SOIL SURVEY OF

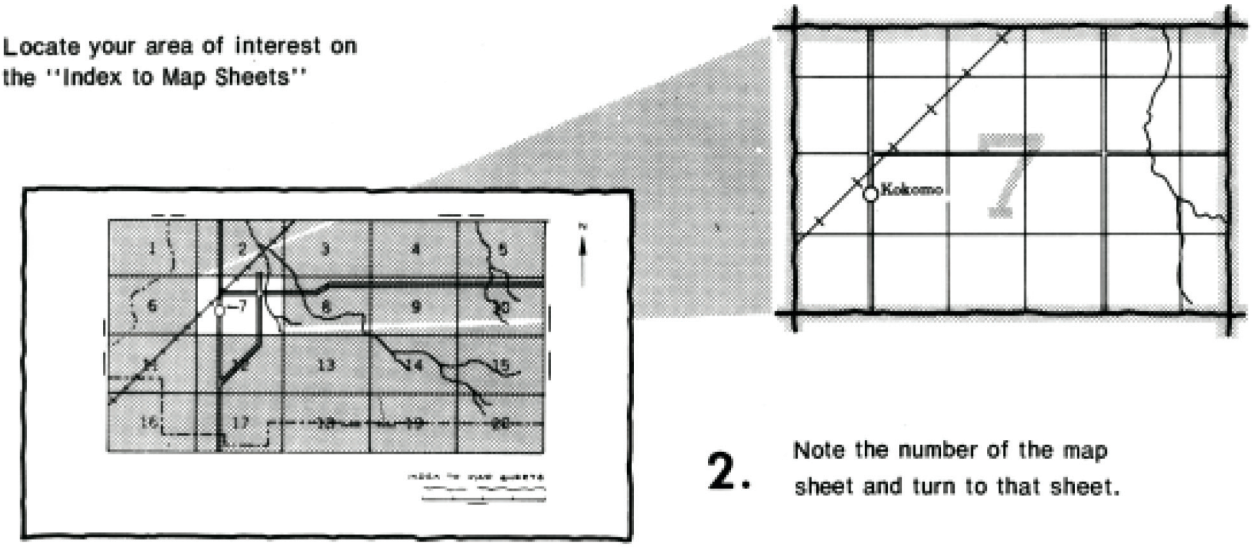
Sumner County, Kansas

United States Department of Agriculture
Soil Conservation Service

In cooperation with
Kansas Agricultural Experiment Station

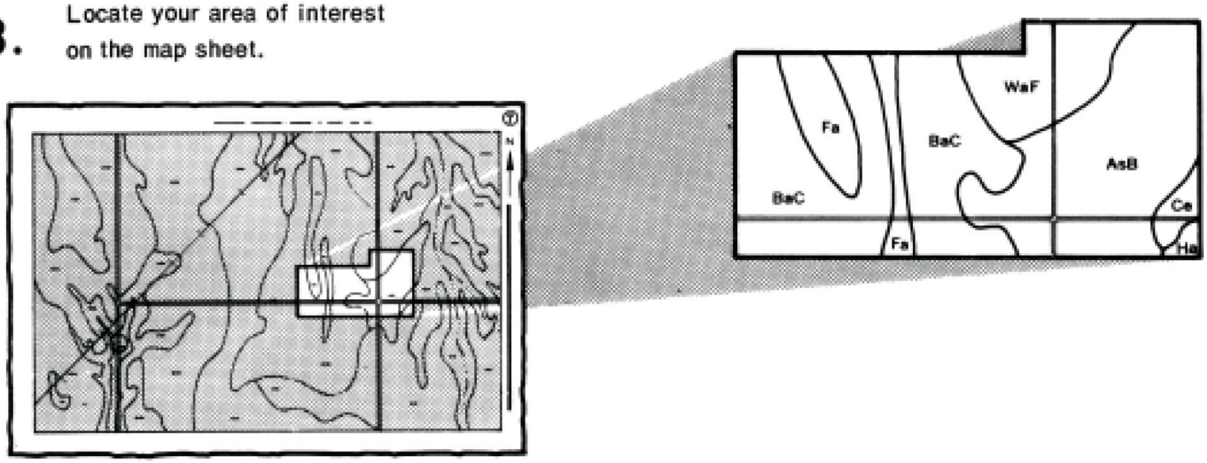
HOW TO USE

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

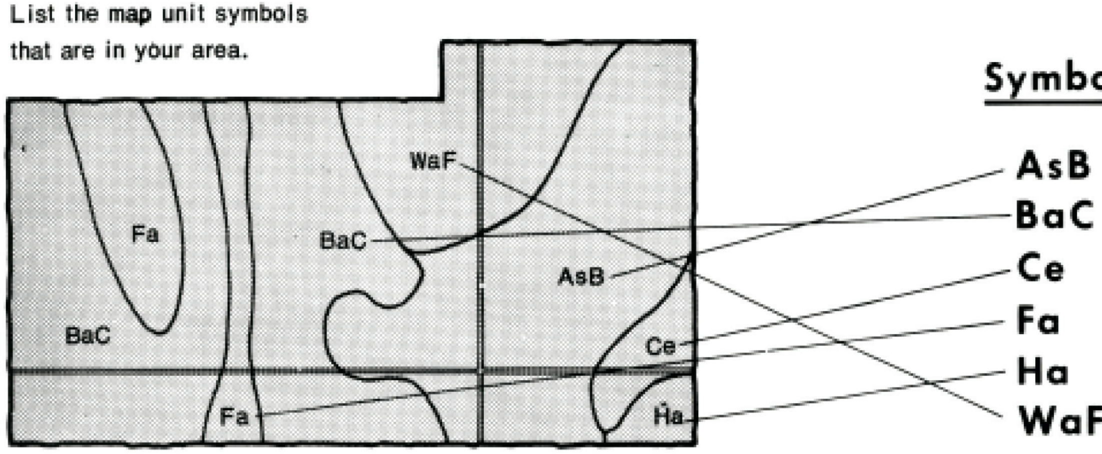


2. Note the number of the map sheet and turn to that sheet.

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

