgrazing reduces the natural plant community and allows weeds, bushes, and trees to invade the range. Proper stocking and timely deferment of grazing help keep the grass in good condition.

Depth to bedrock or large stones are severe limitations if this unit is used as sites for dwellings. Excavation is easier if the buildings are constructed on the deeper soils. The low strength and large stones or the depth to bedrock are severe limitations if this unit is

Figure 9.—Roadcut shows the Clareson soil, which is about 24 inches deep to limestone, and the Shidler soil, which is about 12 inches deep to limestone.

used for local roads. Strengthening or replacing the base material helps to overcome low strength and large stones.

This unit is generally unsuitable as sites for septic tank absorption fields and sewage lagoons. Depth to bedrock is the main limitation for these uses. The deeper included soils on the foot slopes are suitable sites for lagoons.

The capability subclass is VIe.

Db—Dennis silt loam, 1 to 4 percent slopes. This deep, gently sloping soil is moderately well drained. It is on side slopes and foot slopes. Individual areas of this unit are irregular in shape and range from about 10 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 11 inches thick. The subsoil, which extends to a depth of 60 inches, is dark brown, friable silty clay loam in the upper part. The lower part is brown, yellowish brown, and strong brown silty clay that is mottled and very firm. In many places the textural transition between the surface layer and the subsoil is abrupt. In some areas shale is at a depth of 20 to 40 inches. In places this soil is more sloping.

Included with this soil in mapping are small areas of well drained Bates and Olpe soils. The loamy Bates soils and the gravelly Olpe soils are on ridgetops and the upper part of side slopes. These included soils make up about 5 percent of the map unit.

Permeability is slow in this Dennis soil, and the available water capacity is high. Surface runoff is medium. Natural fertility is medium, and the organic matter content is moderate. The subsoil has a high shrink-swell potential. A perched seasonal high water table is at a depth of 2 to 3 feet. When unlimed, this soil is medium acid in the surface layer.

Most areas of this soil are used for cultivated crops. The rest is in range or pastures of tame grass. This soil is well suited to soybeans, wheat, grain sorghum, and corn. Water erosion is a hazard if the soil is cultivated. Terraces, grassed waterways, contour farming, and minimum tillage help to prevent excessive soil loss. Using crop residue in or on top of the plow layer improves soil tilth and increases the infiltration rate.

This soil is well suited to rangeland and pasture. It is used for grazing livestock or for hay. Overgrazing destroys the protective plant cover and causes deterioration of the plant community. The more desirable grasses are then replaced by less productive grasses and by weeds. Proper stocking rates, rotation grazing, and timely deferment of grazing help keep the range and pasture in good condition. Native grass used for hay should be mowed early so the plants recover before frost. Timely mowing of tame grasses used for hay maintains plant vigor. Fertilizer stimulates growth of tame grasses and increases the vegetative cover, which, in turn, reduces runoff.

The shrink-swell potential is a severe limitation if this soil is used as sites for dwellings. Wetness is an additional severe limitation for dwellings with basements. Backfilling with a porous material around the foundation, installing foundation drains, and reinforcing foundations help overcome these limitations. The shrink-swell potential and low strength are severe limitations for local roads and streets. Strengthening or replacing the base material helps overcome these limitations.

This soil generally is unsuitable as a site for septic tank absorption fields. Slow permeability and wetness are severe limitations. The slope is a moderate limitation for sewage lagoons. If the less sloping areas are selected as sites for lagoons, less leveling and banking are needed.

The capability subclass is IIe.

De—Dennis silty clay loam, 2 to 5 percent slopes, eroded. This deep, gently sloping soil is moderately well drained. It is on short, uneven side slopes and foot slopes. Individual areas of this unit are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 6 inches thick. The subsoil extends to a depth of 60 inches. It is dark brown, very firm silty clay loam in the upper part; dark yellowish brown, very firm silty clay in the middle part; and strong brown, mottled, very firm silty clay in the lower part. In some places the subsoil is darker. In some areas the surface layer is thicker and less clayey. In a few places shale is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of well drained Bates and Olpe soils. The less clayey Bates soils and the gravelly Olpe soils are on the upper part of side slopes. These included soils make up about 5 percent of the map unit.

Permeability is slow in this Dennis soil, and the available water capacity is high. Surface runoff is medium. Natural fertility is low, and the organic matter content is moderately low. When unlimed, the surface layer is commonly medium acid. The subsoil has a high shrink-swell potential. A perched seasonal high water table is at a depth of 2 to 3 feet.

Most areas of this soil are used for cultivated crops, but a few areas are in pastures of tame grass. This soil is moderately well suited to grain sorghum, wheat, and soybeans. If cultivated crops are grown, further erosion is a hazard. Grassed waterways, terraces, and contour farming help to reduce soil loss. Minimum tillage and using crop residue in or on top of the plow layer improve tilth and increase the infiltration rate.

This soil is well suited to range or pasture. The major concerns in managing range or pasture are erosion and low forage production on abandoned cropland. An adequate plant cover and ground mulch reduce the runoff rate, help prevent excessive soil loss, and increase moisture supply. Proper stocking rates, timely deferment of grazing, and brush control help keep the range in good condition. Fertilizing the tame grasses promotes growth.

The shrink-swell potential is a severe limitation if this soil is used as sites for dwellings. Wetness is an additional severe limitation for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help overcome these limitations. The shrink-swell potential and low strength are severe limitations for local roads and streets. Strengthening or replacing the base material help overcome these limitations.

This soil generally is unsuitable as a site for septic tank absorption fields. Slow permeability and wetness are severe limitations. Sewage lagoons are a suitable alternative in many areas, but the slope is a moderate limitation. If the less sloping areas are selected as sites for lagoons, less leveling and banking are required.

The capability subclass is IIIe.

Eb—Eram silt loam, 1 to 3 percent slopes. This moderately deep, gently sloping soil is moderately well drained. It is mainly on ridgetops but is also on side slopes. Individual areas of this soil are irregular in shape and range from about 10 to 300 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 11 inches thick. The subsoil is mottled, very firm silty clay about 20 inches thick. The upper part is dark brown, and the lower part is brown. Shale bedrock is at a depth of about 31 inches. In some places the subsoil is less clayey. Also, in places the depth to bedrock is more than 40 inches. In some areas the soil is underlain by limestone bedrock.

Included with this soil in mapping are small areas of Collinsville and Dwight soils. The shallow Collinsville soils are on side slopes. Dwight soils have a thin surface layer, and the subsoil has a higher sodium content than that of the Eram soil. The Dwight soils are on slightly concave ridgetops. These included soils make up less than 5 percent of the map unit.

Permeability is slow in this Eram soil, and surface runoff is medium. Available water capacity is low. The organic matter content is moderate, and the natural fertility is medium. The surface layer is medium acid or slightly acid when unlimed. The subsoil has a high shrink-swell potential. A perched seasonal high water table is at a depth of 2 to 3 feet.

About one-half of this soil is used for cultivated crops. The other half is in range or pastures of tame grass. This soil is suited to wheat, grain sorghum, and soybeans. It is less suited to corn because of the low available water capacity. Erosion is a hazard if cultivated crops are grown. Terraces, contour farming, and grassed waterways reduce soil loss and conserve moisture. Minimum tillage and using crop residue in or on top of the plow layer help increase organic matter and improve tilth.

This soil is well suited to rangeland and pasture and is used for grazing livestock and for hay. The major concern in managing range and pasture is the droughtiness caused by low available water capacity. An adequate plant cover and ground mulch reduce the runoff rate and increase the moisture supply. Keeping the range in good condition helps control erosion. If grasses are overgrazed, their vigor and growth is reduced. Proper stocking rates, timely deferment of grazing, and brush control keep the range in good condition. When native grass is used for hay, early mowing allows plants to recover before frost. Tame grass pastures benefit from deferred grazing, early mowing, and fertilization.

Shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Wetness is an additional severe limitation for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help overcome these limitations. The low strength and the shrink-swell potential are severe limitations if this soil is used for local roads and streets. Strengthening or replacing the base material helps overcome these limitations.

This soil is generally unsuitable as a site for septic tank absorption fields. It is severely limited by depth to rock, wetness, and slow permeability. Depth to bedrock is a severe limitation for sewage lagoons. The deeper included soils are suitable sites for lagoons.

The capability subclass is IIIe.

Ec—Eram silt loam, 3 to 7 percent slopes. This moderately deep, moderately sloping soil is moderately well drained. It is mainly on narrow ridgetops and side slopes. Individual areas of this soil are long and moderately narrow in shape and range from about 5 to 250 acres in size.

Typically, the surface layer is very dark brown silt loam about 10 inches thick. The subsoil is mottled, very firm silty clay about 18 inches thick. The upper part is very dark grayish brown, and the lower part is dark grayish brown. Shale bedrock is at a depth of about 28 inches. In a few small eroded areas the surface layer is silty clay loam or silty clay. In some places the subsoil is less clayey. In a few places the bedrock is at a depth of more than 40 inches.

Included with this soil in mapping are small areas of Collinsville and Shidler soils and soils that have shale at a depth of less than 20 inches. Collinsville soils are shallow over sandstone and are on the upper part of side slopes. The soils that are shallow over shale are also on the upper part of side slopes. Shidler soils are shallow over limestone. They are along the upper rim of the side slopes. These included soils make up about 5 percent of the map unit.

Permeability is slow in this Eram soil, and surface runoff is rapid. Available water capacity is low. The organic-matter content is moderate, and the natural fertility is medium. The surface layer is medium acid or slightly acid when unlimed. The subsoil has a high shrink-swell potential. A perched seasonal high water table is at a depth of 2 to 3 feet.

Most of this soil is used for rangeland or pasture. The rest is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and soybeans. Erosion is the principal hazard when cultivated crops are grown. Grassed waterways, terraces, contour farming, and minimum tillage help to prevent excessive soil loss. Using crop residue on top of or in the plow layer improves soil tilth and increases the infiltration rate.

This soil is well suited to rangeland and pasture and is used for grazing livestock and for hay. Overgrazing reduces the vigor of grasses and retards their growth. Proper stocking rates, rotation grazing, and timely deferment of grazing help keep the range in good condition. When native grasses are used for hay, early mowing allows for recovery before frost. Tame grass pasture benefits from timely deferred grazing, early mowing, and fertilization.

Shrink-swell potential is a severe limitation if this soil is used as sites for dwellings. Wetness is an additional severe limitation for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help overcome these limitations. The low strength and the shrink-swell potential are severe limitations if this soil is used as sites for local roads and streets. Strengthening or replacing the base material helps overcome these limitations.

This soil is generally unsuitable as a site for septic tank absorption fields. It is severely limited by depth to bedrock, wetness, and slow permeability. Depth to bedrock is also a severe limitation for sewage lagoons. Deeper included soils are more favorable sites for lagoons.

The capability subclass is IVe.

Eh—Eram silty clay loam, 3 to 7 percent slopes, eroded. This moderately deep, moderately sloping soil is moderately well drained. It is on short, uneven side slopes. Individual areas of this unit are irregular in shape and range from about 5 to 35 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 6 inches thick. It is a mixture of the original surface layer and the subsoil. The subsoil is mottled, very firm silty clay about 16 inches thick. It is very dark grayish brown in the upper part and olive brown in the lower part. Shale is at a depth of about 22 inches. A few rocks are in the solum in some areas. In some places the subsoil is clay loam. In a few places it is more than 40 inches thick.

Included with this soil in mapping are small areas of Collinsville and Shidler soils and soils that are 10 to 20 inches deep to shale. These shallow soils are on the upper part of side slopes. The included soils make up about 5 percent of the map unit.

Permeability is slow in this Eram soil. Surface runoff is rapid, and available water capacity is low. Natural fertility is low, and organic matter content is moderately low. This soil has high shrink-swell potential. A perched seasonal high water table is at a depth of 2 to 3 feet. The surface layer is firm and has poor tilth.

Many areas of this soil have been revegetated to tame and native grasses and are used mainly for grazing livestock. A few areas are used for cultivated crops. This eroded soil is better suited to pasture and range, which helps control soil loss. Establishing grasses is a problem because of the occasional, deep gulleys and the clayey surface texture. Land shaping is often needed to smooth the gullies. Proper stocking rates, rotation grazing, and timely deferment of grazing help maintain grasses and prevent further erosion of the soil. Fertilizing tame grass pasture also increases yields and reduces soil loss.

This soil is poorly suited to cultivated crops. If this soil is cultivated, close growing crops like wheat are better suited. Drought significantly reduces yields because it lowers the available water capacity. Grassed waterways, terraces, contour farming, and using crop residue in or on top of the plow layer help minimize erosion and help maintain the physical condition of the soil. Also, no-till and minimum tillage help reduce soil exposure during winter months. The soil fertility has been depleted by erosion, and it needs to be increased by using barnyard manure, green manure, or commercial fertilizer.

Shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Wetness is an additional severe limitation for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help overcome these limitations. Low strength and shrink-swell potential are severe limitations if this soil is used for local roads and streets. Damage to roads and streets can be lessened by strengthening or replacing the base material.

This soil is generally unsuitable as a site for septic tank absorption fields. It is severely limited by depth to bedrock, wetness, and slow permeability. Depth to bedrock is also a severe limitation for sewage lagoons. The deeper soils included in this unit are more favorable sites.

The capability subclass is IVe.

Ep—Eram-Apperson silty clay loams, 4 to 7 percent slopes. This map unit consists of moderately deep and deep, moderately sloping soils that are moderately well drained. These soils are on side slopes. A few limestone rocks are on the surface. Individual areas are long and narrow or irregular in shape and range from about 10 to 400 acres in size.

This map unit is made up of about 50 percent Eram soils and 35 percent Apperson soils. The Eram soil is on the upper part of side slopes but is also below limestone ledges. The less sloping Apperson soil is above the limestone ridges. These soils are so intricately mixed or the areas are so narrow that it is not practical to separate them in mapping.

Typically, the Eram soil has a surface layer of black silty clay loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 18 inches thick. The upper part is very dark brown and the lower part is olive brown. Shale bedrock is at a depth of about 26 inches. It has a few lime accumulations in seams. In a few eroded areas the surface layer is silty clay and occasionally has fragments of shale.

Typically, the Apperson soils have a surface layer of black silty clay loam about 9 inches thick. The subsoil is about 33 inches thick. The upper part is very dark grayish brown, firm silty clay loam. The middle part is very dark grayish brown and dark brown, very firm silty clay, and the lower part is dark yellowish brown, very firm silty clay. Limestone bedrock is at a depth of about 42 inches. In a few places, mainly in the western part of the survey area, the subsoil is redder. Also, in some places the bedrock is at a depth of more than 60 inches.

Included with these soils in mapping are small areas of Clareson and Shidler soils. The moderately deep Clareson soils are on the ridgetops and have flaggy limestone in the subsoil. The shallow Shidler soils are on the ridgetops and are above limestone ledges on side slopes. These included soils make up about 10 percent of the map unit.

The Eram and Apperson soils have slow permeability. Available water capacity is low in the Eram soil and moderate in the Apperson soil. Natural fertility is medium in the Eram soil and high in the Apperson soil. Surface runoff is rapid and organic matter content is moderate for both soils. The subsoil of these soils has a high shrink-swell potential. A perched seasonal high water table is at a depth of 1.5 to 3 feet.

Most of this map unit is in range or pasture. The rest is used for cultivated crops. This map unit is moderately well suited to grain sorghum, soybeans, and wheat. Water erosion is the principal hazard when these soils are cultivated. Cultivation also exposes rock in a few places. Grassed waterways, terraces, contour farming, and minimum tillage help reduce excessive soil loss. Using crop residue in or on top of this plow layer improves soil tilth and the infiltration rate.

This map unit is well suited to rangeland and pasture and is used for grazing livestock and for hay. Overgrazing reduces the vigor of grasses and retards growth. Proper stocking rates, timely deferment of grazing, and rotation grazing help keep the grass in good condition. Properly placing salt and water improves grazing distribution. If native grass used for hay is mowed early, the plants can recover before frost. Timely mowing of tame grasses, which depends on the species, allows these plants to recover. Fertilizing tame grasses increases the vigor of plants and reduces erosion.

Shrink-swell potential is a severe limitation if the soils are used as sites for dwellings. Wetness is an additional limitation for dwellings with basements. Properly designing and reinforcing foundations, backfilling with porous material, and installing foundation drains help overcome these limitations. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material helps overcome these limitations.

These soils are generally unsuitable as a site for septic tank absorption fields. Slow permeability and wetness are severe limitations. Depth to bedrock is an additional limitation in the Eram soil. If these soils are used for sewage lagoons, the depth to rock is a severe limitation in the Eram soil and slope is a moderate limitation in the Apperson soil. Less sloping and less rocky included soils are better sites for lagoons.

The capability subclass is IVe.

Er—Eram-Collinsville complex, 4 to 15 percent slopes. This map unit consists of moderately deep and shallow, moderately sloping and strongly sloping soils that are moderately well drained and well drained. These soils are on ridgetops, on side slopes, and along a few drainageways. A few sandstone rocks are on the surface in some places. Individual areas are long and narrow or irregular in shape and range from about 10 to 700 acres in size.

This map unit is made up of about 65 percent Eram soils and about 20 percent Collinsville soils. The Eram soil is on side slopes. The Collinsville soil is mainly on ridgetops and the upper part of side slopes. These two soils are so intricately mixed that mapping them separately is not practical.

Typically, the Eram soil has a surface layer of very dark brown silt loam about 10 inches thick. The subsoil is mottled, very firm silty clay about 18 inches thick. The upper part is very dark grayish brown, and the lower part is dark grayish brown. Shale bedrock is at a depth of about 28 inches. In some places the subsoil is loam. Also, in a few places on the lower part of side slopes, the bedrock is at a depth of more than 40 inches.

Typically, the Collinsville soil has a surface layer of very dark brown loam about 10 inches thick. The subsurface layer is dark brown loam about 4 inches thick. Sandstone bedrock is at a depth of about 14 inches. In some places it is at a depth of 20 to 40 inches. In a few places limestone is at a depth of 10 to 20 inches.

Permeability is slow in the Eram soil and moderately rapid in the Collinsville soil. Available water capacity is low in the Eram soil and very low in the Collinsville soil. The Eram soil has high shrink-swell potential in the subsoil. Root development in the Collinsville soil is restricted below a depth of about 14 inches. Surface runoff on both soils is rapid. The natural fertility of these soils is medium, and organic matter content is moderate. A perched seasonal high water table is at a depth of 2 to 3 feet.

Nearly all of this unit is used for range. This unit is better suited to this use. These soils generally are unsuitable for cultivation because of a severe hazard of erosion. The hazard of erosion and low or very low available water capacity are concerns of management. An adequate plant cover and ground mulch reduce the runoff rate, help prevent excessive soil loss, and increase the moisture supply. Overgrazing destroys the protective plant cover and causes deterioration of the plant community. The more desirable grasses are then replaced by less productive grasses and weeds. Proper stocking rates and timely deferment of grazing help keep the range in good condition.

The shrink-swell potential of the Eram soil and the depth to rock in the Collinsville soil are severe limitations at sites for dwellings. The Eram soil has an additional limitation of wetness for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help prevent the structural damage caused by the shrinking and swelling of the Eram soil. The deeper, less sloping adjacent soils are better building sites. The shrink-swell potential and low strength of the Eram soil and the depth to rock in the Collinsville soil are severe limitations for local roads and streets. The adverse effects of shrinking and swelling and low strength can be lessened by strengthening or replacing the base material.

These soils generally are unsuitable as sites for septic tank absorption fields. Severe limitations are the depth to bedrock in both soils and the wetness and slow permeability in the Eram soil. The depth to bedrock and the slope are severe limitations for sewage lagoons. The deeper, less sloping included soils on foot slopes are suitable sites for lagoons.

The capability subclass is VIe.

Es—Eram-Shidler silty clay loams, 4 to 15 percent slopes. This map unit consists of moderately deep and shallow, moderately sloping and strongly sloping soils that are moderately well drained and well drained. These soils are on rims of ridgetops and side slopes. Individual areas of this unit are long, narrow, and curved in shape and range from about 10 acres to nearly 1,000 acres in size.

This map unit is made up of about 60 percent Eram soils and about 25 percent Shidler soils. The gently sloping Shidler soil is on the rims of ridgetops and on the upper part of side slopes. The Eram soil is below the Shidler soil on side slopes. These soils are so intricately mixed or the areas are so narrow that mapping them separately is not practical.

Typically, the Eram soil has a surface layer of black silty clay loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 18 inches thick. The upper part is very dark grayish brown, and the lower part is olive brown. Shale bedrock is at a depth of about 26 inches. In some places shale is either at a depth of 10 to 20 inches or more than 40 inches.

