

United States
Department of
Agriculture

In cooperation with
Kansas Agricultural
Experiment Station

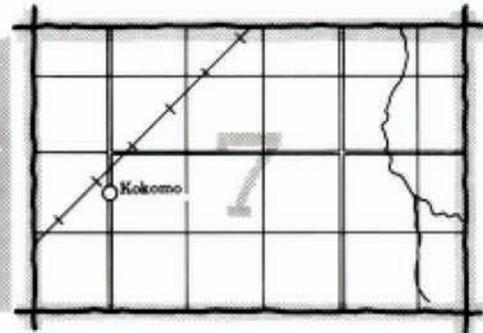
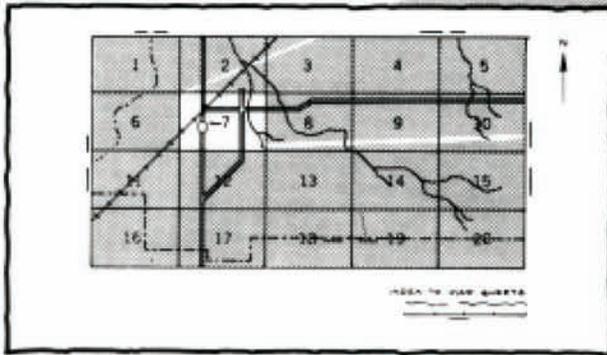
Soil
Conservation
Service

Soil Survey of Neosho County Kansas



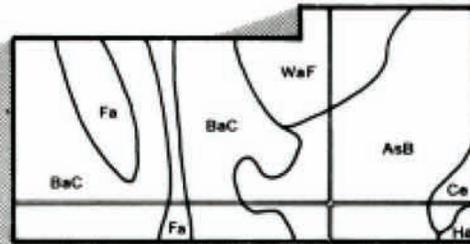
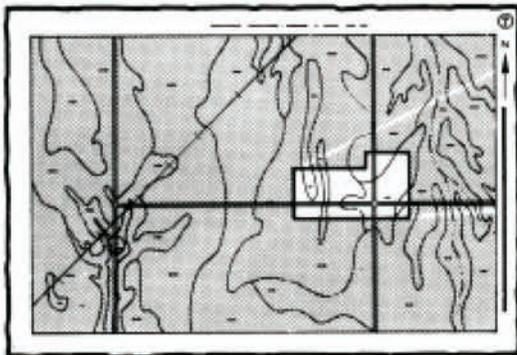
HOW TO USE

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

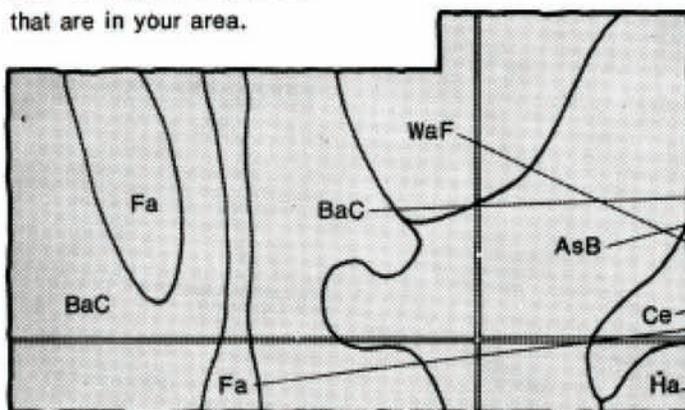


2. Note the number of the map sheet and turn to that sheet.

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



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

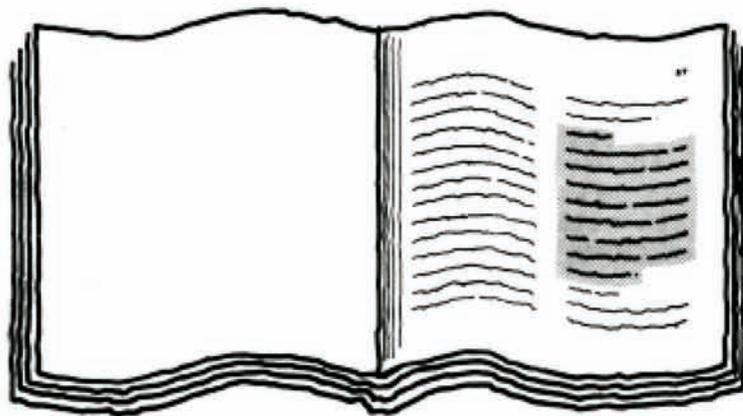


Symbols

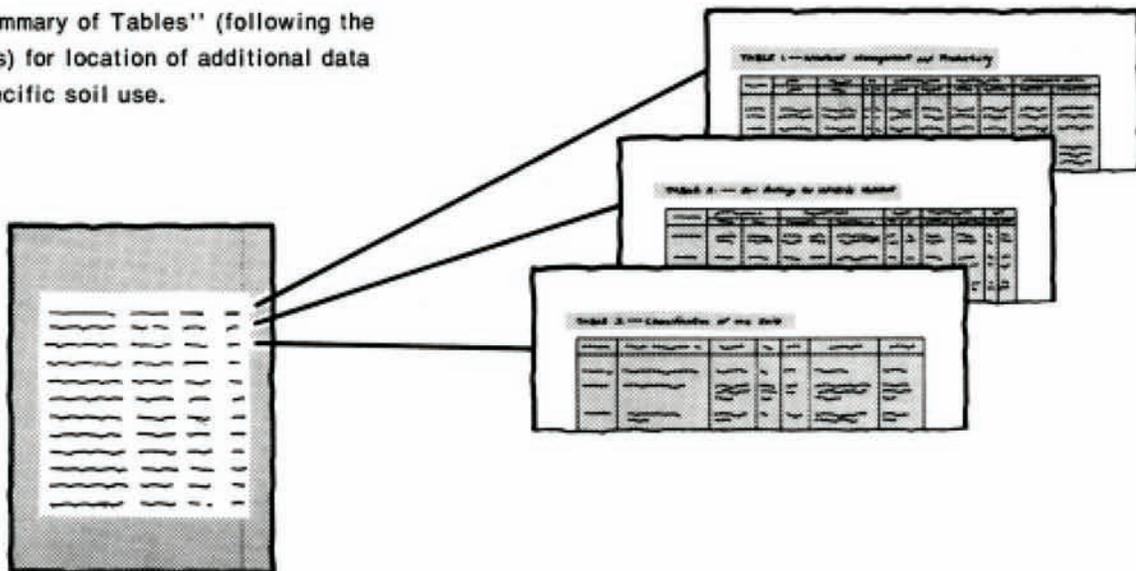
AsB
BaC
Ce
Fa
Ha
WaF

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.

A detailed view of the 'Index to Soil Map Units' table. It is a multi-column table with various entries, likely listing map unit names and their corresponding page numbers. The text is small and difficult to read, but the structure is that of a standard index.

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.

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 Neosho County Conservation District. Major fieldwork was performed in the period 1978-80. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980.

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: Soybeans planted on the contour in an area of Kenoma silt loam, 1 to 3 percent slopes.

contents

Index to map units	iv	Windbreaks and environmental plantings	38
Summary of tables	v	Recreation	38
Foreword	vii	Wildlife habitat	39
General nature of the county	1	Engineering	40
How this survey was made	3	Soil properties	45
General soil map units	5	Engineering index properties	45
Soil descriptions	5	Physical and chemical properties	46
Detailed soil map units	11	Soil and water features	47
Soil descriptions	11	Classification of the soils	49
Prime farmland	30	Soil series and their morphology	49
Use and management of the soils	33	Formation of the soils	61
Crops and pasture	33	References	63
Rangeland	35	Glossary	65
Woodland management and productivity	37	Tables	69

soil series

Bates series	49	Nowata series	54
Catoosa series	50	Olpe series	55
Collinsville series	50	Osage series	55
Darnell series	51	Parsons series	56
Deepwater series	51	Shidler series	56
Dennis series	52	Stephenville series	57
Eram series	52	Verdigris series	57
Kenoma series	53	Woodson series	58
Lanton series	53	Zaar series	58
Lebo series	54		

Issued May 1982

index to map units

Ba—Bates loam, 1 to 3 percent slopes	11	La—Lanton silt loam	21
Bc—Bates loam, 3 to 7 percent slopes	12	No—Nowata silt loam, 3 to 7 percent slopes.....	22
Bd—Bates-Collinsville loams, 1 to 4 percent slopes..	13	Od—Olpe-Dennis complex, 3 to 7 percent slopes	24
Bh—Bates-Collinsville complex, 4 to 20 percent slopes.....	13	Os—Osage silty clay.....	24
Ca—Catoosa silt loam, 0 to 2 percent slopes.....	14	Pa—Parsons silt loam, 0 to 1 percent slopes	26
Da—Deepwater silt loam, 1 to 4 percent slopes	15	Pt—Pits, quarries	26
Db—Dennis silt loam, 1 to 3 percent slopes	15	Sc—Shidler-Catoosa silt loams, 1 to 8 percent slopes.....	26
Dc—Dennis silt loam, 3 to 6 percent slopes	16	Sd—Stephenville-Darnell fine sandy loams, 3 to 20 percent slopes	28
Dn—Dennis-Lanton silt loams, 2 to 8 percent slopes	17	Va—Verdigris silt loam.....	28
Eb—Eram silty clay loam, 1 to 3 percent slopes	18	Vb—Verdigris silt loam, channeled	29
Ec—Eram silty clay loam, 3 to 7 percent slopes	19	Wa—Woodson silt loam, 0 to 1 percent slopes.....	29
Et—Eram-Lebo silty clay loams, 4 to 15 percent slopes.....	19	Zb—Zaar silty clay, 0 to 2 percent slopes.....	30
Ka—Kenoma silt loam, 1 to 3 percent slopes.....	20		

summary of tables

Temperature and precipitation (table 1).....	70
Freeze dates in spring and fall (table 2).....	71
<i>Probability. Minimum temperature.</i>	
Growing season (table 3).....	71
<i>Probability. Daily minimum temperature during growing season.</i>	
Acreage and proportionate extent of the soils (table 4).....	72
<i>Acres. Percent.</i>	
Yields per acre of crops and pasture (table 5).....	73
<i>Grain sorghum. Winter wheat. Soybeans. Alfalfa hay. Corn. Tall fescue.</i>	
Rangeland productivity and characteristic plant communities (table 6).....	74
<i>Range site name. Total production. Characteristic vegetation. Composition.</i>	
Woodland management and productivity (table 7).....	77
<i>Ordination symbol. Management concerns. Potential productivity. Trees to plant.</i>	
Windbreaks and environmental plantings (table 8).....	78
Recreational development (table 9).....	81
<i>Camp areas. Picnic areas. Playgrounds. Paths and trails.</i>	
Wildlife habitat potentials (table 10).....	83
<i>Potential for habitat elements. Potential as habitat for—Openland wildlife, Woodland wildlife, Wetland wildlife, Rangeland wildlife.</i>	
Building site development (table 11).....	85
<i>Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Local roads and streets.</i>	
Sanitary facilities (table 12).....	87
<i>Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.</i>	
Construction materials (table 13).....	89
<i>Roadfill. Sand. Gravel. Topsoil.</i>	
Water management (table 14).....	91
<i>Limitations for—Pond reservoir areas; Embankments, dikes, and levees. Features affecting—Drainage, Irrigation, Terraces and diversions, Grassed waterways.</i>	

Engineering index properties (table 15)	93
<i>Depth. USDA texture. Classification—Unified, AASHTO.</i>	
<i>Fragments greater than 3 inches. Percentage passing</i>	
<i>sieve number—4, 10, 40, 200. Liquid limit. Plasticity index.</i>	
Physical and chemical properties of the soils (table 16)	96
<i>Depth. Clay. Moist bulk density. Permeability. Available</i>	
<i>water capacity. Soil reaction. Salinity. Shrink-swell</i>	
<i>potential. Erosion factors. Wind erodibility group. Organic</i>	
<i>matter.</i>	
Soil and water features (table 17).....	98
<i>Hydrologic group. Flooding. High water table. Bedrock.</i>	
<i>Risk of corrosion.</i>	
Classification of the soils (table 18).....	99
<i>Family or higher taxonomic class.</i>	

foreword

This soil survey contains information that can be used in land-planning programs in Neosho County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, 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 Neosho County, Kansas

By Edward L. Fleming, Howard V. Campbell, Robert D. Weihrouch,
and Steven B. Bruckerhoff, Soil Conservation Service

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

NEOSHO COUNTY is in the southeastern part of Kansas (fig. 1). It has a total area of 375,680 acres, or 587 square miles. The population was 17,896 in 1979. Chanute, the largest town, has a population of 9,724. Erie is the county seat. The county was organized in 1864.

Farming and related services are the most important enterprises in the county. Small industries are also important. The climate favors cash grain and livestock farming. The main crops are wheat, grain sorghum, and soybeans.

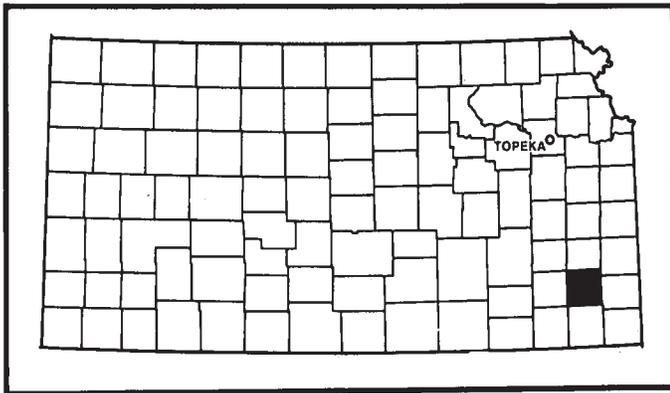


Figure 1.—Location of Neosho County in Kansas.

This soil survey updates the soil survey of Neosho County published in 1930 (4). It provides additional information and larger maps, which show the soils in greater detail.

general nature of the county

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

climate

Prepared by L. Dean Bark, climatologist, Kansas Agricultural Experiment Station.

The climate of Neosho County is typical continental, as can be expected of a location in the interior of a large land mass in the middle latitudes. It is characterized by large daily and annual variations in temperature. Winter is cold because of the frequent outbreaks of polar air. It lasts from December through February. Warm summer temperatures last for about 6 months every year. They provide a long growing season for the crops commonly grown in the county. Spring and fall generally are short.

Neosho County is in the path of a fairly dependable current of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest late in spring and early in summer. Much of it falls during late-evening or nighttime thunderstorms. Although the total precipitation generally is adequate for any crop, its distribution causes problems in some years. Prolonged dry periods of several weeks are not uncommon during the growing season. A surplus

of precipitation often results in muddy fields and a delay in planting and harvesting.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Chanute 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 34.2 degrees F, and the average daily minimum temperature is 24.0 degrees. The lowest temperature on record, which occurred at Chanute on January 30, 1949, is minus 23 degrees. In summer the average temperature is 72.6 degrees, and the average daily maximum temperature is 89.1 degrees. The highest recorded temperature, which occurred at Chanute on July 18, 1936, is 116 degrees.

The annual precipitation is 39.68 inches. Of this, 27.11 inches, or 68 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 20.61 inches. The heaviest 1-day rainfall was 8.92 inches at Chanute on April 8, 1927.

Average seasonal snowfall is 13.7 inches. The greatest snowfall, 36.3 inches, occurred during the winter of 1898-99. On an average of 16 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 69 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 11.5 miles per hour, in spring.

Tornadoes and severe thunderstorms strike occasionally. These storms usually are local in extent and of short duration, so that the risk of damage is small. Hailstorms occur during the warmer part of the year, but they are infrequent and local in extent. They cause less crop damage than the hailstorms in western Kansas.

physiography, drainage, and relief

Neosho County is in the Cherokee Prairie land resource area. Generally, the uplands include low hills, broad gently sloping areas, broad flat areas, and a few steep escarpments. Elevation ranges from 830 to 1,080 feet above sea level.

The Neosho River flows in a southeasterly direction in a shallow valley. The river and its tributaries drain all the county, except for the southwestern corner, which is drained by a tributary of the Verdigris River.

The water for farms is supplied by wells, ponds (fig. 2), streams, and rural water district supply lines. The water for towns generally comes from streams and lakes.



Figure 2.—Pond used for livestock water in an area of Kenoma silt loam, 1 to 3 percent slopes.

natural resources

Soil is the most important natural resource in the county. Also important are native range, timber, game and fish, shale, limestone, oil, and gas.

Limestone is the most common mineral in the county. It is mined for use in the manufacturing of cement and agricultural lime. Low producing oil and gas wells are throughout the county.

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 the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an 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 another, 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 association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions, names, and delineations of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjoining counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

soil descriptions

1. Kenoma-Zaar-Woodson association

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

This association is on broad ridges and flats and in swales. It is dissected by shallow drainageways. Slope ranges from 0 to 3 percent.

This association makes up about 12 percent of the county. It is about 36 percent Kenoma soils, 26 percent Zaar soils, 20 percent Woodson soils, and 18 percent minor soils (fig. 3).

The moderately well drained Kenoma soils formed in old alluvial sediments on side slopes and ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsoil is mottled, firm and very firm silty clay about 37 inches thick. The upper part is dark brown, and the lower part is dark grayish brown and dark yellowish brown. The substratum to a

depth of about 60 inches is grayish brown and dark yellowish brown, mottled silty clay.

The somewhat poorly drained Zaar soils formed in material weathered from shale. They are on side slopes and in swales and drainageways. Typically, the surface layer is black silty clay about 7 inches thick. The subsurface layer is black, firm silty clay about 15 inches thick. The subsoil is mottled, very firm silty clay about 30 inches thick. The upper part is black, and the lower part is very dark gray. The substratum to a depth of about 60 inches is dark gray silty clay.

The somewhat poorly drained Woodson soils formed in old alluvial sediments on broad ridgetops. Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 35 inches thick. The upper part is very dark gray, the next part is dark gray, and the lower part is gray. The substratum to a depth of about 60 inches is gray, mottled silty clay.

Of minor extent in this association are the moderately well drained Dennis soils on side slopes. These soils are similar to the Kenoma soils but have a B1 horizon.

This association is used mainly for cultivated crops. Some areas are used as tame grass pasture or native range. The main concerns of management are controlling water erosion and maintaining tilth and fertility. In some areas of Woodson and Zaar soils, a surface drainage system is needed.

2. Osage-Lanton-Verdigris association

Deep, nearly level, poorly drained to moderately well drained soils that have a clayey or silty subsoil; on flood plains

This association is on flood plains along the major streams. The soils are occasionally or frequently flooded. Slope ranges from 0 to 2 percent.

This association makes up about 14 percent of the county. It is about 41 percent Osage soils, 30 percent Lanton soils, and 29 percent Verdigris soils.

The poorly drained Osage soils formed in clayey alluvium. Typically, the surface layer is very dark gray silty clay about 7 inches thick. The subsurface layer is very dark gray, mottled, very firm silty clay about 12 inches thick. The subsoil to a depth of about 60 inches is very dark gray, mottled, extremely firm silty clay.

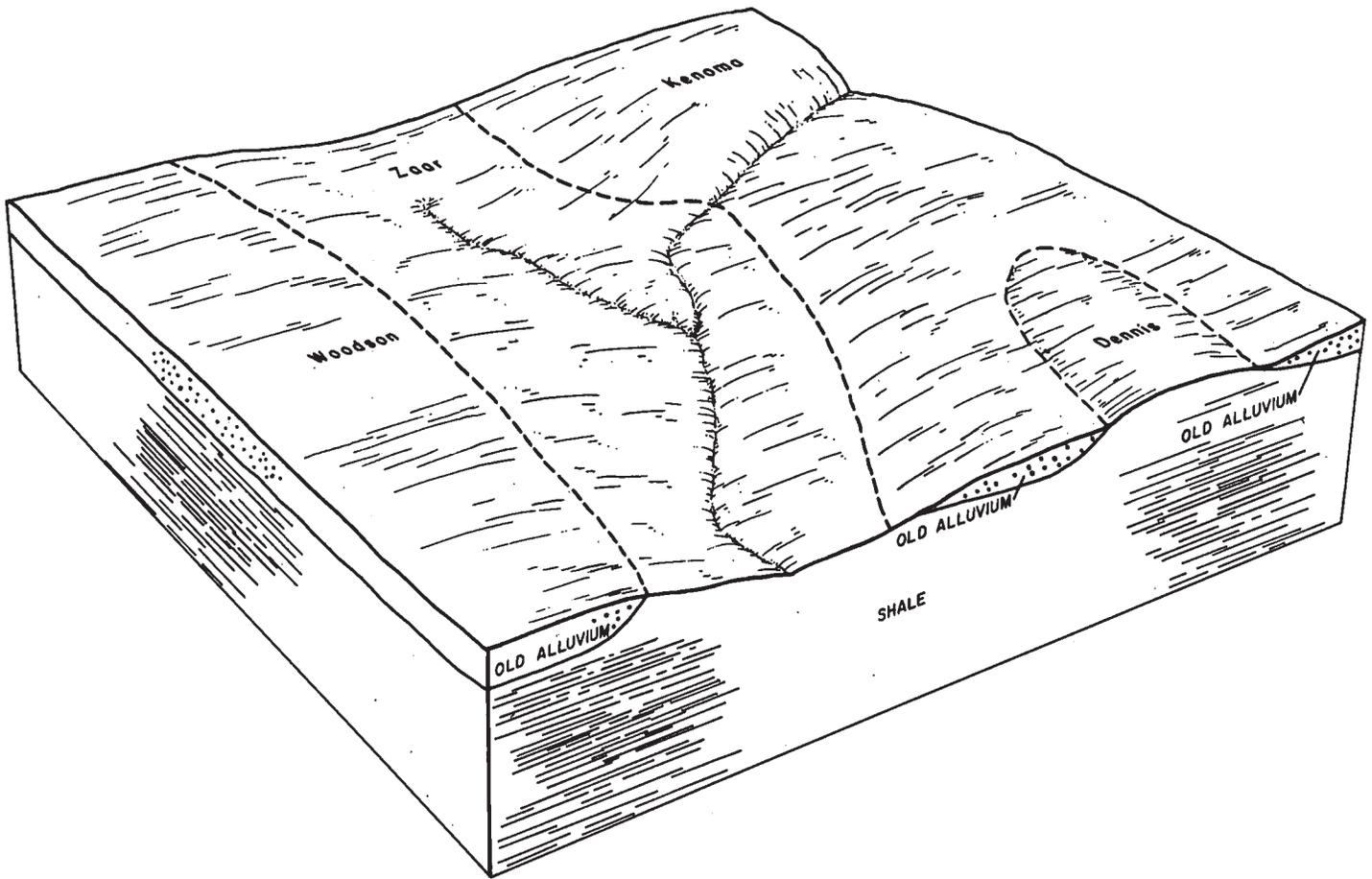


Figure 3.—Pattern of soils in the Kenoma-Zaar-Woodson association.

The somewhat poorly drained Lanton soils formed in alluvium. Typically, the surface layer is black silt loam about 10 inches thick. The subsurface layer is very dark gray and very dark grayish brown, mottled, firm silty clay loam about 24 inches thick. The substratum to a depth of about 60 inches is gray, mottled silty clay loam.

The moderately well drained Verdigris soils formed in silty alluvium. Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 20 inches thick. The substratum is dark brown, friable silt loam about 17 inches thick. Below this to a depth of about 60 inches is a buried surface layer of very dark grayish brown silt loam.

This association is used mainly for cultivated crops. Some areas support tame and native grasses or trees. Flooding and wetness are the main management concerns.

3. Bates-Dennis-Eram association

Moderately deep and deep, gently sloping and moderately sloping, well drained and moderately well drained soils that have a loamy or dominantly clayey subsoil; on uplands

This association is on knolls and ridges that have short sides and narrow tops. Most areas are dissected by drainageways. Slope ranges from 1 to 7 percent.

This association makes up about 25 percent of the county. It is about 31 percent Bates soils, 26 percent Dennis soils, 18 percent Eram soils, and 25 percent minor soils (fig. 4).