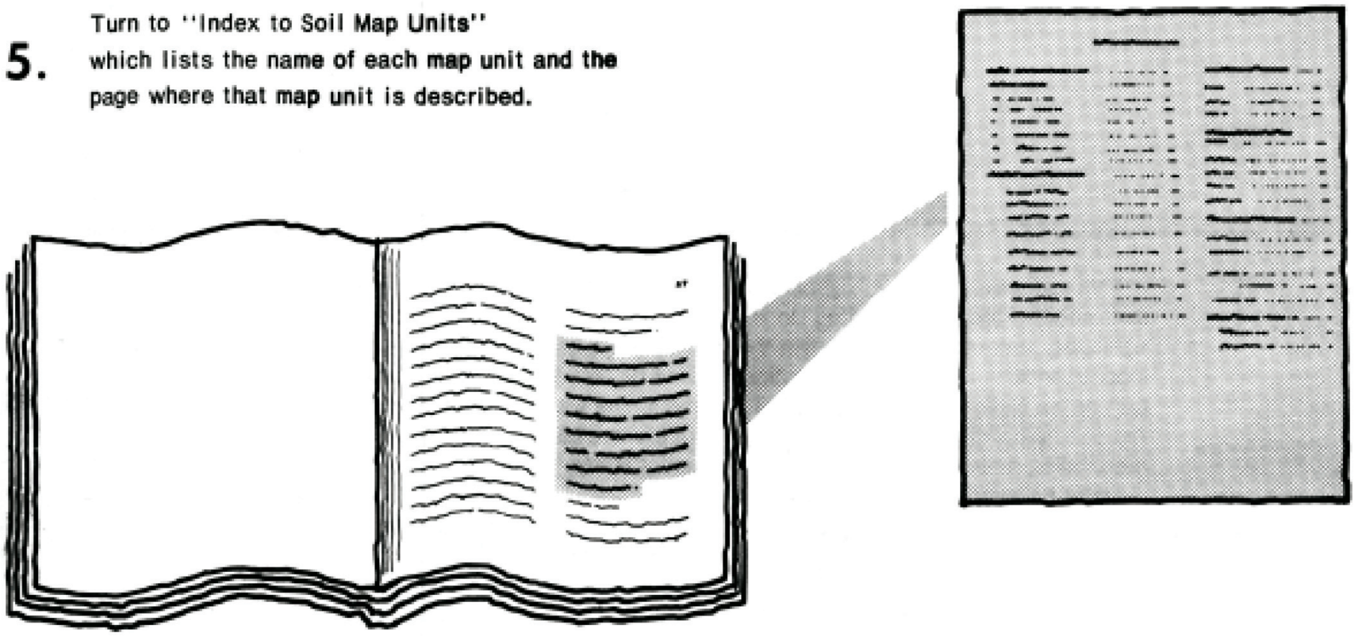


4. List the map unit symbols that are in your area.

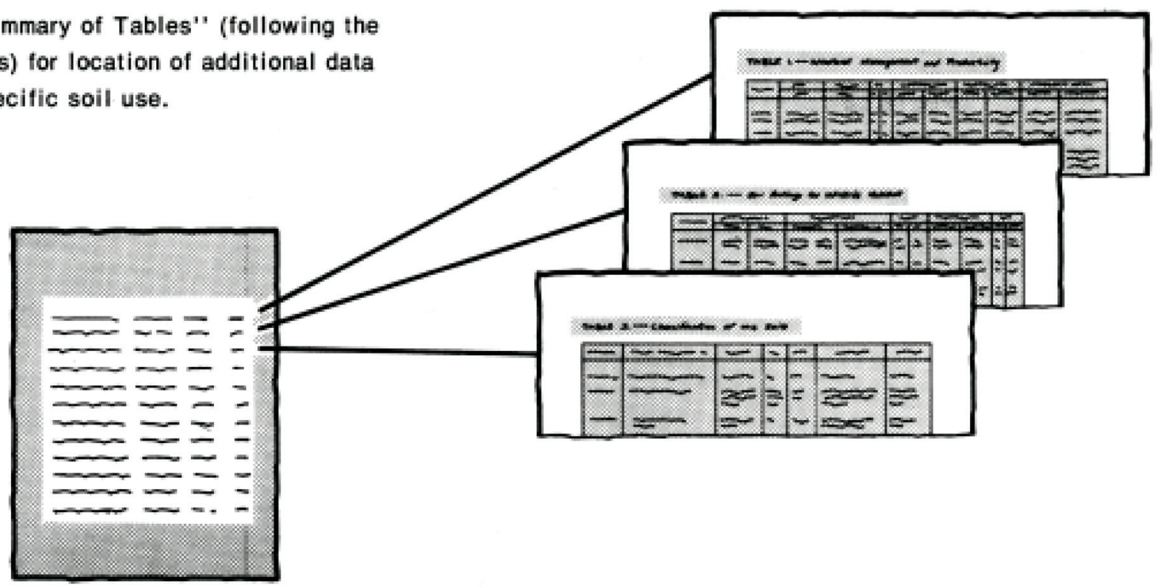


THIS SOIL SURVEY

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



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



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

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

Major fieldwork for this soil survey was completed in the period 1963-74. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1974. 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 Sumner County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover picture: Grass waterway and terraces on Farnum loam, 1 to 3 percent slopes.

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Issued April 1979

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Summary of Tables

Foreword

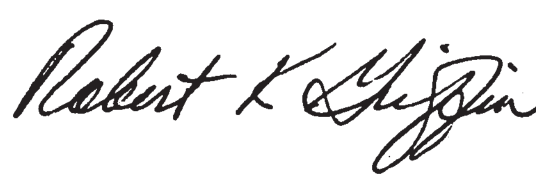
The Soil Survey of Sumner County, Kansas, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