Typically, the Shidler soil has a surface layer of black silty clay loam about 12 inches thick. Limestone bedrock is below the surface layer. In some places flaggy limestone is at a depth of 40 to 60 inches. In a few places sandstone is at a depth of 10 to 20 inches.

Included with these soils in mapping are small areas of Olpe soils. The deep, well drained, gravelly Olpe soils are on ridgetops and side slopes. This included soil makes up about 5 percent of the map unit.

Permeability is slow in the Eram soil and moderate in the Shidler soil. Available water capacity is low in the Eram soil and very low in the Shidler soil. The shrink-swell potential of the subsoil is high in the Eram soil and moderate in the Shidler soil. The Eram soil has a perched seasonal high water table at a depth of 2 to 3 feet. Root development is restricted in the Shidler soil at a depth of about 12 inches. Surface runoff is rapid on both soils. The natural fertility of these soils is medium, and the organic matter content is moderate.

This map unit is mostly used for range and is better suited to this use. These soils generally are unsuitable for cultivation because of a severe hazard of erosion. The hazard of erosion and low or very low available water capacity are concerns of management. Overgrazing reduces the growth and vigor of grasses, which, in turn, increases runoff. Range management that maintains a good vegetative cover helps reduce runoff and erosion. Proper stocking rates and timely deferment of grazing help keep the grass in good condition.

These soils have severe limitations, and they are generally unsuitable as sites for dwellings and for local roads and streets. The shrink-swell potential of the Eram soil and the depth to bedrock in the Shidler soil are severe limitations if these soils are used as sites for dwellings. The Eram soil has an additional limitation of wetness for dwellings with basements. Low strength and shrink-swell potential are severe limitations if the Eram soil is used for local roads and streets. The depth to rock in the Shidler soil is also a severe limitation for local roads and streets. The deep adjacent soils are better sites for dwellings and local roads and streets.

These soils are generally unsuitable as a site for septic tank absorption fields. Severe limitations are depth to bedrock, wetness, and slow permeability in the Eram soil and depth to rock in the Shidler soil. Depth to bedrock and slope are severe limitations for sewage lagoons. The deeper adjacent soils are better sites for lagoons.

The capability subclass is VIe.

Kb—Kenoma silt loam, 1 to 3 percent slopes. This deep, gently sloping soil is moderately well drained. The soil is on broad uplands. It is occasionally dissected by drainageways. Individual areas of this unit are irregular in shape and range in size from about 10 acres to over 1,000 acres.

Typically, the surface layer is very dark grayish brown silt loam about 11 inches thick. The very firm subsoil is about 45 inches thick. The upper part is very dark grayish brown silty clay, and the lower part is dark brown, mottled silty clay. The substratum is yellowish brown, mottled silty clay to a depth of 60 inches. The surface layer is silty clay loam or silty clay where it has been mixed with the upper part of the subsoil by plowing. Where the soil has long, gentle slopes, the subsoil is very dark gray in some places. Where the soil is on the lower part of side slopes that are adjacent to drainageways, the subsoil may be silty clay loam in the upper part.

Included with this soil in mapping are well drained Lula soils and moderately well drained Dwight soils. Lula soils are redder and have a less clayey subsoil than this Kenoma soil. They are on ridgetops. Dwight soils have a subsoil that has a high sodium content. They are in slightly concaved areas of ridgetops. These included soils make up about 5 to 10 percent of the map unit.

Permeability is very slow in this Kenoma soil, and surface runoff is medium. The available water capacity is moderate. The subsoil has high shrink-swell potential (fig. 10). The natural fertility is medium, and the organic matter content is moderate. When unlimed, the surface layer is medium acid or slightly acid.

Most of this soil is used for cultivated crops. The rest is used for range and pasture. This soil is well suited to grain sorghum, wheat, and soybeans. Erosion is a hazard if cultivated crops are grown. Also, the soil is droughty in summer because the clayey subsoil absorbs and releases moisture slowly. Grassed waterways, terraces, contour farming, and minimum tillage prevent excessive soil loss and conserve moisture. Using crop residue in or on top of the plow layer increases the content of organic matter and improves tilth.

This soil is suited to rangeland and is used for both livestock grazing and hay. Overgrazing reduces the vigor of the grasses and retards their growth. Proper stocking rates and rotation grazing help keep the range in good condition. Native grass used for hay should be mowed early enough in the season to allow the plants to recover before frost.

Pastures of mainly cool season grasses are used for grazing livestock and for hay. Controlled grazing and timely mowing are important for maintaining good condition of pastures. Fertilizers increase plant growth and vigor.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations and backfilling with porous material help prevent structural damage. The low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material helps overcome these limitations.

This soil is generally unsuitable as a site for septic tank absorption fields. It is severely limited by very slow permeability. It is suitable as a site for sewage lagoons.

The capability subclass is IIIe.

Ke—Kenoma silty clay loam, 1 to 3 percent slopes, eroded. This deep, gently sloping soil is moderately well drained. It is on short side slopes in uplands. Individual areas are irregular in shape. Their delineation may follow a field boundary. They range from 5 to 30 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is very firm silty clay about 35 inches thick. The upper part is very dark grayish brown, and the lower part is dark

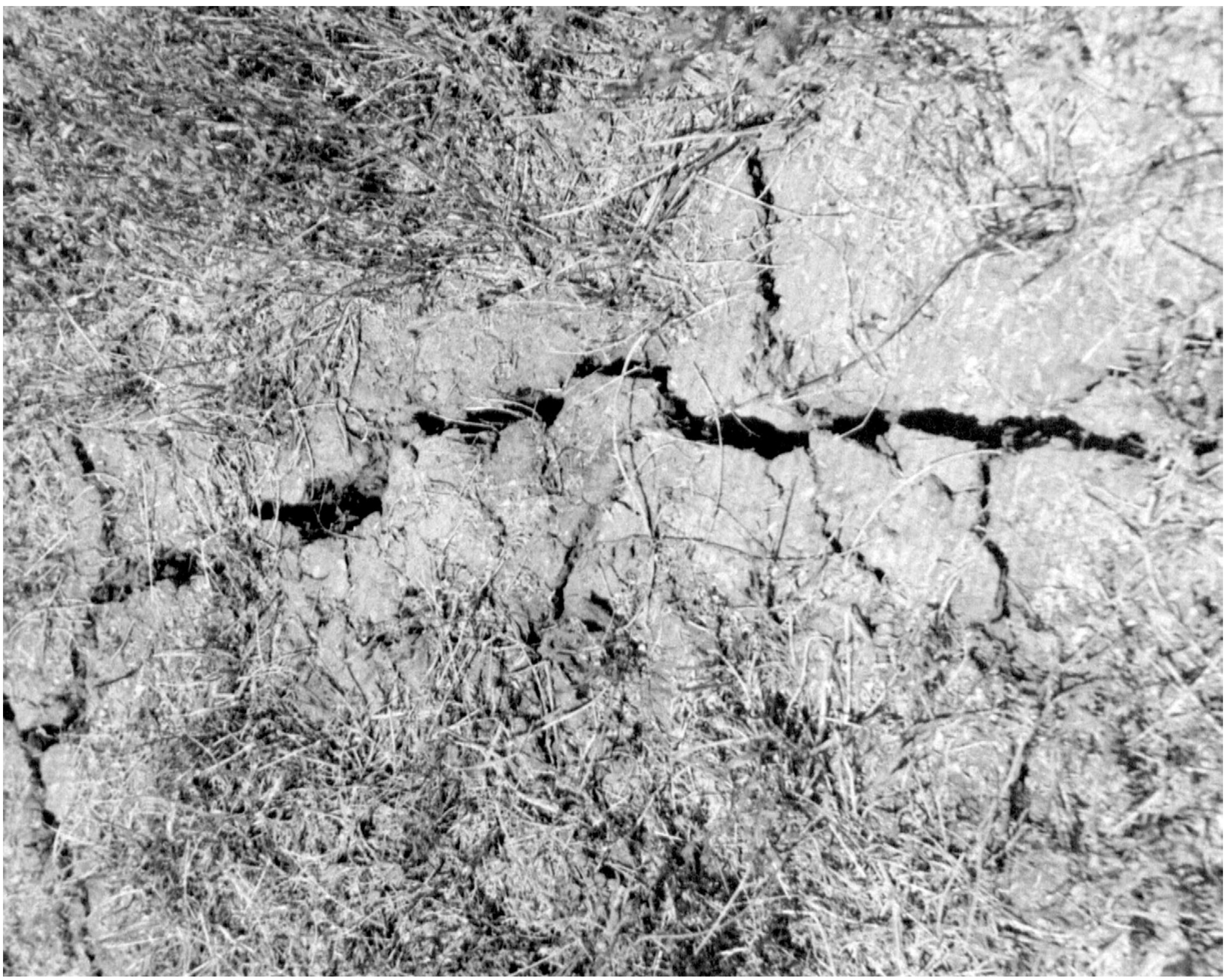


Figure 10.—The shrinking and swelling of the clayey subsoil of this Kenoma soil causes cracks during dry periods.

brown. The substratum is yellowish brown, mottled silty clay. Limestone bedrock is at a depth of about 46 inches. In some places there is no bedrock to a depth of 60 inches. In places the subsoil is very dark gray, or the surface layer is silt loam.

Included with this soil in mapping are small areas of Dwight soils. The subsoil of the Dwight soils contains sodium. Dwight soils are in slightly concave areas. This included soil makes up about 5 percent of this map unit.

This Kenoma soil has very slow permeability, and surface runoff is medium. The available water capacity is moderate. The organic matter content is moderately low, and the natural fertility is low. The surface layer is firm and is difficult to till. The subsoil has a high shrink-swell potential.

Almost all areas have been used for cultivated crops; however, most areas are now used for pasture or range. This soil is moderately well suited to wheat. If cultivated crops are grown, further erosion is a hazard. Also, the soil is droughty in summer because the clayey subsoil absorbs and releases moisture slowly. Terraces, contour farming, grassed waterways, and minimum tillage help control runoff and erosion. Leaving crop residue on the surface and adding barnyard manure to the plow layer increase the infiltration rate and improve tilth.

This soil is moderately well suited to pastures of tame grass and rangeland. A cover of grasses is effective in controlling erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, timely deferment of grazing, brush control, and restricted use during wet periods help keep the pasture and range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations and backfilling with porous material help prevent structural damage. The low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps overcome these limitations.

This soil is generally unsuitable as a site for septic tank absorption fields. The very slow permeability is a severe limitation. The soil is unsuitable as a site for sewage lagoons because it is limited by depth to rock. Soils deep enough for sewage lagoons can be located by onsite investigation.

The capability subclass is IVe.

Ko—Kenoma-Olpe complex, 2 to 7 percent slopes. This map unit consists of deep, moderately well drained and well drained soils that are gently sloping and moderately sloping. These soils are on low hills. Drainageways dissect most areas. Individual areas of this unit are irregular in shape and range from 15 acres to several hundred acres in size.

This map unit is made up of about 45 percent Kenoma soils and 35 percent Olpe soils. The Kenoma soil is on the broader ridgetops and on the lower part of foot slopes. The Olpe soil is mainly on ridgetops and side slopes. The two soils are so intricately mixed or so small in size that it is not practical to separate them in mapping.

Typically, the Kenoma soil has a surface layer of very dark grayish brown silt loam about 11 inches thick. The subsoil is very firm silty clay about 45 inches thick. The upper part is very dark grayish brown, and the lower part is dark brown. The substratum is yellowish brown, mottled silty clay to a depth of 60 inches. In places the upper part of the subsoil is silty clay loam. Also, in some places shale bedrock is at a depth of 20 to 40 inches.

Typically, the Olpe soil has a surface layer of very dark brown gravelly silt loam about 10 inches thick. The subsoil, which extends to a depth of about 60 inches, is dark brown, firm gravelly silty clay loam in the upper part. The middle part is dark reddish brown, very firm very gravelly silty clay and the lower part is dark brown and mixed yellowish red and strong brown, very firm very gravelly silty clay. In a few places the upper part of the subsoil does not have gravel.

Included with these soils in mapping are small areas of the shallow Shidler soils. They are above limestone ledges along the ridgetops. This included soil makes up less than 5 percent of the map unit.

Permeability is very slow in the Kenoma soil and slow in the Olpe soil. The shrink-swell potential of the Olpe soil is moderate, and it is high in the Kenoma soil. The available water capacity is moderate in the Kenoma soil and low in the Olpe soil. Surface runoff is medium on both soils. The natural fertility is medium, and the organic matter content is moderate. When unlimed, the surface layer of these soils is medium acid or slightly acid.

Most of the acreage is used for range. A few small areas are cultivated. These soils are moderately well suited to wheat. Erosion is a hazard when the soils are cultivated. The Olpe soil is droughty because of low available water capacity. Gravel is on or near the surface and hampers tillage. Maintaining fertility and improving tilth are also concerns in managing this soil. Terraces, grassed waterways, and returning crop residue to the surface help control erosion and conserve moisture.

This unit is well suited to rangeland. Overgrazing causes deterioration of the plant community. The more desirable grasses are then replaced by less productive grasses and weeds. Proper stocking rates, timely deferment of grazing, and brush control help keep the range in good condition.

The shrink-swell potential is a severe limitation if the Kenoma soil is used for dwellings. It is a moderate limitation in the Olpe soil. Properly designing and reinforcing foundations and backfilling with porous material help prevent structural damage. Shrink-swell potential and low strength in the Kenoma soil is a severe limitation for local roads and streets. Shrink-swell potential is a moderate limitation if the Olpe soil is used for local roads and streets. Strengthening or replacing the base material helps overcome these limitations.

These soils are generally unsuitable as a site for septic tank absorption fields. The slow and very slow permeability is a severe limitation. These soils are moderately limited as a site for sewage lagoons by slope. In addition, seepage in the Olpe soil is a moderate limitation. The less sloping Kenoma soil is a better site for lagoons.

The capability subclass is IVe.

La—Lanton silty clay loam. This deep, nearly level soil is somewhat poorly drained. The soil is on flood plains. It is occasionally flooded. If this soil is protected by large dams, flooding is less frequent downstream from the dam but is more frequent, of longer duration, and extends further upstream during high water. Individual areas are irregular in shape or long and narrow and range from about 10 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 22 inches thick. The lower 14 inches is mottled. The next layer is about 19 inches thick. It is dark gray, very firm silty clay loam that is mottled throughout. The substratum is dark gray silty clay loam to a depth of 60 inches. In some places there are no mottles within 20 inches of the surface.

Included with this soil in mapping are small areas of Osage soils, which have a subsoil of silty clay. The Osage soils are in concave areas and are poorly drained. This included soil makes up about 5 to 10 percent of the map unit.

Permeability is moderately slow in this Lanton soil. Surface runoff is slow, and available water capacity is high. Natural fertility is high, and the organic matter content is moderate. The surface layer is friable and easily tilled. The subsoil has a moderate shrink-swell potential. A seasonal high water table is a depth of 1 to 2 feet.

Most of this soil is used for cultivated crops. The rest is in rangeland, pasture, and woodland. This soil is well suited to grain sorghum, soybeans, wheat, and corn. Crops are sometimes damaged by floods or prolonged wetness. Field drainage ditches help remove excess surface water. Using crop residue in or on top of the plow layer helps improve tilth and increase the content of organic matter.

This soil is well suited to pasture and rangeland and is used for hay and livestock grazing. Overgrazing, however, reduces the vigor of grasses and retards their growth. Proper stocking rates, rotation grazing, and brush control keep the grass in good condition.

This soil is suited to growing trees. A few small areas support native hardwoods. Tree cuttings and seedlings grow well if competing vegetation is controlled. Plant competition can be controlled by site preparation; by controlled burning; or by spraying, cutting, and girdling.

This soil is generally unsuitable as a site for dwellings and sanitary facilities. Flooding is a severe hazard. Providing protection from flooding is difficult without installing major flood controls.

The capability subclass is IIw.

Le—Leanna silt loam. This deep, nearly level soil is somewhat poorly drained. This soil is on flood plains. It is occasionally flooded. Individual areas are irregular in shape. They are mainly along the larger streams and range from about 15 to 160 acres in size.

Typically, the surface layer is black silt loam about 10 inches thick. The subsurface layer is very dark gray silt loam about 8 inches thick. The mottled subsoil extends to a depth of 60 inches. It is very dark gray and dark grayish brown, very firm silty clay in the upper part and grayish brown, very firm clay in the lower part. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Woodson soils. Woodson soils do not have a subsurface layer and are on adjacent uplands. This included soil makes up about 10 percent of the map unit.

Permeability is very slow in the Leanna soil. Surface runoff is slow, and the available water capacity is high. Natural fertility is medium, and the organic matter content is moderate. When unlimed, the surface layer is strongly acid or medium acid. The subsoil has a high shrink-swell potential. A perched seasonal high water table is at a depth of about 0.5 foot to 2 feet.

Most of this soil is used for cultivated crops. It is well suited to grain sorghum, wheat, and soybeans. Flooding or ponding delays spring planting in some years. Drainage ditches or bedding systems help remove excess surface water. Using crop residue in or on top of the plow layer and minimum tillage help maintain good soil tilth and improve the infiltration rate.

This soil is suited to rangeland and pasture and is used for hay and for grazing livestock. Overgrazing reduces the growth and vigor of the plants; then less desirable grasses and brush increase. Proper stocking rates, timely deferment of grazing, and brush control help keep the pasture and range in good condition. Some areas are used for hay. In these areas grass should be mowed early enough to allow the plants to recover before frost. Also, fertilizers help growth of tame grasses.

This soil is suited to growing trees, and a few small areas support native woodland. If this unit is managed for trees, the proper spacing of trees and the desired species are maintained by eliminating competing vegetation. This can be done by prescribed cutting, girdling, and spraying.

This soil is generally unsuitable for dwellings and sanitary facilities. Flooding is a severe hazard. Overcoming this hazard is difficult without installing major flood controls.

The capability subclass is IIw.

Lu—Lula silt loam, 0 to 2 percent slopes. This deep, nearly level soil is well drained. It is on ridgetops. Individual areas are irregular in shape and range from 10 to 700 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is about 39 inches thick. The upper part is dark reddish brown, firm silty clay loam, and the lower part is reddish brown, firm and very firm silty clay loam. Limestone bedrock is at a depth of about 48 inches. In places bedrock is at a depth of 20 to 40 inches. In a few areas it is at a depth of more than 60 inches. Also, in several places, especially in the northern part of the county, the subsoil is grayer and has reddish mottles.

Included with this soil in mapping are small areas of Apperson, Dwight, Kenoma, and Shidler soils. The moderately well drained Apperson, Dwight, and Kenoma soils are on ridgetops. The Dwight soils have high sodium content in the subsoil. The Kenoma soils have a silty clay subsoil. The shallow Shidler soils are along the rim of the ridgetops. These inclusions make up about 15 percent of the map unit.

Permeability is moderate in this Lula soil, and surface runoff is medium. Available water capacity is moderate. This soil has moderate organic-matter content and medium natural fertility. When unlimed, the surface layer is medium acid or slightly acid. The shrink-swell potential in the subsoil is moderate.

Most of this soil is used for cultivated crops. The rest is in range or pasture. This soil is well suited to wheat, grain sorghum, and soybeans. If cultivated crops are grown, erosion is a hazard. Also, a concern of management is efficient use of available water. Grassed waterways, terraces, and contour farming help prevent excessive soil loss and conserve moisture. Using crop residue in or on top of the plow layer increases the content of organic matter and the infiltration rate and improves soil tilth.

This soil is well suited to pasture and rangeland and is used for grazing livestock and for hay. Management is needed to prevent overgrazing and the invasion of undesirable grasses, shrubs, and trees. Proper stocking rates, timely deferment of grazing, rotation grazing, and controlling unwanted vegetation help keep the pasture and rangeland in good condition. Native grass for hay should be mowed early enough to allow the plants to recover before frost. Timely mowing of tame grasses, according to species, and fertilizing increase hay production.

Shrink-swell potential is a moderate limitation if this soil is used as a site for dwelings. Depth to rock is an additional moderate limitation for dwellings with basements. Properly designing and reinforcing foundations and backfilling with porous material help prevent structural damage to buildings caused by shrinking and swelling of the soil. This soil is severely limited for local roads and streets by low strength. Strengthening or replacing the base material helps overcome this limitation.

Depth to bedrock and moderate permeability are moderate limitations if this soil is used as a site for septic tank absorption fields. Increasing the size of the absorption field or installing two absorption fields that are used alternately helps improve the functioning of the septic system. Depth to bedrock and seepage are also moderate limitations for sewage lagoons. Deeper included soils are better sites for lagoons.

The capability subclass is IIe.