The moderately deep, well drained Bates soils formed in material weathered from thinly bedded sandstone and interbedded sandy and silty shale. They are on ridgetops and side slopes. Typically, the surface layer is very dark brown loam about 12 inches thick. The subsoil is about

22 inches thick. It is dark brown. The upper part is friable loam, and the lower part is firm clay loam. Soft sandstone bedrock is at a depth of about 34 inches.

The deep, moderately well drained Dennis soils formed in material weathered from shale. They are on side slopes. Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil extends to a depth of about 60 inches. It is mottled. The upper part is dark brown, friable silty clay loam; and the lower part is dark brown, brown, gray, and strong brown, firm and very firm silty clay.

The moderately deep, moderately well drained Eram soils formed in material weathered from shale. They are on side slopes. Typically, the surface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is dark grayish brown, mottled, very firm silty clay about 19 inches thick. Soft shale bedrock is at a depth of about 29 inches.

Of minor extent in this association are Kenoma, Stephenville, and Verdigris soils. The deep Kenoma soils are on ridgetops. They are similar to the Dennis soils but do not have a B1 horizon. The moderately deep Stephenville soils are on tree covered side slopes. The deep Verdigris soils are on flood plains along drainageways.

About 50 percent of this association is used as tame grass pasture or native range. The rest is used for cultivated crops. The main concerns of management are improving grass production and controlling erosion.

4. Catoosa-Kenoma-Zaar association

Moderately deep and deep, nearly level to moderately sloping, well drained to somewhat poorly drained soils that have a silty or clayey subsoil; on uplands

This association is on broad ridgetops and long side slopes. Most areas are dissected by drainageways. Slope ranges from 0 to 8 percent.

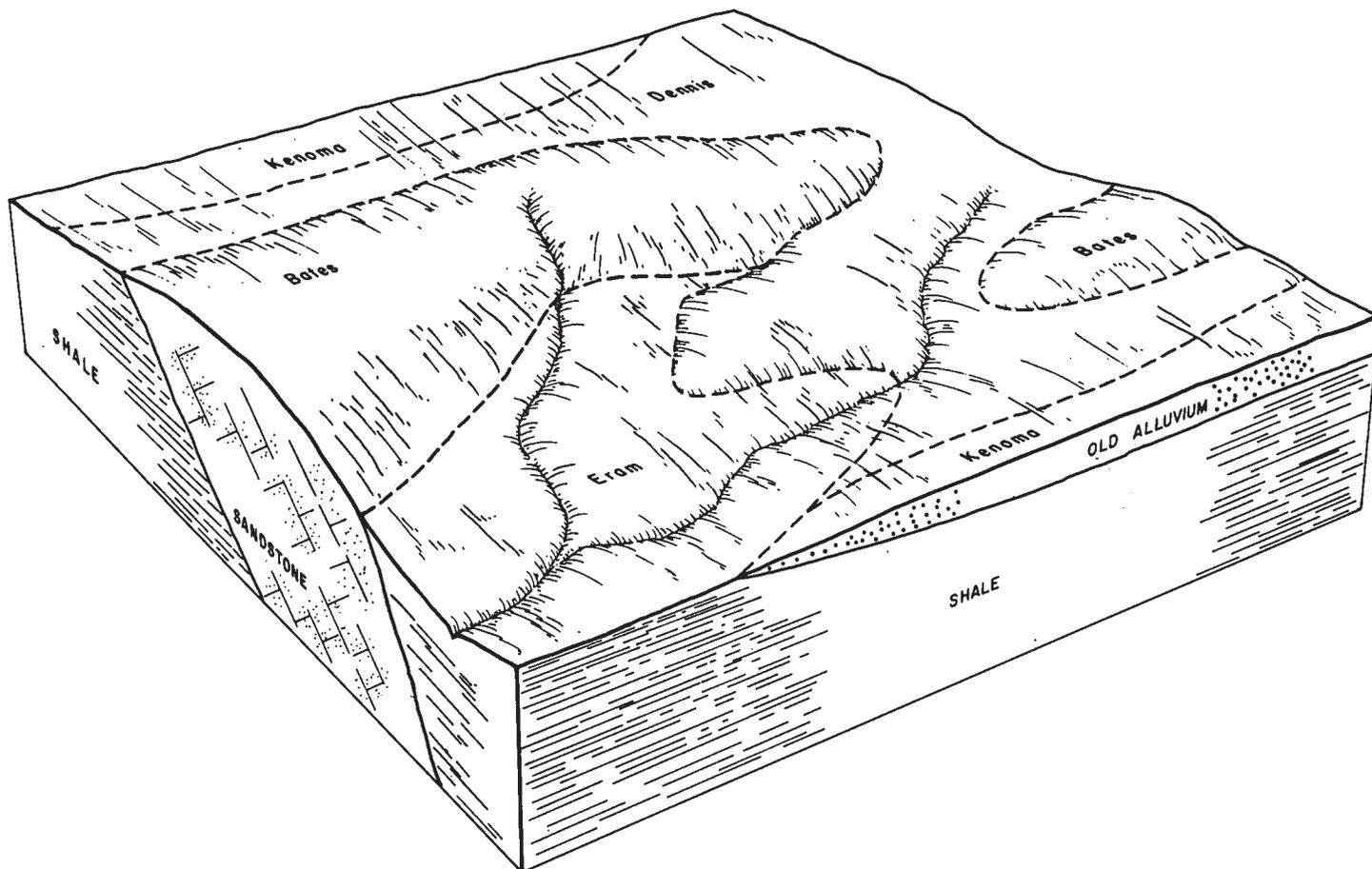


Figure 4.—Pattern of soils in the Bates-Dennis-Eram association.

This association makes up about 30 percent of the county. It is about 33 percent Catoosa soils, 17 percent Kenoma soils, 13 percent Zaar soils, and 37 percent minor soils (fig. 5).

The moderately deep, well drained Catoosa soils formed in material weathered from limestone. They are on ridgetops and long side slopes. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is dark brown and dark reddish brown, firm silty clay loam about 20 inches thick. Hard limestone is at a depth of about 28 inches.

The deep, moderately well drained Kenoma soils formed in old alluvial sediments on broad ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsoil is mottled, firm and very firm silty clay about 37 inches thick. The upper part is dark brown, and the lower part is dark grayish brown and dark yellowish brown. The substratum to a depth of about 60 inches is grayish brown and dark yellowish brown, mottled silty clay.

The deep, somewhat poorly drained Zaar soils formed

in material weathered from shale. They are on side slopes and along small drainageways. Typically, the surface layer is black silty clay about 7 inches thick. The subsurface layer is black, firm silty clay about 15 inches thick. The subsoil is mottled, very firm silty clay about 30 inches thick. The upper part is black, and the lower part is very dark gray. The substratum to a depth of about 60 inches is dark gray silty clay.

Of minor extent in this association are Dennis, Eram, Nowata, and Shidler soils. The deep Dennis soils are on ridgetops and side slopes. They are similar to the Kenoma soils but have a B1 horizon. The moderately deep Eram soils are on side slopes. They are underlain by shale. The moderately deep Nowata and shallow Shidler soils are on ridgetops and are underlain by limestone. Also, Nowata soils contain chert in the subsoil.

About 40 percent of this association is used for cultivated crops. The rest is used mainly as tame grass pasture and native range. The main concerns of management are controlling erosion and wetness,

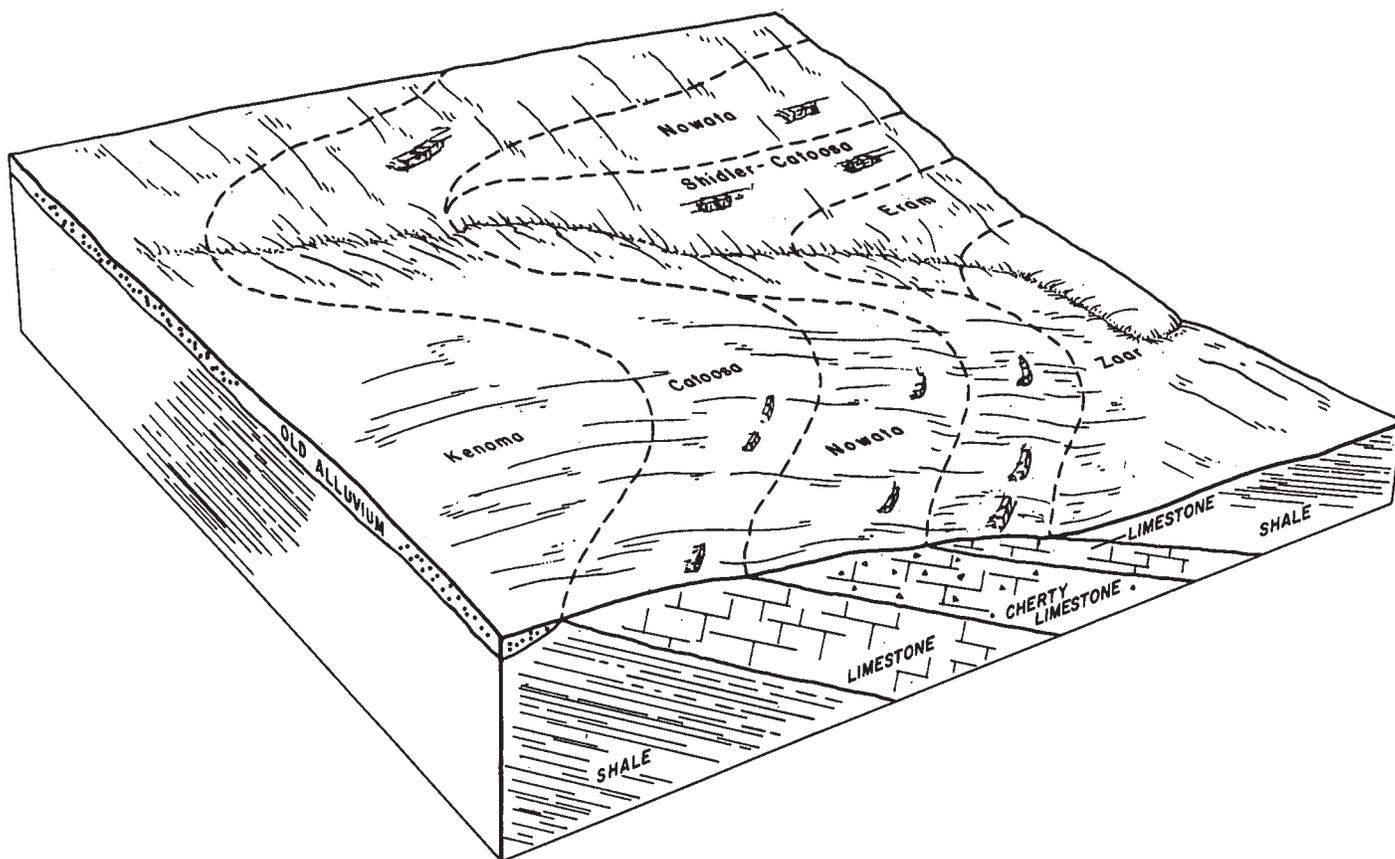


Figure 5.—Pattern of soils in the Catoosa-Kenoma-Zaar association.

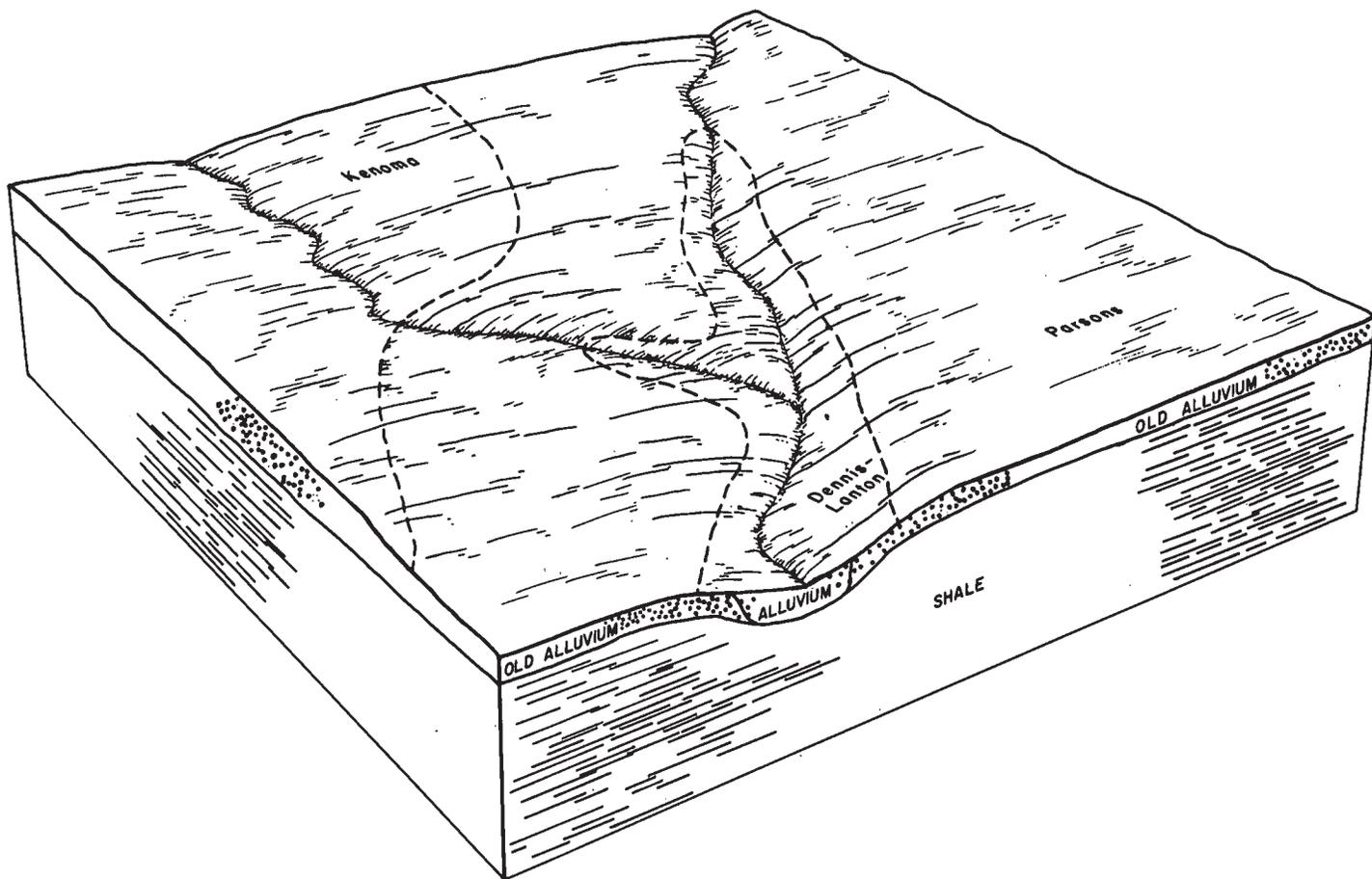


Figure 6.—Pattern of soils in the Parsons-Kenoma association.

maintaining tilth and fertility, and improving grass production.

5. Parsons-Kenoma association

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

This association is on broad ridgetops and long side slopes. It is dissected by shallow drainageways. Slope ranges from 0 to 3 percent.

This association makes up about 19 percent of the county. It is about 42 percent Parsons soils, 32 percent Kenoma soils, and 26 percent minor soils (fig. 6).

The somewhat poorly drained Parsons soils formed in old alluvium on broad ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. It has an abrupt lower boundary. The subsoil to a depth of about 60 inches is

very firm, mottled silty clay. The upper part is dark grayish brown, and the lower part is gray, strong brown, and yellowish red.

The moderately well drained Kenoma soils formed in old alluvium on side slopes and ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsoil is mottled, firm and very firm silty clay about 37 inches thick. The upper part is dark brown, and the lower part is dark grayish brown and dark yellowish brown. The substratum to a depth of about 60 inches is grayish brown and dark yellowish brown, mottled silty clay.

Of minor extent in this association are Dennis, Lanton, and Verdigris soils. The moderately well drained Dennis soils are on side slopes along upland drainageways. They are similar to the Kenoma soils but have a B1 horizon. The somewhat poorly drained Lanton and moderately well drained Verdigris soils are on flood plains along upland drainageways.

Most of this association is used for cultivated crops.

Some areas are used as tame grass pasture or native range. The main concerns of management are

controlling water erosion, improving drainage, and maintaining or improving tilth and fertility.

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 identifies 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 substratum, 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 substratum. 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, Bates loam, 1 to 3 percent slopes, is one of several phases in the Bates series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Bates-Collinsville complex, 4 to 20 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. These dissimilar soils are described in each map unit. Also,

some of the more unusual or strongly contrasting soils are identified by a special symbol on the soil maps.

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

The descriptions and names of the soils identified on the detailed maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

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 and capabilities for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

Ba—Bates loam, 1 to 3 percent slopes. This gently sloping, well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 600 acres in size.

Typically, the surface layer is very dark brown loam about 12 inches thick (fig. 7). The subsoil is about 22 inches thick. The upper part is dark brown, friable loam, and the lower part is dark brown, mottled, firm clay loam. Soft sandstone bedrock is at a depth of about 34 inches. In places the surface layer and subsoil contain many sandstone fragments.

Included with this soil in mapping are small areas of Collinsville, Dennis, and Eram soils. The shallow Collinsville soils generally are more sloping than the Bates soil. The deep Dennis soils have a dominantly clayey subsoil. They are on side slopes. The moderately well drained Eram soils are on foot slopes. They have a clayey subsoil. Included soils make up 10 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Bates soil. Surface runoff is medium.

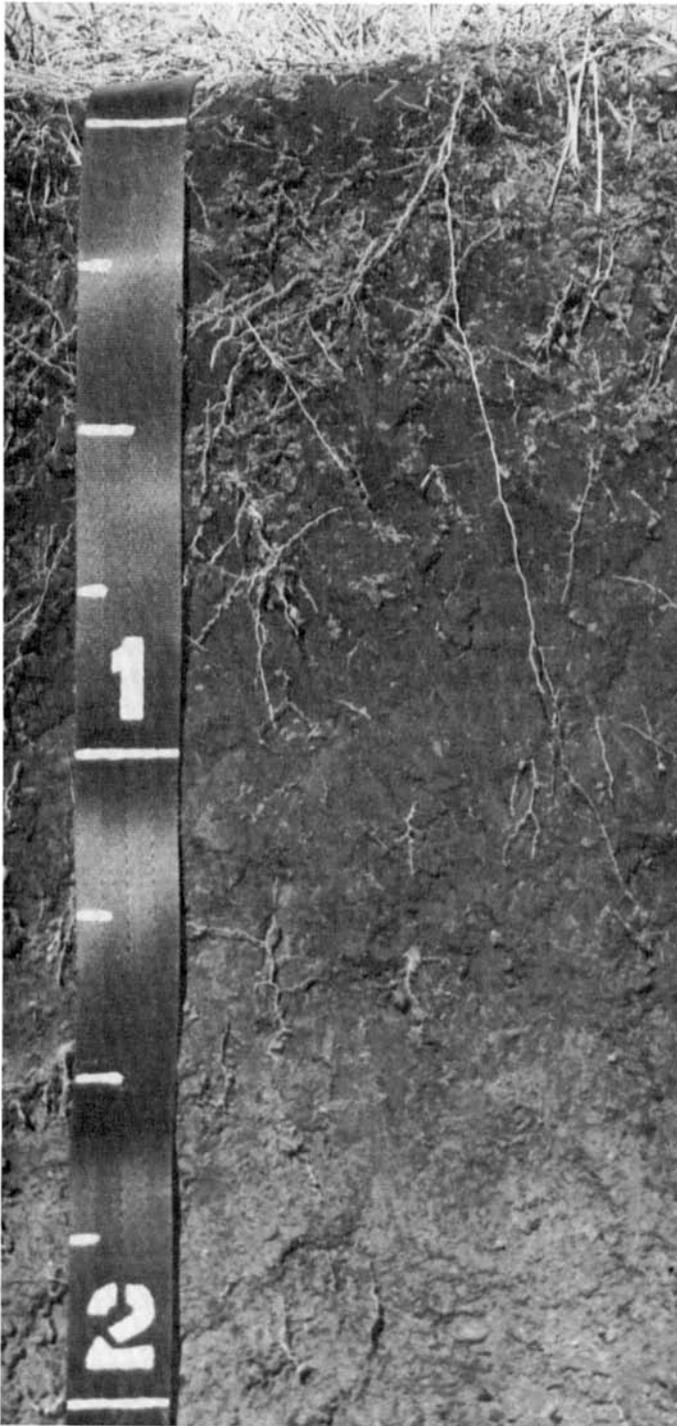


Figure 7.—Profile of Bates loam, 1 to 3 percent slopes.
The surface layer is dark and friable. Depth is
marked in feet.

The surface layer is friable and can be easily tilled. Root penetration is restricted at a depth of about 34 inches. Reaction is strongly acid to slightly acid in the subsoil

and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is moderately well suited to soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, returning crop residue to the soil, establishing grassed waterways, terracing, and farming on the contour. In a few places most of the soil overlying the bedrock is removed when terraces are constructed. As a result, the root zone is severely restricted. Building the terraces on the contour and in areas where the soil is deepest helps to maintain an adequate root zone.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

This soil is suitable as a site for dwellings without basements. It has a moderate limitation as a site for local roads and streets because of low strength. Strengthening or replacing the base material, however, helps to overcome this limitation. The soil generally is unsuitable as a site for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The deeper included soils are better sites for sewage lagoons.

The capability subclass is IIe.

Bc—Bates loam, 3 to 7 percent slopes. This moderately sloping, well drained soil is on the tops and sides of ridges in the uplands. Individual areas are irregularly shaped or long and narrow and range from 20 to 300 acres in size.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsoil is about 17 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, firm clay loam. Soft sandstone bedrock is at a depth of about 24 inches. In places the surface layer and subsoil contain many sandstone fragments.

Included with this soil in mapping are small areas of Collinsville, Dennis, and Eram soils. The shallow Collinsville soils generally are more sloping than the Bates soil. The deep Dennis soils have a dominantly clayey subsoil. They are on the lower side slopes. The moderately well drained Eram soils are on foot slopes. They have a clayey subsoil. Included soils make up 10 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Bates soil. Surface runoff is medium. The surface layer is friable and can be easily tilled. Root penetration is restricted at a depth of about 24 inches.

Reaction is strongly acid to slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is moderately well suited to soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, returning crop residue to the soil, establishing grassed waterways, terracing, and farming on the contour. In a few places most of the soil overlying the bedrock is removed when terraces are constructed. As a result, the root zone is severely restricted. Building the terraces on the contour and in areas where the soil is deepest helps to maintain an adequate root zone.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

This soil is suitable as a site for dwellings without basements. It has a moderate limitation as a site for local roads and streets because of low strength. Strengthening or replacing the base material, however, helps to overcome this limitation. The soil generally is unsuitable as a site for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The deeper included soils are better sites for sewage lagoons.

The capability subclass is IIIe.

Bd—Bates-Collinsville loams, 1 to 4 percent slopes. These gently sloping, well drained soils are on the tops of ridges in the uplands. The Collinsville soil generally is more sloping than the Bates soil. Individual areas are long and narrow or irregularly shaped and range from 20 to 400 acres in size. They are about 55 percent Bates soil and 35 percent Collinsville soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Bates soil has a surface layer of very dark brown loam about 8 inches thick. The subsoil is about 19 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, firm clay loam. Soft sandstone bedrock is at a depth of about 27 inches. In places the surface layer and subsoil contain many sandstone fragments.

Typically, the Collinsville soil has a surface layer of very dark grayish brown loam about 8 inches thick. The substratum is dark brown loam that contains many small sandstone fragments. Sandstone bedrock is at a depth of about 14 inches. In places the surface layer contains many sandstone fragments.