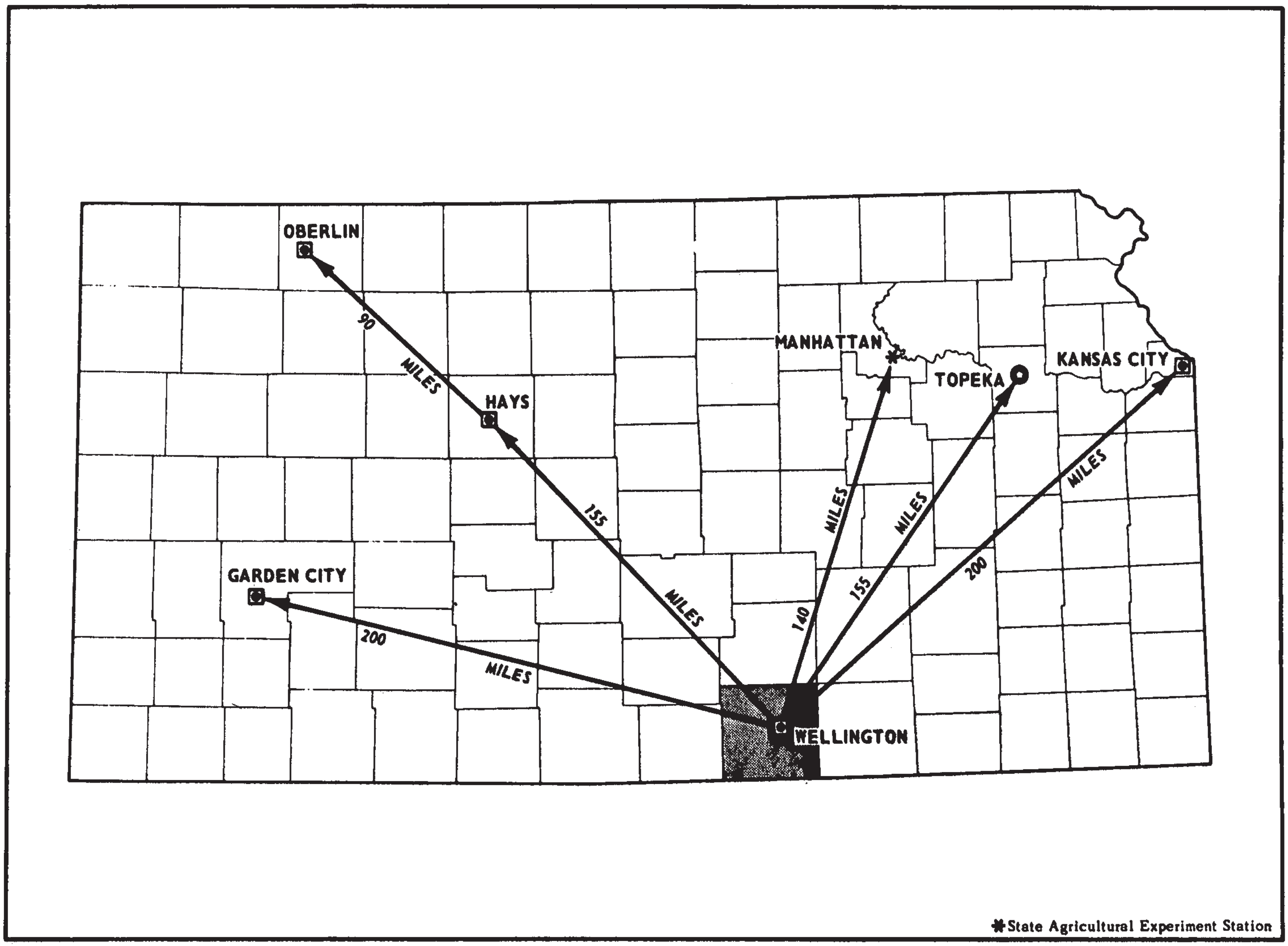
Many people assume that soils are all more or less alike. They are unaware that great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to 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 kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

We believe that this soil survey can help bring us a better environment and a better life. Its widespread use can greatly assist us in the conservation, development, and productive use of our soil, water, and other resources.



Robert K. Griffin
State Conservationist
Soil Conservation Service



Location of Sumner County in Kansas.