Ma—Mason silt loam. This deep, nearly level soil is well drained. The soil is on stream terraces. It is rarely flooded. Individual areas of this unit are irregular in shape and range from about 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil, which extends to a depth of 60 inches, is very dark grayish brown and dark brown, firm silty clay loam. In a few places limestone bedrock is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Leanna and Lanton soils. These soils are on slightly lower flood plains. These included soils make up about 5 to 10 percent of the map unit.

Permeability in this Mason soil is moderately slow, and the available water capacity is high. Surface runoff is slow. Organic matter content is moderate, and natural fertility is high. The surface layer is friable and easily tilled. When unlimed, it is commonly medium acid or slightly acid. The subsoil has a moderate shrink-swell potential.

Nearly all of this soil is used for cultivated crops. This soil is well suited to grain sorghum, soybeans, corn, wheat, and alfalfa. Crop residue returned to the surface or incorporated into the plow layer helps maintain or improve the soil tilth and organic matter content.

This soil is well suited to pasture and rangeland, although not many areas are used for this purpose. Overgrazing causes deterioration of the plant community, which allows weeds and shrubs to invade. Proper stocking rates and deferred grazing help keep the grass in good condition.

This soil is well suited to growing trees. A few small areas support native woodland. Tree cuttings and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation or by spraying, cutting, or girdling. There are no hazards or limitations when planting or harvesting trees.

Flooding is a severe limitation if this soil is used as a site for dwellings. Protection from flooding by dikes, levees, or other structures or by building on slightly higher included soils lessens this hazard. Low strength is a severe limitation for local roads and streets. Strengthening or replacing the base material helps overcome this limitation.

This soil is severely limited as a site for septic tank absorption fields by moderately slow permeability.

Increasing the size of the absorption field helps improve the functioning of the septic system. The soil is suitable as a site for sewage lagoons.

The capability class is I.

Ob—Olpe gravelly silt loam, 4 to 15 percent slopes. This deep, well drained soil is moderately sloping and strongly sloping. It is on smooth hills. Individual areas are irregular in shape and range from about 20 acres to several hundred acres in size.

Typically, the surface layer is very dark brown gravelly silt loam about 10 inches thick. The subsoil extends to a depth of 60 inches. It is dark brown, firm gravelly silty clay loam in the upper part; dark reddish brown, very firm very gravelly silty clay loam in the middle part; and dark brown and mixed yellowish red and strong brown, very firm very gravelly silty clay in the lower part.

Included with this soil in mapping are small areas of Eram, Kenoma, Lula, and Shidler soils. The moderately deep Eram soils and the shallow Shidler soils are on the upper part of side slopes. Lula soils have limestone bedrock at a depth of 40 to 60 inches. They are on ridgetops. The moderately well drained Kenoma soils are on the lower part of foot slopes. These included soils make up 10 to 15 percent of the map unit.

Permeability is slow in the Olpe soil, and surface runoff is rapid. Available water capacity is low. Natural fertility is medium, and organic matter content is moderate. This soil has moderate shrink-swell potential.

This map unit is well suited to range. Most of this unit is in range used for grazing livestock. It is generally unsuitable for cultivated crops because of the severe hazard of erosion and droughtiness. Overgrazing the range reduces plant vigor and causes invasion of unwanted vegetation. Proper stocking rates and timely deferment of grazing keep the grass in good condition. Distributing salt and water aids in uniform grazing.

The shrink-swell potential and slope are moderate limitations if this soil is used as sites for dwellings and local roads and streets. Properly designing and reinforcing foundations and backfilling with porous materials help prevent structural damage to buildings. Strengthening or replacing the base material help overcome limitations for local roads and streets.

This soil is generally unsuitable as a site for septic tank absorption fields. It is severely limited by slow permeability. Slope is a severe limitation if the soil is used as sites for sewage lagoons. The deep included soils on the foot slopes are better sites for sewage lagoons.

Gravel is mined from many areas and is used mostly for surfacing roads.

The capability subclass is VIe.

Oc—Orthents, clayey. This map unit consists of soils in excavated depressions and on side slopes. In this map unit, the surface soil and part or all of the subsoil have been removed and used as fill material in roads or dams. The side slopes are steep and the depressional areas are nearly level. Individual areas are generally rectangular, but in some places they are irregular in shape. They range from about 10 to 80 acres in size.

The soil is silty clay or silty clay loam. It commonly is brown, olive brown, or reddish brown. Depth to bedrock ranges from 40 inches to more than 60 inches.

Permeability is slow. Surface runoff is rapid on the side slopes. On the nearly level soils, water runs very slow or ponds. Shrink-swell potential is high.

Most of this map unit is in grass. A few areas adjacent to rangeland are grazed by livestock. The soil is generally not suited to cultivated crops. Erosion is a problem in most areas. Reseeding to native or tame grasses helps reduce erosion. The established vegetative cover can be maintained if it is not overgrazed. Drainage of the lower levels is a problem in places. Because of inadequate outlets, water ponds following rainfall in some places.

This map unit is generally unsuitable for dwellings and septic tank absorption fields. Shrink-swell potential, wetness, and rock fragments are limitations. This map unit is severely limited for sewage lagoons by wetness. Onsite investigations may locate deep soils that are suitable for lagoons.

The capability subclass is VIs.

Oh—Orthents, hilly. This soil is a mixture of soil material, rocks, and shale from coal mine spoil. Orthents are strongly sloping to steep. Individual areas are irregular in shape and range from about 5 to 70 acres in size.

The soil is shaly silty clay or shaly silty clay loam. It commonly is brown or yellowish brown. Rocks are on the surface in some places.

Reaction ranges from medium acid to mildly alkaline. Natural fertility and content of organic matter are low.

These soils are used for grazing livestock or for wildlife habitat. The vegetation, mainly on the lower part of slopes and in swales, is weeds, annual grasses, and trees. In many areas there is no vegetation.

These soils are generally not suited to cultivated crops. The steep slope and rock fragments are limitations. It is difficult to establish desirable grasses and trees unless the slopes are entensively graded and shaped.

These soils are generally unsuitable for dwellings and sanitary facilities. Onsite investigation is needed to determine the suitability of the soil for specific uses.

The capability subclass is VIs.

Os—Osage silty clay loam. This deep, nearly level soil is poorly drained. It is on flood plains and is occasionally flooded. Flooding is less frequent, however, for several miles downstream from the John Redmond Reservoir and from other large reservoirs in the county. Flooding is more frequent, of longer durations, and extends further upstream from the John Redmond

Reservoir during high water. Individual areas are irregular in shape and mainly are along the larger streams. They range from about 15 acres to a few hundred acres in size.

Typically, the surface layer is black silty clay loam about 12 inches thick. The subsoil is extremely firm silty clay to a depth of 60 inches. The upper part is black, and the lower part is very dark gray. In some places the surface layer is silty clay.

Included with this soil in mapping are moderately well drained Verdigris soils and somewhat poorly drained Lanton soils. Verdigris soils are adjacent to the stream channel. Lanton soils are mainly on flood plains adjacent to uplands. These included soils make up about 10 to 15 percent of the map unit.

Permeability is very slow in this Osage soil, and surface runoff is slow. The available water capacity is moderate. The natural fertility is high, and the organic matter content is moderate. When unlimed, the surface layer is commonly medium acid or slightly acid. The subsoil has a very high shrink-swell potential. A seasonal high water table is within 1 foot of the surface.

Most of this soil is used for cultivated crops, but a small acreage is in range, pasture, or trees. This soil is well suited to grain sorghum, soybeans, wheat, and corn. If the soil is used for cultivated crops, the wetness and flooding can delay farming operations and reduce yields. Surface drainage ditches, bedding systems, or land leveling reduce wetness. Minimum tillage and using crop residue on the surface or in the plow layer help maintain good tilth and increase the infiltration rate.

This soil is well suited to rangeland and pasture. Native and tame grasses are used mostly for hay. Overgrazing or mowing hay and grazing during wet periods cause surface compaction and poor tilth. Proper stocking, fertilization, timely deferment of grazing, and restricted use during wet periods help keep the soil and grass in good condition.

This soil is moderately well suited to trees, and a few areas remain in native hardwoods. Equipment limitations and seedling mortality are moderate and plant competition is severe if this soil is used as woodland. Harvesting equipment can be used during the dry seasons. Tree cuttings and seedlings grow well if competing vegetation is controlled by site preparation; by controlled burning; or by spraying, cutting, or girdling.

This soil is generally unsuitable for dwellings and sanitary facilities. Flooding is a severe limitation. It is difficult to overcome unless major controls are installed.

The capability subclass is IIw.

Ot—Osage silty clay. This deep, nearly level soil is poorly drained. The soil is on broad flood plains. It is occasionally flooded. Flooding is less frequent for several miles below the John Redmond Reservoir but is more frequent, of longer duration, and extends further upstream during high water. Individual areas are irregular in shape. They range from about 20 acres to several hundred acres in size.

Typically, the surface layer is black silty clay about 7 inches thick. The subsurface layer is black, very firm silty clay about 8 inches thick. The subsoil is mottled, extemely firm silty clay to a depth of about 60 inches. The upper part is very dark gray, and the lower part is dark gray. In some places the surface layer is silty clay loam.

Included with this soil in mapping are the moderately well drained Verdigris soils and the somewhat poorly drained Lanton soils. Verdigris soils are adjacent to the stream channel. Lanton soils are mainly on the terrace fans adjacent to the uplands. These included soils make up about 10 percent of the map unit.

Permeability and surface runoff are very slow for the Osage soil. Shrink-swell potential is very high, and available water capacity is moderate. The surface layer is very firm, so tilling is difficult. When unlimed, it is commonly medium acid or slightly acid. Natural fertility is high, and organic matter content is moderate. A seasonal high water table is within 1 foot of the surface.

Most of the acreage is used for cultivated crops, but a small acreage is in native grass, tame grass, or trees. This soil is suited to grain sorghum, soybeans, and wheat. Wetness and flooding can delay farming operations and reduce yields. Field drainage ditches, a bedding system, or land leveling help remove excess surface water. Fall tillage improves the seedbed for the following spring. Winter freezing and thawing is beneficial; it causes a loose, granular surface structure that is 3 or 4 inches thick. Using crop residue in or on top of the plow layer improves soil tilth and the infiltration rate.

This soil is well suited to range and pasture. Native and tame grasses are used mostly for hay. Overgrazing or mowing hay and grazing during wet periods cause surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the soil and grass in good condition.

This soil is moderately well suited to trees, and a few areas remain in native hardwoods. Equipment limitations and seedling mortality are moderate and plant competition is severe if the soil is used as woodland. Harvesting equipment can be used during the dry season. Tree cuttings and seedlings grow well if competing vegetation is controlled or removed by site preparation; by controlled burning; or by spraying, cutting, or girdling.

This soil is generally unsuitable for dwellings and sanitary facilities because of flooding. Flooding is difficult to overcome without installing major flood controls.

The capability subclass is IIIw.

Pt—Pits, quarries. This map unit consists of deep, excavated quarries where the soil material and the underlying limestone have been stripped away. The side walls are typically vertical and the floors of the quarries are nearly level or undulating. Individual areas are irregular in shape and range from about 5 to 80 acres in size.

The crushed limestone is used mainly for aggregate in concrete mixture and for road surfacing. Some quarries are being enlarged in size.

The excavated quarries consist of exposed limestone. Also included in this unit are small piles of crushed limestone and piles of soil overburden removed from above the limestone. These piles are usually underlain by undisturbed soil.

This map unit is suited to wildlife, recreation, and as a source for water. Many quarries are presently used for these purposes. These pits generally are unsuited to cultivated crops and range.

No capability subclass is assigned.

Sa—Summit silty clay loam, 1 to 4 percent slopes. This deep, gently sloping soil is moderately well drained. It is below limestone ledges on side slopes and foot slopes. Individual areas of this unit are irregular in shape and range from about 10 to 500 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil extends to a depth of about 60 inches. It is black, very firm silty clay loam and silty clay in the upper part and very dark gray and dark gray, mottled, very firm silty clay in the lower part. In some cultivated areas the surface layer is silty clay. In some places the textural transition between the surface layer and subsoil is more abrupt than gradual and smooth. In a few areas shale is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Lula and Shidler soils. The deep, well drained Lula soils are on ridgetops. The shallow, well drained Shidler soils are along the rim of ridgetops. These included soils make up less than 5 percent of the map unit.

Permeability is slow in this Summit soil, and the available water capacity is high. Surface runoff is medium. Natural fertility is high, and the organic matter content is moderate. When unlimed, the surface layer is medium acid or slightly acid. The subsoil has a high shrink-swell potential. A perched seasonal high water table is at a depth of 2 to 3 feet.

Most of this soil is used for cultivated crops, but a large acreage is in native grass or pastures of tame grass. This soil is well suited to grain sorghum, soybeans, and wheat. When the soil is used for cultivated crops, erosion is a hazard. Grassed waterways, terraces, and contour farming help reduce soil loss. Minimum tillage and using crop residue in or on top of the plow layer improves the tilth, increases infiltration rate, and reduces soil loss.

This soil is well suited to pasture and rangeland. Much of the area is used for grazing livestock, and the rest is mowed for hay. Overgrazing causes deterioration of the natural plant community; then desirable grasses are replaced by less productive grasses, weeds, and brush. Proper stocking rates, timely deferment of grazing, and rotation grazing help keep the pasture and range in good condition. Native grass for hay should be mowed early enough to allow the plants to recover before frost. Fertilizers increase productivity of tame grass.

Shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Wetness is an additional severe limitation for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help overcome these limitations. Low strength and shrink-swell potential are severe limitations if this soil is used for local roads and streets. Strengthening or replacing the base material helps overcome these limitations.

This soil is generally unsuitable as a site for septic tank absorption fields. Wetness and slow permeability are severe limitations. Slope is a moderate limitation for sewage lagoons. Construction of the lagoon requires less leveling and banking on the more nearly level soils.

The capability subclass is IIe.

Sc—Summit silty clay loam, 4 to 7 percent slopes. This deep, moderately sloping soil is moderately well drained. The soil is below limestone ledges on side slopes. Individual areas of this unit are long and relatively narrow in shape and range from about 10 to 300 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil, which extends to a depth of 60 inches, is very dark grayish brown, very firm silty clay loam in the upper part. The middle part is dark grayish brown, very firm silty clay, and the lower part is gray, mottled, very firm silty clay. In some cultivated areas the surface layer is silty clay. In some areas shale is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of the well drained Lula and the shallow Shidler soils. They are on the upper part of side slopes and ridgetops. These included soils make up about 5 percent of the map unit.

Permeability is slow in this Summit soil, and the available water capacity is high. Surface runoff is rapid. Natural fertility is high, and the organic matter content is moderate. When unlimed, the surface layer is medium acid or slightly acid. The subsoil has a high shrink-swell potential. A perched seasonal high water table is at a depth of 2 to 3 feet.

About one-half of the acreage is in range or pasture that is used for grazing livestock and for hay. The other half is used for cultivated crops. This soil is moderately well suited to grain sorghum, soybeans, and wheat. When cultivated crops are grown, erosion is a hazard. Grassed waterways, terraces, and contour farming help reduce excessive soil loss and conserve moisture. Using crop residue in or on top of the plow layer improves the tilth and increases the infiltration rate.

This soil is well suited to rangeland. Overgrazing reduces the vigor of grasses and retards their growth.

Proper stocking rates, timely deferment of grazing, and pasture rotation help keep the range in good condition. When the soil is used for hay, early seasonal mowing of the grass allows recovery of plants before frost.

This soil is suited to pastures. Maintaining good grass cover and using ground mulch reduce the runoff rate. Proper stocking rates, deferred grazing, even distribution of water and salt, fertilization, and controlling unwanted vegetation help maintain or increase forage production. When mowing tame grasses for hay, the plants need to grow through critical stages before they are mowed.

Shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Wetness is an additional severe limitation for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help overcome these limitations. Low strength and shrink-swell potential are severe limitations if this soil is used for local roads and streets. Strengthening or replacing the base material helps overcome these limitations.

This soil is generally unsuitable as a site for septic tank absorption fields. Wetness and slow permeability are severe limitations. Slope is a moderate limitation for sewage lagoons. Included soils that are less sloping are better sites for lagoons.

The capability subclass is IIIe.

Sd—Summit-Dwight complex, 1 to 3 percent slopes. This map unit consists of deep, gently sloping soils that are moderately well drained. These soils are on foot slopes, mainly in the western part of the county. Individual areas are irregular in shape and range in size from 20 to 200 acres.

This map unit is made up of about 50 percent Summit soils and 20 percent Dwight soils. The more sloping Summit soil generally is on the higher part of the foot slopes. The Dwight soil is on the lower part of the foot slopes. The two soils are in areas that are so small or so intricately mixed that mapping them separately is not practical.

Typically, the Summit soil has a surface layer of black silty clay loam about 9 inches thick. The subsoil, which extends to a depth of about 60 inches, is black, very firm silty clay loam in the upper part. The lower part is black, very dark gray, and dark gray silty clay that is very firm. In some places the textural transition between surface layer and subsoil is abrupt.

Typically, the Dwight soil has a surface layer of very dark gray silt loam about 4 inches thick. The subsoil is about 47 inches thick. It is very dark gray, extremely firm silty clay in the upper part; very dark grayish brown, extremely firm silty clay in the middle part; and dark grayish brown, very firm silty clay in the lower part. The substratum is dark brown silty clay to a depth of about 60 inches.

The Summit soil is slowly permeable, and available water capacity is high. The Dwight soil is very slowly permeable, and available water capacity is moderate. Natural fertility is high in the Summit soil and medium in the Dwight soil. The Summit soil has a perched seasonal high water table at a depth of about 2 to 3 feet. Root growth is reduced in the Dwight soil because of a dense subsoil which is near the surface and contains sodium (fig. 11). Both soils have a high shrink-swell potential. Surface runoff is medium. These soils have moderate organic matter content.

Most of the acreage of this soil is in range. A few areas are used for cultivated crops. These soils are moderately well suited to cultivated crops; however, areas of Dwight soil are difficult to till, puddle when wet, and are droughty. Using crop residue on the surface, applying barnyard manure in the plow layer, and minimum tillage help maintain good tilth and increase the infiltration rate.

These soils are well suited to rangeland and pasture and are used for grazing livestock and for hay. A desirable and vigorous plant community can be maintained when rangeland and pasture management include proper stocking rates, uniform grazing distribution, and brush control. Timely mowing of hay keeps the grasses in good condition.

Shrink-swell potential is a severe limitation if these soils are used as a site for dwellings. The Summit soil has an additional severe limitation of wetness for dwellings with basements. Properly designing and reinforcing foundations and backfilling with porous material help overcome these limitations. Foundation drains need to be installed in the Summit soil. The low strength and shrink-swell potential are severe limitations if these soils are used for local roads and streets. Strengthening or replacing the base material help overcome these limitations.

These soils are generally unsuitable as a site for septic tank absorption fields. Wetness and slow permeability or very slow permeability are severe limitations. The Dwight soil is generally suited as a site for sewage lagoons, but the Summit soil is moderately limited by slope.

The capability subclass is IIIe.

Vb—Verdigris silt loam. This deep, nearly level soil is moderately well drained. The soil is on flood plains and is occasionally flooded. Flooding is less frequent for several miles downstream of the John Redmond Reservoir. Flooding is more frequent, of longer duration, and extends further upstream during high water. Individual areas of this unit are mainly long and narrow in shape and extend along both sides of streams. These areas range from about 10 to 600 acres in size.

Typically, the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is friable silt loam about 17 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The next layer is dark brown, friable silty clay loam about

Figure 11.—The light areas in the field indicate the sodium content in the Dwight soil of the Summit-Dwight complex, 1 to 3 percent slopes.

18 inches thick. The substratum, which extends to a depth of about 60 inches, is dark brown, mottled silty clay loam. In a few places the soil is mottled to a depth of 20 inches.

Included with this soil in mapping are small areas of the poorly drained Osage soils on broad flats adjacent to uplands. This included soil makes up about 5 percent of the map unit.

Permeability of this Verdigris soil is moderate, and the available water capacity is high. Surface runoff is slow. Natural fertility is high, and the organic matter content is moderate. The surface layer is friable and easily tilled. When unlimed, it is medium acid or slightly acid. The subsoil has a moderate shrink-swell potential.

Most areas of this soil are used for cultivated crops. Native trees usually are along the meandering stream channel, mainly in the lower, more frequently flooded areas. This soil is well suited to soybeans, grain sorghum, corn, alfalfa, and wheat. Spring flooding delays planting in some years. Using crop residue in or on top of the plow layer helps improve tilth and increase the infiltration rate.

This soil is well suited to pasture and range, although few acres are in grass. Proper stocking rates, deferred grazing, and brush control help keep the soil and grass in good condition.

This soil is well suited to trees. Flooding and plant competition are concerns in management. Tree cuttings and seedlings grow well if competing vegetation is controlled by site preparation; by controlled burning; or by spraying, cutting, or girdling.