Included with these soils in mapping are small areas of Eram and Lebo soils. The moderately well drained Eram soils are on the upper side slopes. Lebo soils have a shaly subsoil. They are on the steeper side slopes. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the Bates soil and moderately rapid in the Collinsville soil. Available water capacity is moderate in the Bates soil and low in the Collinsville soil. Surface runoff is medium on both soils. Reaction is strongly acid to slightly acid in the subsoil or substratum and varies widely in the surface layer as a result of local liming practices. Root penetration is restricted at a depth of about 27 inches in the Bates soil and 14 inches in the Collinsville soil.

About half the acreage is cultivated. The rest generally is native range or tame grass pasture. These soils are moderately well suited to soybeans, grain sorghum, wheat, and tall fescue. Measures that control erosion, improve tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour. Terracing is difficult, however, on the shallow Collinsville soil.

These soils are well suited to native range and tame grass pasture. The major concerns of management are the encroachment of undesirable plants and erosion. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. If the soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, deferred grazing, and brush control increase forage production. Seeding desirable mid and tall grasses on abandoned cropland also increases forage production.

The Bates soil is suitable as a site for dwellings without basements. It has a moderate limitation as a site for local roads and streets because of low strength. Strengthening or replacing the base material, however, helps to overcome this limitation. The Collinsville soil is not suitable as a site for dwellings or local roads and streets because the depth to rock is a severe limitation. Both soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation.

The capability subclass is IVe.

Bh—Bates-Collinsville complex, 4 to 20 percent slopes. These moderately sloping and moderately steep, well drained soils are on the sides and tops of ridges in the uplands. The Collinsville soil generally is more

sloping than the Bates soil. Individual areas are long and narrow or irregularly shaped and range from 20 to 200 acres in size. They are about 45 percent Bates soil and 40 percent Collinsville soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Bates soil has a surface layer of very dark brown loam about 8 inches thick. The subsoil is about 19 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, firm clay loam. Soft sandstone bedrock is at a depth of about 27 inches. In places the surface layer and subsoil contain many sandstone fragments.

Typically, the Collinsville soil has a surface layer of very dark grayish brown fine sandy loam about 8 inches thick. The substratum is dark brown fine sandy loam that contains many small sandstone fragments. Sandstone bedrock is at a depth of about 14 inches. In places the surface layer contains many sandstone fragments.

Included with these soils in mapping are small areas of Dennis, Eram, and Lebo soils. The deep Dennis soils are on the lower side slopes. The moderately well drained Eram soils are on foot slopes. Lebo soils are on the steeper side slopes. They have a shaly subsoil. Included soils make up about 15 percent of the map unit.

Permeability is moderate in the Bates soil and moderately rapid in the Collinsville soil. Available water capacity is moderate in the Bates soil and low in the Collinsville soil. Surface runoff is rapid on both soils. Reaction is strongly acid to slightly acid throughout the soils. Root penetration is restricted at a depth of about 25 inches in the Bates soil and 14 inches in the Collinsville soil.

These soils generally are unsuitable for cultivation. Erosion is a hazard if cultivated crops are grown.

Most areas are used as native range. These soils are well suited to native range and tame grass pasture. The major concerns of management are the encroachment of undesirable plants and erosion. If the native range or tame grass pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. If the soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, deferred grazing, and brush control increase forage production. Seeding desirable mid and tall grasses on abandoned cropland also increases forage production.

The Bates soil is suitable as a site for dwellings without basements. It has a moderate limitation as a site for local roads and streets because of low strength. Strengthening or replacing the base material, however,

helps to overcome this limitation. The Collinsville soil is not suitable as a site for dwellings or local roads and streets because the depth to rock is a severe limitation. Both soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. Also, the slope of the Collinsville soil is a severe limitation on sites for sewage lagoons. The less sloping, deeper included or adjacent soils are better sites for sewage lagoons.

The capability subclass is VIe.

Ca—Catoosa silt loam, 0 to 2 percent slopes. This nearly level, well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 500 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is dark brown and dark reddish brown, firm silty clay loam about 20 inches thick. Limestone bedrock is at a depth of about 28 inches. In places the depth to bedrock is more than 40 inches. In some small areas limestone fragments are on the surface and throughout the soil.

Included with this soil in mapping are small areas of Kenoma, Shidler, and Zaar soils. The deep, moderately well drained Kenoma soils are in the higher convex areas. They are grayer than the Catoosa soil. The shallow Shidler soils are on the steeper side slopes. The somewhat poorly drained Zaar soils are along drainageways. They have a clayey surface layer and subsoil. Also included are small areas where rock crops out. Included areas make up 5 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Catoosa soil. Surface runoff is medium. The surface layer is friable and can be easily tilled. The shrink-swell potential is moderate. Root penetration is restricted at a depth of about 28 inches. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is well suited to soybeans, grain sorghum, wheat, and tall fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour. In a few places most of the soil overlying the bedrock is removed when terraces are constructed. As a result, the root zone is severely restricted. Building the terraces on the contour and in areas where the soil is deepest helps to maintain an adequate root zone.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good

condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

The depth to rock and the shrink-swell potential are moderate limitations if this soil is used as a site for dwellings without basements. Properly designing and reinforcing foundations help to prevent the structural damage caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome this limitation.

This soil generally is unsuitable as a site for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The deeper included soils are better sites for sewage lagoons.

The capability subclass is IIe.

Da—Deepwater silt loam, 1 to 4 percent slopes.

This gently sloping, moderately well drained soil is on concave foot slopes. It occurs as long, continuous, irregularly shaped areas about 75 to 200 acres in size.

Typically, the surface layer is very dark brown silt loam about 14 inches thick. The subsurface layer is dark brown, friable silt loam about 5 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is brown, firm silty clay loam; and the lower part is yellowish brown, mottled, firm and friable clay loam. In places the subsoil is silty clay.

Included with this soil in mapping are small areas of the shallow Darnell soils on the higher side slopes and ridgetops. These soils make up 5 to 10 percent of the map unit.

Permeability is moderate in the Deepwater soil, and available water capacity is high. Surface runoff is medium. The surface layer is friable and can be easily tilled. The shrink-swell potential of the subsoil is moderate. A perched seasonal high water table is at a depth of 3 to 4.5 feet. Reaction is slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

This soil is suited to trees. Some areas remain in native hardwoods. Tree seeds, cuttings, and seedlings grow well if competing vegetation is controlled or removed. Site preparation, spraying, cutting, and girdling help to control undesirable vegetation.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Also, the wetness is a moderate limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome this limitation.

This soil generally is unsuitable as a septic tank absorption field because the wetness is a severe limitation. The wetness also is a severe limitation on sites for sewage lagoons. The areas where the subsoil is silty clay are suitable sites for lagoons.

The capability subclass is IIe.

Db—Dennis silt loam, 1 to 3 percent slopes. This gently sloping, moderately well drained soil is on side slopes and low knolls in the uplands. Individual areas are irregular in shape and range from 40 to 400 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 4 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark brown, mottled, friable silty clay loam. The next part is dark brown and brown, very firm and firm silty clay mottled with dark grayish brown and yellowish red. The lower part is gray and strong brown, mottled, firm and very firm silty clay. In some areas the upper part of the subsoil is silty clay.

Included with this soil in mapping are small areas of Bates and Eram soils. Bates soils have a loamy subsoil and are moderately deep over sandstone. They are on the upper side slopes. Eram soils are more clayey in the surface layer than the Dennis soil and are moderately deep over shale. They are on the upper side slopes. Also included are small areas of sodic soils or slick spots. Included soils make up 5 to 15 percent of the map unit.

Permeability is slow in the Dennis soil, and available water capacity is high. Surface runoff is medium. The surface layer is friable and can be easily tilled. The shrink-swell potential of the subsoil is high. A perched seasonal high water table is at a depth of 2 to 3 feet. Reaction is slightly acid to strongly acid in the upper part of the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall

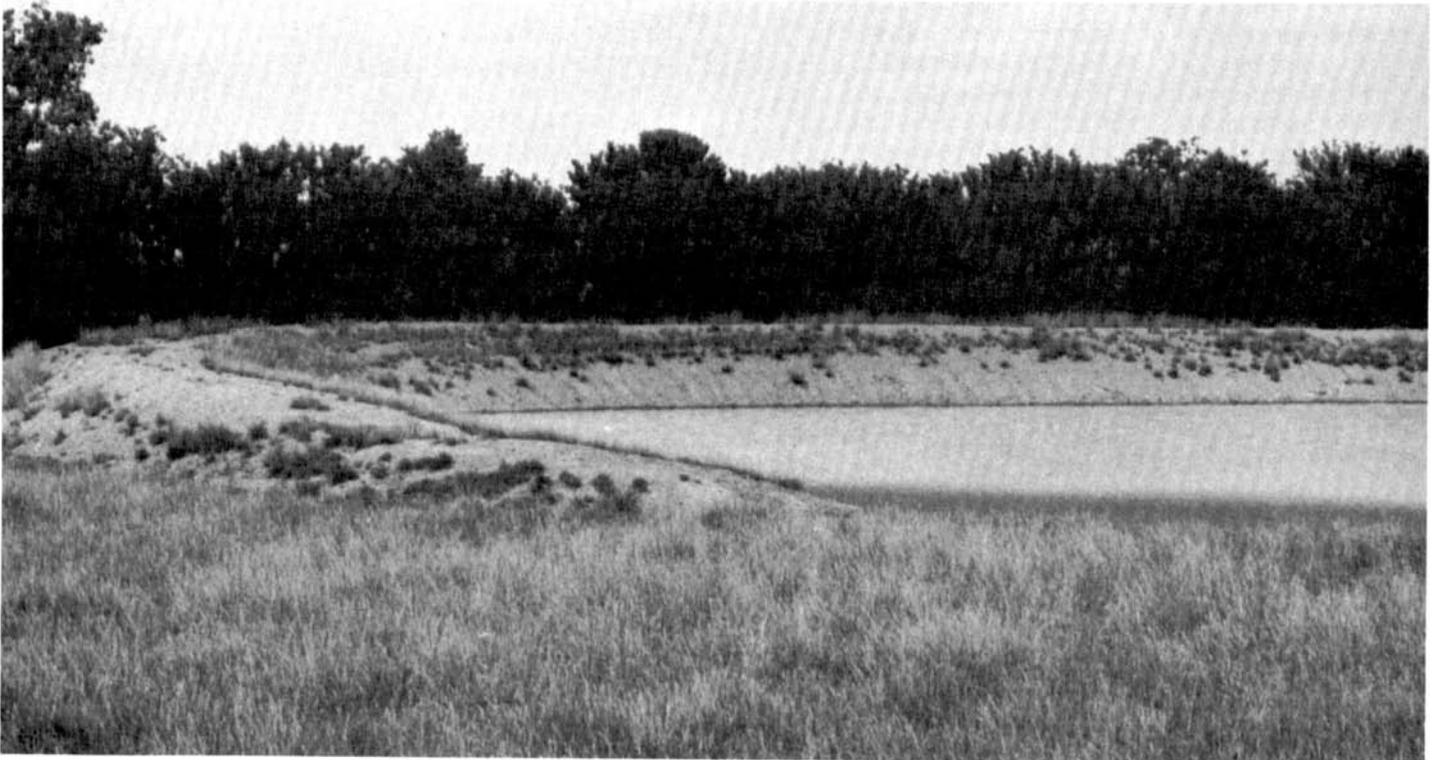


Figure 8.—A small pond used to water livestock in an area of Dennis silt loam, 1 to 3 percent slopes. Well distributed watering sites help to achieve a uniform distribution of grazing.

fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition (fig. 8). If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Also, the wetness is a severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material, however, help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. The less sloping areas are the better sites.

The capability subclass is 1Ie.

Dc—Dennis silt loam, 3 to 6 percent slopes. This moderately sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 150 acres in size.

Typically, the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark brown, friable silty clay loam. The next part is brown, firm and very firm silty clay mottled with dark grayish brown and yellowish red. The lower part is light gray and strong brown, mottled, firm silty clay. In some areas the upper part of the subsoil is silty clay.

Included with this soil in mapping are small areas of Bates and Eram soils. Bates soils have a loamy subsoil and are moderately deep over sandstone. They are on the upper side slopes. Eram soils are more clayey in the surface layer than the Dennis soil and are moderately

deep over shale. They are on the upper side slopes. Included soils make up 5 to 15 percent of the map unit.

Permeability is slow in the Dennis soil, and available water capacity is high. Surface runoff is medium. The surface layer is friable and can be easily tilled. The shrink-swell potential of the subsoil is high. A perched seasonal high water table is at a depth of 2 to 3 feet. Reaction is slightly acid to strongly acid in the upper part of the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Also, the wetness is a severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material, however, help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons (fig. 9). The less sloping areas are the better sites.

The capability subclass is IIIe.

Dn—Dennis-Lanton silt loams, 2 to 8 percent slopes. These moderately sloping soils are on the sides of upland drainageways and on narrow valley floors. The moderately well drained Dennis soil is on broken side slopes. The somewhat poorly drained Lanton soil is on the narrow valley floors. It is frequently flooded for very brief periods. Areas are irregularly shaped, range from about 250 to 1,000 feet wide, and are about 20 to 100



Figure 9.—Sewage lagoons in an area of Dennis silt loam, 3 to 6 percent slopes. Sewage lagoons generally are suitable in areas where septic tank absorption fields are unsuitable.

acres in size. They are about 55 percent Dennis soil and 30 percent Lanton soil. The two soils occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the Dennis soil has a surface layer of very dark brown silt loam about 10 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark brown, friable silty clay loam. The next part is brown, firm and very firm silty clay mottled with dark grayish brown and yellowish red. The lower part is light gray and strong brown, mottled, firm silty clay. In places the upper part of the subsoil is firm silty clay.

Typically, the Lanton soil has a surface layer of black silt loam about 12 inches thick. The subsurface layer is very dark gray, mottled silty clay loam about 20 inches thick. The substratum to a depth of about 60 inches is gray, mottled silty clay loam.

Included with these soils in mapping are small areas of Osage and Parsons soils. The somewhat poorly drained Parsons soils are on the higher side slopes. The poorly drained Osage soils are in concave areas on narrow flood plains. They have a silty clay surface layer and subsoil. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Dennis soil and moderately slow in the Lanton soil. Available water capacity is high in both soils. The shrink-swell potential is high in the Dennis soil and moderate in the Lanton soil. The Dennis soil has a perched seasonal high water table at a depth of 1 to 3 feet. The Lanton soil has a seasonal high water table at a depth of 1 to 2 feet. Surface runoff is medium on the Dennis soil and slow on the Lanton soil. Reaction is dominantly slightly acid or neutral in both soils.

About half the areas are cultivated, and the rest are mainly native range or tame grass pasture. These soils are moderately well suited to soybeans, grain sorghum, wheat, and tall fescue. Controlling erosion on the Dennis soil is the main management concern if cultivated crops are grown. Other concerns are maintaining tilth and increasing the content of organic matter in both soils. Keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour help to prevent excessive soil loss, maintain tilth, and increase the organic content. Constructing terraces is difficult, however, in the narrow areas of the Dennis soil.

These soils are well suited to native range and tame grass pasture. The major concerns of management are the encroachment of undesirable plants, the hazard of erosion, and low forage production on abandoned cropland. If the native range or tame grass pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An

adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. If the soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, deferred grazing, and brush control maintain or increase forage production. Seeding desirable mid and tall grasses on abandoned cropland also increases forage production.

The Lanton soil is generally unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, or sewage lagoons because of the frequent flooding and the wetness. The Dennis soil occurs as narrow areas that generally are too small for sewage disposal systems or building site development. Soils that are suitable for these uses generally are on the adjacent uplands.

The capability subclass is IVe.

Eb—Eram silty clay loam, 1 to 3 percent slopes.

This gently sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 300 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 11 inches thick. The subsoil is dark grayish brown, very firm silty clay about 21 inches thick. Soft shale bedrock is at a depth of about 32 inches. In some areas the surface layer is silt loam or silty clay. In some small areas the depth to bedrock is more than 40 inches. In places seams of lime are in the lower part of the subsoil.

Included with this soil in mapping are small areas of Bates and Lebo soils. Bates soils have a loamy subsoil and are moderately deep over sandstone. They are on the upper side slopes. Lebo soils contain less clay in the subsoil than the Eram soil. Also, they are more sloping and are on ridges and side slopes. Included soils make up 5 to 10 percent of the map unit.

Permeability is slow in the Eram soil, and available water capacity is low. Surface runoff is medium. The surface layer is friable and can be easily tilled. The shrink-swell potential is high. A perched seasonal high water table is at a depth of 2 to 3 feet. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. Root penetration is restricted at a depth of about 32 inches.

Most areas are cultivated. This soil is well suited to soybeans, grain sorghum, wheat, and tall fescue. Measures that control erosion, improve tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour. In a few places most of the soil overlying the bedrock is removed when terraces are constructed. As a result, the root zone is severely restricted. Building

the terraces on the contour and in areas where the soil is deepest helps to maintain an adequate root zone.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Also, the wetness is a severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material, however, help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability, the wetness, and the depth to rock are severe limitations. The depth to rock is a severe limitation on sites for sewage lagoons. The areas where the depth to bedrock is more than 40 inches are suitable sites for lagoons.

The capability subclass is IIIe.

Ec—Eram silty clay loam, 3 to 7 percent slopes.

This moderately sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 250 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is dark grayish brown, mottled, very firm silty clay about 19 inches thick. Soft shale bedrock is at a depth of about 29 inches. In some areas the surface layer is silty clay. In some small areas the depth to shale is more than 40 inches. In places seams of lime are in the lower part of the subsoil.

Included with this soil in mapping are small areas of Bates and Lebo soils. Bates soils have a loamy subsoil and are moderately deep over sandstone. They are on the upper side slopes. Lebo soils contain less clay in the subsoil than the Eram soil. Also, they are more sloping and are on ridges and side slopes. Included soils make up 5 to 15 percent of the map unit.

Permeability is slow in the Eram soil, and available water capacity is low. Surface runoff is medium. The surface layer is friable and can be easily tilled. The shrink-swell potential is high. A perched seasonal high water table is at a depth of 2 to 3 feet. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming

practices. Root penetration is restricted at a depth of about 29 inches.

About half the acreage is cultivated. The rest mainly is used for pasture. This soil is suited to soybeans, grain sorghum, wheat, and tall fescue. Measures that control erosion, improve tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour. In a few places most of the soil overlying the bedrock is removed when terraces are constructed. As a result, the root zone is severely restricted. Building the terraces on the contour and in areas where the soil is deepest helps to maintain an adequate root zone.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Also, the wetness is a severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material, however, help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability, the wetness, and the depth to rock are severe limitations. The depth to rock is a severe limitation on sites for sewage lagoons. The deeper adjacent soils are better sites for lagoons.

The capability subclass is IVe.

Et—Eram-Lebo silty clay loams, 4 to 15 percent slopes. These moderately sloping and moderately steep soils are on the tops and sides of ridges in the uplands. The Eram soil is moderately well drained. The Lebo soil is well drained. Individual areas are long and narrow or irregularly shaped and range from 20 to 200 acres in size. They are about 50 percent Eram soil and 35 percent Lebo soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Eram soil has a surface layer of very dark brown silty clay loam about 8 inches thick. The subsoil is very firm silty clay about 19 inches thick. The upper part is very dark grayish brown, the next part is dark grayish brown, and the lower part is grayish brown.

Soft shale bedrock is at a depth of about 27 inches. In some areas the surface layer is silty clay. In some small areas the depth to shale is more than 40 inches. In places seams of lime are in the lower part of the subsoil.

Typically, the Lebo soil has a surface layer of very dark grayish brown silty clay loam about 9 inches thick. The subsoil is about 18 inches thick. It is dark grayish brown and firm. The upper part is silty clay loam, and the lower part is shaly silty clay loam. The substratum is grayish brown very shaly silty clay loam. Soft shale bedrock is at a depth of about 32 inches.

Included with these soils in mapping are small areas of Bates, Collinsville, and Dennis soils. Bates soils have a loamy subsoil and are moderately deep over sandstone. They generally are less sloping than the Eram and Lebo soils and are on side slopes. The shallow Collinsville soils are on ridgetops. The deep Dennis soils are on the lower side slopes. Also included are small areas where shale crops out on breaks and the steeper side slopes. Included areas make up about 15 percent of the map unit.

Permeability is slow in the Eram soil and moderate in the Lebo soil. Available water capacity is low in both soils. Surface runoff is rapid. The shrink-swell potential is high in the subsoil of the Eram soil and moderate in the Lebo soil. Both soils are dominantly slightly acid or medium acid throughout. The Eram soil has a perched seasonal high water table at a depth of 2 to 3 feet. Root penetration is restricted at a depth of about 27 inches in the Eram soil and 32 inches in the Lebo soil.

These soils generally are unsuitable for cultivation. Erosion is a severe hazard if cultivated crops are grown.

Most areas are used as native range. These soils are well suited to native range and tame grass pasture. The major concerns of management are the encroachment of undesirable plants and erosion. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. If the soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, deferred grazing, and brush control increase forage production. Seeding desirable mid and tall grasses on abandoned cropland also increases forage production.

The shrink-swell potential and the wetness are severe limitations if the Eram soil is used as a site for dwellings with basements. The Lebo soil is moderately limited as a site for these dwellings because of the slope, the depth to rock, and the shrink-swell potential. The less sloping, deeper included soils are better suited than the Lebo soil. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous

material help to prevent the structural damage caused by shrinking and swelling and by wetness. The shrink-swell potential of the Eram soil and the low strength of both soils are severe limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome these limitations.

These soils generally are unsuitable as septic tank absorption fields because the depth to rock in both soils and the slow permeability and wetness in the Eram soil are severe limitations. The depth to rock and the slope are severe limitations on sites for sewage lagoons. The less sloping, deeper adjacent soils are better sites.

The capability subclass is VIe.

Ka—Kenoma silt loam, 1 to 3 percent slopes. This gently sloping, moderately well drained soil is on broad upland ridgetops. Individual areas are irregular in shape and range from 20 to 400 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsoil is mottled, firm and very firm silty clay about 37 inches thick. The upper part is dark brown, and the lower part is dark grayish brown and dark yellowish brown. The substratum to a depth of about 60 inches is grayish brown and dark yellowish brown, mottled silty clay. In some areas the upper part of the subsoil is friable silty clay loam. In other areas the surface layer is silty clay loam. In places shale is within a depth of 40 inches.

Included with this soil in mapping are small areas of Catoosa and Zaar soils. Catoosa soils are moderately deep over limestone. They are lower on the landscape than the Kenoma soil. Zaar soils have a clayey surface layer. They are along drainageways. Also included are small areas of sodic soils and slick spots. Included areas make up 5 to 15 percent of the map unit.

Permeability is very slow in the Kenoma soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable and can be easily tilled. The shrink-swell potential is high in the subsoil. Reaction is slightly acid or neutral in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. The silty clay subsoil fails to release water readily to plants, however, and crops are adversely affected during prolonged dry periods. Controlling erosion, maintaining tillage, and increasing the content of organic matter are concerns of management. Keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour (fig. 10) help to control surface runoff and erosion, maintain tillage, and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range (fig. 11). Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good



Figure 10.—Soybeans planted on the contour in an area of Kenoma silt loam, 1 to 3 percent slopes. Planting on the contour reduces the runoff rate and helps to control erosion.

condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

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

Because the very slow permeability is a severe limitation, this soil generally is unsuitable as a septic tank

absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIIe.

La—Lanton silt loam. This nearly level, somewhat poorly drained soil is on flood plains along streams. It is occasionally flooded for very brief periods. Individual areas are long and narrow or irregularly shaped and range from 40 to 200 acres in size.

Typically, the surface layer is black silt loam about 10 inches thick. The subsurface layer is very dark gray and very dark grayish brown, mottled, firm silty clay loam about 24 inches thick. The substratum to a depth of about 60 inches is gray, mottled silty clay loam.



Figure 11.—Cattle grazing tall fescue in an area of Kenoma silt loam, 1 to 3 percent slopes.

Included with this soil in mapping are small areas of Osage soils. These soils have a silty clay surface layer and subsoil. They are in swales and other concave areas and are wet for longer periods than the Lanton soil. They make up about 5 to 10 percent of the map unit.