This soil is generally not suited to dwellings and sanitary facilities. Flooding is a severe hazard that is difficult to overcome without use of major flood controls.

The capability subclass is IIw.

Vc—Verdigris silt loam, channeled. This deep, nearly level soil is moderately well drained. This soil is on narrow flood plains that are deeply incised by stream channels. It is frequently flooded. Individual areas are long and about 150 to 300 feet wide. They range from 10 to 80 acres in size.

Typically, the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is friable silt loam about 17 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The next layer is dark brown, friable silty clay loam about 18 inches thick. The substratum is dark brown silty clay loam to a depth of 60 inches. In a few places there is a mottled subsoil within 15 inches of the surface.

Included with this unit in mapping are the somewhat poorly drained Leanna soils and the poorly drained Osage soils. These soils are on slightly lower parts of the flood plain. The included soils make up 5 to 15 percent of the unit.

Permeability of this Verdigris soil is moderate, and the available water capacity is high. Natural fertility is high, and the organic matter content is medium. Surface runoff is slow. The shrink-swell potential of the subsoil is moderate.

Most of the acreage is in native grass or trees. This soil is generally not suited to cultivated crops because of flooding. It is also difficult to use machinery along the meandering stream channel.

This soil is well suited to rangeland. Overgrazing reduces the growth and vigor of the grasses, which, in turn, increases the growth of brush and trees. Proper stocking rates help keep the range in good condition. Good sites for farm ponds are often available in this map unit, especially upstream.

This soil is well suited to trees, and some areas remain in native hardwoods. The tree seeds, cuttings, and seedlings grow well if competing vegetation is controlled or removed. Undesirable vegetation can be controlled by site preparation; by controlled burning; or spraying, cutting, or girdling. Flooding is also a concern in management.

This soil is generally not suited to dwellings and sanitary facilities. The hazard of flooding is a severe limitation. It is difficult to overcome without use of major flood controls.

The capability subclass is Vw.

Wo—Woodson silt loam. This deep, nearly level soil is somewhat poorly drained. The soil is on broad flats of uplands. Individual areas of this unit are irregular in shape and range from about 30 acres to over 1,000 acres in size.

Typically, the surface layer is very dark gray silt loam about 9 inches thick. The subsoil is extremely firm silty clay about 47 inches thick. It is black in the upper part and gray and dark gray in the lower part. The substratum is mottled, grayish brown silty clay to a depth of about 60 inches. In some places the subsoil is dark brown. In others the change in texture between the surface layer and the subsoil is gradual.

Included with the soil in mapping are small areas of Dennis soils. The moderately well drained Dennis soils are below the Woodson soils on side slopes. This included soil makes up less than 5 percent of the map unit.

Permeability is very slow in this Woodson soil, and the available water capacity is moderate. Surface runoff is slow. Natural fertility is medium, and the organic matter content is moderate. When unlimed, the surface layer is medium acid or slightly acid. The subsoil has a high shrink-swell potential. A perched seasonal high water table is at a depth of 0.5 foot to 2 feet.

Most of this soil is used for cultivated crops. The rest is in range of native grass or pastures of tame grass. This soil is well suited to wheat, soybeans, and grain sorghum. Crop yields can be reduced by wetness. The clayey subsoil does not release water readily, and crop yields are reduced during droughts. Minimum tillage and using crop residue in or on top of the plow layer help increase the water intake and improve tilth. A few depressional areas may need surface drainage.

This soil is well suited to pasture and rangeland. It is used for hay and for grazing livestock. Grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, restricted use during wet periods, and deferred grazing help keep the grass and soil in good condition. Tame grasses usually require fertilizer for vigorous growth. Native grasses used for hay should be mowed early enough to allow plants to recover before frost. Timely mowing of tame grasses for hay allows the plants to recover.

Shrink-swell potential and wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material helps prevent structural damage caused by shrinking and swelling and by wetness. The shrink-swell potential, low strength, and wetness are severe limitations for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

This soil is generally unsuitable as a site for septic tank absorption fields. The very slow permeability and the wetness are severe limitations. The soil is suitable as a site for sewage lagoons.

The capability subclass is IIs.

prime farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The supply of high quality farmland is limited and the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, must encourage and facilitate the best use of our nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when it is treated and managed using acceptable farming methods. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland may now be in crops, pasture, woodland, or other land, but not urban and built-up land or water areas. It must either be used for producing food or fiber or be available for these uses.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. It also has favorable temperature and growing season, acceptable acidity or alkalinity. It has few or no rocks and is permeable to water and air. Prime farmland is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. For more detailed information on the criteria for prime farmland, consult the local staff of the Soil Conservation Service.

About 292,600 acres, or about 70 percent, of Coffey County meet the soil reqirements for prime farmland. Areas are scattered throughout the county. Approximately 154,650 acres of this prime farmland is used for cultivated crops (*3*). Crops grown on this land are mainly grain sorghum, wheat, soybeans, and corn.

Soil map units that make up prime farmland in Coffey County are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps in the back of this publication. The soil qualities that affect use and management are described in the section "Soil maps for detailed planning."

Soils that have limitations—a high water table, flooding, or inadequate rainfall—may qualify for prime farmland if these limitations are overcome by such measures as drainage, flood control, or irrigation. In the following list the measures needed to overcome the limitations, if any, are shown in parentheses after the map unit name. Onsite evaluation is necessary to see if these limitations have been overcome by corrective measures. The wet Woodson soils generally have been adequately drained by the application of drainage measures or by the incidental drainage that results from farming, roadbuilding, or other kinds of land development.

The map units that meet the soil requirements for prime farmland are:

Ae—Apperson-Eram silty clay loams, 1 to 4 percent slopes
Bb—Bates loam, 1 to 4 percent slopes
Bc—Bates loam, 4 to 7 percent slopes
Db—Dennis silt loam, 1 to 4 percent slopes
De—Dennis silty clay loam, 2 to 5 percent slopes, eroded
Eb—Eram silt loam, 1 to 3 percent slopes
Kb—Kenoma silt loam, 1 to 3 percent slopes
Ke—Kenoma silty clay loam, 1 to 3 percent slopes, eroded
La—Lanton silty clay loam (where drained)
Le—Leanna silt loam (where drained)
Ma—Mason silt loam
Os—Osage silty clay loam (where drained)
Ot—Osage silty clay (where drained)
Sa—Summit silty clay loam, 1 to 4 percent slopes
Vb—Verdigris silt loam
Wo—Woodson silt loam

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 52 percent of the acreage in Coffey County is used for cultivated crops. About 7 percent of the acreage is used for pasture.

During the last 10 years, soybeans were produced on about 27 percent of the harvested crop acreage, sorghum on 19 percent, wheat on 15 percent, and hay on 23 percent. The remaining 16 percent of the cropland was used for minor crops, such as corn, alfalfa, and oats (*3*). Tall fescue is the main grass in pastures.

The acreage of sorghum, soybeans, and hay has increased over the previous 10-year period. All other crops have remained constant or declined during this time.

Crops and pasture can be increased on most farms by using the latest crop production technology. This soil survey can facilitate the application of such technology. A system of soil management consists of a combination of practices used to grow crops and grass. The main considerations in managing the soils are controlling erosion, making the most efficient use of available water, and maintaining soil fertility.

Soil erosion is the major problem on about 65 percent of the acreage in cropland in the survey area. Where the slope is more than 1 percent, erosion is a hazard. Apperson, Bates, Dennis, Eram, Kenoma, and Summit are arable soils that have slopes that exceed 1 percent.

Loss of the surface layer by erosion is damaging for two reasons. First, not only does any loss of material from the surface layer include available plant nutrients, but part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging to soils that have a loamy surface layer and a clayey subsoil, such as Kenoma and Dennis soils. Second, soil erosion results in the sedimentation of streams. Control of erosion minimizes the pollution of streams by sediment and improves the water quality for municipal use, for recreation, and for fish and wildlife.

Erosion can be effectively controlled by terracing, contour farming (fig. 12), grassed waterways, maintaining crop residue on the soil surface, and minimum tillage. Terraces reduce the length of the slope and, thereby, reduce runoff and erosion. Contour farming should generally be used in combination with terraces. Leaving

Figure 12.—Contour farming helps control erosion. Soybeans growing on Dennis silt loam, 1 to 4 percent slopes.

crop residue on the surface and minimum tillage increase the infiltration rate and reduce the runoff rate and the hazard of erosion.

A cropping system that keeps vegetative cover on the soil for extended periods helps reduce soil losses to amounts that do not reduce the productivity of the soil. On livestock farms, which require pasture and hay, the legumes and tame grasses in the cropping system reduce erosion on the sloping land and also provide nitrogen and improve tilth for the following crop. Close growing crops like wheat, oats, and barley in the cropping sequence also reduce soil loss.

Organic matter content can be maintained by regularly adding all available crop residue and barnyard manure into the plow layer. This improves soil tilth and builds a storehouse of available plant nutrients. Soils that have good tilth are granular and porous. Good tilth allows for better infiltration of water into the soil and better seedbed preparation. Soil tilth is a concern for all the soils, but particularly for the Osage soils and the eroded soils on uplands, where the clayey subsoil has been mixed into the surface layer.

Management practices that reduce runoff, maintain soil tilth, and increase water infiltration help conserve moisture for plant use. Available water is especially a concern for arable soils in which underlaying bedrock restricts root development, such as the Bates and Eram soils.

Unless they have been limed, most soils in the survey area have a surface layer that is slightly acid or medium acid. Applying lime can increase the growth of such legumes as alfalfa and other crops that are more productive on neutral soils. The amount of lime and fertilizer used on all soils should be based on the needs of the crop, on the expected yields, on the results of soil tests, and on the experience of farmers. The Cooperative Extension Service can help to determine the kind and amount of fertilizer and lime needed.

Drainage of excess surface water is needed in some areas of Lanton, Leanna, Osage, and Woodson soils if cultivated crops are grown. Surface drains or a bedding system helps remove excess surface water.

Some management practices needed to maintain a good stand of tame grasses are: Proper stocking rates, rotation grazing, even distribution of water and salt, fertilization, and controlling unwanted vegetation.

Further information about cropland and tame grass management can be obtained from the local representative of the Soil Conservation Service or the Cooperative Extension Service.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined 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. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

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 very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed soil map units."

rangeland

Lynn Gibson, range conservationist, Soil Conservation Service, assisted in preparing this section.

About 35 percent of Coffey County is rangeland. Cow-calf and steer operations are the dominant enterprises that use the rangeland for forage.

In the winter the native forage is supplemented by hay and high energy protein concentrates. Combined with an abundant supply of improved pasture and crop aftermath, rangeland is the backbone of the county's number one agricultural industry, livestock.

Soils strongly influence the natural vegetation where it is still used as rangeland. The largest area of continuous range is south of the Neosho River where shallow to moderately deep soils are abundant. Range in the remainder of the county is interspersed with cropland. Shallow soils, gravelly soils, and soils that have steep slopes generally are used as native rangeland. Potential production of plants on the shallow soils is less than that of the other upland soils.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

The native vegetation in some parts of the survey area has been depleted by excessive use. Some of the acreage that was once open grassland is now covered with brush, trees, and weeds. The amount of forage produced may be less than half of the potential production.

The major management goal on most of the rangeland is to improve or maintain the plants that make up the potential plant communities. Controlling brush and trees is also an important management concern. Productivity of the range can be improved by using management practices that are suited to specific kinds of soils and range sites.

woodland management and productivity

Keith A. Ticknor, forester, Soil Conservation Service, assisted in preparing this section.

Approximately 2 percent of Coffey County is wooded. The woodland is scattered throughout the county. It is in small irregular tracts along streams, in upland drainageways, and on sloping, upland soils that are underlain by shale.

The woodland is divided into two main forest types: lowland plains hardwoods and elm-ash-locust. The lowland plains hardwoods forest type is along the major streams in the Osage-Verdigris-Lanton soil association. It includes a large number of species (fig. 13). The elm-ash-locust forest type is on all the uplands.

Most of the trees, especially oaks, black walnut, hickories, green ash, common hackberry, and eastern cottonwood, have commercial value for wood products; however, only a small part of the woodland is managed for commercial wood production. Most of the woodland is small acreages on private farms.

The acreage used for woodland has decreased steadily during recent years. Most of this decline is the result of clearing woodland and converting it to cropland.

Most of the soils in Coffey County have good potential for the production of veneer, sawtimber, firewood, Christmas trees, fence posts, and other wood products, but these soils are used primarily as cropland and are unlikely to be converted to the production of wood products. The soils along river and stream bottoms produce highly valued, hardwood products within a short period of time in contrast to the upland soils, which produce low value products over a long time.

Figure 13.—Walnut trees along South Fork Big Creek in the Osage-Verdigris-Lanton association.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *w* indicates excessive water in or on the soil. The letter *o* indicates that limitations or restrictions are insignificant.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

Keith A. Ticknor, forester, Soil Conservation Service, assisted in preparing this section.

Most farmsteads in Coffey County have trees around them which were either present when the farmstead was established or which have been planted at various times by the landowners. Siberian elm, common hackberry, green ash, northern catalpa, eastern redcedar, eastern cottonwood, black walnut, red mulberry, and pecan are some of the common trees in windbreaks or are used as environmental plantings.

Only a few windbreaks are planted each year in Coffey County, but numerous trees and bushes are planted around farmsteads and rural homesites. Tree planting is a continual process because old trees pass maturity and deteriorate; other trees are lost to storms, disease, or insect attacks; and new plantings are needed for recent, expanding farmsteads.

In order for windbreaks and environmental plantings to fulfill their intended purpose, the species of tree or shrub selected must be those adapted to the soils in the area. Matching the proper tree with the soil type is the first step towards ensuring survival and a maximum rate of growth. Permeability, available water capacity, and fertility are soil characteristics that greatly affect the rate of growth for trees and shrubs.

Trees can be established easily in Coffey County at most sites and on most soils. Proper site preparation prior to planting and controlling weeds and other competition after planting are the major concerns when establishing and managing windbreaks and environmental plantings.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

Coffey County has several excellent public parks for sportsmen and recreationists. John Redmond Reservoir provides many facilities for boating, camping, fishing (fig. 14), hunting, picnicking, and sightseeing. Farm ponds and the Neosho River provide similar recreation opportunities on privately-owned land.

Recreation use and demand has increased greatly in the past several years. Much of this is caused by the

Figure 14.—Fishing is one of the recreational opportunities provided by the water impoundments in Coffey County.

construction of John Redmond Reservoir. Potential is fair for additional recreational development within the county.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

The primary game species in Coffey County are the bobwhite quail, mourning dove, prairie chicken, cottontail rabbit, fox squirrel, white-tailed deer, and several species of waterfowl.

Nongame species of wildlife in the county are numerous because of the diversity of habitat types. Cropland, woodland, and grassland are intermixed throughout the county creating "edges" of wood and field that are attractive to many species. Each of these habitat types provides a home for a particular group of wildlife.

Furbearers are common along the Neosho River and its tributaries. Trapping is done on a limited basis.

The John Redmond Reservoir, the watershed lakes, and the numerous ponds and streams provide good to excellent fishing. Species commonly caught in the county are: bass, bluegill, crappie, and walleye and channel, bullhead, and flathead catfish.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, grain sorghum, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, switchgrass, indiangrass, ragweed, sunflowers, wheatgrass, and native legumes.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, sycamore, hackberry, green ash, elm, mulberry, and hickory. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, plum, fragrant sumac, winterberry, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are red cedar, pine, and spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, prairie cordgrass, buttonbush, indigobush, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, mourning dove, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include owls, hawks, thrushes, woodpeckers, squirrels, opossum, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, redwinged blackbirds, muskrat, mink, and beaver.

Developing habitat for wildlife requires proper location of the various types of plant cover on suitable soils. Technical assistance in planning wildlife developments and in determining suitable vegetation for plantings can be obtained from the office of the Soil Conservation Service. Additional information and assistance can be obtained from the Kansas Fish and Game Commission and from the Extension Service.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

sanitary facilities

Table 12 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*5*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 18, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Cumulic* identifies the subgroup that has a dark surface soil that is thicker than is typical for the great group. An example is Cumulic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, thermic cumulic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*4*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*5*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Apperson series

The Apperson series consists of deep, moderately well drained soils that are slowly permeable. These soils are on uplands. They formed in residuum weathered from limestone. Slope ranges from 1 to 4 percent.

Apperson soils are similar to Eram, Kenoma, and Summit soils and are commonly adjacent to Eram, Kenoma, Lula, and Shidler soils. Eram soils are less than 40 inches deep to shale. They are on side slopes and are lower than Apperson soils on the landscape. Kenoma soils increase abruptly in clay between the surface layer and the subsoil. They are on the ridgetops.

Summit soils are more than 60 inches deep to bedrock and are on foot slopes. Lula soils are redder than the Apperson soils. They also are on ridgetops. Shidler soils are less than 20 inches deep to limestone and are on the rim of the ridgetops.

Typical pedon of Apperson silty clay loam in an area of Apperson-Eram silty clay loams, 1 to 4 percent slopes; 1,300 feet east and 300 feet north of the southwest corner of sec. 27, T. 20 S., R. 15 E.

A1—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; hard, firm; many fine roots; slightly acid; gradual smooth boundary.

B1—9 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; strong medium and fine subangular blocky structure; hard, firm; many fine roots; medium acid; gradual smooth boundary.

B21t—14 to 18 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; few fine faint dark reddish brown (5YR 3/4) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; slightly acid; gradual smooth boundary.

B22t—18 to 28 inches; dark brown (10YR 3/3) silty clay, brown (10YR 4/3) dry; common medium distinct dark brown (7.5YR 4/4) mottles; moderate medium blocky structure; extremely hard, very firm; few fine chert fragments; slightly acid; gradual smooth boundary.

B3—28 to 42 inches; dark yellowish brown (10YR 4/4) silty clay, yellowish brown (10YR 5/4) dry; common fine faint brown (7.5YR 4/4) mottles; weak medium blocky structure; extremely hard, very firm; few fine black concretions; neutral; abrupt irregular boundary.

R—42 inches; hard limestone.

The thickness of the solum and depth to limestone bedrock ranges from 40 to 60 inches. In some pedons the lower part of the solum is from 0 to 10 percent chert or limestone fragments. The fragments are less than 3 inches in diameter. This lower part also contains carbonates.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. It is slightly acid or medium acid. The upper part of the B2t horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. The lower part has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 6 dry), and chroma of 2 or 3. The B2t horizon is silty clay loam or silty clay. It ranges from slightly acid to mildly alkaline.

Bates series

The Bates series consists of moderately deep, well drained soils that are moderately permeable. These soils are on uplands. They formed in residuum of sandstone and sandy shale. Slope ranges from 1 to 7 percent.

Bates soils are similar to Collinsville soils, and they are commonly adjacent to Collinsville, Dennis, and Eram soils. Collinsville soils are less than 20 inches deep to sandstone. They are slightly lower on the landscape than Bates soils. Dennis soils have a clayey subsoil and are on foot slopes. The Eram soils have a clayey subsoil. The Eram and Bates soils are in similar positions on the landscape.

Typical pedon of Bates loam, 1 to 4 percent slopes; 2,560 feet west and 60 feet north of the southeast corner of sec. 27, T. 21 S., R. 17 E.

A1—0 to 11 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

B1—11 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.

B21t—17 to 22 inches; dark brown (7.5YR 4/4) clay loam, brown (7.5YR 5/4) dry; common medium distinct red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; hard, firm; common fine roots; medium acid; gradual smooth boundary.

B22t—22 to 26 inches; dark brown (7.5YR 4/4) clay loam, brown (7.5YR 4/4) dry; many medium distinct red (2.5YR 4/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; medium acid; abrupt smooth boundary.

Cr—26 inches; sandstone.

The thickness of the solum and depth to sandstone or sandy shale ranges from 20 to 40 inches. In some pedons the solum is from 0 to 15 percent fragments of weathered sandstone. It is slightly acid to strongly acid.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is dominantly loam, but the range includes silt loam. The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 3 to 6. It is clay loam or sandy clay loam.

Clareson series

The Clareson series consists of moderately deep, well drained soils that are moderately slowly permeable. These soils are on uplands. They formed in residuum weathered from limestone. Slope ranges from 1 to 8 percent.

Clareson soils are similar to Olpe and Shidler soils, and they are commonly adjacent to Lula, Olpe, Shidler, and Summit soils. Lula soils are more than 40 inches deep to limestone and are higher than Clareson soils on ridgetops. The deep Olpe soils are steeper and on side slopes. Shidler soils are less than 20 inches deep to limestone. They are lower than Clareson soils on the landscape. The subsoil of the Summit soils is less than 5 percent coarse fragments. The Summit soils are on the lower part of side slopes or on foot slopes.

Typical pedon of Clareson silty clay loam from an area of Clareson-Shidler silty clay loams, 1 to 8 percent slopes; 1,550 feet west and 100 feet north of the southeast corner of sec. 12, T. 19 S., R. 16 E.

A1—0 to 12 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; hard, friable; many fine roots; neutral; gradual smooth boundary.

B1—12 to 18 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; moderate fine subangular blocky structure; hard, firm; few fine roots; less than 5 percent limestone fragments; slightly acid; gradual smooth boundary.

B2t—18 to 24 inches; dark reddish brown (5YR 3/2) very flaggy silty clay, dark reddish gray (5YR 4/2) dry; moderate medium subangular blocky structure; very hard, very firm; 60 percent flaggy limestone fragments; slightly acid; abrupt wavy boundary.

R—24 inches; hard limestone.

The thickness of the solum and the depth to limestone ranges from 20 to 40 inches. The solum ranges from medium acid to neutral.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is dominantly silty clay loam, but the range includes silt loam. The B2t horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 3 or 4 (4 or 5 dry); and chroma of 2 to 5. This horizon is 35 to 65 percent limestone fragments.

Collinsville series

The Collinsville series consists of shallow, well drained soils that are moderately rapidly permeable. These soils are on uplands. They formed in residuum weathered from sandstone. Slope ranges from 4 to 15 percent.

Collinsville soils are similar to Bates and Shidler soils and are commonly adjacent to Bates, Dennis, and Eram soils. Bates soils are more than 20 inches deep to sandstone. They are higher than the Collinsville soils on ridgetops. Eram soils have a clayey subsoil and are more than 20 inches deep to shale. They are on the lower part of side slopes. The deep Dennis soils have a clayey subsoil and are on the lower part of side slopes and on foot slopes. Shidler soils are siltier throughout and formed in residuum weathered from limestone. The Shidler and Collinsville soils are on similar parts of the landscape.

Typical pedon of Collinsville loam from an area of Eram-Collinsville complex, 4 to 15 percent slopes; 560 feet east and 100 feet north of the southwest corner of sec. 35, T. 22 S., R. 15 E.

A11—0 to 10 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.

A12—10 to 14 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; moderate medium granular structure; slightly hard, friable; common fine roots; less than 5 percent sandstone fragments; strongly acid; abrupt wavy boundary.

R—14 inches; hard sandstone.

The thickness of the solum and the depth to sandstone ranges from 4 to 20 inches. In some pedons fragments of sandstone are either on the surface or are within the soil, but they are less than 35 percent of the volume. Reaction ranges from slightly acid to strongly acid.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. Some pedons have a C horizon.

Dennis series

The Dennis series consists of deep, moderately well drained soils that are slowly permeable. These soils are on uplands. They formed in residuum or colluvium weathered from shale. Slope ranges from 1 to 5 percent.

Dennis soils are similar to Eram, Kenoma, and Summit soils and are commonly adjacent to Bates, Eram, Kenoma, and Olpe soils. Bates soils have a loamy subsoil. Eram soils are less than 40 inches deep to shale. Kenoma soils do not have a B1 horizon. Olpe soils are clayey-skeletal. The surface layer of the Summit soils is thinner over the clayey subsoil than that of the Dennis soils. Kenoma soils are on ridgetops. Bates, Eram, and Olpe soils are higher than Dennis soils on side slopes. Summit and Dennis soils are in similar positions on the landscape.

Typical pedon of Dennis silt loam, 1 to 4 percent slopes; 2,260 feet east and 100 feet north of the southwest corner of sec. 1, T. 23 S., R. 15 E.

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

B1—11 to 18 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; moderate fine subangular blocky structure; hard, friable; few fine roots; medium acid; gradual smooth boundary.

B21t—18 to 28 inches; brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common fine distinct reddish brown (5YR 4/4) mottles; moderate fine and medium subangular blocky structure; very hard, very firm; few fine roots; few fine black concretions and black stains; slightly acid; gradual smooth boundary.

B22t—28 to 43 inches; yellowish brown (10YR 5/4) silty clay, light yellowish brown (10YR 6/4) dry; few fine faint dark grayish brown (10YR 4/2) mottles; moderate fine and medium blocky structure; very

hard, very firm; few fine roots; few fine black concretions; slightly acid; gradual smooth boundary.
B3t—43 to 60 inches; strong brown (7.5YR 5/6) silty clay, reddish yellow (7.5YR 6/6) dry; many medium and coarse faint yellowish brown (10YR 5/4) mottles; weak medium blocky structure; very hard, very firm; few fine black concretions; mildly alkaline.

The solum is more than 60 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It ranges from medium acid to strongly acid. The B1 horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 or 4. The B2t horizon has hue of 10YR, 7.5YR, or 2.5Y; value of 4 or 5 (5 or 6 dry); and chroma of 3 to 6. It is silty clay or silty clay loam mottled with gray, brown, yellow, or red.

Dennis silty clay loam, 2 to 5 percent slopes, eroded, does not have a mollic epipedon, which is definitive for the series, but this difference does not alter the usefulness or behavior of the soil.

Dwight series

The Dwight series consists of deep, moderately well drained soils that are very slowly permeable. These soils are on foot slopes. They formed in clayey sediment. Slope ranges from 1 to 3 percent.

Dwight soils are commonly adjacent to Kenoma, Summit, and Woodson soils. Kenoma, Summit, and Woodson soils have a thicker surface layer than the Dwight soils but do not have a natric horizon. Kenoma and Summit soils are on slightly higher parts of the landscape. Woodson soils are on broad flats of uplands.

Typical pedon of Dwight silt loam in an area of Summit-Dwight complex, 1 to 3 percent slopes; 1,330 feet south and 170 feet east of the northwest corner of sec. 11, T. 22 S., R. 13 E.

A1—0 to 4 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate fine granular structure; slightly hard, friable; many fine roots; slightly acid; abrupt smooth boundary.
B21t—4 to 13 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate medium and fine columnar structure; extremely hard, extremely firm; many fine roots along faces of peds; mildly alkaline; gradual smooth boundary.
B22t—13 to 20 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak medium and coarse blocky structure; extremely hard, extremely firm; few masses and streaks of gypsum in the lower part; few fine roots; mildly alkaline; gradual smooth boundary.
B23t—20 to 32 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; weak medium blocky structure; extremely hard, extremely firm; few masses and streaks of gypsum; moderately alkaline; gradual smooth boundary.
B3—32 to 51 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles below a depth of 40 inches; weak fine blocky structure; extremely hard, very firm; few small round brownish concretions; moderately alkaline; gradual smooth boundary.
C—51 to 60 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; many medium distinct yellowish red (5YR 4/6) mottles; massive; very hard, very firm; few fine very dark brown concretions; moderately alkaline.

The solum ranges from 40 to 55 inches in thickness. The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It ranges from medium acid to neutral. The B2t horizon has hue of 10YR or 7.5YR, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It is clay or silty clay. Reaction ranges from slightly acid to moderately alkaline. The C horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 3 or 4.

Eram series

The Eram series consists of moderately deep, moderately well drained soils that are slowly permeable. These soils are on uplands. They formed in residuum weathered from shale. Slope ranges from 1 to 15 percent.

Eram soils are similar to Apperson and Dennis soils and are commonly adjacent to Apperson, Collinsville, and Shidler soils. Apperson soils are more than 40 inches deep to limestone and are mainly higher than Eram soils in the landscape. Collinsville soils are less than 20 inches deep to sandstone. They are on ridgetops and the upper part of side slopes. The deep Dennis soils are on foot slopes and the lower part of side slopes. Shidler soils are less than 20 inches deep to limestone and are higher than the Eram soils on side slopes.

Typical pedon of Eram silt loam, 3 to 7 percent slopes; 300 feet north and 100 feet east of the southwest corner of sec. 25, T. 20 S., R. 16 E.

A1—0 to 10 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; common fine roots; medium acid; gradual smooth boundary.
B2t—10 to 16 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; few fine faint dark yellowish brown (10YR 3/4) mottles; moderate medium and fine blocky structure; very hard, very firm; few fine roots; less than 5 percent sandstone fragments; medium acid; gradual smooth boundary.
B3—16 to 28 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; many medium

distinct light olive brown (2.5Y 5/6) mottles and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium blocky structure; extremely hard, very firm; few fine roots; neutral; gradual smooth boundary.

Cr—28 inches; soft clayey shale; few accumulations of lime in seams.

The thickness of the solum and depth to shale ranges from 20 to 40 inches. In some pedons the upper part of the solum is up to 15 percent sandstone fragments.

The A horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 2 or 3 (3 or 4 dry); and chroma of 1 to 3. It is dominantly silt loam, but the range includes silty clay loam. It has a reaction of medium acid or slightly acid. The B2t horizon has hue of 5YR, 7.5YR, 10YR, or 2.5Y; value of 3 to 5 (4 to 6 dry); and chroma of 2 to 4. It is silty clay loam or silty clay. The B2t horizon has a reaction of medium acid to neutral.

Kenoma series

The Kenoma series consists of deep, moderately well drained soils that are very slowly permeable. These soils are on uplands. They formed in old alluvium. They are an admixture of loess in the upper part and residuum weathered from shale or interbedded limestone in the lower part. Slope ranges from 1 to 7 percent.

Kenoma soils are similar to Apperson, Dennis, Summit, and Woodson soils and are commonly adjacent to Dennis, Lula, and Woodson soils. The Apperson, Dennis, and Summit soils gradually increase in clay between the surface soil and subsoil. These soils are on the lower part of side slopes. Lula soils have a less clayey subsoil. Lula and Dennis soils are in similar positions on the landscape. Woodson soils have a grayer subsoil than Dennis soils and are on broad ridgetops.

Typical pedon of Kenoma silt loam, 1 to 3 percent slopes (fig. 15); 2,340 feet west and 200 feet north of southeast corner of sec. 24, T. 21 S., R. 13 E.

A1—0 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; common fine roots; medium acid; abrupt smooth boundary.

B21t—11 to 28 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate medium blocky structure; very hard, very firm; few fine roots; few fine dark brown concretions; slightly acid; gradual smooth boundary.

B22t—28 to 56 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common coarse faint grayish brown (10YR 5/2) mottles; moderate medium blocky structure; very hard, very firm; few fine dark brown concretions; mildly alkaline; gradual smooth boundary.

C—56 to 60 inches; yellowish brown (10YR 5/6) silty clay, brownish yellow (10YR 6/6) dry; many coarse

Figure 15.—Representative profile of Kenoma silt loam, 1 to 3 percent slopes. Arrow indicates top of the subsoil. Depth is marked in feet.

grayish brown (10YR 5/2) mottles; weak medium blocky structure; very hard, very firm; few fine dark brown concretions; mildly alkaline.

The solum is 40 to 60 inches thick. Shale or limestone is at a depth of more than 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 2 or 3. It is silt loam or silty clay loam that is medium acid or slightly acid. The B21t horizon has hue of 10YR or 7.5YR, value of 2 or 3 (4 or 5 dry), and chroma of 2 or 3. It is medium acid or slightly acid. The B22t horizon has hue of 7.5YR or 10YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 6. It ranges from medium acid to mildly alkaline. The C horizon has hue of 7.5YR to 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 6. It is mottled silty clay or silty clay loam. It has a reaction of slightly acid to moderately alkaline.

Lanton series

The Lanton series consists of deep, somewhat poorly drained soils that are moderately slowly permeable. These soils are on flood plains. They formed in silty alluvium. Slope ranges from 0 to 1 percent.

Lanton soils are similar to Verdigris soils and commonly adjacent to Leanna, Osage, and Verdigris soils. Leanna and Osage soils have a clayey subsoil. Leanna and Lanton soils are in similar positions on the landscape. Osage soils are on slightly lower flood plains. The moderately well drained Verdigris soils are adjacent to stream channels.

Typical pedon of Lanton silty clay loam; 2,600 feet north and 600 feet west of the southeast corner of sec. 12, T. 23 S., R. 15 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; few fine roots; slightly acid; abrupt smooth boundary.

A12—7 to 15 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; few fine roots; slightly acid; gradual smooth boundary.

A13—15 to 29 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; common medium distinct olive brown (2.5Y 4/4) mottles; weak medium and fine subangular blocky structure; slightly hard, firm; few fine roots; few fine worm holes; slightly acid; gradual smooth boundary.

ACg—29 to 48 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 5/1) dry; many medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; very hard, very firm; few fine worm holes; slightly acid; gradual smooth boundary.

Cg—48 to 60 inches; dark gray (10YR 4/1) silty clay loam, light gray (10YR 6/1) dry; few medium distinct dark yellowish brown (10YR 4/4) mottles; massive; very hard, very firm; slightly acid.

The solum ranges from 24 to 50 inches in thickness. It is slightly acid or neutral throughout. The mollic epipedon is more than 24 inches thick.

The A horizon has hue of 10YR, value is 2 or 3 (3 or 4 dry), and chroma is 1 or 2. Brown mottles are in the lower part. The A horizon is dominantly silty clay loam, but the range includes silt loam. The C horizon has hue of 10YR, value 4 or 5 (5 or 6 dry), and chroma of 1. It is silty clay loam or silty clay.

Leanna series

The Leanna series consists of deep, somewhat poorly drained soils that are very slowly permeable. These soils are on flood plains. They formed in clayey alluvium. Slope ranges from 0 to 1 percent.

Leanna soils are similar to Osage soils and are commonly adjacent to Lanton, Osage, Verdigris, and Woodson soils. Lanton soils are less clayey in the subsoil than Leanna soils. The two soils are in similar positions on the landscape. The poorly drained Osage soils are on slightly lower flood plains. The moderately well drained Verdigris soils are adjacent to stream channels. Woodson soils do not have an A2 horizon and are on adjacent uplands.

Typical pedon of Leanna silt loam; 600 feet south and 100 feet east of the northwest corner of sec. 33, T. 21 S., R. 17 E.

A1—0 to 10 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard, friable; common fine roots; slightly acid; clear smooth boundary.

A2—10 to 18 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; few fine faint dark yellowish brown (10YR 3/4) mottles; weak medium granular structure; slightly hard, friable; few fine roots; medium acid; clear smooth boundary.

B21t—18 to 24 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; common medium distinct dark yellowish brown (10YR 3/4) mottles; moderate medium blocky structure; very hard, very firm; few fine roots; medium acid; gradual smooth boundary.

B22t—24 to 32 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; many medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium blocky structure; very hard, very firm; few fine roots; slightly acid; gradual smooth boundary.

B31—32 to 51 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; many coarse distinct yellowish brown (10YR 5/6) mottles; weak medium blocky structure; very hard, very firm; slightly acid; gradual smooth boundary.

B32—51 to 60 inches; grayish brown (10YR 5/2) clay, light brownish gray (10YR 6/2) dry; many coarse distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very hard, very firm; neutral.

The solum ranges from 30 inches to more than 60 inches in thickness. It ranges from strongly acid to slightly acid. The mollic epipedon is more than 24 inches thick.

The A1 horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It is dominantly silt loam, but the range includes silty clay loam. The A2 horizon has hue of 10YR, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. It is silt loam or silty clay loam. The B2 horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1. It is silty clay loam or silty clay.

Lula series

The Lula series consists of deep, well drained soils that are moderately permeable. These soils are on uplands. They formed in residuum weathered from limestone (fig. 16). Slope ranges from 0 to 2 percent.

Lula soils are similar to Mason soils and are commonly adjacent to Clareson, Kenoma, Shidler, and Summit soils. The subsoil of Clareson soils are more than 35 percent coarse fragments. The Clareson soils are slightly lower than Lula soils in the landscape. Mason soils do not have limestone bedrock within a depth of 60 inches. They are on terraces. Kenoma soils have a clayey subsoil. Kenoma and Lula soils are in similar positions on the landscape. Shidler soils are less than 20 inches deep to limestone and are along the rim of the ridgetops. Summit soils have a clayey subsoil and are on the lower part of side slopes and on foot slopes.

Typical pedon of Lula silt loam, 0 to 2 percent slopes; 1,680 feet east and 100 feet north of the southwest corner of sec. 7, T. 19 S., R. 17 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; hard, friable; common fine roots; slightly acid; gradual smooth boundary.

B1—9 to 16 inches; dark reddish brown (5YR 3/3) silty clay loam, dark reddish gray (5YR 4/2) dry; strong fine subangular blocky structure; hard, firm; common fine roots; medium acid; gradual smooth boundary.

B21t—16 to 30 inches; reddish brown (5YR 4/4) silty clay loam, reddish brown (5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm; few fine roots; medium acid; gradual smooth boundary.

B22t—30 to 41 inches; reddish brown (5YR 4/4) silty clay loam, reddish brown (5YR 5/4) dry; many medium faint dark red (2.5YR 3/6) mottles and few fine faint brown (10YR 4/3) mottles; moderate medium blocky structure; very hard, very firm; few fine black concretions and stains; slightly acid; gradual smooth boundary.

Figure 16.—Representative profile of Lula silt loam, 0 to 2 percent slopes. Arrow indicates limestone bedrock at a depth of about 48 inches. Depth is marked in feet.

B23t—41 to 48 inches; reddish brown (5YR 4/4) silty clay loam, reddish brown (5YR 5/4) dry; weak medium blocky structure; extremely hard, very firm; few fine black concretions; neutral; abrupt wavy boundary.
R—48 inches; hard limestone.

The thickness of the solum and the depth to limestone is 40 to 60 inches.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is slightly acid or medium acid. The B2t horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 3 or 4 (4 or 5 dry); and chroma of 4 to 6.

Mason series

The Mason series consists of deep, well drained soils that are moderately slowly permeable. These soils are on terraces. They formed in silty alluvium. Slope ranges from 0 to 2 percent.

Mason soils are similar to Lula and Verdigris soils and are commonly adjacent to Lanton, Leanna, and Verdigris soils. The somewhat poorly drained Lanton and Leanna soils are on flood plains. Lula soils are 40 to 60 inches deep to limestone. They are on uplands. The moderately well drained Verdigris soils are on flood plains.

Typical pedon of Mason silt loam; 2,600 feet west and 660 feet north of the southeast corner of sec. 1, T. 23 S., R. 14 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; hard, friable; few fine roots; slightly acid; gradual smooth boundary.
A12—6 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine granular structure; hard, friable; few fine roots; few worm casts; slightly acid; gradual smooth boundary.
B21t—16 to 24 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, firm; few fine roots; few worm casts; slightly acid; gradual smooth boundary.
B22t—24 to 38 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; hard, firm; slightly acid; diffuse boundary.
B3—38 to 60 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; hard, firm; neutral.

The solum ranges from 40 inches to more than 60 inches in thickness. The mollic epipedon is more than 20 inches thick.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is dominantly silt loam, but the range includes silty clay loam. The A horizon ranges from neutral to medium acid. The B2t horizon has hue of 10YR or 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 2 to 4. It is silty clay loam or silt loam. It has a reaction of slightly acid or medium acid.

Olpe series

The Olpe series consist of deep, well drained soils that are slowly permeable. These soils are on uplands. They formed in old gravelly, alluvial sediment (fig. 17). Slope ranges from 2 to 15 percent.

Olpe soils are similar to Clareson soils and are commonly adjacent to Clareson, Dennis, Eram, and Kenoma soils. Clareson soils are less than 40 inches deep to limestone and are on the ridgetops. Dennis and Eram soils do not have gravel in the subsoil. Dennis soils are on the lower part of foot slopes, and Eram soils are on the upper part of side slopes. The subsoil of the Kenoma soils is less than 35 percent gravel. The Kenoma soils are on broad hill crests and on the lower part of foot slopes.

Typical pedon of Olpe gravelly silt loam, 4 to 15 percent slopes; 1,800 feet north and 40 feet east of the southwest corner of sec. 31, T. 22 S., R. 14 E.

A1—0 to 10 inches; very dark brown (10YR 2/2) gravelly silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; many fine roots; 15 percent rounded chert pebbles; medium acid; gradual smooth boundary.
B1—10 to 14 inches; dark brown (7.5YR 3/2) gravelly silty clay loam, brown (7.5YR 4/2) dry; moderate medium granular structure; hard, firm; many fine roots; 20 percent rounded chert pebbles; medium acid; gradual smooth boundary.
B21t—14 to 26 inches; dark reddish brown (5YR 3/4) very gravelly silty clay loam, reddish brown (5YR 5/4) dry; moderate fine subangular blocky structure; very hard, very firm; common fine roots; 70 percent rounded chert pebbles; slightly acid; gradual smooth boundary.
B22t—26 to 36 inches; dark brown (7.5YR 4/4) very gravelly silty clay, strong brown (7.5YR 5/6) dry; moderate fine subangular blocky structure; very hard, very firm; few fine roots; 80 percent rounded chert pebbles; medium acid; gradual smooth boundary.
B3t—36 to 60 inches; mixed yellowish red (5YR 4/6) and strong brown (7.5YR 5/6) very gravelly silty clay, yellowish red (5YR 5/6) and reddish yellow (7.5YR 6/6) dry; few fine faint very pale brown (10YR 7/3) mottles; weak fine subangular blocky structure; very hard, very firm; few fine black concretions; 80 percent rounded chert pebbles; medium acid.