Permeability is moderately slow in the Lanton soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable and can be easily tilled. The shrink-swell potential of the substratum is moderate. A seasonal high water table is at a depth of 1 to 2 feet. Reaction ranges from slightly acid to strongly acid in the subsurface layer and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. The main concern of management is the crop damage caused by wetness. Improving tilth and maintaining the content of organic matter are other concerns. Drainage ditches reduce the wetness. Keeping tillage at a minimum and leaving crop residue on the surface improve tilth and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely

deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

This soil is well suited to trees. A few areas are in native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Site preparation, controlled burning, spraying, and cutting or girdling control plant competition.

This soil generally is unsuitable as a site for dwellings, septic-tank absorption fields, sewage lagoons, and local roads and streets because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

No—Nowata silt loam, 3 to 7 percent slopes. This moderately sloping, well drained soil is on side slopes in the uplands. Scattered chert fragments are on the surface. Individual areas are irregular in shape and range from 20 to 250 acres in size.

Typically, the surface layer is very dark brown silt loam about 10 inches thick. It contains a few chert fragments. The subsoil is about 20 inches thick. The upper part is dark reddish brown, firm silt loam containing many angular chert fragments as much as 7 inches in

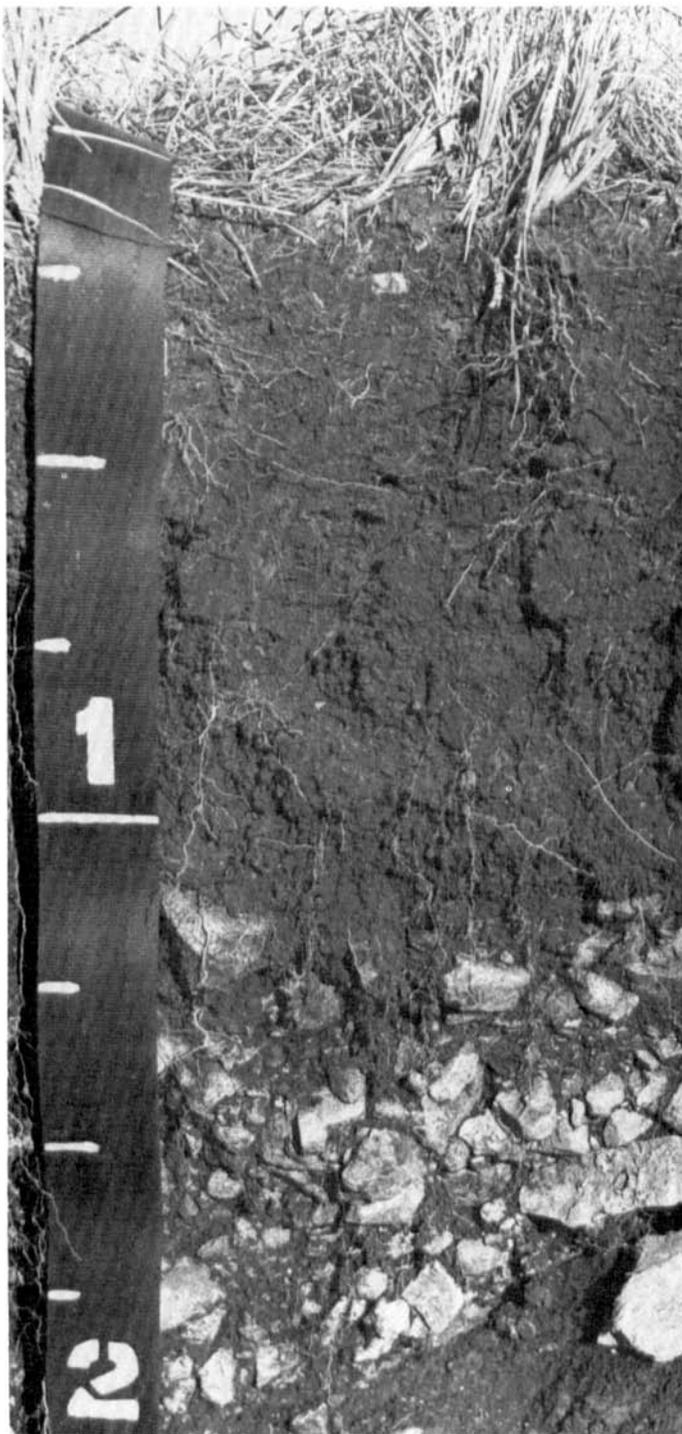


Figure 12.—Profile of Nowata silt loam, 3 to 7 percent slopes. The subsoil contains many chert fragments. Depth is marked in feet.

diameter, and the lower part is dark reddish brown and reddish brown, firm very cherty silty clay loam (fig. 12).

Limestone bedrock is at a depth of about 30 inches. In places the bedrock is shale rather than limestone. In a few areas the subsoil is silty clay loam.

Included with this soil in mapping are small areas of the shallow Shidler soils on the lower slopes. Also included, mainly on the lower slopes, are small areas where limestone crops out. Included areas make up 5 to 10 percent of the map unit.

Permeability is moderately slow, and available water capacity is moderate. Surface runoff is medium. The surface layer is friable but cannot be easily tilled because of the chert fragments. The shrink-swell potential is moderate in the subsoil. Root penetration is restricted at a depth of about 30 inches. In unlimed areas the surface layer and the upper part of the subsoil are slightly acid.

Most areas are used as native range or tame grass pasture. This soil is moderately well suited to soybeans, grain sorghum, wheat, and tall fescue. Erosion is a severe hazard if cultivated crops are grown. Improving tillage and increasing the content of organic matter are other management concerns. Minimum tillage, a protective cover of crop residue, grassed waterways, terraces, and contour farming help to prevent excessive soil loss, improve tillage, and increase the organic matter content.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing maintain or increase forage production.

The shrink-swell potential, the depth to rock, and the large stones are moderate limitations if this soil is used as a site for dwellings without basements. Properly designing or reinforcing foundations helps to prevent the structural damage caused by shrinking and swelling. Included soils that do not have chert fragments are better sites for dwellings without basements. The depth to rock is a severe limitation on sites for dwellings with basements. Low strength, the shrink-swell potential, and the large stones are moderate limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome the low strength and the shrink-swell potential.

This soil generally is unsuitable as a septic tank absorption field because of the moderately slow permeability and the depth to rock. It is also unsuitable as a site for sewage lagoons because of the depth to rock. Onsite investigation is needed to identify soils that are better sites for lagoons.

The capability subclass is IVe.

Od—Olpe-Dennis complex, 3 to 7 percent slopes.

These moderately sloping soils are on uplands. The well drained Olpe soil generally is more sloping than the Dennis soil and is on the higher side slopes. The moderately well drained Dennis soil is on foot slopes. Individual areas are long and narrow or irregularly shaped and range from 20 to 200 acres in size. They are about 55 percent Olpe soil and 35 percent Dennis soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

In a typical area of the Olpe soil, the surface soil is dark brown gravelly silt loam about 15 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, firm and very firm very gravelly silty clay loam; and the lower part is strong brown, yellowish red, and light yellowish brown, mottled, very firm very gravelly silty clay. In some areas the subsoil is less clayey.

Typically, the Dennis soil has a surface layer of very dark brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark brown, friable silty clay loam. The next part is dark brown and brown, firm and very firm silty clay mottled with dark grayish brown and yellowish red. The lower part is light gray and strong brown, mottled, firm silty clay. In places the upper part of the subsoil is firm silty clay. In some areas the content of small pebbles is 5 to 10 percent throughout the soil.

Included with these soils in mapping are small areas of the moderately deep Bates soils on ridgetops. Also included are small areas where limestone crops out on the lower side slopes. Included areas make up about 10 percent of the map unit.

Permeability is slow in the Olpe and Dennis soils, and surface runoff is medium. Available water capacity is moderate in the Olpe soil and high in the Dennis soil. The shrink-swell potential is moderate in the subsoil of the Olpe soil and high in the subsoil of the Dennis soil. The Dennis soil has a perched seasonal high water table at a depth of 2 to 3 feet. Both soils dominantly are slightly acid or neutral.

These soils generally are unsuitable for cultivation. The hazard of erosion is severe if cultivated crops are grown.

Most areas are used as native range. These soils are well suited to native range and tame grass pasture. The major concerns of management are the encroachment of undesirable plants and erosion. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to

keep the range in good condition. If the soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, deferred grazing, and brush control increase forage production. Seeding desirable mid and tall grasses on abandoned cropland also increases forage production.

The shrink-swell potential of the Olpe soil is a moderate limitation on sites for dwellings with basements, and the shrink-swell potential and wetness of the Dennis soil are severe limitations. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling and by wetness. The shrink-swell potential of the Olpe soil is a moderate limitation on sites for local roads and streets, and the shrink-swell potential and low strength of the Dennis soil are severe limitations. The adverse effects of the shrinking and swelling and low strength can be lessened by strengthening or replacing the base material. Gravel is mined in some areas of the Olpe soil (fig. 13). It is used mostly for road surfacing.

These soils generally are unsuitable as septic tank absorption fields because the slow permeability of both soils and the wetness of the Dennis soil are severe limitations. The slope of both soils and seepage in the Olpe soil are moderate limitations on sites for sewage lagoons. Sealing the lagoon helps to control the seepage. Less sloping soils are better sites for sewage lagoons.

The capability subclass is VIe.

Os—Osage silty clay. This nearly level, poorly drained soil is on flood plains. It is occasionally flooded for very brief periods. Individual areas are long and irregularly shaped and range from 40 to 300 acres in size.

Typically, the surface layer is very dark gray silty clay about 7 inches thick. The subsurface layer is very dark gray, mottled, very firm silty clay about 12 inches thick. The subsoil to a depth of about 60 inches is very dark gray, mottled, extremely firm silty clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Lanton and moderately well drained Verdigris soils. These soils are less clayey than the Osage soil. Also, they are slightly higher on the landscape and are nearer stream channels. Included soils make up 5 to 10 percent of the map unit.

Permeability is very slow in the Osage soil, and available water capacity is moderate. Surface runoff is very slow. The surface layer is very firm and cannot be easily tilled. The shrink-swell potential is very high. A seasonal high water table is within a depth of 1 foot. Reaction is slightly acid or neutral in the subsoil and varies widely in the surface layer as a result of local liming practices.



Figure 13.—A small gravel pit in an area of the Olpe soil in the Olpe-Dennis complex, 3 to 7 percent slopes.

Most areas are cultivated. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. Crops are damaged, however, during some wet periods. Also, they are adversely affected during dry periods because the clayey subsoil fails to release water readily to plants. Improving tilth and increasing the content of organic matter are concerns of management. A bedding system or surface drainage ditches reduce the wetness. Keeping tillage at a minimum and leaving crop residue on the surface improve tilth and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely

deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

This soil is suited to trees. A few areas are native woodland. The equipment limitation is moderate, and seedling mortality and plant competition are severe. Because of the wetness, the use of equipment is limited to dry periods. Tree cuttings and seedlings survive and grow well only if competing vegetation is controlled or removed. Site preparation, controlled burning, spraying, and cutting or girdling control plant competition.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe

hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIIw.

Pa—Parsons silt loam, 0 to 1 percent slopes. This nearly level, somewhat poorly drained soil is on uplands. Individual areas are irregular in shape and range from 40 to 500 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. It has an abrupt lower boundary. The subsoil to a depth of about 60 inches is mottled, very firm silty clay. The upper part is dark grayish brown, and the lower part is gray, strong brown, and yellowish red. In some areas the subsurface layer is darker.

Included with this soil in mapping are small areas of Zaar soils along drainageways. These soils have a clayey surface layer. They make up about 5 to 10 percent of the map unit.

Permeability is very slow in the Parsons soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable and can be easily tilled. The shrink-swell potential of the subsoil is high. A perched seasonal high water table is at a depth of 0.5 to 1.5 feet. Reaction is slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. Crops are adversely affected during dry periods, however, because the clayey subsoil fails to release water readily to plants. Also, they are damaged during some wet periods. Maintaining tilth and increasing the content of organic matter are concerns of management. Keeping tillage at a minimum and leaving crop residue on the surface help to maintain tilth and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

The shrink-swell potential and the 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, however, help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength, wetness, and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material, however, help to overcome these limitations.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIs.

Pt—Pits, quarries. This map unit consists of areas from which soil and some underlying limestone or shale have been removed. The underlying material has been quarried for use as gravel and for use in the manufacturing of cement, brick, and agricultural lime. Individual areas are irregular in shape and range from 20 to 200 acres in size.

A typical quarry is a pit surrounded by vertical walls 8 to 20 feet high. Small piles of rock, shale, and gravel are around the outer edge of some quarries.

This map unit is unsuitable for cultivation and for most other uses. The surface generally is bare. Scattered trees, shrubs, and clumps of grass border the quarries.

No capability class or subclass is assigned to this map unit.

Sc—Shidler-Catoosa silt loams, 1 to 8 percent slopes. These gently sloping and moderately sloping, well drained soils are on uplands. The Shidler soil is along drainageways, and the Catoosa soil is on ridgetops. Individual areas are long and narrow or irregularly shaped and range from 20 to 300 acres in size. They are about 45 percent Shidler soil and 40 percent Catoosa soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Shidler soil has a surface layer of very dark brown silt loam about 12 inches thick. This layer contains limestone fragments. Limestone bedrock is at a depth of about 12 inches.

Typically, the Catoosa soil has a surface layer of very dark grayish brown silt loam about 10 inches thick. The subsoil is dark reddish brown, firm silty clay loam about 21 inches thick. Limestone bedrock is at a depth of about 31 inches. In places the depth to bedrock is more than 40 inches. In some areas limestone fragments are throughout the soil. In a few areas the underlying bedrock is sandstone.

Included with these soils in mapping are small areas of Lebo soils. These included soils have a silty clay loam surface layer and are underlain by shale. They are in areas where shale crops out between ledges of limestone. Also included are small areas where limestone crops out. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Shidler and Catoosa soils, and surface runoff is medium. Available water capacity is low in the Shidler soil and moderate in the

Catoosa soil. The shrink-swell potential is moderate in the subsoil of the Catoosa soil. Root penetration is restricted at a depth of about 12 inches in the Shidler soil and 31 inches in the Catoosa soil. Reaction is slightly acid or neutral in the surface layer of the Shidler soil. It is slightly acid or medium acid in the surface layer of the Catoosa soil.

These soils generally are unsuitable for cultivation. The depth to bedrock is a limitation, and erosion is a hazard.

Most areas are used as native range. These soils are well suited to range and moderately well suited to tame grass pasture. The major concerns of management are the encroachment of undesirable plants (fig. 14) and erosion. If the pasture or range is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant

community is annual grasses, shrubs, and trees. An adequate plant cover helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. If the soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, deferred grazing, and brush control increase forage production. Seeding desirable mid and tall grasses on abandoned cropland also increases forage production.

The depth to rock is a severe limitation if these soils are used as sites for dwellings with basements. The deeper adjacent soils are better sites. The depth to rock in the Shidler soil and low strength in the Catoosa soil are severe limitations on sites for local roads and streets. Low strength can be overcome by properly designing the roads or streets and by strengthening or replacing the base material.



Figure 14.—Invasion of weeds, shrubs, and trees in an area of Shidler-Catoosa silt loams, 1 to 8 percent slopes.

These soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The less sloping, deeper adjacent soils are better sites for sewage lagoons.

The capability subclass is Vle.

Sd—Stephenville-Darnell fine sandy loams, 3 to 20 percent slopes. These gently sloping to moderately steep, well drained soils are on the tops of ridges in the uplands. The Stephenville soil is less sloping than the Darnell soil and is higher on the landscape. Individual areas are irregular in shape and range from 50 to 200 acres in size. They are about 45 percent Stephenville soil and 40 percent Darnell soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Stephenville soil has a surface layer of dark grayish brown fine sandy loam about 4 inches thick. The subsurface layer is brown fine sandy loam about 7 inches thick. The subsoil is yellowish red and strong brown, friable sandy clay loam about 15 inches thick. Soft sandstone bedrock is at a depth of about 26 inches. In places the surface layer and subsurface layer are very dark grayish brown.

Typically, the Darnell soil has a surface layer of dark brown fine sandy loam about 8 inches thick. The subsoil is strong brown, friable fine sandy loam about 6 inches thick. Soft sandstone bedrock is at a depth of about 14 inches. In some areas the depth to sandstone is less than 10 inches.

Included with these soils in mapping are small areas of Deepwater soils. These soils are on the lower side slopes. They are deep. Their surface layer is darker than that of either the Stephenville or Darnell soil. Also included are small areas where sandstone crops out. Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Stephenville soil and moderately rapid in the Darnell soil. Available water capacity is moderate in the Stephenville soil and low in the Darnell soil. Surface runoff is medium on both soils. Root penetration is restricted at a depth of about 26 inches in the Stephenville soil and 14 inches in the Darnell soil. Both soils are slightly acid to strongly acid throughout.

Most areas occur as woodland that has an understory of shrubs and grasses. They are not productive as woodland and are used as range. Native grasses are interspersed with the trees. A small acreage has been cleared and supports tame grasses.

These soils are suited to native range and tame grass pasture. The major concerns of management are the encroachment of undesirable plants and erosion. If the pasture or range is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After

continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. If the soils are used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, deferred grazing, and brush control increase forage production. Seeding desirable mid and tall grasses on abandoned cropland also increases forage production.

The Stephenville soil is suitable as a site for dwellings without basements and for local roads and streets. The Darnell soil is more poorly suited, however, because the depth to rock and the slope are severe limitations. Both soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The less sloping, deeper included or adjacent soils are better sites for sewage lagoons.

The capability subclass is Vle.

Va—Verdigris silt loam. This nearly level, moderately well drained soil is on flood plains. It is occasionally flooded for very brief periods. Individual areas are long and narrow or irregularly shaped and range from 4 to 300 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 20 inches thick. The substratum is dark brown silt loam about 17 inches thick. Below this to a depth of about 60 inches is a buried surface layer of very dark grayish brown silt loam. In some areas the surface layer or subsurface layer is silty clay loam.

Included with this soil in mapping are small areas of Osage soils. These soils have a silty clay surface layer and subsoil. They are in swales and other concave areas and are wet for longer periods than the Verdigris soil. They make up about 5 to 10 percent of the map unit.

Permeability is moderate in the Verdigris soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable and can be easily tilled. The shrink-swell potential of the substratum is moderate. Reaction is slightly acid or neutral in the subsurface layer and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. Spring flooding delays planting in some years. Measures that maintain tilth and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum and leaving crop residue on the surface.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking

rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

This soil is well suited to trees. A few areas are native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Site preparation, controlled burning, spraying, and cutting or girdling control plant competition. No hazards or limitations affect planting or harvesting.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Vb—Verdigris silt loam, channeled. This nearly level, moderately well drained soil is on narrow flood plains that are dissected by drainageways and meandering stream channels. It is frequently flooded for very brief periods. Individual areas are long and about 200 feet to 500 feet wide and range from 10 to 60 acres in size.

Typically, the surface layer is very dark brown silt loam about 10 inches thick. The subsurface layer is very dark brown, friable silt loam about 20 inches thick. The substratum to a depth of about 60 inches is brown silt loam. In some areas the surface layer or subsurface layer is silty clay loam.

Included with this soil in mapping are small areas of Osage soils. These soils have a silty clay surface layer and subsoil. They are in swales and other concave areas and are wet for longer periods than the Verdigris soil. They make up about 5 to 10 percent of the map unit.

Permeability is moderate in the Verdigris soil, and available water capacity is high. Surface runoff is slow. The shrink-swell potential of the substratum is moderate. The soil is slightly acid or neutral throughout.

This soil generally is unsuitable for cultivation because it is subject to flooding. Also, using farm machinery is difficult along the meandering stream channels.

Most areas are used as native range. This soil is well suited to native range and tame grass pasture. The major concerns in managing the range or pasture are the encroachment of undesirable plants and flooding. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, deferred grazing, and brush control increase forage production. Reseeding cleared areas with mid or tall grasses also increases forage production.

This soil is well suited to trees. A few areas are native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Site preparation, controlled burning, spraying, and cutting or girdling control plant competition. No hazards or limitations affect planting or harvesting.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is Vw.

Wa—Woodson silt loam, 0 to 1 percent slopes.

This nearly level, somewhat poorly drained soil is on broad uplands. Individual areas are irregular in shape and range from 40 to 500 acres in size.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 35 inches thick. The upper part is very dark gray, the next part is dark gray, and the lower part is gray. The substratum to a depth of about 60 inches is gray, mottled silty clay. In some areas, the surface layer is lighter colored and the upper part of the subsoil is more brown.

Included with this soil in mapping are small areas of Zaar soils along drainageways. These soils have a clayey surface layer. They make up about 10 percent of the map unit.

Permeability is very slow in the Woodson soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable and can be easily tilled. The shrink-swell potential of the subsoil is high. A perched seasonal high water table is at a depth of 0.5 to 2 feet. Reaction is medium acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. Crops are adversely affected during dry periods, however, because the clayey subsoil fails to release water readily to plants. Also, they are damaged during some wet periods. Measures that maintain tillage and increase the content of organic matter are needed. Examples are keeping tillage at a minimum and leaving crop residue on the surface. A surface drainage system is needed in a few depressional areas.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

The shrink-swell potential and the 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, however, help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength, the shrink-swell potential, and wetness are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material, however, help to overcome these limitations.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIs.

Zb—Zaar silty clay, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on foot slopes in the uplands. Individual areas are long and narrow or irregularly shaped and range from 20 to 300 acres in size.

Typically, the surface layer is black silty clay about 7 inches thick. The subsurface layer is black, firm silty clay about 15 inches thick. The subsoil is very firm, mottled silty clay about 30 inches thick. The upper part is black, and the lower part is very dark gray. The substratum to a depth of about 60 inches is dark gray silty clay. In places the surface layer is silty clay loam. In some areas shale is within a depth of 40 inches.

Included with this soil in mapping are small areas of Parsons, Verdigris, and Woodson soils. The silty Verdigris soils are on narrow flood plains that are channeled. Parsons and Woodson soils have a silt loam surface layer. They are on broad ridgetops. Included soils make up 5 to 15 percent of the map unit.

Permeability is very slow in the Zaar soil, and available water capacity is high. Surface runoff is slow. The surface layer is firm and cannot be easily tilled. The shrink-swell potential is high. Cracks are common during dry periods. A perched seasonal high water table is at a depth of 1 to 2 feet. Reaction is neutral or slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is well suited to alfalfa, soybeans, grain sorghum, corn, wheat, and tall fescue. Crops are damaged, however, during some wet periods. Also, they are adversely affected during dry periods because the clayey subsoil fails to release water readily to plants. A surface bedding system and drainage ditches reduce the wetness. Measures that improve tilth and increase the content of organic matter are needed. Keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour help to prevent excessive soil loss, improve tilth, and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor

and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. If the soil is used for tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and deferred grazing increase forage production.

The shrink-swell potential and the 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, however, help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material, however, help to overcome these limitations.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIIw.

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. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise 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 food, feed, forage, fiber, and oilseed crops. It may be cropland, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber or is available for those uses. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. 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 usually has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It 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. More detailed information about the criteria for prime farmland is available at local offices of the Soil Conservation Service.

About 306,000 acres in Neosho County, or nearly 81 percent of the total acreage, meets the requirements for prime farmland (fig. 15). About 200,000 acres of the prime farmland is used for crops, mainly alfalfa, soybeans, grain sorghum, corn, and wheat.

Parts of the county recently have been losing some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and difficult to cultivate and are less productive.

The map units considered prime farmland in the 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 at the back of this publication. The soil qualities that affect use and management are described in the section "Detailed soil map units."

Some of the map units meet the requirements for prime farmland only in areas where the soil is drained. Onsite investigation is needed to determine whether or not a specific area of the soil is adequately drained.