The solum is more than 60 inches thick. The mollic epipedon ranges from 10 to 20 inches in thickness.

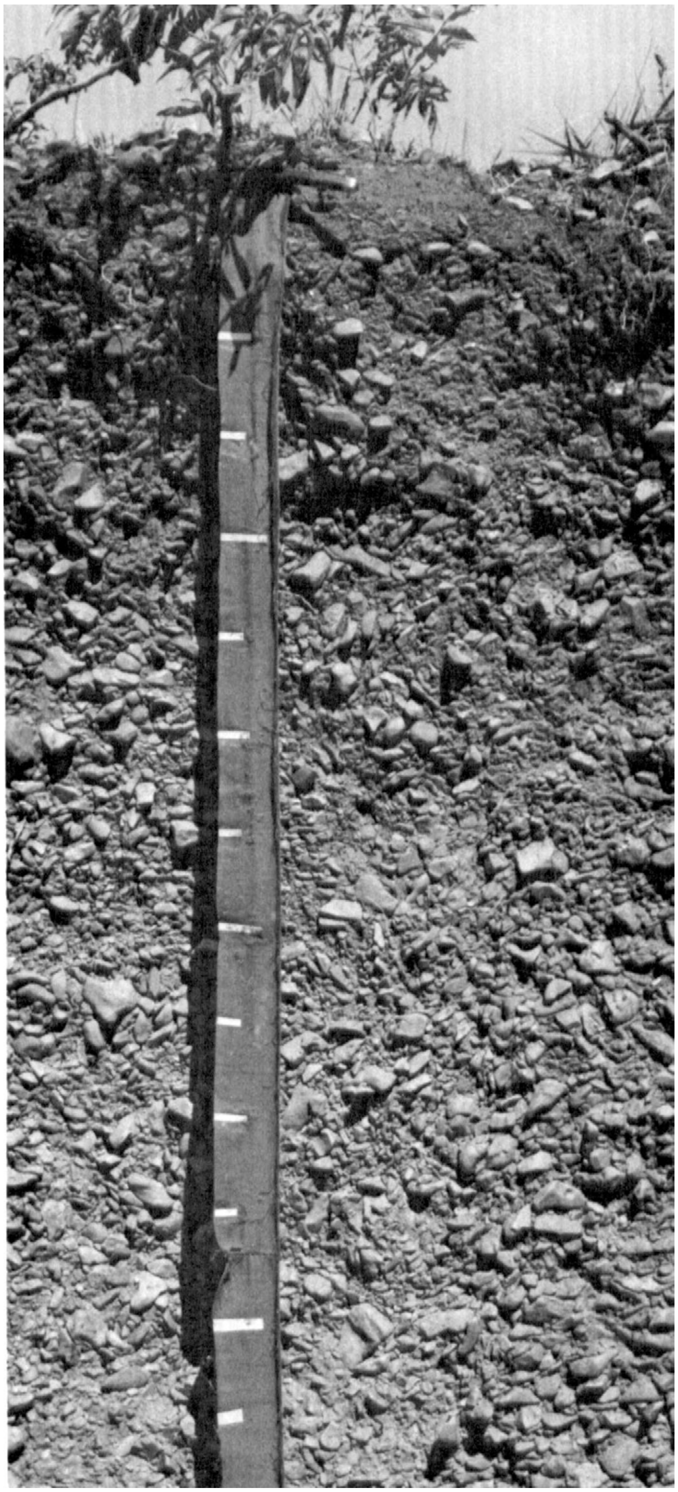


Figure 17.—Representative profile of Olpe gravelly silt loam, 4 to 15 percent slopes. The soil contains many rounded chert pebbles.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is dominantly gravelly silt loam, but the range includes silt loam, silty clay loam, and gravelly silty clay loam. It is slightly acid or medium acid. The B2t horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 3 or 4 (4 or 5 dry); and chroma from 4 to 6. It is very gravelly silty clay or very gravelly silty clay loam. It has a reaction of medium acid to neutral.

Osage series

The Osage series consists of deep, poorly drained soils that are very slowly permeable. These soils are on flood plains. They formed in clayey alluvium. Slope ranges from 0 to 1 percent.

Osage soils are similar to Leanna soils and are commonly adjacent to Lanton, Leanna, and Verdigris soils. Lanton and Verdigris soils have a less clayey subsoil than the Osage soils. Lanton soils are on slightly higher flood plains than Osage soils, and Verdigris soils are adjacent to stream channels. Leanna soils have a lighter colored subsurface layer. The Leanna and Osage soils are on similar positions of the landscape.

Typical pedon of Osage silty clay; 1,000 feet west and 100 feet north of the southeast corner of sec. 18, T. 23 S., R. 17 E.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, dark gray (10YR 3/1) dry; moderate fine and medium granular structure; very hard, very firm; common fine roots; slightly acid; clear smooth boundary.

A12—7 to 15 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong fine and medium blocky structure; very hard, very firm; few fine roots; slightly acid; gradual smooth boundary.

B2g—15 to 30 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct olive brown (2.5Y 4/4) mottles; moderate fine and medium blocky structure; extremely hard, extremely firm; few fine roots; few fine dark brown concretions; slightly acid; gradual smooth boundary.

B3g—30 to 60 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; common fine distinct olive brown (2.5Y 4/4) mottles; weak medium blocky structure; extremely hard, extremely firm; few fine dark brown concretions; neutral.

The solum is 40 to 60 inches or more thick.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It ranges from medium acid to neutral. The B2 horizon has hue of 10YR or 2.5Y, or is neutral; value of 3 to 5 (4 or 5 dry); and chroma less than 1.5. It has few or common olive brown, yellowish brown, or dark yellowish brown mottles. In some pedons the lower part of the B horizon has gypsum crystals.

Shidler series

The Shidler series consists of shallow, well drained soils that are moderately permeable. These soils are on uplands. They formed in residuum weathered from limestone. Slope ranges from 1 to 8 percent.

Shidler soils are similar to Clareson and Collinsville soils and are commonly adjacent to Apperson, Clareson, Eram, Lula, and Summit soils. Apperson soils are more than 40 inches deep to limestone. They are higher than the Shidler soils on the ridgetops and side slopes. Clareson soils are more than 20 inches deep to limestone. They are in slightly higher positions on the landscape than the Shidler soils. Collinsville soils are loam throughout. The Collinsville and Shidler soils are in similar positions on the landscape. Eram soils are more than 20 inches deep to shale and are lower than the Shidler soils on side slopes. Lula soils have an argillic horizon and are slightly higher than Shidler soils on ridgetops. Summit soils have a clayey subsoil and are on the lower part of side slopes and on foot slopes.

Typical pedon of Shidler silty clay loam from an area of Eram-Shidler silty clay loams, 4 to 15 percent slopes; 100 feet west and 1,400 feet south of the northeast corner of sec. 29, T. 20 S., R. 17 E.

A1—0 to 12 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; abrupt irregular boundary.
R—12 inches; hard limestone.

The thickness of the solum and depth to limestone ranges from 4 to 20 inches. The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. The A horizon is from 10 to 15 percent coarse limestone fragments. Reaction ranges from slightly acid to mildly alkaline.

Summit series

The Summit series consists of deep, moderately well drained soils that are slowly permeable. These soils are on uplands. They formed in colluvium or residuum weathered from shale. Slope ranges from 1 to 7 percent.

Summit soils are similar to Apperson, Dennis, Kenoma, and Woodson soils and are commonly adjacent to Eram, Kenoma, Lula, and Woodson soils. Apperson soils are 40 to 60 inches deep to limestone and are on the upper part of side slopes. Dennis soils are deeper to the clayey subsoil. The Dennis and Summit soils are in similar positions on the landscape. Eram soils are less than 40 inches deep to shale and are on the upper part of side slopes. Both the Kenoma and Woodson soils increase abruptly in clay between the surface layer and subsoil. These two soils are on broad ridgetops. Lula soils have a redder subsoil than the Dennis soils and are on ridgetops.

Typical pedon of Summit silty clay loam, 1 to 4 percent slopes; 400 feet east and 75 feet north of the southwest corner, sec. 20, T. 21 S., R. 14 E.

A1—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; strong medium granular structure; hard, firm; many fine roots; medium acid; gradual smooth boundary.
B1—9 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; very hard, very firm; many fine roots; slightly acid; gradual smooth boundary.
B21t—14 to 26 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium blocky structure; extremely hard, very firm; many fine roots; slightly acid; gradual smooth boundary.
B22t—26 to 38 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few medium faint dark brown (10YR 3/3) mottles; moderate medium blocky structure; extremely hard, very firm; few fine roots; few slickensides; neutral; gradual smooth boundary.
B3—38 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; many medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium blocky structure; extremely hard, very firm; few black stains; black silty clay loam in vertical cracks; few fine lime concretions and accumulations; few fine very dark brown concretions; moderately alkaline.

The solum ranges from 50 inches to more than 60 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It ranges from medium acid to neutral. The B2 horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 4. It is silty clay or clay that ranges from medium acid to mildly alkaline.

Verdigris series

The Verdigris series consists of deep, moderately well drained soils that are moderately permeable. These soils are on flood plains. They formed in silty alluvium. Slope ranges from 0 to 1 percent.

Verdigris soils are similar to Lanton and Mason soils and are commonly adjacent to Lanton, Mason, and Osage soils. The somewhat poorly drained Lanton soils are on slightly higher parts of the flood plain. Mason soils have an argillic horizon and are on terraces. The poorly drained, clayey Osage soils and the Verdigris soils are both on flood plains, but the Osage soils are further from the stream channel.

Typical pedon of Verdigris silt loam; 1,150 feet south and 100 feet west of the northeast corner of sec. 4, T. 19 S., R. 15 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; few fine roots; neutral; abrupt smooth boundary.

A12—7 to 12 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; few fine roots; neutral; gradual smooth boundary.

A13—12 to 24 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; few fine roots; neutral; gradual smooth boundary.

AC—24 to 42 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; hard, friable; few fine roots; neutral; gradual smooth boundary.

C—42 to 60 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; common fine distinct strong brown (7.5YR 5/6) mottles; massive; hard, friable; neutral.

The solum ranges from 24 to 50 inches in thickness. It ranges from medium acid to neutral. The mollic epipedon ranges from 24 to 60 inches in thickness. Mottles of higher chroma or lower value are below a depth of 20 inches in most pedons.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 to 3. It is dominantly silt loam, but the range includes loam or silty clay loam. The C horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is silty clay loam or silt loam.

Woodson series

The Woodson series consists of deep, somewhat poorly drained soils that are very slowly permeable. These soils are on uplands. They formed in old alluvial sediment. In some places they have loess in the upper part. Slope ranges from 0 to 1 percent.

Woodson soils are similar to Kenoma soils and are commonly adjacent to Dennis, Kenoma, and Summit soils. Dennis and Kenoma soils have a browner subsoil. Dennis soils are on the lower part of side slopes. Kenoma soils are gently sloping and are on the lower part of ridgetops. The Summit soils gradually increase in clay between the surface layer and subsoil. They are on foot slopes.

Typical pedon of Woodson silt loam (fig. 18); 2,200 feet east and 100 feet south of the northwest corner of sec. 14, T. 22 S., R. 16 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate fine granular structure; slightly hard, friable; many fine roots; medium acid; abrupt smooth boundary.

B2t—9 to 28 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium blocky

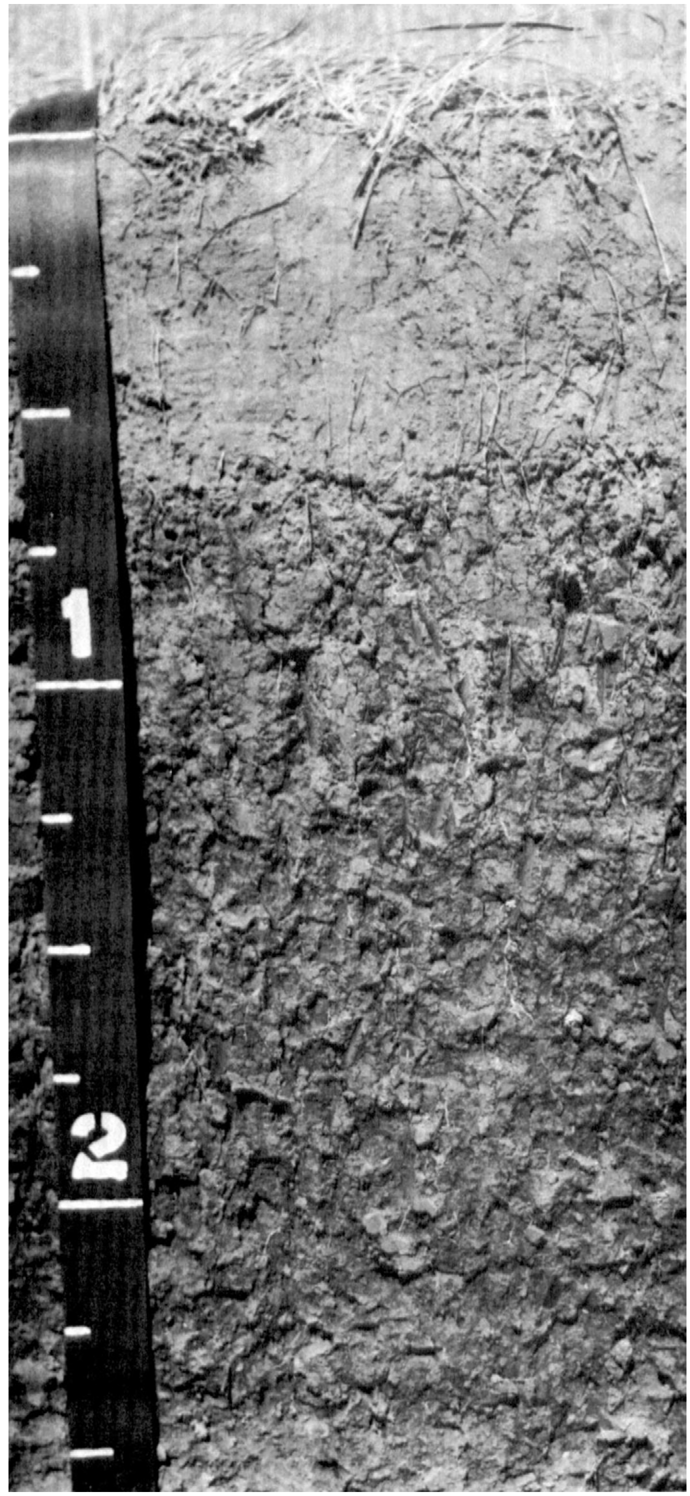


Figure 18.—Representative profile of Woodson silt loam. The boundary between the surface layer and the clayey subsoil is abrupt.

structure; extremely hard, extremely firm; common fine roots; slightly acid; gradual smooth boundary.

B3t—28 to 56 inches; gray (10YR 5/1) and dark gray (10YR 4/1) silty clay, gray (10YR 5/1) and light gray (10YR 6/1) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium blocky structure; extremely hard, extremely firm; few fine roots; few black stains; neutral; gradual smooth boundary.

C—56 to 60 inches; grayish brown (10YR 5/2) silty clay, light gray (10YR 7/2) dry; few fine distinct yellowish brown (10YR 5/4) and dark brown (10YR 3/3) mottles; weak medium and fine blocky structure; very hard, very firm; slightly acid.

The solum ranges from 40 to 60 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. It is dominantly silt loam, but the range includes silty clay loam. It is medium acid or slightly acid. The B2t horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1. It is silty clay or clay. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 3.

formation of the soils

This section describes the factors of soil formation, relates them to the formation of soils in the survey area, and explains the process of soil formation.

There are five factors of soil formation that influence characteristics of the soil. These include parent material; climate; plant and animal life; relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material. Each of these factors affects the formation of all soils, and each modifies the effects of the other four. The relative effects of the individual factors vary from place to place.

Climate and plant and animal life act on parent material that has weathered from rock, gradually changing it into soil. This process is conditioned by relief, which affects the runoff and drainage. Finally, time is needed for the transformation of rock into soil. Generally, a long period is required for distinct soil horizons to develop.

The following paragraphs describe the effects of the five major factors of soil formation on the soils of this survey area.

parent material

Parent material is the unconsolidated material in which soil forms. It forms from the physical and chemical weathering of rocks. The composition of the geological materials affects the mineralogical composition of the soil and its natural fertility.

Most soils in the survey area formed in material weathered from limestone, sandstone, or shale of the Pennsylvania Period. Apperson, Clareson, Collinsville, Dennis, Eram, Lula, Shidler, and Summit soils formed in material weathered from local bedrock. Bates and Collinsville soils formed in material weathered from sandstone; Apperson, Clareson, Lula, and Shidler soils formed in material weathered from limestone; and Dennis, Eram, and Summit soils formed in material weathered from shale.

Old and recent alluvium consists of sediment transported by water to the present location. The old alluvial sediment (Tertiary and Quaternary Period) is on high terraces and uplands. Dwight, Kenoma, Olpe, and Woodson soils formed in this material. The parent material of Olpe soils contains smooth, chert pebbles. Recent alluvial sediment is on flood plains and low terraces. Lanton and Verdigris soils formed in loamy alluvium, and Leanna and Osage soils formed in clayey alluvium.

climate

Climate is an active factor of soil formation. It directly influences the formation of a soil by weathering the parent material. Its effect on the decomposition of plants and animals, which provide nutrients in the soil, is an indirect influence.

The climate of Coffey County is continental and is characterized by intermittent dry and moist periods. These changes can occur within a year or in cycles of several years. During dry periods the soil material dries to varying depths. During wet periods it slowly regains moisture and can become so saturated that excess moisture penetrates the substratum.

This wetting and drying has helped in the formation of soils by leaching some of the basic nutrients, and even clay particles, from the upper horizons to the lower horizons. Mature soils have distinct horizons. In Coffey County, soils that have well developed horizons are generally nearly level to gently sloping rather than steep.

plant and animal life

All plants and animals are important to soil formation. Plants generally influence the amount of nutrients and organic matter in the soil and the color of the surface layer. Animals, such as earthworms, cicadas, and burrowing animals, help keep the soil open and porous. Bacteria and fungi help decompose the plants, thus releasing more nutrients for plant food.

The mid and tall prairie grasses have had the greatest influence on soil formation in Coffey County. As a result of these grasses, a typical soil in the county has a dark-colored upper part that is high in organic matter; a transitional part that, in many places, is more clayey and somewhat lighter than the layer above; and the underlying parent material that generally is light in color.

relief

Relief influences soil formation by its effect on drainage, runoff, and erosion. The amount of water that moves into the soil depends partly on relief. Generally the steeper soils receive less water than the gently sloping soils and lose more soil material by erosion. The level or depressional soils generally receive extra water from higher lying soils. Because of this additional water, the upper layers of the soil are gray or mottled and are thicker. Level or gently sloping soils, such as the Kenoma and Woodson soils, generally have a more strongly developed profile than steeper soils, such as the Collinsville soils. Runoff is slower or ponds on the level soil, so more water can flow through it. On most of the nearly level soils that formed in alluvium, additional sediment has been deposited during flooding.

time

The length of time needed for soil formation depends largely on the other factors of soil formation. Water moves through the soil, and soluble matter and fine particles are leached gradually from the surface layer and are deposited in the subsoil. The amount of leaching depends on the amount of time that has elapsed and the amount of water that penetrates the soil. For example, Verdigris soils, which formed in recent alluvium, are young soils and show very little horizon development other than a slight darkening of the surface layer. Dennis soils, which have been exposed to soil-forming processes for thousands of years, are older and have well-defined soil horizons.

references

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

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Kansas State Board of Agriculture. 1965. 1964-1965 farm facts. Spec. Rep. Kans. Crop & Kans. Cattle Mark. Stat., 96 pp., illus.

(4) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(5) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Bedding system. A series of elevated beds that are arranged on the surface of fields by plowing or grading and are separated by shallow ditches so that surface drainage is implemented.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

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.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

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

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

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

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

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

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

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons.

Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

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

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

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

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

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

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

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and 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 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of 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 plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

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 physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Underlying material. The part of the soil below the solum.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Most data recorded in the period 1951-76 at Burlington, Kansas. Average snowfall data recorded in the period 1941-70 at Garnett, Kansas.]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	40.8	17.9	29.4	70	-11	0.87	0.17	1.63	2	5.3
February---	46.5	23.3	34.9	76	-1	1.00	.26	1.48	3	3.4
March------	55.9	30.9	43.4	85	3	2.32	1.15	3.37	5	3.6
April------	69.2	43.6	56.4	91	24	3.18	1.81	4.55	6	0.2
May--------	77.5	53.5	65.5	93	33	4.27	2.34	5.71	7	0.0
June-------	86.0	62.6	74.3	99	46	5.28	2.56	8.06	7	0.0
July-------	91.8	67.0	79.4	106	52	4.13	1.06	6.52	6	0.0
August-----	91.0	65.1	78.1	105	50	3.61	1.39	5.98	5	0.0
September--	82.5	56.4	69.5	100	37	4.75	1.61	8.40	5	0.0
October----	72.3	45.4	58.9	92	24	3.22	1.30	5.26	5	T
November---	56.4	32.5	44.5	79	7	1.66	.15	2.69	3	0.7
December---	44.4	23.7	34.1	70	-4	1.13	.55	1.69	3	4.3
Year-----	67.9	43.5	55.7	108	-10	35.42	26.59	43.68	57	17.5

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1931-60 at Burlington, Kansas]

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 6	April 14	April 29
2 years in 10 later than--	April 1	April 9	April 24
5 years in 10 later than--	March 23	March 30	April 14
First freezing temperature in fall:			
1 year in 10 earlier than--	October 25	October 17	October 8
2 years in 10 earlier than--	October 29	October 22	October 12
5 years in 10 earlier than--	November 8	October 31	October 22

TABLE 3.--GROWING SEASON

[Recorded in the period 1931-60 at Burlington, Kansas]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	207	194	168
8 years in 10	215	201	176
5 years in 10	230	215	191
2 years in 10	245	228	206
1 year in 10	253	235	214

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ae	Apperson-Eram silty clay loams, 1 to 4 percent slopes	12,200	2.9
Bb	Bates loam, 1 to 4 percent slopes	4,400	1.1
Bc	Bates loam, 4 to 7 percent slopes	4,400	1.1
Cs	Clareson-Shidler silty clay loams, 1 to 8 percent slopes	2,800	0.7
Db	Dennis silt loam, 1 to 4 percent slopes	23,400	5.6
De	Dennis silty clay loam, 2 to 5 percent slopes, eroded	1,850	0.4
Eb	Eram silt loam, 1 to 3 percent slopes	9,000	2.1
Ec	Eram silt loam, 3 to 7 percent slopes	13,600	3.2
Eh	Eram silty clay loam, 3 to 7 percent slopes, eroded	1,400	0.3
Ep	Eram-Apperson silty clay loams, 4 to 7 percent slopes	11,350	2.7
Er	Eram-Collinsville complex, 4 to 15 percent slopes	9,800	2.3
Es	Eram-Shidler silty clay loams, 4 to 15 percent slopes	20,700	4.9
Kb	Kenoma silt loam, 1 to 3 percent slopes	95,000	22.7
Ke	Kenoma silty clay loam, 1 to 3 percent slopes, eroded	1,400	0.3
Ko	Kenoma-Olpe complex, 2 to 7 percent slopes	9,500	2.3
La	Lanton silty clay loam	7,250	1.7
Le	Leanna silt loam	2,800	0.7
Lu	Lula silt loam, 0 to 2 percent slopes	26,200	6.2
Ma	Mason silt loam	1,400	0.3
Ob	Olpe gravelly silt loam, 4 to 15 percent slopes	5,250	1.3
Oc	Orthents, clayey	500	0.1
Oh	Orthents, hilly	130	*
Os	Osage silty clay loam	8,900	2.1
Ot	Osage silty clay	6,200	1.5
Pt	Pits, quarries	350	0.1
Sa	Summit silty clay loam, 1 to 4 percent slopes	36,000	8.6
Sc	Summit silty clay loam, 4 to 7 percent slopes	11,000	2.6
Sd	Summit-Dwight complex, 1 to 3 percent slopes	1,200	0.3
Vb	Verdigris silt loam	19,300	4.6
Vc	Verdigris silt loam, channeled	14,700	3.5
Wo	Woodson silt loam	32,900	7.8
	**Water	24,960	6.0
	Total	419,840	100.0

* Less than 0.1 percent.

** Included in this total are about 15,000 acres of land within the flood pool of John Redmond Reservoir. This land is mapped as Verdigris or Osage soils on the detailed soil map.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Winter wheat	Grain sorghum	Soybeans	Corn	Tall fescue
	Bu	Bu	Bu	Bu	AUM*
Ae: Apperson-Eram	32	60	26	55	5.0
Bb: Bates	36	55	22	50	5.0
Bc: Bates	32	50	18	45	5.0
Cs: Clareson-Shidler	---	---	---	---	---
Db: Dennis	42	75	30	70	6.0
De: Dennis	34	65	23	60	5.5
Eb: Eram	32	55	22	50	5.0
Ec: Eram	28	50	18	45	5.0
Eh: Eram	22	40	15	35	4.0
Ep: Eram-Apperson	28	55	20	50	5.0
Er: Eram-Collinsville	---	---	---	---	---
Es: Eram-Shidler	---	---	---	---	---
Kb: Kenoma	38	65	26	60	5.0
Ke: Kenoma	27	50	20	45	4.0
Ko: Kenoma-Olpe	28	45	18	40	4.0
La: Lanton	38	85	34	85	7.5
Le: Leanna	36	70	30	70	7.0
Lu: Lula	42	65	30	60	6.0
Ma: Mason	46	90	36	90	7.5
Ob: Olpe	---	---	---	---	---
Oc**, Oh**. Orthents					

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Winter wheat	Grain sorghum	Soybeans	Corn	Tall fescue
	Bu	Bu	Bu	Bu	AUM*
Os------------------------ Osage	38	85	35	80	7.0
Ot------------------------ Osage	32	65	30	60	6.5
Pt**. Pits					
Sa------------------------ Summit	40	75	30	70	6.0
So------------------------ Summit	36	70	28	65	6.0
Sd------------------------ Summit-Dwight	29	55	22	50	4.5
Vb------------------------ Verdigris	44	90	36	90	7.5
Vo------------------------ Verdigris	---	---	---	---	---
Wo------------------------ Woodson	38	70	28	65	5.0

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ae*:					
Apperson	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	5
Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	5
				Tall dropseed	5
Bb, Bc: Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	10
Cs*:					
Clareson	Shallow Flats	Favorable	5,000	Little bluestem	30
		Normal	4,000	Big bluestem	15
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	10
				Switchgrass	5
				Tall dropseed	5
Shidler	Shallow Limy	Favorable	3,000	Sideoats grama	30
		Normal	2,000	Little bluestem	15
		Unfavorable	1,000	Big bluestem	15
				Switchgrass	5
				Indiangrass	5
Db, De: Dennis	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	5
Eb: Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	5
				Tall dropseed	5
Ec: Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	5
				Tall dropseed	5
Eh: Eram	Clay Upland	Favorable	4,400	Little bluestem	25
		Normal	3,200	Big bluestem	20
		Unfavorable	2,400	Switchgrass	15
				Indiangrass	10
				Tall dropseed	10
				Sideoats grama	5
Ep*:					
Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	5
				Tall dropseed	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ep*:					
Apperson	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	5
Er*:					
Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	5
				Tall dropseed	5
Collinsville	Shallow Savannah	Favorable	4,500	Little bluestem	30
		Normal	3,700	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
Es*:					
Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Sideoats grama	5
				Tall dropseed	5
Shidler	Shallow Limy	Favorable	3,000	Sideoats grama	30
		Normal	2,000	Little bluestem	15
		Unfavorable	1,000	Big bluestem	15
				Switchgrass	5
				Indiangrass	5
Kb, Ke Kenoma	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
Ko*:					
Kenoma	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
Olpe	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
La Lanton	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	8,000	Indiangrass	20
		Unfavorable	6,000	Switchgrass	15
				Eastern gamagrass	5

See footnotes at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production		Characteristic vegetation	Compo- sition
		Kind of year	Dry weight		
			Lb/acre		Pct
Le------------------ Leanna	Clay Lowland	Favorable	10,000	Prairie cordgrass	35
		Normal	8,000	Big bluestem	15
		Unfavorable	6,000	Eastern gamagrass	10
				Indiangrass	10
				Switchgrass	10
				Sedge	5
Lu------------------ Lula	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	10
Ma------------------ Mason	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	9,000	Indiangrass	20
		Unfavorable	7,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Ob------------------ Olpe	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
Os, Ot-------------- Osage	Clay Lowland	Favorable	9,000	Prairie cordgrass	40
		Normal	8,000	Switchgrass	15
		Unfavorable	6,000	Big bluestem	15
				Eastern gamagrass	10
				Indiangrass	5
				Sedge	5
Sa, Sc-------------- Summit	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	5
Sd*:					
Summit--------------	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	5
Dwight--------------	Claypan	Favorable	4,000	Big bluestem	15
		Normal	3,000	Little bluestem	10
		Unfavorable	2,000	Prairie dropseed	10
				Tall dropseed	10
				Western wheatgrass	10
				Blue grama	10
				Switchgrass	5
				Sideoats grama	5
				Buffalograss	5
				Dotted gayfeather	5
Vb, Vc-------------- Verdigris	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	8,500	Indiangrass	15
		Unfavorable	6,000	Eastern gamagrass	15
				Switchgrass	10
				Prairie cordgrass	5
Wo------------------ Woodson	Clay Upland	Favorable	6,000	Big bluestem	35
		Normal	4,500	Little bluestem	15
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	15

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
La: Lanton	3o	Slight	Slight	Slight	Slight	Green ash	71	Pecan, eastern cottonwood, green ash, pin oak.
						Pin oak	80	
						Eastern cottonwood	85	
						Pecan	63	
Le: Leanna	3w	Slight	Slight	Slight	Slight	Pin oak	80	Pecan, green ash, American sycamore, eastern cottonwood, northern red oak.
						Eastern cottonwood	85	
						Pecan	50	
						Common hackberry	60	
						Green ash	75	
Ma: Mason	3o	Slight	Slight	Slight	Slight	Eastern cottonwood	90	Bur oak, green ash, black walnut, pecan, American sycamore, eastern cottonwood.
						Northern red oak	65	
						Green ash	75	
						Black walnut	69	
Os, Ot: Osage	4w	Slight	Moderate	Moderate	Severe	Pin oak	75	Pin oak, pecan.
						Pecan	50	
						Eastern cottonwood	65	
Vb, Vc: Verdigris	3o	Slight	Slight	Slight	Slight	Eastern cottonwood	87	Eastern cottonwood, American sycamore, pin oak, black walnut, green ash, northern red oak.
						Pin oak	75	
						Shagbark hickory	---	
						Common hackberry	69	
						Black walnut	69	
						Silver maple	---	
						Green ash	69	

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ae*:					
Apperson	Lilac, Peking cotoneaster.	Amur honeysuckle, Siberian peashrub.	Green ash, Austrian pine, common hackberry, eastern redcedar, osageorange.	Honeylocust	---
Eram	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Bb, Bc Bates	Lilac, Peking cotoneaster, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, green ash, Austrian pine, bur oak, common hackberry, Russian-olive.	Siberian elm, honeylocust.	---
Cs*:					
Clareson	Peking cotoneaster, Amur honeysuckle, lilac, fragrant sumac.	---	Austrian pine, eastern redcedar, green ash, Russian-olive, common hackberry, bur oak.	Siberian elm, honeylocust.	---
Shidler.					
Db, De Dennis	American plum, fragrant sumac, Peking cotoneaster, lilac.	Manchurian crabapple.	Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust	---
Eb, Ec, Eh Eram	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Ep*:					
Eram	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Apperson	Lilac, Peking cotoneaster.	Amur honeysuckle, Siberian peashrub.	Eastern redcedar, osageorange, green ash, Austrian pine, common hackberry.	Honeylocust	---
Er*:					
Eram	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Collinsville	---	---	---	---	---
Es*:					
Eram	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Shidler.					

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Kb, Ke: Kenoma	Peking cotoneaster, lilac, fragrant sumac.	Amur honeysuckle	Green ash, common hackberry, Austrian pine, Russian-olive, eastern redcedar.	Siberian elm, honeylocust.	---
Ko*:					
Kenoma	Peking cotoneaster, lilac, fragrant sumac.	Amur honeysuckle	Common hackberry, Austrian pine, Russian-olive, eastern redcedar.	Green ash, Siberian elm, honeylocust.	---
Olpe	Fragrant sumac, Peking cotoneaster, Amur honeysuckle, lilac.	Russian-olive	Bur oak, eastern redcedar, common hackberry, Austrian pine, green ash.	Siberian elm, honeylocust.	---
La: Lanton	Fragrant sumac	American plum, Peking cotoneaster.	Russian mulberry	Austrian pine, honeylocust, green ash, pin oak, Scotch pine, common hackberry.	Pecan, silver maple.
Le: Leanna	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, common hackberry.	Northern red oak, green ash, Austrian pine, honeylocust, silver maple, golden willow.	Eastern cottonwood.
Lu: Lula	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Ma: Mason	Fragrant sumac	American plum, Peking cotoneaster.	Russian mulberry	Austrian pine, honeylocust, green ash, pin oak, Scotch pine, common hackberry.	Pecan, silver maple.
Ob: Olpe	Fragrant sumac, Peking cotoneaster, Amur honeysuckle, lilac.	Russian-olive	Bur oak, eastern redcedar, common hackberry, Austrian pine, green ash.	Siberian elm, honeylocust.	---
Oc*, Oh*. Orthents					
Os, Ot: Osage	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, common hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
Pt*. Pits					

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Sa, Sc------------ Summit	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive------	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Sd*:					
Summit-----------	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive------	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Dwight-----------	Silver buffaloberry, Siberian peashrub, lilac.	Eastern redcedar, Russian-olive, green ash.	Siberian elm	---	---
Vb, Vc------------ Verdigris	---	American plum, lilac, Peking cotoneaster, Amur honeysuckle.	Eastern redcedar	Austrian pine, honeylocust, eastern white pine, bur oak, green ash, common hackberry.	Eastern cottonwood.
Wo---------------- Woodson	Peking cotoneaster, lilac, fragrant sumac.	Amur honeysuckle	Green ash, common hackberry, eastern redcedar, Russian-olive.	Austrian pine, honeylocust, Siberian elm.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ae*:				
Apperson	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Eram	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, small stones, wetness.	Severe: erodes easily.
Bb, Bc: Bates	Slight	Slight	Moderate: slope, small stones, depth to rock.	Slight.
Cs*:				
Clareson	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight.
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
Db, De: Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Eb, Ec, Eh: Eram	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, small stones, wetness.	Severe: erodes easily.
Ep*:				
Eram	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, small stones, wetness.	Severe: erodes easily.
Apperson	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Er*:				
Eram	Moderate: slope, wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: slope.	Severe: erodes easily.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones.	Slight.
Es*:				
Eram	Moderate: slope, wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: slope.	Severe: erodes easily.
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Kb, Ke: Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.
Ko*:				
Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.
Olpe	Severe: small stones.	Severe: small stones.	Severe: small stones.	Slight.
La: Lanton	Severe: flooding, wetness.	Moderate: flooding, wetness, percs slowly.	Severe: wetness, flooding.	Moderate: wetness.
Le: Leanna	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, erodes easily.
Lu: Lula	Slight	Slight	Slight	Severe: erodes easily.
Ma: Mason	Severe: flooding.	Moderate: percs slowly.	Moderate: percs slowly.	Severe: erodes easily.
Ob: Olpe	Severe: small stones.	Severe: small stones.	Severe: slope, small stones.	Slight.
Oc*, Oh*. Orthents				
Os: Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
Ot: Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Pt*. Pits				
Sa, Sc: Summit	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Severe: erodes easily.
Sd*:				
Summit	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Severe: erodes easily.
Dwight	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Severe: erodes easily.
Vb: Verdigris	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Vc: Verdigris	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Wo: Woodson	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Ae*:										
Apperson	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
Eram	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Bb, Bc Bates	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Cs*:										
Clareson	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
Shidler	Very poor.	Very poor.	Poor	---	---	Very poor.	Very poor.	Very poor.	---	Very poor.
Db Dennis	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
De Dennis	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Eb Eram	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Ec, Eh Eram	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Ep*:										
Eram	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Apperson	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
Er*:										
Eram	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Collinsville	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Es*:										
Eram	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Shidler	Very poor.	Very poor.	Poor	---	---	Very poor.	Very poor.	Very poor.	---	Very poor.
Kb, Ke Kenoma	Good	Good	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor.
Ko*:										
Kenoma	Fair	Good	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
Olpe	Fair	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
La Lanton	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Le Leanna	Fair	Good	Fair	Good	Good	Fair	Good	Fair	Good	Fair.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
Lu: Lula	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Ma: Mason	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Ob: Olpe	Fair	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
Oc*, Oh*. Orthents										
Os: Osage	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Ot: Osage	Fair	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
Pt*. Pits										
Sa: Summit	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
Sc: Summit	Fair	Good	Fair	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
Sd*:										
Summit	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
Dwight	Fair	Fair	Fair	---	---	Poor	Fair	Fair	---	Poor.
Vb: Verdigris	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
Vc: Verdigris	Poor	Fair	Fair	Good	Good	Poor	Fair	Fair	Good	Poor.
Wo: Woodson	Good	Good	Fair	Poor	Poor	Poor	Good	Fair	Fair	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ae*:					
Apperson	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Bb: Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Slight	Moderate: low strength.
Bc: Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Cs*:					
Clareson	Severe: depth to rock, large stones.	Severe: large stones.	Severe: depth to rock, large stones.	Severe: large stones.	Severe: low strength, large stones.
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Db, De: Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Eb, Ec, Eh: Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ep*:					
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Apperson	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Er*:					
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Es*:					
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Kb: Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ke: Kenoma	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ko*:					
Kenoma	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Olpe	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell.
La Lanton	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding.
Le Leanna	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
Lu Lula	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Ma Mason	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Ob Olpe	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope, shrink-swell.
Oc*, Oh*. Orthents					
Os, Ot Osage	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
Pt*. Pits					
Sa, Sc Summit	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Sd*:					
Summit	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Dwight	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Vb, Vc Verdigris	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Wo Woodson	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ae*:					
Apperson	Severe: wetness, percs slowly.	Moderate: slope.	Severe: depth to rock, wetness, too clayey.	Moderate: depth to rock, wetness.	Poor: too clayey, hard to pack.
Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Bb, Bc: Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Cs*:					
Clareson	Severe: depth to rock, percs slowly, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, too clayey, large stones.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Db, De: Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Eb, Ec, Eh: Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Ep*:					
Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Apperson	Severe: wetness, percs slowly.	Moderate: slope.	Severe: depth to rock, wetness, too clayey.	Moderate: depth to rock, wetness.	Poor: too clayey, hard to pack.
Er*:					
Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Collinsville	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock.	Poor: area reclaim.
Es*:					
Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Kb------------------- Kenoma	Severe: percs slowly.	Slight-----------	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
Ke------------------- Kenoma	Severe: percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Moderate: depth to rock.	Poor: too clayey, hard to pack.
Ko*:					
Kenoma--------------	Severe: percs slowly.	Moderate: slope.	Severe: depth to rock, too clayey.	Moderate: depth to rock.	Poor: too clayey, hard to pack.
Olpe----------------	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, small stones.
La------------------- Lanton	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, thin layer.
Le------------------- Leanna	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Lu------------------- Lula	Moderate: depth to rock, percs slowly.	Moderate: seepage, depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Fair: area reclaim, too clayey, thin layer.
Ma------------------- Mason	Severe: percs slowly.	Slight-----------	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
Ob------------------- Olpe	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, small stones.
Oc*, Oh*. Orthents					
Os, Ot--------------- Osage	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Pt*. Pits					
Sa, Sc--------------- Summit	Severe: wetness, percs slowly.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Sd*:					
Summit--------------	Severe: wetness, percs slowly.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Dwight--------------	Severe: percs slowly.	Slight-----------	Severe: too clayey, excess sodium.	Slight-----------	Poor: too clayey, hard to pack, excess sodium.
Vb, Vc--------------- Verdigris	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Wo-------------------- Woodson	Severe: percs slowly, wetness.	Slight------------	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ae*:				
Apperson	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Bb, Bc Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Cs*:				
Clareson	Poor: area reclaim, low strength, large stones.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones.
Shidler	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Db, De Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Eb, Ec, Eh Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ep*:				
Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Apperson	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Er*:				
Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Collinsville	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Es*:				
Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Shidler	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Kb, Ke: Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ko*:				
Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Olpe	Fair: shrink-swell.	Improbable: excess fines.	Probable	Poor: small stones, area reclaim.
La: Lanton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, thin layer.
Le: Leanna	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
Lu: Lula	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ma: Mason	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ob: Olpe	Fair: shrink-swell.	Improbable: excess fines.	Probable	Poor: small stones, area reclaim.
Oc*, Oh*. Orthents				
Os: Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Ot: Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Pt*. Pits				
Sa, Sc: Summit	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Sd*:				
Summit	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Dwight	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Vb, Vc: Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Wo: Woodson	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
Ae*:						
Apperson	Moderate: depth to rock.	Severe: hard to pack.	Percs slowly	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Eram	Moderate: depth to rock.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Bb Bates	Moderate: seepage, depth to rock.	Severe: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Bc Bates	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Cs*:						
Clareson	Moderate: depth to rock, slope.	Severe: large stones.	Deep to water	Large stones, droughty, percs slowly.	Large stones, depth to rock.	Large stones, droughty.
Shidler	Severe: depth to rock.	Slight	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Db Dennis	Slight	Moderate: hard to pack, wetness.	Percs slowly	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
De Dennis	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Eb Eram	Moderate: depth to rock.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Ec, Eh Eram	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Ep*:						
Eram	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Apperson	Moderate: depth to rock, slope.	Severe: hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Er*:						
Eram	Severe: slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Collinsville	Severe: depth to rock, slope.	Slight	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Es*:						
Eram	Severe: slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Shidler	Severe: depth to rock.	Slight	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Kb Kenoma	Slight	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Ke Kenoma	Moderate: depth to rock.	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Ko*:						
Kenoma	Moderate: depth to rock, slope.	Severe: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Olpe	Moderate: slope.	Slight	Deep to water	Percs slowly, slope.	Percs slowly	Percs slowly.
La Lanton	Slight	Severe: piping, wetness.	Percs slowly, flooding.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
Le Leanna	Slight	Severe: wetness.	Percs slowly, flooding.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Lu Lula	Moderate: seepage, depth to rock.	Moderate: thin layer, piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Ma Mason	Slight	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Ob Olpe	Severe: slope.	Slight	Deep to water	Percs slowly, slope.	Slope, percs slowly.	Slope, percs slowly.
Oc*, Oh*. Orthents						
Os Osage	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness	Wetness, percs slowly.	Wetness, percs slowly.
Ot Osage	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Pt*. Pits						
Sa Summit	Slight	Severe: hard to pack.	Percs slowly	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
Sc Summit	Moderate: slope.	Severe: hard to pack.	Percs slowly, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
Sd*:						
Summit	Slight	Severe: hard to pack.	Percs slowly	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
Dwight	Slight	Severe: excess sodium.	Deep to water	Percs slowly, erodes easily, excess sodium.	Erodes easily, percs slowly.	Excess sodium, erodes easily, percs slowly.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Vb, Vc: Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Favorable	Favorable.
Wo: Woodson	Slight	Severe: wetness.	Percs slowly	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Percs slowly, wetness, erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ae*:											
Apperson	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-98	33-44	12-20
	9-14	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	95-100	80-99	41-70	20-40
	14-42	Silty clay	CL, CH	A-7	0	85-100	83-100	80-100	75-99	41-70	20-40
	42	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Eram	0-16	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	16-34	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	34	Weathered bedrock	---	---	---	---	---	---	---	---	---
Bb, Bc: Bates	0-17	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	17-26	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7	0	85-100	85-100	80-100	45-85	25-45	3-20
	26	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cs*:											
Clareson	0-12	Silty clay loam	CL	A-4, A-6	0-25	90-100	90-100	85-95	85-95	30-40	8-18
	12-18	Silty clay loam, flaggy silty clay loam.	CL	A-6, A-7	0-65	90-100	90-100	85-95	85-95	35-45	11-20
	18-24	Very flaggy silty clay, flaggy silty clay loam.	CL, CH	A-7	50-85	85-100	85-100	80-95	80-95	41-60	18-35
	24	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Shidler	0-12	Silty clay loam	CL	A-6, A-7	0	90-100	90-100	90-100	80-98	33-42	12-19
	12	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Db: Denhis	0-11	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	11-18	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	18-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
De: Dennis	0-6	Silty clay loam	CL	A-6, A-7	0	100	98-100	94-100	75-98	33-48	13-25
	6-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
Eb, Ec: Eram	0-10	Silt loam	CL	A-4, A-6	0	85-100	85-100	85-100	75-95	30-37	8-13
	10-28	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---
Eh: Eram	0-6	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	6-22	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	22	Weathered bedrock	---	---	---	---	---	---	---	---	---
Ep*:											
Eram	0-8	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	8-26	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	26	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Ep*:											
Apperson	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-98	33-44	12-20
	9-14	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	95-100	80-99	41-70	20-40
	14-42	Silty clay	CL, CH	A-7	0	85-100	83-100	80-100	75-99	41-70	20-40
	42	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Er*:											
Eram	0-10	Silt loam	CL	A-4, A-6	0	85-100	85-100	85-100	75-95	30-37	8-13
	10-28	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---
Collinsville	0-14	Loam	SM, SC, ML, CL	A-4	0-3	80-100	60-100	60-95	36-75	<30	NP-10
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Es*:											
Eram	0-8	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	8-26	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	26	Weathered bedrock	---	---	---	---	---	---	---	---	---
Shidler	0-12	Silty clay loam	CL	A-6, A-7	0	90-100	90-100	90-100	80-98	33-42	12-19
	12	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Kb	0-11	Silt loam	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18
Kenoma	11-56	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48
	56-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-44
Ke	0-5	Silty clay loam	CL	A-6	0	85-100	85-100	85-100	85-100	30-40	10-30
Kenoma	5-46	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-50
	46	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ko*:											
Kenoma	0-11	Silt loam	CL, CL-ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	5-20
	11-56	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-50
	56-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-45
Olpe	0-10	Gravelly silt loam.	GC, SC	A-2, A-4, A-6	0	30-75	30-75	20-55	15-50	20-40	7-20
	10-60	Very gravelly silty clay, very gravelly clay, gravelly silty clay loam.	GC, SC, GP-GC, SP-SC	A-2-7, A-7	0	30-65	10-50	10-50	10-45	40-65	25-40
La	0-7	Silty clay loam	CL	A-4, A-6	0	100	95-100	90-100	80-95	25-38	8-15
Lanton	7-48	Silt loam, silty clay loam.	CL	A-4, A-6	0	100	95-100	85-100	80-95	30-38	8-16
	48-60	Clay, silty clay, silty clay loam.	CH, CL	A-6, A-7	0	100	95-100	85-100	75-95	40-55	18-28
Le	0-18	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
Leanna	18-60	Silty clay, silty clay loam, clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-65	25-40