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

- Ba Bates loam, 1 to 3 percent slopes
- Bc Bates loam, 3 to 7 percent slopes
- Ca Catoosa silt loam, 0 to 2 percent slopes
- Da Deepwater silt loam, 1 to 4 percent slopes
- Db Dennis silt loam, 1 to 3 percent slopes
- Dc Dennis silt loam, 3 to 6 percent slopes
- Eb Eram silty clay loam, 1 to 3 percent slopes
- Ka Kenoma silt loam, 1 to 3 percent slopes
- La Lanton silt loam (where drained)
- Os Osage silty clay (where drained)
- Pa Parsons silt loam, 0 to 1 percent slopes (where drained)¹
- Va Verdigris silt loam
- Wa Woodson silt loam, 0 to 1 percent slopes (where drained)¹
- Zb Zaar silty clay, 0 to 2 percent slopes

¹ This soil generally has been adequately drained either by drainage measures or through the incidental drainage that results from farming, roadbuilding, and other kinds of land development.



Figure 15.—An area of Dennis silt loam, 1 to 3 percent slopes, an example of prime farmland.

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, and trees and shrubs.

crops and pasture

Earl J. Bondy, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, 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.

crops

About 52 percent of the acreage in Neosho County is used for cultivated crops. These crops are grown mainly on Kenoma, Dennis, Zaar, Bates, Catoosa, and Parsons soils but also are grown on Verdigris, Eram, Osage, Lanton, and Woodson soils. During the period 1968 to 1978, soybeans were grown on about 27 percent of the acreage used for harvested crops, wheat on 22 percent, and sorghum on 21 percent. The remaining 30 percent was used for other crops, such as corn, oats, barley, alfalfa, and hay (3). The acreage planted to sorghum and soybeans has increased over the previous 10-year period. The acreage of all other crops remained the same or decreased.

The main management needs in cultivated areas of the county are measures that help to control erosion, improve fertility and tilth, and reduce wetness.

Soil erosion is a problem on about 55 percent of the cropland in the county. Loss of the surface layer through erosion reduces the productivity of soils and results in sedimentation in streams. Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Kenoma, Dennis, Parsons, and Woodson soils. Control of erosion helps to maintain the productivity of soils and improves the quality of water by minimizing the pollution of streams.

Erosion control practices provide a protective plant cover, reduce the runoff rate, and increase the infiltration rate. A cropping system that keeps a plant cover on the surface for extended periods reduces the risk of erosion and preserves the productive capacity of the soils.

Terraces and diversions reduce the length of slopes, the runoff rate, and the risk of erosion. They are most practical on the deep, well drained soils that have uniform, regular slopes. Almost all of the soils in the county are examples of such soils.

Contour farming should generally be used in combination with terraces. It is best suited to soils that have smooth, uniform slopes and can be terraced.

Leaving crop residue on the surface through minimum tillage increases the infiltration rate, reduces the runoff rate, and helps to control erosion. It is becoming more common in Neosho County.

Soil tilth is an important factor in germination of seeds and in the infiltration of water into the soil. Most of the soils used for crops have a silt loam surface layer that is moderately dark and moderate or low in content of organic matter. Generally, the soil structure is weak, and intense rainfall causes the formation of a crust on the surface. The crust reduces the infiltration rate and increases the runoff rate. Regularly adding a large amount of crop residue to the soil or leaving part of the residue on the surface not only helps to control erosion but also improves the soil structure and helps to prevent surface crusting. Minimum tillage not only helps to prevent excessive soil loss in cultivated areas of the more sloping soils but also improves the tilth of those soils.

Most of the soils in the county have a slightly acid or medium acid surface layer unless they have been limed. Applying lime can increase the vigor of legumes, such as alfalfa, and other crops that are more productive on neutral soils. On all soils the amount of lime and fertilizer applied should be based on the need of the crop, on the expected level of yields, on the results of soil tests, and on past experience.

Soil drainage is a management need on some soils on flood plains. Unless drained by a system of surface drains or surface bedding, the somewhat poorly drained Lanton and poorly drained Osage soils are so wet that crop yields are reduced.

Information about the design of erosion control practices is available in local offices of the Soil Conservation Service. The latest information and suggestions about growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

pasture

About 15 percent of the acreage in Neosho County is pastured to cool-season tame grasses, such as tall fescue. This acreage is throughout the county. Some areas support only tame grasses, and others support both tame and native grasses.

The main concerns in managing pasture are maintaining or improving the quality and quantity of forage, providing protection against erosion, and reducing water loss. Measures that promote leaf development, root growth, forage regrowth, and food storage in roots are essential if maximum forage yields are to be maintained.

The management needed to maintain a good stand of tame grasses is described in the following paragraphs.

Proper stocking rates help to keep the pasture in good condition. The number of livestock should be adjusted to the expected level of yields. Generally, about 40 pounds of forage per mature cow per day is needed for continuous seasonal grazing, or 35 pounds for rotation grazing. Adjusting the number of livestock allows the pasture to provide forage for the entire grazing season.

Delaying grazing in the spring until the soil is dry and firm helps to prevent the surface compaction caused by trampling. Grazing should be deferred during the midsummer dormancy of tall fescue. Rotation grazing helps to prevent depletion of the pasture by allowing the grasses to recover after the pasture has been grazed. Providing water and salt at a variety of locations results in a uniform distribution of grazing.

Applying fertilizer helps to keep the pasture in good condition. The kind and amount should be based on the results of the soil tests and on field observations.

Mowing a pasture that has been grazed unevenly or has an excess of forage and spraying with herbicides control invading trees, brush, low quality grass, and broadleaf weeds.

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.

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 slight 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

Leonard J. Jurgens, range conservationist, Soil Conservation Service, helped prepare this section.

About 80,000 acres in Neosho County, or 21 percent of the total acreage, is rangeland. The range vegetation is representative of the Cherokee Plains resource region. Most of the rangeland is on the Catoosa-Kenoma-Zaar association, which is described in the section "General soil map units." The rest is scattered throughout the county. Many of the small scattered tracts are used principally for native hay meadows. Many of these meadows are in good to excellent condition and support most of the species of the potential natural plant community.

Cow-calf enterprises dominate, but rangeland also provides a part of the forage for a few stocker-feeder and yearling enterprises. Pasture, crop aftermath, and wheat pasture, when available, supplement the native forage grown on rangeland.

If well managed, nearly all of the soils in the county have an excellent potential for growing a high percentage of the quality forage plants grazed by livestock and by rangeland wildlife (fig. 16).

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 in the survey area, 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. An 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 ascertained 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.



Figure 16.—Well managed native range in an area of Dennis silt loam, 1 to 3 percent slopes.

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. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control 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.

Only about 10 percent of the rangeland in the county is producing near its potential. Grazing management, brush management, and prescribed burning are needed to restore excellent condition on more than half of the rangeland. On the rest of the rangeland, grazing management alone or in combination with prescribed burning increases forage production and improves habitat for rangeland wildlife.

woodland management and productivity

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

About 20,600 acres in Neosho County, or 5.5 percent of the total acreage, is forested. The wooded acreage has decreased steadily during recent years, mainly because of the conversion of woodland to cropland. The woodland is scattered throughout the county. It occurs as irregularly shaped tracts along streams and in upland drainageways and as areas of upland soils underlain by limestone, sandstone, or shale. Also, numerous trees have invaded pastures and are along fence rows and farm boundaries. Hedgerows are common throughout the county.

The woodland is divided into two main forest types—lowland plains hardwoods and post-blackjack oaks. The lowland plains hardwoods are along the major streams on the Osage-Lanton-Verdigris association, which is described under the heading "General soil map units." They include a large number of species, most commonly black walnut; common hackberry; pecan; bur, black, pin, northern red, and white oaks; honeylocust; green ash; shagbark, pignut, bitternut, and mockernut hickories; boxelder; black willow; red and American elms; osageorange; eastern cottonwood; silver maple; Kentucky coffeetree; eastern redbud; and flowering dogwood.

The post-blackjack oaks are in upland areas on the Bates-Dennis-Eram association. Some areas support nearly pure stands of post oak and blackjack oak. Others also support eastern redcedar; northern red, bur, black, and chinkapin oaks; Ohio buckeye; bitternut and pignut hickories; black cherry; black walnut; American and red elms; eastern hophornbeam; eastern redbud; and sumac.

Many of the woodland species, especially black walnut, pecan, the oaks, green ash, the hickories, common hackberry, and eastern cottonwood, can be used for wood products. These products include veneer, sawtimber, pecan nuts, Christmas trees, and fenceposts. On most of the soils in the county, the potential is good for these products. Most of these soils, however, are used for cropland and are unlikely to be converted to woodland. Only a small part of the woodland is managed for commercial wood products because most of the wooded areas are privately owned and occur as small acreages on farms. The soils on river and stream bottoms support high-value hardwoods that grow within a short period, but those on uplands support low-value trees that mature over a long period.

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 *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: *x*, *w*, *t*, *d*, *c*, *s*, *f*, and *r*.

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, helped prepare this section.

Trees are on most farmsteads in Neosho County. They either were present when the farmsteads were established or have been planted at various times by the landowners. Siberian elm, green ash, common hackberry, osageorange, northern catalpa, eastern redcedar, black walnut, and pecan are the most common trees grown as windbreaks and environmental plantings.

Only a few windbreaks are planted each year in the county, but numerous environmental plantings are established on rural homesites, around farmsteads, and in other areas. Tree planting is a continual need because old trees deteriorate after they pass maturity, because some trees die as a result of storms, diseases, or insects, and because new plantings are needed in areas where farming is expanding.

Trees and shrubs can be easily established on most of the soils in the county. In order for windbreaks and environmental plantings to fulfill their intended purpose, however, the species selected for planting should be those suited to the soils on the site. Permeability, available water capacity, and fertility greatly affect the growth rate. Selecting suitable species helps to ensure survival and a maximum growth rate. Weed and grass competition is the greatest threat to successful plantings. Proper site preparation prior to planting and control of weeds and other competing plants after planting are the major concerns in 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, keep snow from blowing off 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, helped prepare this section.

Neosho County has many areas of scenic, geologic, and historic interest. Lake Parsons, the Neosho State Fishing Lake, farm ponds, and the Neosho River provide opportunities for water sports. Several private lakes provide opportunities for weekend retreats and vacations. Facilities for hunting, fishing, camping, picnicking, and sightseeing are numerous throughout the county.

The Neosho State Waterfowl Management Area, in the southeastern part of the county, attracts hunters and birdwatchers. The rolling topography and wooded streams and hillsides in the county are scenic. The demand for recreation has increased in the county over the past several years.

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, helped prepare this section.

The primary game species in Neosho County are bobwhite quail, mourning dove, cottontail rabbit, fox squirrel, white-tailed deer, and several species of waterfowl. Ducks and geese are hunted around lakes and farm ponds. The Neosho State Waterfowl Management Area, which is about the size of five sections, is flooded to provide waterfowl with a good place to stop and feed during their migrations.

Nongame species are numerous because of the diverse habitat types in the county. Cropland, woodland, and grassland are interspersed throughout the county. Each of these types provides a habitat for a particular group of species. Birdwatchers and observers of other kinds of wildlife frequently use the Neosho State Waterfowl Management Area.

Furbearers are common along the Neosho River and its tributaries as well as in the refuge area. Raccoon, bobcat, coyote, and fox are trapped or hunted.

Stock water ponds, the Neosho River, and several lakes provide good to excellent fishing. The species commonly caught are bass, bluegill, crappie, channel catfish, 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, grain sorghum, wheat, oats, 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 bluestems, switchgrass, indiagrass, goldenrod, 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, cottonwood, black walnut, hackberry, willow, green ash, sycamore, hickory, mulberry, and pecan. 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 redcedar, pine, spruce, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are gooseberry, dogwood, blackberry, buckbrush, prairie rose, and sumac.

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, meadowlark, cottontail rabbit, 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, muskrat, redwing blackbird, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyotes, jackrabbits, hawks, killdeer, and meadowlarks.

Technical assistance in planning wildlife areas and in determining vegetation suitable for planting can be obtained from the local office of the Soil Conservation Service. Additional information and assistance can be obtained from local offices of the Kansas Fish and Game Commission and the Cooperative 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 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 filter the effluent effectively. 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, 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 wind or water 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 the content of particles coarser than sand is as much as 15 or 20 percent, 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-SC.

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 oven-dry 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 (oven-dry) 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 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 is 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. Only saturated zones within a depth of about 6 feet are indicated.

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.

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 generally 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 excavations.

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 (6). 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 Udoll (*Ud*, meaning humid, 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 Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that have a udic 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 *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

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 Typic Argiudolls.

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* (5). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (6). 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."

Bates series

The Bates series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from thinly bedded sandstone and interbedded sandy and silty shale. Slope ranges from 1 to 8 percent.

Bates soils are similar to Catoosa and Stephenville soils and are commonly adjacent to Collinsville, Dennis, and Eram soils. Catoosa and Stephenville soils are on ridgetops. Catoosa soils are moderately deep over limestone. Stephenville soils have an A2 horizon and do not have a mollic epipedon. They have a low base

saturation. Collinsville soils are on the steeper side slopes. They are less than 20 inches deep over sandstone. Dennis and Eram soils are in positions on the landscape similar to those of the Bates soils. Their subsoil is more clayey than that of the Bates soils.

Typical pedon of Bates loam, 1 to 3 percent slopes, 2,700 feet north and 600 feet east of the southwest corner of sec. 27, T. 29 S., R. 18 E.

- A1—0 to 12 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.
- B1—12 to 21 inches; dark brown (10YR 3/3) loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; common fine roots; medium acid; gradual smooth boundary.
- B2t—21 to 27 inches; dark brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium and fine subangular blocky structure; hard, firm; common fine roots; thin clay films on faces of peds; about 10 percent small soft sandstone fragments; strongly acid; gradual smooth boundary.
- B3—27 to 34 inches; dark brown (7.5YR 4/4) clay loam, brown (7.5YR 5/4) dry; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few small black concretions; about 15 percent sandstone and shale fragments; strongly acid; clear wavy boundary.
- Cr—34 inches; soft sandstone interbedded with sandy and silty shale.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. The mollic epipedon ranges from 8 to 24 inches in thickness. Scattered sandstone fragments are throughout some pedons.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is medium acid or slightly acid unless it is limed. It is dominantly loam, but the range includes silt loam and fine sandy 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 5. It is clay loam or loam that ranges from 18 to 35 percent clay. It is strongly acid to slightly acid.

Catoosa series

The Catoosa series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 0 to 8 percent.

Catoosa soils are similar to Bates and Nowata soils and are commonly adjacent to Kenoma, Nowata, Shidler, and Zaar soils. Bates soils are moderately deep over sandstone. They are on narrow ridgetops. Nowata soils

contain many chert fragments in the subsoil. They are on side slopes. Kenoma soils are on broad ridgetops. Their subsoil is more clayey than that of the Catoosa soils. Also, their solum is thicker. Shidler soils are less than 20 inches deep over limestone. They are on the steeper side slopes. Zaar soils have a clayey solum. They are along drainageways.

Typical pedon of Catoosa silt loam, 0 to 2 percent slopes, 750 feet west and 300 feet north of the southeast corner of sec. 35, T. 29 S., R. 19 E.

- A1—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; common fine roots; slightly acid; gradual smooth boundary.
- B1—8 to 13 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; moderate medium and fine granular structure; hard, firm; common fine roots; slightly acid; gradual wavy boundary.
- B2t—13 to 28 inches; dark reddish brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) dry; moderate medium and fine subangular blocky structure; very hard, firm; common fine roots; few fine black concretions; strongly acid; abrupt wavy boundary.
- R—28 inches; limestone.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is slightly acid or neutral. The B2t horizon has hue of 5YR or 2.5YR, value of 3 or 4 (moist or dry), and chroma of 3 or 4. It ranges from strongly acid to neutral.

Collinsville series

The Collinsville series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 1 to 20 percent.

Collinsville soils are similar to Darnell and Shidler soils and are commonly adjacent to Bates and Dennis soils. Darnell soils do not have a mollic epipedon. They are on ridgetops. Shidler soils also are on ridgetops. They are shallow over limestone. Bates and Dennis soils are more than 20 inches deep over bedrock and have an argillic horizon. They generally are less sloping than the Collinsville soils and are higher or lower on the landscape.

Typical pedon of Collinsville loam, in an area of Bates-Collinsville loams, 1 to 4 percent slopes, 2,000 feet east and 100 feet north of the southwest corner of sec. 35, T. 29 S., R. 19 E.

- A1—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine granular structure; slightly hard, friable; many fine roots; slightly acid; gradual wavy boundary.
- C—8 to 14 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; massive; slightly hard, friable; many fine roots; about 15 percent sandstone fragments 1/4 inch to 3 inches in diameter; strongly acid; gradual wavy boundary.
- R—14 inches; sandstone.

The thickness of the solum and the depth to sandstone range from 4 to 20 inches. The mollic epipedon is 7 to 12 inches thick. Reaction is slightly acid to strongly acid throughout the profile. In places fragments of sandstone are on the surface or are throughout the solum.

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

Darnell series

The Darnell series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 3 to 20 percent.

Darnell soils are similar to Collinsville and Stephenville soils and are commonly adjacent to Deepwater and Stephenville soils. Collinsville soils have a mollic epipedon. Stephenville soils are moderately deep over sandstone. They are higher on the landscape than the Darnell soils. Deepwater soils are more than 20 inches deep over bedrock. They are lower on the landscape than the Darnell soils.

Typical pedon of Darnell fine sandy loam, in an area of Stephenville-Darnell fine sandy loams, 3 to 20 percent slopes, 2,000 feet south and 275 feet east of the northwest corner of sec. 31, T. 29 S., R. 18 E.

- A1—0 to 8 inches; dark brown (7.5YR 4/4) fine sandy loam, brown (7.5YR 5/4) dry; moderate medium granular structure; slightly hard, friable; common fine and medium roots; about 5 percent gravel; strongly acid; gradual smooth boundary.
- B2—8 to 14 inches; strong brown (7.5YR 5/6) fine sandy loam, pink (7.5YR 7/4) dry; moderate medium granular structure; slightly hard, friable; common fine and medium roots; about 15 percent sandstone fragments less than 3 inches in diameter; strongly acid; clear wavy boundary.
- Cr—14 inches; sandstone.

The thickness of the solum, or the depth to sandstone bedrock, ranges from 10 to 20 inches. Reaction is slightly acid to strongly acid throughout the profile.

The A1 horizon has hue of 7.5YR or 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 3 or 4. The B2 horizon has hue of 5YR or 7.5YR, value of 4 to 6 (5 to 7 dry), and chroma of 4 to 6. The content of sandstone fragments less than 3 inches in diameter is, by volume, less than 15 percent in the A1 horizon and less than 20 percent in the B2 horizon.

Deepwater series

The Deepwater series consists of deep, moderately well drained, moderately permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 1 to 4 percent.

Deepwater soils are similar to Dennis soils and are commonly adjacent to Darnell, Stephenville, and Verdigris soils. Dennis soils have a clayey subsoil. They are on side slopes. Darnell soils are less than 20 inches deep over sandstone. They are on ridgetops and the upper side slopes. Stephenville soils are 20 to 40 inches deep over sandstone. They are on the upper side slopes. Verdigris soils do not have an agrillic horizon. They are on flood plains.

Typical pedon of Deepwater silt loam, 1 to 4 percent slopes, 300 feet north and 50 feet east of the southwest corner of sec. 25, T. 29 S., R. 17 E.

- A1—0 to 14 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; common fine roots; neutral; gradual smooth boundary.
- A3—14 to 19 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; moderate fine granular structure; slightly hard, friable; common fine roots; slightly acid; clear smooth boundary.
- B21t—19 to 30 inches; brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 5/6) dry; moderate fine subangular blocky structure; slightly hard, firm; few discontinuous clay films; few roots; medium acid; gradual smooth boundary.
- B22t—30 to 47 inches; yellowish brown (10YR 5/6) clay loam, brownish yellow (10YR 6/6) dry; moderate medium subangular blocky structure; slightly hard, firm; thin discontinuous clay films; few fine black concretions; few roots; dark coatings along old root channels; medium acid; gradual smooth boundary.
- B3—47 to 60 inches; yellowish brown (10YR 5/6) clay loam, brownish yellow (10YR 6/6) dry; common medium light gray (10YR 7/1) and few fine faint strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; slightly hard, friable; few fine roots; slightly acid.

The solum ranges from 48 to more than 60 inches in thickness. The mollic epipedon ranges from 11 to 20 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It ranges from neutral to medium acid. It is dominantly silt loam, but the range includes silty clay loam. The B2t horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. It ranges from slightly acid to strongly acid.

Dennis series

The Dennis series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 1 to 8 percent.

Dennis soils are similar to Deepwater and Kenoma soils and are commonly adjacent to Bates, Eram, and Kenoma soils. Deepwater soils contain less clay in the subsoil than the Dennis soils. They are on side slopes. Kenoma soils do not have a B1 horizon. They are on broad ridgetops. Bates and Eram soils are underlain by bedrock within a depth of 40 inches. They generally are on the upper side slopes.

Typical pedon of Dennis silt loam, 1 to 3 percent slopes, 375 feet east and 150 feet south of the northwest corner of sec. 34, T. 28 S., R. 18 E.

- Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; medium acid; clear smooth boundary.
- A12—7 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; few fine brown (10YR 4/3) silt coatings on faces of peds in the lower 3 inches; moderate medium and fine granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.
- B1—11 to 19 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine faint yellowish brown (10YR 5/6) and distinct reddish brown (5YR 4/4) mottles; moderate medium and fine subangular blocky structure; slightly hard, friable; many fine roots; few worm casts; gray silt grains on faces of peds in the upper 2 inches; strongly acid; gradual smooth boundary.
- B21t—19 to 29 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common medium distinct dark grayish brown (2.5Y 4/2) and many medium coarse yellowish red (5YR 4/6) mottles; moderate medium and fine blocky structure; very hard, firm; many fine roots; clay films on faces of most peds; few black stains and masses; slightly acid; gradual smooth boundary.

- B22t—29 to 37 inches; brown (10YR 5/3) silty clay, pale brown (10YR 6/3) dry; many coarse distinct yellowish red (5YR 5/6) and few fine faint dark grayish brown (2.5Y 4/2) mottles; moderate medium blocky structure; very hard, very firm; few fine roots; clay films on faces of peds; few fine soft black concretions; slightly acid; gradual smooth boundary.
- B31—37 to 46 inches; gray (10YR 5/1) and strong brown (7.5YR 5/6) silty clay, gray (10YR 6/1) and reddish yellow (7.5YR 6/6) dry; moderate medium blocky structure; very hard, very firm; neutral; gradual smooth boundary.
- B32—46 to 60 inches; strong brown (7.5YR 5/6) and gray (10YR 6/1) silty clay, brownish yellow (10YR 6/6) and light gray (10YR 7/1) dry; weak medium subangular blocky structure; very hard, firm; mildly alkaline.

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

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It ranges from neutral to strongly acid. The B1 horizon has hue of 10YR or 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 or 4. It ranges from medium acid to very strongly acid. The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5 (5 or 6 dry), and chroma of 3 or 4. It ranges from slightly acid to strongly acid. It is silty clay or silty clay loam.

Eram series

The Eram series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 1 to 10 percent.

Eram soils are commonly adjacent to Bates, Dennis, and Lebo soils. Bates soils are moderately deep over sandstone and sandy and silty shale. Their positions on the landscape are similar to those of the Eram soils. Dennis soils are more than 40 inches deep over bedrock. They are lower on the landscape than the Eram soils. Lebo soils do not have an argillic horizon. They are steeper than the Eram soils.

Typical pedon of Eram silty clay loam, 3 to 7 percent slopes, 1,800 feet south and 200 feet west of the northeast corner of sec. 9, T. 30 S., R. 18 E.

- A1—0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; hard, friable; many fine roots; slightly acid; gradual wavy boundary.
- B2t—10 to 18 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; common medium prominent yellowish red (5YR 4/6) mottles; moderate fine blocky structure; very hard, very firm; common fine roots; about 5 percent small shale fragments; medium acid; gradual smooth boundary.

B3—18 to 29 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky and blocky structure; very hard, very firm; few fine roots; about 10 percent shale fragments; strongly acid; gradual smooth boundary.