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Lu----------------- Lula	0-9	Silt loam--------	CL, ML,	A-4, A-6	0	100	100	96-100	65-97	25-40	8-20
	9-16	Silty clay loam, clay loam, silt loam.	CL	A-6, A-4, A-7	0	100	100	96-100	65-98	30-43	9-20
	16-48	Silty clay loam, clay loam.	CL	A-6, A-7	0	95-100	95-100	95-100	75-98	33-50	12-26
	48	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ma----------------- Mason	0-6	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-98	20-35	1-13
	6-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-4, A-7	0	98-100	98-100	96-100	65-98	30-43	9-20
Ob----------------- Olpe	0-10	Gravelly silt loam.	GC, SC	A-2, A-4, A-6	0	30-75	30-75	20-55	15-50	20-40	7-20
	10-60	Very gravelly silty clay, very gravelly silty clay loam, gravelly silty clay loam.	GC, SC, GP-GC, SP-SC	A-2-7, A-7	0	30-65	10-50	10-50	10-45	40-65	25-40
Oc*, Oh*. Orthents											
Os----------------- Osage	0-12	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	16-25
	12-60	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	50-80	30-55
Ot----------------- Osage	0-15	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-55
	15-60	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	50-80	30-55
Pt*. Pits											
Sa, Sc------------ Summit	0-9	Silty clay loam	CL, CH, ML, MH	A-6, A-7	0	100	100	96-100	80-99	35-60	11-30
	9-14	Silty clay, silty clay loam, clay.	CL, CH, MH	A-7, A-6	0	100	100	96-100	80-99	37-65	15-35
	14-60	Clay, silty clay	CH, MH, CL	A-7	0	98-100	98-100	96-100	80-98	41-70	18-40
Sd*:											
Summit----------	0-9	Silty clay loam	CL, CH, ML, MH	A-6, A-7	0	100	100	96-100	80-99	35-60	11-30
	9-14	Silty clay, silty clay loam, clay.	CL, CH, MH	A-7, A-6	0	100	100	96-100	80-99	37-65	15-35
	14-60	Clay, silty clay	CH, MH, CL	A-7	0	98-100	98-100	96-100	80-98	41-70	18-40
Dwight----------	0-4	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	85-100	25-40	3-15
	4-51	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	51-60	Clay, silty clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-100	45-60	25-40
Vb, Vc------------ Verdigris	0-24	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	24-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
Wo----------------- Woodson	0-9	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	9-60	Silty clay, clay	CH	A-7-6	0	100	95-100	95-100	90-100	50-65	30-45

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
Ae*:												
Apperson--------	0-9	27-35	1.30-1.60	0.2-0.6	0.16-0.20	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	9-14	35-45	1.35-1.70	0.2-0.6	0.16-0.20	5.6-7.8	<2	High------	0.37			
	14-42	40-60	1.35-1.60	0.06-0.2	0.14-0.18	6.1-8.4	<2	High------	0.32			
	42	---	---	---	---	---	---	----------	----			
Eram------------	0-16	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	16-34	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High------	0.37			
	34	---	---	---	---	---	---	----------	----			
Bb, Bc----------- Bates	0-17	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low-------	0.28	4	5	1-4
	17-26	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-------	0.28			
	26	---	---	---	---	---	---	----------	----			
Cs*:												
Clareson--------	0-12	15-30	1.25-1.35	0.6-2.0	0.16-0.22	5.6-7.3	<2	Moderate	0.32	2	7	---
	12-18	27-40	1.30-1.40	0.2-2.0	0.09-0.21	5.6-7.3	<2	Moderate	0.24			
	18-24	35-50	1.35-1.45	0.06-0.6	0.04-0.07	5.6-7.3	<2	Moderate	0.24			
	24	---	---	---	---	---	---	----------	----			
Shidler---------	0-12	27-35	1.30-1.60	0.6-2.0	0.18-0.22	5.6-8.4	<2	Moderate	0.32	1	7	1-3
	12	---	---	---	---	---	---	----------	----			
Db--------------- Dennis	0-11	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low-------	0.43	5	6	1-3
	11-18	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	18-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High------	0.37			
De--------------- Dennis	0-6	27-35	1.30-1.60	0.2-0.6	0.15-0.20	5.1-6.0	<2	Moderate	0.37	5	6	1-3
	6-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High------	0.37			
Eb, Ec----------- Eram	0-10	18-27	1.30-1.50	0.2-2.0	0.16-0.24	5.6-6.5	<2	Low-------	0.43	3	6	1-3
	10-28	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High------	0.37			
	28	---	---	---	---	---	---	----------	----			
Eh--------------- Eram	0-6	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	6-22	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High------	0.37			
	22	---	---	---	---	---	---	----------	----			
Ep*:												
Eram------------	0-8	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	8-26	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High------	0.37			
	26	---	---	---	---	---	---	----------	----			
Apperson--------	0-9	27-35	1.30-1.60	0.2-0.6	0.16-0.20	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	9-14	35-45	1.35-1.70	0.2-0.6	0.16-0.20	5.6-7.8	<2	High------	0.37			
	14-42	40-60	1.35-1.60	0.06-0.2	0.14-0.18	6.1-8.4	<2	High------	0.32			
	42	---	---	---	---	---	---	----------	----			
Er*:												
Eram------------	0-10	18-27	1.30-1.50	0.2-2.0	0.16-0.24	5.6-6.5	<2	Low-------	0.43	3	6	1-3
	10-28	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High------	0.37			
	28	---	---	---	---	---	---	----------	----			
Collinsville----	0-14	5-20	1.30-1.65	2.0-6.0	0.12-0.16	5.1-6.5	<2	Low-------	0.32	2	5	1-2
	14	---	---	---	---	---	---	----------	----			
Es*:												
Eram------------	0-8	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	8-26	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High------	0.37			
	26	---	---	---	---	---	---	----------	----			
Shidler---------	0-12	27-35	1.30-1.60	0.6-2.0	0.18-0.22	5.6-8.4	<2	Moderate	0.32	1	7	1-3
	12	---	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
Kb---------------- Kenoma	0-11	18-27	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low--------	0.43	4	6	2-4
	11-56	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High------	0.32			
	56-60	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High------	0.32			
Ke---------------- Kenoma	0-5	27-35	1.35-1.45	0.2-0.6	0.21-0.23	5.1-6.5	<2	Moderate	0.43	4	6	1-2
	5-46	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High------	0.32			
	46	---	---	---	---	---	---	----------	----			
Ko*:												
Kenoma----------	0-11	18-27	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low--------	0.43	4	6	2-4
	11-56	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High------	0.32			
	56-60	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High------	0.32			
Olpe------------	0-10	15-30	1.20-1.30	0.6-2.0	0.06-0.13	5.1-6.5	<2	Low--------	0.24	3	8	---
	10-60	35-50	1.35-1.45	0.06-0.2	0.04-0.10	5.6-7.8	<2	Moderate	0.24			
La---------------- Lanton	0-7	20-30	1.30-1.55	0.6-2.0	0.18-0.22	6.1-7.3	<2	Low--------	0.37	5	7	2-6
	7-48	20-35	1.40-1.60	0.2-0.6	0.17-0.22	6.1-7.3	<2	Moderate	0.43			
	48-60	20-35	1.40-1.60	0.06-0.6	0.12-0.18	6.1-7.3	<2	Moderate	0.32			
Le---------------- Leanna	0-18	15-27	1.25-1.35	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low--------	0.37	5	6	1-4
	18-60	35-50	1.35-1.50	<0.06	0.11-0.18	5.1-7.3	<2	High------	0.37			
Lu---------------- Lula	0-9	18-27	1.30-1.50	0.6-2.0	0.16-0.20	5.6-6.5	<2	Low--------	0.37	3	6	1-3
	9-16	24-35	1.40-1.70	0.6-2.0	0.16-0.20	5.6-6.5	<2	Moderate	0.37			
	16-48	27-35	1.45-1.70	0.6-2.0	0.16-0.20	5.1-7.3	<2	Moderate	0.32			
	48	---	---	---	---	---	---	----------	----			
Ma---------------- Mason	0-6	20-30	1.30-1.60	0.6-2.0	0.16-0.20	5.1-7.3	<2	Low--------	0.37	5	6	1-3
	6-60	20-35	1.40-1.70	0.2-0.6	0.16-0.20	4.5-7.8	<2	Moderate	0.37			
Ob---------------- Olpe	0-10	15-30	1.20-1.30	0.6-2.0	0.06-0.13	5.1-6.5	<2	Low--------	0.24	3	8	---
	10-60	35-50	1.35-1.45	0.06-0.2	0.04-0.10	5.6-7.8	<2	Moderate	0.24			
Oc*, Oh*. Orthents												
Os---------------- Osage	0-12	35-40	1.45-1.65	<0.06	0.21-0.23	5.1-7.3	<2	High------	0.28	5	4	1-4
	12-60	35-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Ot---------------- Osage	0-15	40-50	1.40-1.60	<0.06	0.12-0.14	5.1-7.3	<2	Very high	0.28	5	4	1-4
	15-60	35-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Pt*. Pits												
Sa, Sc------------ Summit	0-9	27-45	1.25-1.50	0.2-0.6	0.16-0.20	5.6-7.3	<2	Moderate	0.37	4	7	1-3
	9-14	32-45	1.35-1.65	0.2-0.6	0.10-0.18	5.6-7.3	<2	High------	0.37			
	14-60	40-60	1.35-1.60	0.06-0.2	0.10-0.18	5.6-8.4	<2	High------	0.32			
Sd*:												
Summit----------	0-9	27-45	1.25-1.50	0.2-0.6	0.16-0.20	5.6-7.3	<2	Moderate	0.37	4	7	1-3
	9-14	32-45	1.35-1.65	0.2-0.6	0.10-0.18	5.6-7.3	<2	High------	0.37			
	14-60	40-60	1.35-1.60	0.06-0.2	0.10-0.18	5.6-8.4	<2	High------	0.32			
Dwight----------	0-4	18-30	1.20-1.35	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low--------	0.43	3	6	---
	4-51	45-60	1.30-1.40	<0.06	0.10-0.14	6.1-8.4	<4	High------	0.32			
	51-60	35-50	1.30-1.40	0.06-0.2	0.09-0.16	6.6-8.4	<8	High------	0.32			
Vb, Vc------------ Verdigris	0-24	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low--------	0.32	5	6	2-4
	24-60	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32			
Wo---------------- Woodson	0-9	18-27	1.25-1.45	0.2-0.6	0.22-0.24	5.6-6.5	<2	Low--------	0.43	4	6	1-4
	9-60	40-60	1.30-1.45	<0.06	0.12-0.15	5.6-7.3	<2	High------	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Ae*:											
Apperson	C	None	---	---	1.5-2.0	Perched	Dec-Apr	40-60	Hard	High	Low.
Eram	C	None	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High	Moderate.
Bb, Bc Bates	B	None	---	---	>6.0	---	---	20-40	Soft	Low	Moderate.
Cs*:											
Clareson	C	None	---	---	>6.0	---	---	20-40	Hard	High	Moderate.
Shidler	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	Low.
Db, De Dennis	C	None	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High	Moderate.
Eb, Ec, Eh Eram	C	None	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High	Moderate.
Ep*:											
Eram	C	None	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High	Moderate.
Apperson	C	None	---	---	1.5-2.0	Perched	Dec-Apr	40-60	Hard	High	Low.
Er*:											
Eram	C	None	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High	Moderate.
Collinsville	C	None	---	---	>6.0	---	---	4-20	Hard	Low	Moderate.
Es*:											
Eram	C	None	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High	Moderate.
Shidler	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	Low.
Kb Kenoma	D	None	---	---	>6.0	---	---	>60	---	High	Moderate.
Ke Kenoma	D	None	---	---	>6.0	---	---	40-60	Hard	High	Moderate.
Ko*:											
Kenoma	D	None	---	---	>6.0	---	---	40-60	Hard	High	Moderate.
Olpe	C	None	---	---	>6.0	---	---	>60	---	High	Moderate.
La Lanton	D	Occasional	Very brief	Jan-May	1.0-2.0	Apparent	Dec-May	>60	---	High	Low.
Le Leanna	D	Occasional	Very brief	Jan-Dec	0.5-2.0	Perched	Dec-Jun	>60	---	High	Moderate.
Lu Lula	B	None	---	---	>6.0	---	---	40-60	Hard	Moderate	Moderate.
Ma Mason	B	Rare	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
Ob Olpe	C	None	---	---	>6.0	---	---	>60	---	High	Moderate.
Oc*, Oh*. Orthents											
Os, Ot Osage	D	Occasional	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	High	Moderate.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Pt*. Pits											
Sa, Sc------------ Summit	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High-----	Low.
Sd*:											
Summit-----------	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High-----	Low.
Dwight-----------	D	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate.
Vb---------------- Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low------	Low.
Vc---------------- Verdigris	B	Frequent----	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low------	Low.
Wo---------------- Woodson	D	None--------	---	---	0.5-2.0	Perched	Dec-Apr	>60	---	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Apperson	Fine, montmorillonitic, thermic Vertic Argiudolls
Bates	Fine-loamy, siliceous, thermic Typic Argiudolls
Clareson	Clayey-skeletal, mixed, thermic Typic Argiudolls
Collinsville	Loamy, siliceous, thermic Lithic Hapludolls
Dennis	Fine, mixed, thermic Aquic Paleudolls
Dwight	Fine, montmorillonitic, mesic Typic Natrustolls
Eram	Fine, mixed, thermic Aquic Argiudolls
Kenoma	Fine, montmorillonitic, thermic Vertic Argiudolls
Lanton	Fine-silty, mixed, thermic Cumulic Haplaquolls
Leanna	Fine, mixed, thermic Typic Argialbolls
Lula	Fine-silty, mixed, thermic Typic Argiudolls
Mason	Fine-silty, mixed, thermic Typic Argiudolls
Olpe	Clayey-skeletal, montmorillonitic, thermic Typic Paleudolls
Orthents	Fine, mixed, thermic Typic Udorthents
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
Shidler	Loamy, mixed, thermic Lithic Haplustolls
Summit	Fine, montmorillonitic, thermic Vertic Argiudolls
Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls
Woodson	Fine, montmorillonitic, thermic Abruptic Argiaquolls

★ U.S. GOVERNMENT PRINTING OFFICE: 1982-355-095/1116

NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.