Cr—29 inches; light olive brown (2.5Y 5/4) soft shale.

The thickness of the solum, or the depth to shale, ranges from 20 to 40 inches. The mollic epipedon ranges from 8 to 20 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is slightly acid or medium acid. It is dominantly silty clay loam, but the range includes silt loam. In some pedons sandstone fragments cover as much as 5 percent of the surface and make up as much as 5 percent of the A horizon. The B2t horizon has hue of 10YR, value of 3 or 4 (4 to 6 dry), and chroma of 2 or 3. It ranges from strongly acid to neutral. In some pedons seams of lime are in the Cr horizon.

Kenoma series

The Kenoma series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in old alluvial sediments. Slope ranges from 1 to 3 percent.

Kenoma soils are similar to Dennis, Parsons, and Woodson soils and are commonly adjacent to those soils and to Catoosa soils. Dennis soils have a B1 horizon. Parsons soils have an albic horizon. Woodson soils are grayer in the lower part of the mollic epipedon than the Kenoma soils. Catoosa soils are 20 to 40 inches deep over bedrock. Dennis and Catoosa soils are slightly lower on the landscape than the Kenoma soils, and Parsons and Woodson soils are less sloping.

Typical pedon of Kenoma silt loam, 1 to 3 percent slopes, 1,800 feet north and 100 feet east of the southwest corner of sec. 25, T. 29 S., R. 18 E.:

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

B21t—7 to 16 inches; dark brown (10YR 3/3) silty clay, brown (10YR 5/3) dry; few vertical streaks of very dark brown (10YR 2/2); few fine faint reddish brown (5YR 4/3) mottles; weak fine and very fine subangular blocky and blocky structure; hard, firm; common fine roots; few fine black concretions; common black streaks; clay films on faces of peds; slightly acid; gradual wavy boundary.

B22t—16 to 26 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; few vertical streaks of very dark brown (10YR 2/2); few fine faint strong brown (7.5YR 5/6) mottles; weak medium subangular blocky and blocky structure; very hard, very firm; common fine roots; thin clay films on faces of peds; few fine black concretions; few rounded chert pebbles less than one-half inch in diameter; neutral; gradual wavy boundary.

B23t—26 to 35 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common medium distinct yellowish brown (10YR 5/6) mottles; few black films and fine concretions; very hard, very firm; neutral; gradual smooth boundary.

B3—35 to 44 inches; mixed dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) silty clay, grayish brown (10YR 5/2) dry; weak fine blocky structure; very hard, very firm; few fine roots; neutral; gradual smooth boundary.

C—44 to 60 inches; mixed grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4) silty clay, light brownish gray (10YR 6/2) and yellowish brown (10YR 5/4) dry; massive; very hard, very firm; scattered shale fragments in the lower few inches; neutral.

The solum is more than 40 inches thick. The mollic epipedon ranges from 10 to more than 20 inches in thickness. The content of fine and medium chert fragments is less than 10 percent throughout some pedons.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 to 3. It is strongly acid to slightly acid. It is dominantly silt loam, but the range includes silty clay loam. The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 7 dry), and chroma of 2 or 3. It ranges from strongly acid to neutral.

Lanton series

The Lanton series consists of deep, somewhat poorly drained soils on flood plains. Permeability is moderately slow. These soils formed in alluvium. Slope is 0 to 2 percent.

Lanton soils are similar to Verdigris soils and are commonly adjacent to Dennis, Osage, and Verdigris soils. Verdigris soils generally are not mottled. They are in positions on the landscape similar to those of the Lanton soils. Dennis soils are on upland side slopes. Their subsoil is more clayey than that of the Lanton soils. Osage soils contain more clay than the Lanton soils. Also, they are somewhat lower on the landscape.

Typical pedon of Lanton silt loam, 1,200 feet south and 150 feet east of the northwest corner of sec. 21, T. 29 S., R. 21 E.

- Ap—0 to 5 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable; many fine roots; neutral; clear smooth boundary.
- A12—5 to 10 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; slightly hard, friable; common fine roots; neutral; gradual smooth boundary.
- A13—10 to 16 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine faint dark brown (10YR 3/3) mottles; moderate medium granular structure; hard, firm; common fine roots; slightly acid; gradual smooth boundary.
- A14—16 to 34 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium granular structure; hard, firm; few fine roots; many medium black concretions; slightly acid; gradual smooth boundary.
- C—34 to 60 inches; gray (10YR 5/1) silty clay loam, gray (10YR 6/1) dry; common medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm; scattered black coatings and fine concretions; slightly acid.
- A1—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; hard, friable; many fine roots; few medium shale fragments; neutral; clear wavy boundary.
- B2—9 to 16 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; strong fine subangular blocky structure; very hard, firm; slightly more clayey than the B3 horizon; common fine roots; about 10 percent fine and medium shale fragments; medium acid; gradual wavy boundary.
- B3—16 to 27 inches; dark grayish brown (2.5Y 4/2) shaly silty clay loam, grayish brown (2.5Y 5/2) dry; moderate fine subangular blocky structure; very hard, firm; common fine roots; about 35 percent fine to coarse shale fragments; medium acid; gradual wavy boundary.
- C—27 to 32 inches; grayish brown (2.5Y 5/2) very shaly silty clay loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; very hard, firm; few fine roots; about 80 percent unweathered shale fragments increasing in number with increasing depth; medium acid; gradual smooth boundary.
- Cr—32 inches; soft platy shale.

The solum is more than 30 inches thick. Reaction is slightly acid or neutral throughout the profile.

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

Lebo series

The Lebo series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from shale and thin layers of sandstone. Slope ranges from 8 to 15 percent.

Lebo soils are commonly adjacent to Collinsville, Eram, and Shidler soils. Collinsville soils have bedrock within a depth of 20 inches. Their positions on the landscape are similar to those of the Lebo soils. Eram soils have an argillic horizon. They are less sloping than the Lebo soils and are higher or lower on the landscape. Shidler soils are less than 20 inches deep over limestone. They are higher on the landscape than the Lebo soils.

Typical pedon of Lebo silty clay loam, in an area of Eram-Lebo silty clay loams, 4 to 15 percent slopes, 2,000 feet east and 250 feet south of the northwest corner of sec. 18, T. 29 S., R. 19 E.

The thickness of the solum and the depth to shale range from 20 to 40 inches. The soils range from medium acid to mildly alkaline throughout.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. The B2 horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. The content of shale fragments in this horizon ranges, by volume, from 35 to 90 percent and increases as depth increases.

Nowata series

The Nowata series consists of moderately deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in material weathered from limestone high in content of chert fragments. Slope ranges from 3 to 7 percent.

Nowata soils are similar to Catoosa and Olpe soils and are commonly adjacent to Catoosa and Shidler soils. Catoosa soils do not contain chert fragments in the subsoil. They are on ridgetops. Olpe soils have a clayey subsoil and are more than 40 inches deep over bedrock. They are on side slopes. Shidler soils are less than 20 inches deep over limestone. They are lower on the landscape than the Nowata soils.

Typical pedon of Nowata silt loam, 3 to 7 percent slopes, 2,000 feet west and 100 feet north of the southeast corner of sec. 29, T. 27 S., R. 19 E.

- A1—0 to 10 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; common fine and medium roots; about 10 percent angular chert rocks ranging from 1/2 inch to 7 inches in size; neutral; gradual smooth boundary.
- B1—10 to 13 inches; dark reddish brown (5YR 2/2) silt loam, brown (7.5YR 4/2) dry; moderate medium granular structure; slightly hard, firm; common fine and medium roots; about 15 percent angular chert fragments ranging from 1/4 inch to 7 inches in size; medium acid; gradual wavy boundary.
- B2t—13 to 30 inches; mixed dark reddish brown (5YR 3/3) and reddish brown (5YR 4/4) very cherty silty clay loam, reddish brown (5YR 4/3 and 5YR 4/4) dry; moderate fine subangular blocky structure; very hard, firm; common fine and medium roots; few worm casts; thin clay films on faces of peds and chert fragments; about 65 percent angular chert fragments ranging from 1/4 inch to 7 inches in size, most less than 3 inches; medium acid; abrupt wavy boundary.
- R—30 inches; limestone bedrock.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. Scattered chert fragments are generally on the surface. The soils range from medium acid to neutral throughout.

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. The content of coarse fragments in this horizon is less than 10 percent. The B2t horizon has hue of 7.5YR or 5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 or 4. The content of chert fragments in this horizon ranges, by volume, from 35 to 75 percent.

Olpe series

The Olpe series consists of deep, well drained, slowly permeable soils on uplands. These soils formed in gravelly old alluvial sediments. Slope ranges from 3 to 7 percent.

Olpe soils are similar to Nowata soils and are commonly adjacent to Bates, Dennis, and Kenoma soils. Nowata soils contain less clay in the subsoil than the Olpe soils. They are less than 40 inches deep over bedrock. They are in positions on the landscape similar to those of the Olpe soils. Bates, Dennis, and Kenoma soils do not contain chert gravel. They are lower or higher on the landscape than the Olpe soils.

Typical pedon of Olpe gravelly silt loam, in an area of Olpe-Dennis complex, 3 to 7 percent slopes, 2,600 feet east and 500 feet north of the southwest corner of sec. 22, T. 28 S., R. 18 E.

- A11—0 to 8 inches; dark brown (7.5YR 3/2) gravelly silt loam, brown (7.5YR 5/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; about 15 percent rounded chert gravel; slightly acid; gradual wavy boundary.
- A12—8 to 15 inches; dark brown (7.5YR 3/2) gravelly silt loam, brown (7.5YR 5/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; about 30 percent rounded chert gravel; slightly acid; gradual wavy boundary.
- B1—15 to 20 inches; dark brown (7.5YR 3/2) very gravelly silty clay loam, brown (7.5YR 5/2) dry; moderate medium subangular blocky structure; hard, firm; common fine roots; about 80 percent rounded chert gravel; medium acid; gradual wavy boundary.
- B21t—20 to 30 inches; dark brown (7.5YR 4/4) very gravelly silty clay loam, brown (7.5YR 5/4) dry; moderate fine blocky structure; extremely hard, very firm; few fine roots; continuous clay films on faces of peds; about 85 percent rounded chert gravel; medium acid; gradual wavy boundary.
- B22t—30 to 40 inches; strong brown (7.5YR 5/6) very gravelly silty clay, reddish yellow (7.5YR 6/6) dry; few medium distinct red (2.5YR 4/6) mottles; moderate medium blocky structure; extremely hard, very firm; few fine roots; continuous clay films on faces of peds; about 80 percent rounded chert gravel; medium acid; gradual wavy boundary.
- B3—40 to 60 inches; coarsely mottled yellowish red (5YR 5/6) and light yellowish brown (2.5Y 6/4) very gravelly silty clay, reddish yellow (5YR 6/6) and pale yellow (2.5Y 7/4) dry; weak medium blocky structure; extremely hard, very firm; common medium black threads and concretions; few fine roots; thin patchy clay films on faces of peds; about 60 percent rounded chert gravel; neutral.

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

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 strongly acid to slightly acid. It is dominantly gravelly silt loam, but the range includes silt loam. The B2t horizon has hue of 5YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 4 to 6. It is medium acid to neutral. The content of rounded chert gravel in this horizon ranges, by volume, from 50 to 90 percent.

Osage series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains. These soils formed in clayey alluvium. Slope is 0 to 2 percent.

Osage soils are similar to Zaar soils and are commonly adjacent to Lanton and Verdigris soils. Zaar soils are somewhat poorly drained and are on uplands. Lanton and Verdigris soils contain less clay in the solum

than the Osage soils. Lanton soils are on the higher parts of the landscape, and Verdigris soils are in the somewhat higher convex areas.

Typical pedon of Osage silty clay, 2,600 feet east and 600 feet south of the northwest corner of sec. 30, T. 29 S., R. 21 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak fine granular structure; very hard, very firm; many fine roots; slightly acid; clear smooth boundary.

A3—7 to 19 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct dark brown (10YR 3/3) and dark gray (N 4/0) mottles; strong fine granular and subangular blocky structure; very hard, very firm; few fine roots; black material in vertical cracks; slightly acid; gradual smooth boundary.

B2g—19 to 45 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few medium faint dark gray (N 4/0) and few fine distinct dark brown (10YR 4/3) mottles; moderate fine and medium blocky structure; very hard, extremely firm; few fine roots; few slickensides; a few vertical cracks filled with darker material; neutral; diffuse smooth boundary.

B3g—45 to 60 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; common medium faint dark gray (5Y 4/1) and dark yellowish brown (10YR 4/4) mottles; weak medium and coarse blocky structure; extremely hard, extremely firm; neutral.

The solum is more than 40 inches 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 strongly acid to neutral. It is dominantly silty clay, but the range includes silty clay loam. The B2 horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 3 or 4 (4 or 5 dry) and chroma of less than 2. It is medium acid to neutral.

Parsons series

The Parsons series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in old alluvium. Slope is 0 to 1 percent.

Parsons soils are similar to Kenoma and Woodson soils and are commonly adjacent to Kenoma and Zaar soils. None of the similar or adjacent soils have an A2 horizon. Kenoma soils have chroma of 2 or more in the argillic horizon. They commonly are more sloping than the Parsons soils and are higher or lower on the landscape. Woodson soils are in positions on the landscape similar to those of the Parsons soils. Zaar soils are in convex areas and swales.

Typical pedon of Parsons silt loam, 0 to 1 percent slopes, 2,100 feet north and 200 feet east of the southwest corner of sec. 7, T. 30 S., R. 20 E.

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; medium acid; clear smooth boundary.

A2—8 to 12 inches; dark grayish brown (10YR 4/2) silt loam, gray (10YR 5/1) dry; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium granular structure; slightly hard, friable; common fine roots; strongly acid; abrupt smooth boundary.

B21tg—12 to 18 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; common fine-distinct yellowish brown (10YR 5/6) mottles; moderate medium and fine blocky structure; extremely hard, very firm; common fine roots; clay films on faces of peds; strongly acid; gradual smooth boundary.

B22tg—18 to 37 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; many medium and coarse distinct strong brown (7.5YR 5/6) mottles; moderate medium blocky structure; extremely hard, very firm; few fine roots; clay films on faces of peds; medium acid; gradual smooth boundary.

B23g—37 to 55 inches; coarsely mottled gray (10YR 5/1) and strong brown (7.5YR 5/6) silty clay, gray (10YR 6/1) and reddish yellow (7.5YR 6/6) dry; moderate medium blocky structure; extremely hard, very firm; a few vertical cracks filled with lighter colored material; slightly acid; gradual smooth boundary.

B3—55 to 60 inches; coarsely mottled gray (10YR 6/1) and yellowish red (5YR 5/6) silty clay, light gray (10YR 7/1) and reddish yellow (5YR 6/6) dry; weak coarse blocky structure; extremely hard, very firm; few fine black concretions; neutral.

The solum ranges from 40 to more than 60 inches in thickness. The Ap or A1 horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 2. It is strongly acid to slightly acid. The A2 horizon has hue of 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 1 or 2. It is strongly acid or medium acid. The B2tg horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 or 2. It is mottled with shades of gray, brown, or red. It is strongly acid to slightly acid. Some pedons have a C horizon.

Shidler series

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

Shidler soils are similar to Collinsville soils and are commonly adjacent to Catoosa, Collinsville, Kenoma, and Zaar soils. Collinsville soils are shallow over

sandstone. They contain more sand throughout than the Shidler soils. Catoosa soils have a subsoil and are more than 20 inches deep over bedrock. Kenoma and Zaar soils have a clayey subsoil and are more than 40 inches deep over bedrock. Catoosa and Kenoma soils are on the higher parts of the landscape, and Zaar soils are along drainageways.

Typical pedon of Shidler silt loam, in an area of Shidler-Catoosa silt loams, 1 to 8 percent slopes, 400 feet west and 150 feet north of the southeast corner of sec. 35, T. 29 S., R. 19 E.

A1—0 to 12 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; strong medium granular structure; slightly hard, friable; many fine roots; about 10 percent flat limestone fragments on the surface and throughout the horizon; slightly acid; gradual wavy boundary.

R—12 inches; hard limestone.

The thickness of the solum, or the depth to limestone, ranges from 4 to 20 inches. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 to 3. It is slightly acid or neutral. It is dominantly silt loam, but the range includes silty clay loam. The content of thin, flat limestone fragments that range from 3 to 15 inches along the longer axis is less than 15 percent.

Stephenville series

The Stephenville series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 3 to 15 percent.

Stephenville soils are similar to Bates and Darnell soils and are commonly adjacent to those soils. Bates soils lack an A2 horizon and have a mollic epipedon. They are in positions on the landscape similar to those of the Stephenville soils or are on the higher lying side slopes. Darnell soils do not have an argillic horizon and are shallow over sandstone. They are on side slopes below the Stephenville soils.

Typical pedon of Stephenville fine sandy loam, in an area of Stephenville-Darnell fine sandy loams, 3 to 20 percent slopes, 2,600 feet south and 150 feet east of the northwest corner of sec. 31, T. 29 S., R. 18 E.

A1—0 to 4 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; slightly hard, friable; common fine roots; slightly acid; gradual smooth boundary.

A2—4 to 11 inches; brown (10YR 5/3) fine sandy loam, pale brown (10YR 6/3) dry; weak fine granular structure; soft, friable; common fine roots; strongly acid; clear smooth boundary.

B2t—11 to 20 inches; yellowish red (5YR 4/6) sandy clay loam, yellowish red (5YR 5/6) dry; common coarse distinct brown (10YR 4/3) mottles; moderate medium subangular blocky structure; slightly hard, friable; common fine roots; thin patchy clay films; about 2 percent sandstone fragments; medium acid; gradual smooth boundary.

B3—20 to 26 inches; strong brown (7.5YR 5/6) sandy clay loam, light brown (7.5YR 6/4) dry; few fine black stains; moderate medium subangular blocky structure; slightly hard, friable; few fine roots; thin patchy clay films on faces of peds; about 2 percent sandstone fragments; medium acid; gradual smooth boundary.

Cr—26 inches; soft sandstone.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. In some pedons scattered sandstone fragments are on the surface and throughout the solum.

The A horizon is strongly acid to slightly acid. The A1 horizon has hue of 7.5YR or 10YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 or 3. The A2 horizon has hue of 5YR, 7.5YR, or 10YR, value of 5 or 6 (6 to 8 dry), and chroma of 2 or 3. The B2t horizon has hue of 2.5YR or 5YR, value of 4 or 5 (5 or 6 dry), and chroma of 4 to 8. It is strongly acid or medium acid.

Verdigris series

The Verdigris series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slope is 0 to 2 percent.

Verdigris soils are similar to Lanton soils and are commonly adjacent to Lanton and Osage soils. Lanton soils have mottles within 16 inches of the surface. They are in positions on the landscape similar to those of the Verdigris soils. Osage soils have a clayey subsoil. They are in concave areas on the flood plains.

Typical pedon of Verdigris silt loam, 1,100 feet north and 1,000 feet east of the southwest corner of sec. 2, T. 28 S., R. 18 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; medium acid; clear smooth boundary.

A12—7 to 27 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; scattered worm casts; slightly acid; gradual smooth boundary.

C—27 to 44 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; massive; slightly hard, friable; few fine roots; scattered worm casts; slightly acid; gradual smooth boundary.

Ab—44 to 60 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; few fine pores; slightly acid.

The solum and the mollic epipedon range from 24 to more than 50 inches in thickness. The soils are medium acid to neutral to a depth of 50 inches or more. They are silt loam or silty clay loam throughout.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. The C horizon has hue of 2.5Y or 10YR, value of 3 to 5 (4 to 7 dry), and chroma of 2 or 3.

Woodson series

The Woodson series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in old alluvium. Slope is 0 to 1 percent.

Woodson soils are similar to Kenoma and Parsons soils and are commonly adjacent to Kenoma and Zaar soils. Kenoma and Parsons soils have chroma of 2 or more in the subsoil. Kenoma soils are gently sloping. Parsons soils have an A2 horizon. They are in positions on the landscape similar to those of the Woodson soils. Zaar soils lack an abrupt textural change between the A horizon and the Bt horizon. They are in depressions and drainageways.

Typical pedon of Woodson silt loam, 0 to 1 percent slopes, 1,000 feet east and 150 feet north of the southwest corner of sec. 27, T. 27 S., R. 18 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; slightly hard, friable; many fine roots; medium acid; abrupt smooth boundary.

B21t—8 to 19 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine faint dark brown (10YR 3/3) mottles; moderate fine blocky structure; extremely hard, very firm; common fine roots; clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—19 to 30 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; common medium distinct strong brown (7.5YR 5/6) and few medium distinct olive brown (2.5Y 4/4) mottles; moderate and weak fine and medium blocky structure; extremely hard, very firm; few fine roots; clay films on faces of peds; few fine black concretions; few small chert pebbles; medium acid; gradual smooth boundary.

B3—30 to 43 inches; gray (10YR 5/1) silty clay, gray (10YR 6/1) dry; few medium distinct dark reddish brown (5YR 3/4) and dark gray (N 4/0) mottles; weak medium blocky structure; extremely hard, very firm; few fine roots; clay films on faces of most peds; few fine black concretions; common fine gypsum particles; few small chert pebbles; medium acid; diffuse wavy boundary.

C—43 to 60 inches; gray (10YR 5/1) silty clay, gray (5Y 5/1) dry; many medium distinct yellowish brown (10YR 5/6) mottles; weak fine and very fine blocky structure; extremely hard, very firm; very few roots; common fine black concretions; medium acid.

The solum is more than 40 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. Unless limed, it is medium acid or slightly acid. It is dominantly silt loam, but the range includes silty clay loam. The B2t horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 or less. It is medium acid to neutral.

Zaar series

The Zaar series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 0 to 2 percent.

Zaar soils are similar to Osage soils and are commonly adjacent to Catoosa, Parsons, Verdigris, and Woodson soils. Osage soils are poorly drained and are on flood plains. Catoosa, Parsons, and Woodson soils have an argillic horizon. Parsons and Woodson soils are on broad ridgetops, and Catoosa soils are on side slopes. Verdigris soils are on flood plains. Their solum is less clayey than that of the Zaar soils.

Typical pedon of Zaar silty clay, 0 to 2 percent slopes, 600 feet east and 125 feet north of the southwest corner of sec. 6, T. 28 S., R. 21 E.

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

A12—7 to 22 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine and medium blocky structure; very hard, firm; many fine roots; slightly acid; gradual wavy boundary.

B21—22 to 31 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; few fine faint reddish brown (5YR 4/3) mottles; moderate medium blocky structure; extremely hard, very firm; few small black concretions; few slickensides; many fine roots; neutral; gradual wavy boundary.

B22—31 to 41 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; common fine faint reddish brown (5YR 4/3) and few fine faint dark gray (N 4/0) mottles; moderate medium and fine blocky structure; extremely hard, very firm; few small black concretions; few fine roots; large vertical cracks filled with darker material from the horizons above; neutral; gradual wavy boundary.

B3—41 to 52 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; extremely hard, very firm; few small black concretions; few slickensides; large vertical cracks filled with darker material; neutral; gradual wavy boundary.

C—52 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; vertical cracks filled with darker material; massive; extremely hard, very firm; neutral.

The solum is more than 40 inches thick. In some pedons small carbonate concretions are in the lower horizons.

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 is medium acid or slightly acid. It is dominantly silty clay, but the range includes silty clay loam. 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 neutral or slightly acid.

formation of the soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate during and after the accumulation of the soil material, the plant and animal life on and in the soil, the relief, and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Generally, a long period is needed for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

parent material

Parent material is the unconsolidated material in which a soil forms. It determines to a large extent the mineralogical and chemical composition of the soil and the rate of soil formation. It affects texture, structure, color, natural fertility, and other soil properties. Among the agents of mechanical weathering are temperature changes, freezing of water, formation of crystals, the actions of plants and animals, wetting and drying, abrasion, and corrosion. Chemical weathering generally results in the reduction of particle sizes, the addition of water, oxygen, and carbon dioxide, and the loss of soluble salts of such metallic elements as sodium and potassium. If the climate is temperate, clay minerals commonly result from chemical weathering, which can markedly alter the color and general appearance of a deposit.

Most of the soils in Neosho County formed in material weathered from Pennsylvanian limestone, sandstone, and shale. Some formed in recent alluvium and some in scattered deposits of smooth chert gravel. The chert gravel is tertiary material. The alluvial sediments that

weathered in these deposits are the parent material of Olpe soils.

Deepwater, Dennis, Eram, Lebo, and Zaar soils formed in material weathered from shale. Bates, Collinsville, Darnell, and Stephenville soils formed in material weathered from sandstone and sandy shale. Catoosa, Nowata, and Shidler soils formed in material weathered from limestone. Kenoma, Parsons, and Woodson soils formed in old alluvium. Lanton, Osage, and Verdigris soils formed in recent alluvium along streams.

climate

Climate directly affects soil formation by weathering the parent material. It indirectly affects soil formation through its effect on plants and animals.

The climate of Neosho County is continental. It is characterized by intermittent dry and moist periods, which can last for less than a year or for several years. The soil material dries to varying depths during dry periods. It slowly regains moisture during wet periods and can become so saturated that excess moisture penetrates the substratum. As a result of the wetting and drying, some of the basic nutrients, and even clay particles, have been leached from the upper horizons of some soils.

plant and animal life

Plants generally affect the content of nutrients and of organic matter in the soil and the color of the surface layer. Earthworms, cicadas, and burrowing animals help to keep the soil open and porous. Earthworms in Verdigris soils have left many worm casts. Bacteria and fungi help to decompose plants, thus releasing plant nutrients.

The mid and tall prairie grasses have affected soil formation in Neosho County more significantly than other forms of plant and animal life. As a result of the grasses, the upper part of a typical soil in the county is dark and has a high content of organic matter. The next part in many places is slightly finer textured and somewhat lighter colored than the layer above. The underlying parent material generally is light in color.

relief

Relief affects soil formation through its effect on drainage, runoff, plant cover, and soil temperature. Most important is the effect of relief on the movement of water on the surface and into the soil.

Soils having distinct horizons generally are nearly level or gently sloping. The runoff rate is higher on the steeper soils. As a result, erosion is more extensive. Relief has retarded the formation of Lebo and Shidler soils, which formed in the oldest parent material in the county. Runoff is rapid or medium on these moderately sloping and moderately steep soils, and much of the soil material is removed as soon as the soil forms.

time

Differences in the length of time that the parent materials have been in place commonly are reflected in the degree of profile development. Some soils form rapidly; others form slowly.

The soils in Neosho County range from immature to mature. Those on low bottoms, such as Verdigris soils, are subject to stream overflow. They receive new sediment with each flood. They have a thick, dark surface layer, but the soil structure is weak. As a result, these soils are considered immature. Kenoma soils are considered mature because they have distinct 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 vols., 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. 1977. 1976-1977 farm facts. Spec. Rep. Kans. Crop & Kans. Cattle Mark. Stat., 262 pp., illus.
- (4) Layton, M. H., R. W. O'Hara, and C. E. Dornberger. 1930. Soil survey of Neosho County, Kansas. U.S. Dep. Agric., Bur. of Chem. and Soils, 26 pp., illus.
- (5) 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]
- (6) 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.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

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

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	<i>Inches</i>
Very low.....	0 to 3
Low.....	3 to 6
Moderate.....	6 to 9
High.....	9 to 12
Very high.....	more than 12

Bedding. Draining the soil through a series of broad beds made by plowing, grading, or otherwise elevating the surface of a flat field.

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

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

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

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

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.

Deferred grazing. Postponing grazing or resting grazing land 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 removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement

through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

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.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

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.

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 uppercase letter represents the major horizons. Numbers or lowercase 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.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

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.

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

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the 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.

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

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

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.

- Sandstone.** Sedimentary rock containing dominantly sand-size particles.
- Seepage** (in tables). The movement of water through the soil. Seepage adversely affects the specified use.
- 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 substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.
- Shale.** Sedimentary rock formed by the hardening of a clay deposit.
- 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.
- 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.
- 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.
- Slope** (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.
- Slow Intake** (in tables). The slow movement of water into the soil.
- Small stones** (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of 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.
- 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.
- Subsoil.** Technically, the B horizon; roughly, the part of the profile below plow depth.
- Substratum.** The part of the soil below the solum.
- Subsurface layer.** Any surface soil horizon (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).
- 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.
- Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."
- Thin layer** (in tables). Otherwise suitable soil material too thin for the specified use.
- Tilth, soil.** The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.
- Topsoil.** The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.
- 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
 [Recorded in the period 1951-76 at Chanute, Kansas]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have--		Average	2 years in 10 will have--		Average number of days with 0.10 inch or more	Average snowfall
				Maximum temperature higher than--	Minimum temperature lower than--		Less than--	More than--		
<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>In</u>	<u>In</u>	<u>In</u>	<u>In</u>	<u>In</u>	
January----	41.1	20.8	31.0	70	-7	1.30	.40	1.95	3	3.8
February---	47.4	25.9	36.7	75	2	1.25	.67	2.08	3	2.8
March-----	55.7	32.9	44.3	85	8	2.74	1.06	3.23	5	2.9
April-----	68.4	45.1	56.8	89	24	3.70	1.79	5.62	6	0.2
May-----	77.0	55.0	66.0	93	36	5.07	3.17	6.56	7	0.0
June-----	85.7	63.9	74.8	100	48	4.96	2.09	7.33	7	0.0
July-----	91.2	68.2	79.7	105	54	4.69	1.08	7.46	5	0.0
August-----	90.3	66.5	78.4	106	52	3.88	1.47	6.59	5	0.0
September--	81.4	58.4	69.9	98	39	4.81	1.45	7.70	6	0.0
October----	71.2	47.3	59.3	92	26	3.53	.73	6.33	4	0.0
November---	55.8	34.2	45.0	78	9	2.12	.28	3.50	4	1.6
December---	44.6	25.3	35.0	70	-3	1.63	.76	2.46	4	2.4
Year-----	67.5	45.3	56.4	107	-7	39.68	28.47	48.65	59	13.7

TABLE 2.--FREEZE DATES IN SPRING AND FALL
 [Recorded in the period 1931-60 at Chanute, 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 15	April 26
2 years in 10 later than--	April 1	April 10	April 21
5 years in 10 later than--	March 23	March 31	April 11
First freezing temperature in fall:			
1 year in 10 earlier than--	October 29	October 19	October 12
2 years in 10 earlier than--	November 2	October 24	October 16
5 years in 10 earlier than--	November 12	November 2	October 26

TABLE 3.--GROWING SEASON
 [Recorded in the period 1931-60 at Chanute, Kansas]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F Days	Higher than 28° F Days	Higher than 32° F Days
9 years in 10	210	196	178
8 years in 10	219	203	185
5 years in 10	234	216	198
2 years in 10	250	230	212
1 year in 10	258	236	219

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ba	Bates loam, 1 to 3 percent slopes-----	18,500	4.9
Bc	Bates loam, 3 to 7 percent slopes-----	9,000	2.4
Bd	Bates-Collinsville loams, 1 to 4 percent slopes-----	2,350	0.6
Bh	Bates-Collinsville complex, 4 to 20 percent slopes-----	3,500	0.9
Ca	Catoosa silt loam, 0 to 2 percent slopes-----	26,800	7.1
Da	Deepwater silt loam, 1 to 4 percent slopes-----	1,300	0.4
Db	Dennis silt loam, 1 to 3 percent slopes-----	35,000	9.3
Dc	Dennis silt loam, 3 to 6 percent slopes-----	1,100	0.3
Dn	Dennis-Lanton silt loams, 2 to 8 percent slopes-----	3,900	1.0
Eb	Eram silty clay loam, 1 to 3 percent slopes-----	9,600	2.6
Ec	Eram silty clay loam, 3 to 7 percent slopes-----	9,000	2.4
Et	Eram-Lebo silty clay loams, 4 to 15 percent slopes-----	650	0.2
Ka	Kenoma silt loam, 1 to 3 percent slopes-----	70,000	18.6
La	Lanton silt loam-----	15,200	4.0
No	Nowata silt loam, 3 to 7 percent slopes-----	12,500	3.3
Od	Olpe-Dennis complex, 3 to 7 percent slopes-----	1,950	0.5
Os	Osage silty clay-----	21,500	5.7
Pa	Parsons silt loam, 0 to 1 percent slopes-----	29,000	7.7
Pt	Pits, quarries-----	1,000	0.3
Sc	Shidler-Catoosa silt loams, 1 to 8 percent slopes-----	27,000	7.2
Sd	Stephenville-Darnell fine sandy loams, 3 to 20 percent slopes-----	5,700	1.5
Va	Verdigris silt loam-----	21,030	5.6
Vb	Verdigris silt loam, channeled-----	7,700	2.1
Wa	Woodson silt loam, 0 to 1 percent slopes-----	8,900	2.4
Zb	Zaar silty clay, 0 to 2 percent slopes-----	31,000	8.3
	Water-----	2,500	0.7
	Total-----	375,680	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Only arable soils are listed. 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	Grain sorghum	Winter wheat	Soybeans	Alfalfa hay	Corn	Tall fescue
	Bu	Bu	Bu	Ton	Bu	AUM*
Ba----- Bates	55	38	26	3.5	50	5.5
Bc----- Bates	50	34	20	2.5	40	5.0
Ca----- Catoosa	42	60	28	3.0	55	5.5
Da----- Deepwater	75	42	40	4.5	85	6.0
Db----- Dennis	70	42	33	4.5	---	6.0
De----- Dennis	65	38	27	4.0	---	5.5
Eb----- Eram	55	32	25	3.0	50	6.0
Ec----- Eram	50	28	20	2.5	40	5.0
Et----- Eram-Lebo	---	---	---	---	---	4.3
Ka----- Kenoma	65	38	28	3.2	60	5.0
La----- Lanton	90	40	40	4.0	95	7.5
No----- Nowata	50	36	20	2.5	35	4.0
Os----- Osage	65	32	30	2.5	60	6.5
Pa----- Parsons	70	38	30	3.5	65	6.0
Va----- Verdigris	94	44	40	5.0	95	7.5
Vb----- Verdigris	---	---	---	---	---	6.5
Wa----- Woodson	70	38	30	3.5	65	5.0
Zb----- Zaar	65	38	32	3.5	60	5.5

* 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.

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 name	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight Lb/acre		
Ba, Bc----- Bates	Loamy Upland-----	Favorable	7,000	Big bluestem-----	35
		Normal	5,500	Little bluestem-----	25
		Unfavorable	4,500	Indiangrass-----	10
				Switchgrass-----	10
Bd*, Bh*: Bates-----	Loamy Upland-----	Favorable	7,000	Big bluestem-----	35
		Normal	5,500	Little bluestem-----	25
		Unfavorable	4,500	Indiangrass-----	10
				Switchgrass-----	10
Collinsville-----	Shallow Sandstone-----	Favorable	4,500	Little bluestem-----	30
		Normal	3,700	Big bluestem-----	15
		Unfavorable	2,500	Indiangrass-----	10
				Switchgrass-----	10
				Sideoats grama-----	10
				Tall dropseed-----	5
Ca----- Catoosa	Loamy Upland-----	Favorable	6,500	Little bluestem-----	25
		Normal	5,000	Big bluestem-----	25
		Unfavorable	4,000	Indiangrass-----	10
				Switchgrass-----	10
				Sideoats grama-----	5
Da----- Deepwater	Loamy Upland-----	Favorable	7,000	Big bluestem-----	30
		Normal	5,500	Little bluestem-----	25
		Unfavorable	4,500	Indiangrass-----	15
				Switchgrass-----	5
Db, Dc----- Dennis	Loamy Upland-----	Favorable	7,000	Big bluestem-----	35
		Normal	5,500	Little bluestem-----	25
		Unfavorable	4,500	Indiangrass-----	15
				Switchgrass-----	5
Dn*: Dennis-----	Loamy Upland-----	Favorable	7,000	Big bluestem-----	35
		Normal	5,500	Little bluestem-----	25
		Unfavorable	4,500	Indiangrass-----	10
				Switchgrass-----	5
Lanton-----	Loamy Lowland-----	Favorable	10,000	Prairie cordgrass-----	20
		Normal	8,000	Big bluestem-----	20
		Unfavorable	6,000	Eastern gamagrass-----	15
				Switchgrass-----	10
				Indiangrass-----	10
Eb, Ec----- Eram	Clay Upland-----	Favorable	6,000	Big bluestem-----	25
		Normal	4,200	Little bluestem-----	25
		Unfavorable	3,000	Switchgrass-----	15
				Indiangrass-----	10
				Tall dropseed-----	5
				Sideoats grama-----	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight Lb/acre		
Et*: Eram-----	Clay Upland-----	Favorable	6,000	Big bluestem-----	25
		Normal	4,200	Little bluestem-----	25
		Unfavorable	3,000	Switchgrass-----	15
				Indiangrass-----	10
				Tall dropseed-----	5
				Sideoats grama-----	5
Lebo-----	Loamy Upland-----	Favorable	6,000	Big bluestem-----	25
		Normal	5,000	Little bluestem-----	20
		Unfavorable	4,000	Indiangrass-----	15
				Switchgrass-----	5
Ka----- 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
La----- Lanton	Loamy Lowland-----	Favorable	10,000	Prairie cordgrass-----	20
		Normal	8,000	Big bluestem-----	20
		Unfavorable	6,000	Eastern gamagrass-----	15
				Switchgrass-----	10
				Indiangrass-----	10
No----- Nowata	Loamy Upland-----	Favorable	6,000	Little bluestem-----	25
		Normal	5,000	Big bluestem-----	20
		Unfavorable	4,000	Indiangrass-----	10
				Switchgrass-----	10
				Sideoats grama-----	5
Od*: Olpe-----	Loamy Upland-----	Favorable	6,000	Big bluestem-----	30
		Normal	5,000	Little bluestem-----	20
		Unfavorable	4,000	Indiangrass-----	10
				Switchgrass-----	10
				Sideoats grama-----	5
Dennis-----	Loamy Upland-----	Favorable	7,000	Big bluestem-----	35
		Normal	5,500	Little bluestem-----	25
		Unfavorable	4,500	Indiangrass-----	10
				Switchgrass-----	5
Os----- Osage	Clay Lowland-----	Favorable	9,000	Prairie cordgrass-----	40
		Normal	8,000	Switchgrass-----	15
		Unfavorable	6,000	Big bluestem-----	10
				Eastern gamagrass-----	5
				Indiangrass-----	5
Pa----- Parsons	Clay Upland-----	Favorable	6,000	Little bluestem-----	25
		Normal	4,500	Big bluestem-----	25
		Unfavorable	2,500	Switchgrass-----	15
				Indiangrass-----	15
Sc*: Shidler-----	Shallow Limy-----	Favorable	3,000	Sideoats grama-----	30
		Normal	2,000	Little bluestem-----	15
		Unfavorable	1,000	Big bluestem-----	15
				Indiangrass-----	10
				Hairy grama-----	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight Lb/acre		
Sc*: Catoosa-----	Loamy Upland-----	Favorable	6,500	Little bluestem-----	25
		Normal	5,000	Big bluestem-----	25
		Unfavorable	4,000	Indiangrass-----	10
				Switchgrass-----	5
				Sideoats grama-----	5
Tall dropseed-----	5				
Sd*: Stephenville-----	Savannah-----	Favorable	4,500	Big bluestem-----	25
		Normal	3,300	Little bluestem-----	15
		Unfavorable	2,500	Trees-----	15
				Indiangrass-----	10
				Switchgrass-----	10
Darnell-----	Shallow Savannah-----	Favorable	3,200	Little bluestem-----	30
		Normal	2,100	Big bluestem-----	20
		Unfavorable	1,400	Trees-----	20
				Indiangrass-----	5
				Switchgrass-----	5
Va, Vb----- 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
Wa----- Woodson	Clay Upland-----	Favorable	6,000	Big bluestem-----	35
		Normal	4,500	Little bluestem-----	15
		Unfavorable	2,500	Indiangrass-----	15
				Switchgrass-----	15
				Tall dropseed-----	5
Zb----- Zaar	Clay Upland-----	Favorable	6,000	Big bluestem-----	30
		Normal	4,500	Little bluestem-----	25
		Unfavorable	2,500	Indiangrass-----	15
				Switchgrass-----	10
				Tall dropseed-----	5

* 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				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Common trees	Site index	
Da----- Deepwater	3o	Slight	Slight	Slight	Slight	Bur oak----- Black oak----- Shagbark hickory----- Post oak-----	60 60 --- ---	Pin oak, pecan, bur oak, green ash, hackberry.
La----- Lanton	3w	Slight	Moderate	Slight	Severe	Eastern cottonwood-- Pin oak----- Common hackberry---- Pecan-----	85 80 70 63	Eastern cottonwood, pecan, green ash.
Os----- Osage	4w	Slight	Moderate	Severe	Severe	Pin oak----- Pecan----- Bur oak----- Green ash-----	70 75 55 70	Pin oak, pecan, green ash, common hackberry, bur oak.
Sd*: Stephenville-----	5o	Slight	Slight	Slight	Slight	Post oak----- Blackjack oak-----	35 33	Loblolly pine, shortleaf pine.
Darnell-----	5d	Slight	Moderate	Moderate	Slight	Post oak----- Blackjack oak-----	30 30	Northern red oak, bur oak.
Va, Vb----- Verdigris	3o	Slight	Slight	Slight	Slight	Eastern cottonwood-- Pin oak----- Shagbark hickory----- Common hackberry---- Black walnut----- Silver maple----- Green ash----- White oak-----	87 75 --- 69 69 --- 69 56	Eastern cottonwood, pin oak, black walnut, green ash, pecan.

* See description of the map unit for composition and behavior characteristics of the map unit.

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
Ba, Bc----- Bates	Lilac, Peking cotoneaster, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, green ash, Austrian pine, bur oak, common hackberry, Russian-olive.	Siberian elm, honeylocust.	---
Bd#, Bh*: Bates-----	Lilac, Peking cotoneaster, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, green ash, Austrian pine, bur oak, common hackberry, Russian-olive.	Siberian elm, honeylocust.	---
Collinsville.					
Ca----- Catoosa	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Flowering dogwood, Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Siberian elm.	---
Da----- Deepwater	Peking cotoneaster	Lilac, Amur honeysuckle, fragrant sumac.	Eastern redcedar, bur oak, common hackberry, Russian-olive, green ash.	Honeylocust, Austrian pine.	---
Db, Dc----- Dennis	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Flowering dogwood, Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Dn*: Dennis-----	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Flowering dogwood, Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Lanton-----	Fragrant sumac	American plum, Peking cotoneaster.	Russian mulberry	Austrian pine, honeylocust, green ash, pin oak, Scotch pine, common hackberry.	Pecan, silver maple.
Eb, Ec----- Eram	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive, green ash.	Honeylocust, Austrian pine.	---

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
Et*: Eram-----	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive-----	Eastern redcedar, pin oak, common hackberry, Russian-olive, green ash.	Honeylocust, Austrian pine.	---
Lebo-----	Amur honeysuckle, fragrant sumac, lilac, Peking cotoneaster.	---	Eastern redcedar, Russian-olive, green ash, bur oak, Austrian pine, common hackberry.	Siberian elm, honeylocust.	---
Ka----- Kenoma	Peking cotoneaster, lilac, fragrant sumac.	Amur honeysuckle, Manchurian crabapple.	Green ash, common hackberry, Austrian pine, Russian-olive, eastern redcedar.	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.
No----- Nowata	Lilac, Peking cotoneaster, fragrant sumac, American plum.	Autumn-olive-----	Austrian pine, eastern redcedar, green ash, bur oak, Russian-olive.	Siberian elm, honeylocust.	---
Od*: Olpe-----	Fragrant sumac, Peking cotoneaster, Amur honeysuckle, lilac.	Russian-olive-----	Bur oak, eastern redcedar, common hackberry, Austrian pine, green ash.	Siberian elm, honeylocust.	---
Dennis-----	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Flowering dogwood, Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Os----- 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.
Pa----- Parsons	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive-----	Eastern redcedar, pin oak, common hackberry, Russian-olive, green ash.	Honeylocust, Austrian pine.	---
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
Sc#: Shidler.					
Catoosa-----	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Flowering dogwood, Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Siberian elm.	---
Sd#: Stephenville----	Lilac, fragrant sumac, Peking cotoneaster, Amur honeysuckle.	---	Eastern redcedar, red mulberry, green ash, Austrian pine, bur oak, common hackberry.	Honeylocust, Siberian elm.	---
Darnell.					
Va, Vb----- Verdigris	---	American plum, lilac, Peking cotoneaster, Amur honeysuckle.	Eastern redcedar	Austrian pine, honeylocust, eastern white pine, bur oak, green ash, common hackberry.	Eastern cottonwood.
Wa----- Woodson	Peking cotoneaster, lilac, fragrant sumac.	Manchurian crabapple, Amur honeysuckle.	Green ash, common hackberry, eastern redcedar, Russian-olive.	Austrian pine, honeylocust, Siberian elm.	---
Zb----- Zaar	Peking cotoneaster, lilac, Amur honeysuckle, Siberian peashrub.	Eastern redcedar, Manchurian crabapple.	Austrian pine, Russian-olive, common hackberry, green ash, 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
Ba, Bc----- Bates	Slight-----	Slight-----	Moderate: slope, small stones, depth to rock.	Slight.
Bd*: Bates-----	Slight-----	Slight-----	Moderate: slope, small stones, depth to rock.	Slight.
Collinsville-----	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones.	Slight.
Bh*: Bates-----	Slight-----	Slight-----	Moderate: slope, small stones, depth to rock.	Slight.
Collinsville-----	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones.	Slight.
Ca----- Catoosa	Slight-----	Slight-----	Slight-----	Severe: erodes easily.
Da----- Deepwater	Slight-----	Slight-----	Moderate: slope.	Slight.
Db, Dc----- Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Dn*: Dennis-----	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Lanton-----	Severe: flooding, wetness.	Moderate: flooding, wetness, percs slowly.	Severe: wetness, flooding.	Moderate: wetness.
Eb, Ec----- Eram	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, small stones, wetness.	Severe: erodes easily.
Et*: Eram-----	Moderate: slope, wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: slope.	Severe: erodes easily.
Lebo-----	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Ka----- Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
La----- Lanton	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
No----- Nowata	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, depth to rock.	Severe: erodes easily.
Od#: Olpe-----	Severe: small stones.	Severe: small stones.	Severe: small stones.	Slight.
Dennis-----	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Os----- Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Pa----- Parsons	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, erodes easily.
Pt#. Pits				
Sc#: Shidler-----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: erodes easily.
Catoosa-----	Slight-----	Slight-----	Moderate: slope, depth to rock.	Severe: erodes easily.
Sd#: Stephenville-----	Slight-----	Slight-----	Severe: slope.	Slight.
Darnell-----	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Moderate: slope.
Va----- Verdigris	Severe: flooding.	Slight-----	Moderate: flooding.	Slight.
Vb----- Verdigris	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Wa----- Woodson	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.
Zb----- Zaar	Severe: wetness, percs slowly, too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT POTENTIALS

[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 herba- ceous plants	Hard- wood trees	Conif- erous plants	Shrubs	Wetland plants	Shallow water areas	Open- land wild- life	Wood- land wild- life	Wetland wild- life	Range- land wild- life
Ba, Bc----- Bates	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Bd#, Bh#: Bates-----	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Collinsville-----	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Ca----- Catoosa	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Da----- Deepwater	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Db----- Dennis	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Dc----- Dennis	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Dn#: Dennis-----	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Lanton-----	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good	Fair.
Eb----- Eram	Fair	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Ec----- Eram	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Et#: Eram-----	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Lebo-----	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Fair.
Ka----- Kenoma	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor	Fair.
La----- Lanton	Good	Good	Good	Good	Good	Good	Fair	Fair	Good	Fair	Fair	Good.
No----- Nowata	Fair	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Od#: Olpe-----	Fair	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.	Fair.
Dennis-----	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Os----- Osage	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair	Fair.
Pa----- Parsons	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT POTENTIALS--Continued

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	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Pt#: Pits												
Sc#: Shidler-----	Very poor.	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Poor.
Catoosa-----	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Fair.
Sd#: Stephenville-----	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Darnell-----	Poor	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	Fair.
Va----- Verdigris	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor	Good.
Vb----- Verdigris	Poor	Fair	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor	Good.
Wa----- Woodson	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair.
Zb----- Zaar	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Good	Poor	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
Ba----- 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.
Bd*: Bates-----	Moderate: depth to rock.	Slight-----	Moderate: depth to rock.	Slight-----	Moderate: low strength.
Collinsville----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Bh*: Bates-----	Moderate: depth to rock.	Slight-----	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Collinsville----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Ca----- Catoosa	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: low strength.
Da----- Deepwater	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Db, Dc----- Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Dn*: Dennis-----	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Lanton-----	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding.
Eb, Ec----- Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Et*: Eram-----	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
Lebo-----	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Ka----- Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
La----- Lanton	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding.

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
No----- Nowata	Severe: depth to rock.	Moderate: shrink-swell, depth to rock, large stones.	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Moderate: depth to rock, shrink-swell, large stones.
Od#: Olpe-----	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell.
Dennis-----	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Os----- Osage	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
Pa----- Parsons	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.
Pt#. Pits					
Sc#: Shidler-----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Catoosa-----	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Severe: low strength.
Sd#: Stephenville----	Moderate: depth to rock.	Slight-----	Moderate: depth to rock.	Moderate: slope.	Slight.
Darnell-----	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.
Va, Vb----- Verdigris	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Wa----- Woodson	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength, wetness.
Zb----- Zaar	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.

* 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
Ba, Bc----- Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Bd*: Bates-----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Collinsville-----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock.	Poor: area reclaim.
Bh*: Bates-----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Collinsville-----	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock.	Poor: area reclaim.
Ca----- Catoosa	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Da----- Deepwater	Severe: wetness.	Severe: wetness.	Moderate: wetness, too clayey.	Slight-----	Fair: too clayey, wetness.
Db, Dc----- Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Dn*: Dennis-----	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Lanton-----	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, thin layer.
Eb, Ec----- 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.
Et*: 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.
Lebo-----	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Ka----- Kenoma	Severe: percs slowly.	Slight-----	Severe: too clayey.	Slight-----	Poor: too clayey, hard to pack.
La----- Lanton	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, thin layer.

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
No----- Nowata	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, large stones.	Severe: depth to rock.	Poor: area reclaim, small stones.
Od#: Olpe-----	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight-----	Poor: too clayey, small stones.
Dennis-----	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Os----- Osage	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Pa----- Parsons	Severe: wetness, percs slowly.	Slight-----	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Pt#. Pits					
Sc#: Shidler-----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Catoosa-----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Sd#: Stephenville-----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, seepage.	Poor: area reclaim.
Darnell-----	Severe: depth to rock, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, slope.
Va, Vb----- Verdigris	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Wa----- Woodson	Severe: percs slowly, wetness.	Slight-----	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.
Zb----- Zaar	Severe: wetness, percs slowly.	Slight-----	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.

* 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
Ba, Bc----- Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Bd*, Bh*: Bates-----	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Collinsville-----	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Ca----- Catoosa	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Da----- Deepwater	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Db, Dc----- Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Dn*: Dennis-----	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Lanton-----	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Eb, Ec----- Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Et*: Eram-----	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Lebo-----	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Ka----- Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
La----- Lanton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
No----- Nowata	Poor: area reclaim.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: small stones.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Od*: Olpe-----	Fair: shrink-swell.	Improbable: excess fines.	Probable-----	Poor: small stones, area reclaim.
Dennis-----	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Os----- Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Pa----- Parsons	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
Pt*. Pits				
Sc*: Shidler-----	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Catoosa-----	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Sd*: Stephenville-----	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Darnell-----	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Va, Vb----- Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Wa----- Woodson	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Zb----- Zaar	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

* 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--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ba----- 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.
Bd*: Bates-----	Moderate: seepage, depth to rock.	Severe: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Collinsville----	Severe: depth to rock.	Moderate: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Bh*: Bates-----	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Collinsville----	Severe: depth to rock, slope.	Moderate: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Ca----- Catoosa	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Depth to rock, rooting depth.	Depth to rock, erodes easily.	Erodes easily, depth to rock, rooting depth.
Da----- Deepwater	Moderate: seepage, slope.	Slight-----	Deep to water	Slope-----	Erodes easily	Erodes easily.
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.
Dc----- 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.
Dn*: 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.
Lanton-----	Slight-----	Severe: wetness.	Percs slowly, flooding.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily, 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----- 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.

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
Et#: 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.
Lebo-----	Severe: slope.	Moderate: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Ka----- Kenoma	Slight-----	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
La----- Lanton	Slight-----	Severe: wetness.	Percs slowly, flooding.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
No----- Nowata	Moderate: depth to rock, slope.	Severe: large stones.	Deep to water	Large stones, depth to rock, rooting depth.	Large stones, depth to rock, erodes easily.	Large stones, erodes easily, depth to rock.
Od#: Olpe-----	Moderate: slope.	Slight-----	Deep to water	Percs slowly, slope.	Percs slowly---	Percs slowly.
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.
Os----- Osage	Slight-----	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Pa----- Parsons	Slight-----	Severe: wetness.	Percs slowly---	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Pt#. Pits						
Sc#: Shidler-----	Severe: depth to rock.	Slight-----	Deep to water	Depth to rock, slope, erodes easily.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Catoosa-----	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, rooting depth, slope.	Depth to rock, erodes easily.	Erodes easily, depth to rock, rooting depth.
Sd#: Stephenville-----	Moderate: seepage, depth to rock.	Severe: thin layer, piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Darnell-----	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Va, Vb----- Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding-----	Favorable-----	Favorable.
Wa----- Woodson	Slight-----	Severe: wetness.	Percs slowly---	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Percs slowly, wetness, erodes easily.
Zb----- Zaar	Slight-----	Moderate: hard to pack, wetness.	Percs slowly---	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ba, Bc----- Bates	0-21	Loam-----	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	21-34	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7-6	0	85-100	85-100	80-100	45-85	25-45	3-20
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bd*: 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
	17-27	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7-6	0	85-100	85-100	80-100	45-85	25-45	3-20
	27	Unweathered 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.	---	---	---	---	---	---	---	---	---
Bh*: 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
	17-27	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7-6	0	85-100	85-100	80-100	45-85	25-45	3-20
	27	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Collinsville----	0-14	Fine sandy loam	SM, SC, ML, CL	A-4	0-3	80-100	60-100	60-95	36-75	<30	NP-10
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ca----- Catoosa	0-8	Silt loam-----	CL	A-4, A-6	0	100	100	96-100	65-97	30-37	8-14
	8-28	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-43	12-20
	28	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Da----- Deepwater	0-19	Silt loam-----	CL	A-4, A-6	0	100	100	90-100	70-95	25-40	7-15
	19-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	85-100	80-100	75-95	35-50	15-26
Db, Dc----- Dennis	0-11	Silt loam-----	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	11-19	Silty clay loam, clay loam.	CL	A-6, A-7-6	0	98-100	98-100	94-100	75-98	33-48	13-25
	19-60	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
Dn*: Dennis-----	0-15	Silt loam-----	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	15-20	Silty clay loam, clay loam.	CL	A-6, A-7-6	0	98-100	98-100	94-100	75-98	33-48	13-25
	20-60	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
Lanton-----	0-12	Silt loam-----	CL	A-4, A-6	0	100	95-100	90-100	80-95	25-38	8-15
	12-32	Silt loam, silty clay loam.	ML, CL	A-4, A-6	0	100	95-100	85-100	80-95	30-38	8-16
	32-60	Clay, silty clay, silty clay loam.	CH, CL	A-6, A-7	0	100	95-100	85-100	75-95	40-55	18-28

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index	
			Unified	AASHTO		Pct	4	10	40			200
Eb, Ec----- Eram	0-10	Silty clay loam	CL	A-6, A-7-6	0	85-100	85-100	85-100	75-95	33-48	12-25	
	10-29	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35	
	29	Weathered bedrock	---	---	---	---	---	---	---	---	---	
Et*: Eram-----	0-8	Silty clay loam	CL	A-6, A-7-6	0	85-100	85-100	85-100	75-95	33-48	12-25	
	8-27	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35	
	27	Weathered bedrock	---	---	---	---	---	---	---	---	---	
Lebo-----	0-16	Silty clay loam	CL	A-6, A-7-6	0-5	95-100	90-100	90-100	80-95	35-50	15-25	
	16-27	Channery silty clay loam, shaly silty clay loam, silty clay loam.	CL	A-6, A-7-6	0-5	75-95	55-95	55-85	50-80	35-50	15-25	
	27-32	Very shaly silty clay loam, very shaly silt loam.	SC	A-2	0-5	50-75	10-50	5-40	5-35	35-50	15-25	
	32	Weathered bedrock	---	---	---	---	---	---	---	---	---	
Ka----- Kenoma	0-7	Silt loam-----	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18	
	7-44	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48	
	44-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-44	
La----- Lanton	0-10	Silt loam-----	CL	A-4, A-6	0	100	95-100	90-100	80-95	25-38	8-15	
	10-34	Silt loam, silty clay loam.	CL	A-4, A-6	0	100	95-100	85-100	80-95	30-38	8-16	
	34-60	Clay, silty clay, silty clay loam.	CH, CL	A-6, A-7	0	100	95-100	85-100	75-95	40-55	18-28	
No----- Nowata	0-13	Silt loam-----	CL	A-4, A-6	0-15	85-100	80-100	75-95	70-95	30-37	8-13	
	13-30	Gravelly silty clay loam, very cherty silty clay loam, cherty silty clay loam.	GC, GP-GC	A-2, A-6, A-7	0-65	15-50	10-50	10-45	5-40	37-50	15-25	
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---	
Od*: Olpe-----	0-15	Gravelly silt loam.	GC, SC	A-2, A-4, A-6	0	30-75	30-75	20-55	15-50	20-40	7-20	
	15-30	Very gravelly silty clay loam, very gravelly silty clay.	GC, SC, GP-GC, SP-SC	A-2, A-6, A-7	0	30-65	10-50	10-50	10-45	30-50	11-22	
	30-60	Very gravelly silty clay, very gravelly clay.	GC, SC, GP-GC, SP-SC	A-2-7, A-7	0	30-65	10-50	10-50	10-45	40-65	25-40	
Dennis-----	0-11	Silt loam-----	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15	
	11-19	Silty clay loam, clay loam.	CL	A-6, A-7-6	0	98-100	98-100	94-100	75-98	33-48	13-25	
	19-60	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	
Os----- Osage	0-7	Silty clay-----	CH	A-7	0	100	100	100	95-100	50-75	30-55	
	7-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	100	95-100	40-80	20-65	

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Pa----- Parsons	0-12	Silt loam-----	ML, CL, CL-ML	A-4, A-6	0	100	96-100	96-100	80-97	20-37	1-12
	12-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	96-100	96-100	80-99	37-70	15-40
Pt#. Pits											
Sc#: Shidler-----	0-12	Silt loam-----	CL, ML	A-4, A-6	0	90-100	90-100	90-100	75-98	30-37	8-13
	12	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Catoosa-----	0-10	Silt loam-----	CL	A-4, A-6	0	100	100	96-100	65-97	30-37	8-14
	10-31	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-43	12-20
	31	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sd#: Stephenville----	0-11	Fine sandy loam	SM, SC, ML, CL	A-4	0	100	98-100	94-100	36-60	<30	NP-10
	11-26	Fine sandy loam, sandy clay loam.	SC, CL	A-4, A-6	0	100	98-100	90-100	36-65	25-37	7-16
	26	Weathered bedrock	---	---	---	---	---	---	---	---	---
Darnell-----	0-8	Fine sandy loam	SM, SC, ML, CL	A-4	0-5	90-100	90-100	85-100	36-60	<30	NP-10
	8-14	Fine sandy loam, loam.	SM, SC, ML, CL	A-4	0-8	70-100	70-100	60-100	36-60	<30	NP-10
	14	Weathered bedrock	---	---	---	---	---	---	---	---	---
Va, Vb----- Verdigris	0-27	Silt loam-----	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	27-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
Wa----- Woodson	0-8	Silt loam-----	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	8-43	Silty clay, clay	CH	A-7-6	0	100	95-100	95-100	90-100	50-65	30-45
	43-60	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	95-100	95-100	90-100	45-65	20-40
Zb----- Zaar	0-22	Silty clay-----	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	22-52	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	52-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	40-65	15-40

* 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; > means more 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		Wind erodibility group	Organic matter
									K	T		
	In	Pct	G/cm ³	In/hr	In/in	pH	Mmhos/cm					Pct
Ba, Bc----- Bates	0-21	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
	21-34	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-----	0.28			
	34	---	---	---	---	---	---	---	---			
Bd*, Bh*: 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
	17-27	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-----	0.28			
	27	---	---	---	---	---	---	---	---			
Collinsville----	0-14	5-20	1.30-1.65	2.0-6.0	0.12-0.16	5.1-6.5	<2	Low-----	0.20	2	3	1-2
Ca----- Catoosa	0-8	10-20	1.30-1.50	0.6-2.0	0.15-0.24	5.6-6.5	<2	Low-----	0.32	3	6	1-2
	8-28	27-35	1.45-1.75	0.6-2.0	0.15-0.22	5.1-7.3	<2	Moderate	0.32			
	28	---	---	---	---	---	---	---	---			
Da----- Deepwater	0-19	15-27	1.20-1.40	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low-----	0.32	5	6	2-5
	19-60	27-35	1.40-1.60	0.6-2.0	0.18-0.20	5.1-6.5	<2	Moderate	0.43			
Db, Dc----- Dennis	0-11	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low-----	0.37	5	6	1-3
	11-19	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	19-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High-----	0.37			
Dn*: Dennis-----	0-15	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low-----	0.37	5	6	1-3
	15-20	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	20-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High-----	0.37			
Lanton-----	0-12	20-30	1.30-1.55	0.6-2.0	0.18-0.22	6.1-7.3	<2	Low-----	0.37	5	6	2-4
	12-32	20-35	1.40-1.60	0.2-0.6	0.17-0.22	6.1-7.3	<2	Low-----	0.37			
	32-60	30-50	1.40-1.60	0.06-0.6	0.12-0.18	6.1-7.3	<2	Moderate	0.37			
Eb, Ec----- Eram	0-10	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
	10-29	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High-----	0.37			
	29	---	---	---	---	---	---	---	---			
Et*: 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
	8-27	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High-----	0.37			
	27	---	---	---	---	---	---	---	---			
Lebo-----	0-16	22-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.8	<2	Moderate	0.32	4	7	---
	16-27	22-35	1.40-1.50	0.6-2.0	0.15-0.18	5.6-7.8	<2	Moderate	0.24			
	27-32	22-35	1.45-1.65	0.6-2.0	0.07-0.10	5.6-7.8	<2	Moderate	0.24			
	32	---	---	---	---	---	---	---	---			
Ka----- Kenoma	0-7	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
	7-44	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High-----	0.32			
	44-60	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High-----	0.32			
La----- Lanton	0-10	20-30	1.30-1.55	0.6-2.0	0.18-0.22	6.1-7.3	<2	Low-----	0.32	5	6	2-4
	10-34	20-35	1.40-1.60	0.2-0.6	0.17-0.22	6.1-7.3	<2	Low-----	0.43			
	34-60	30-50	1.40-1.60	0.06-0.6	0.12-0.18	6.1-7.3	<2	Moderate	0.32			
No----- Nowata	0-13	15-27	1.30-1.50	0.6-2.0	0.15-0.22	5.6-6.5	<2	Low-----	0.32	3	6	1-3
	13-30	27-35	1.45-1.75	0.2-0.6	0.08-0.12	5.6-7.3	<2	Moderate	0.32			
	30	---	---	---	---	---	---	---	---			
Od*: Olpe-----	0-15	15-30	1.20-1.30	0.6-2.0	0.06-0.13	5.1-6.5	<2	Low-----	0.24	3	8	---
	15-30	27-45	1.30-1.40	0.2-0.6	0.04-0.10	5.1-6.5	<2	Low-----	0.24			
	30-60	35-50	1.35-1.45	0.06-0.2	0.04-0.10	5.6-7.8	<2	Moderate	0.24			

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	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	G/cm ³	In/hr	In/in	pH	Mmhos/cm					Pct
Od*: Dennis-----	0-11 11-19 19-60	10-27 27-35 35-55	1.30-1.55 1.45-1.70 1.35-1.65	0.6-2.0 0.2-0.6 0.06-0.2	0.15-0.20 0.15-0.20 0.15-0.20	5.1-6.0 4.5-6.0 5.1-8.4	<2 <2 <2	Low----- Moderate High-----	0.37 0.37 0.37	5	6	1-3
Os----- Osage	0-7 7-60	40-50 35-60	1.40-1.60 1.50-1.70	<0.06 <0.06	0.12-0.14 0.08-0.12	5.1-7.8 5.6-7.8	<2 <2	Very high Very high	0.28 0.28	5	4	1-4
Pa----- Parsons	0-12 12-60	15-25 35-60	1.30-1.50 1.40-1.70	0.6-2.0 <0.06	0.16-0.24 0.14-0.22	5.1-6.5 5.1-7.8	<2 <2	Low----- High-----	0.43 0.43	4	6	.5-1
Pt*. Pits												
Sc*: Shidler-----	0-12 12	18-25 ---	1.30-1.50 ---	0.6-2.0 ---	0.16-0.24 ---	5.6-8.4 ---	<2 ---	Low----- -----	0.37 ---	1	4L	1-3
Catoosa-----	0-10 10-31 31	10-20 27-35 ---	1.30-1.50 1.45-1.75 ---	0.6-2.0 0.6-2.0 ---	0.15-0.24 0.15-0.22 ---	5.6-6.5 5.1-7.3 ---	<2 <2 ---	Low----- Moderate -----	0.37 0.32 ---	2	6	1-2
Sd*: Stephenville----	0-11 11-26 26	10-20 18-35 ---	1.30-1.60 1.50-1.70 ---	2.0-6.0 0.6-2.0 ---	0.11-0.15 0.11-0.17 ---	5.1-7.3 5.1-6.5 ---	<2 <2 ---	Low----- Low----- -----	0.24 0.32 ---	4	3	<1
Darnell-----	0-8 8-14 14	10-20 10-25 ---	1.30-1.65 1.40-1.70 ---	2.0-6.0 2.0-6.0 ---	0.12-0.16 0.12-0.16 ---	5.1-7.3 5.1-7.3 ---	<2 <2 ---	Low----- Low----- -----	0.24 0.32 ---	2	3	<1
Va, Vb----- Verdigris	0-27 27-60	15-27 18-35	1.30-1.40 1.40-1.65	0.6-2.0 0.6-2.0	0.20-0.24 0.17-0.22	5.6-7.3 5.6-7.3	<2 <2	Low----- Moderate	0.32 0.32	5	6	2-4
Wa----- Woodson	0-8 8-43 43-60	18-27 40-60 30-50	1.25-1.45 1.30-1.45 1.35-1.45	0.2-0.6 <0.06 0.06-0.2	0.22-0.24 0.12-0.15 0.10-0.15	5.6-6.5 5.6-7.3 5.6-7.8	<2 <2 <2	Low----- High----- High-----	0.43 0.32 0.32	4	6	1-4
Zb----- Zaar	0-22 22-52 52-60	40-60 40-60 35-50	1.20-1.30 1.35-1.50 1.35-1.50	<0.06 <0.06 <0.06	0.12-0.14 0.11-0.18 0.10-0.18	5.6-7.3 6.1-8.4 6.6-8.4	<2 <2 <2	High----- High----- High-----	0.28 0.28 0.28	5	4	2-4

* 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 less than; > 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	Hardness	Uncoated steel	Concrete			
					Ft									
												In		
Ba, Bc----- Bates	B	None-----	---	---	>6.0	---	---	20-40	Soft	Low-----	Moderate.			
Bd#, Bh#: Bates-----	B	None-----	---	---	>6.0	---	---	20-40	Soft	Low-----	Moderate.			
Collinsville----	C	None-----	---	---	>6.0	---	---	4-20	Hard	Low-----	Moderate.			
Ca----- Catoosa	B	None-----	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.			
Da----- Deepwater	B	None-----	---	---	3.0-4.5	Perched	Nov-Mar	>60	---	High-----	Moderate.			
Db, Dc----- Dennis	C	None-----	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High-----	Moderate.			
Dn#: Dennis-----	C	None-----	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High-----	Moderate.			
Lanton-----	D	Frequent----	Very brief	Jan-May	1.0-2.0	Apparent	Dec-May	>60	---	High-----	Low.			
Eb, Ec----- Eram	C	None-----	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High-----	Moderate.			
Et#: Eram-----	C	None-----	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High-----	Moderate.			
Lebo-----	B	None-----	---	---	>6.0	---	---	20-40	Soft	Moderate	Low.			
Ka----- Kenoma	D	None-----	---	---	>6.0	---	---	>60	---	High-----	Moderate.			
La----- Lanton	D	Occasional	Very brief	Jan-May	1.0-2.0	Apparent	Dec-May	>60	---	High-----	Low.			
No----- Nowata	B	None-----	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.			
Od#: Olpe-----	C	None-----	---	---	>6.0	---	---	>60	---	High-----	Moderate.			
Dennis-----	C	None-----	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High-----	Moderate.			
Os----- Osage	D	Occasional	Very brief to long.	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High-----	Moderate.			
Pa----- Parsons	D	None-----	---	---	0.5-1.5	Perched	Dec-Apr	>60	---	High-----	Moderate.			
Pt#. Pits														
Sc#: Shidler-----	D	None-----	---	---	>6.0	---	---	4-20	Hard	Moderate	Low.			
Catoosa-----	B	None-----	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.			
Sd#: Stephenville----	B	None-----	---	---	>6.0	---	---	20-40	Soft	Moderate	Moderate.			
Darnell-----	C	None-----	---	---	>6.0	---	---	10-20	Soft	Low-----	Moderate.			
Va----- Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low-----	Low.			

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 Ft	Kind	Months	Depth In	Hardness	Uncoated steel	Concrete
Vb----- Verdigris	B	Frequent----	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low-----	Low.
Wa----- Woodson	D	None-----	---	---	0.5-2.0	Perched	Dec-Apr	>60	---	High-----	Moderate.
Zb----- Zaar	D	None-----	---	---	1.0-2.0	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
Bates-----	Fine-loamy, siliceous, thermic Typic Argiudolls
Catoosa-----	Fine-silty, mixed, thermic Typic Argiudolls
Collinsville-----	Loamy, siliceous, thermic Lithic Hapludolls
Darnell-----	Loamy, siliceous, thermic, shallow Udic Ustochrepts
Deepwater-----	Fine-silty, mixed, thermic Typic Argiudolls
Dennis-----	Fine, mixed, thermic Aquic Paleudolls
Eram-----	Fine, mixed, thermic Aquic Argiudolls
Kenoma-----	Fine, montmorillonitic, thermic Vertic Argiudolls
Lanton-----	Fine-silty, mixed, thermic Cumulic Haplaquolls
Lebo-----	Loamy-skeletal, mixed, thermic Typic Hapludolls
Nowata-----	Loamy-skeletal, mixed, thermic Typic Argiudolls
Olpe-----	Clayey-skeletal, montmorillonitic, thermic Typic Paleudolls
Osage-----	Fine, montmorillonitic, thermic Vertic Haplaquolls
Parsons-----	Fine, mixed, thermic Mollic Albaqualfs
Shidler-----	Loamy, mixed, thermic Lithic Haplustolls
Stephenville-----	Fine-loamy, siliceous, thermic Ultic Haplustalfs
Verdigris-----	Fine-silty, mixed, thermic Cumulic Hapludolls
Woodson-----	Fine, montmorillonitic, thermic Abruptic Argiaquolls
Zaar-----	Fine, montmorillonitic, thermic Vertic Hapludolls

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.