SOIL SURVEY OF SUMNER COUNTY, KANSAS

By Richard W. Fenwick and Ivan W. Ratcliff, Jr., Soil Conservation Service

Fieldwork by Ivan W. Ratcliff, Jr., Soil Conservation Service

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

SUMNER COUNTY is in the south-central part of Kansas. (See map on facing page.) It is 33 miles long and 36 miles wide. The total area is 759,168 acres, or 1,186 square miles. Wellington, the county seat, is near the center of the county.

Farm income in this county comes mainly from the sale of wheat, grain sorghum, alfalfa, and cattle. Farm income is frequently supplemented by work in the aircraft industry at Wichita. Most of the soils are used for dryland farming and range. The range consists mainly of sloping and strongly sloping soils and shallow or moderately deep soils.

General nature of the county

This section provides general information about the climate; physiography, relief, and drainage; and history and development of Sumner County.

Climate

By L. DEAN BARK, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

In Sumner County, winters are cold because of frequent incursions of cold, continental air from the polar regions of Canada. Summers are hot, with only occasional interruptions of cooler air from the north. Precipitation is heaviest late in spring and early in summer; most of it comes as late-evening or night-time thunderstorms. Snowfall during winter is usually light, and snow cover is not persistent. Annual precipitation is normally adequate for wheat, the major crop in Sumner County.

Table 1 gives data on temperature and precipitation for Sumner County, as recorded at Wellington for the period 1941 to 1970 (*4*). Table 2 shows probable dates of the first freeze in fall and the last freeze in spring (*3*). Table 3 provides data on length of the growing season.

In winter the average temperature is 36.6 degrees F and the average daily minimum temperature is 25.4 degrees F. The lowest temperature on record, -19 degrees F, occurred at Wellington on January 8, 1913. In summer the average temperature is 79.6 degrees F, and the average daily maximum is 91.9 degrees F. The highest temperature was 120 degrees F, recorded on July 18, 1936.

The annual precipitation is 33.95 inches. Of this, 24.39 inches, or 72 percent, usually falls during the period from April through September, which includes the growing season for most crops. Two years in 10, the April-September rainfall is less than 14.85 inches. The heaviest one-day rainfall during the period of record was 6.52 inches at Wellington on June 21, 1942.

Average annual snowfall is 13.8 inches. The greatest total occurred in the winter of 1948-49, when 38.5 inches of snow was measured. Several winters have passed with only a trace of snow.

An average of 65 percent of the possible sunshine is received annually in Sumner County. In summer and fall sunshine averages 70 to 80 percent of that possible. In January, it is only 50 percent.

The prevailing wind is from the south, but northerly winds are common in winter and early in spring. The normal annual windspeed for nearby Wichita is 12.7 miles per hour. Monthly average windspeed is greatest in March and April.

Duststorms occur occasionally in spring, when strong dry winds blow over unprotected soils. Tornadoes and severe thunderstorms, some with hail, occur occasionally. These storms are local and of short duration, and the pattern of damage is variable and spotty.

Physiography, relief, and drainage

Sumner County is in the Wellington Lowland and the Arkansas River Lowlands of the Central Lowland physiographic province (*5*). Most of the upland soils of the county are on nearly level to moderately sloping plains. The valleys are wide and nearly level except where sand dunes form.

Elevation ranges from 1,490 feet to 1,050 feet above sea level. The highest points in the county are west of

Conway Springs. The lowest points are near Geuda Springs and Drury along the Arkansas and Chikaskia Rivers.

Drainage in the county is generally to the east and south. The northeastern part of the county is drained by the Arkansas and Ninnescah Rivers and their tributaries. Slate Creek and its tributaries drain the northwestern, central, and east-central parts of the county. The Chikaskia River and its main tributaries, Bluff Creek and Fall Creek, drain the west-central and southwestern parts of the county. Shoo Fly Creek and Bitter Creek, which are tributaries of the Chikaskia River, drain the south-central and southeastern parts of the county.

History and development

Sumner County is sloping to gently rolling prairie. The boundaries of the county were defined by the legislature on May 27, 1868, when a treaty was made with the Indians. For many years Sumner County has ranked first in wheat production in the State.

Wellington, the county seat, is the largest town in the county. There are a number of smaller towns in the county.

Sumner County underwent some of the earliest agricultural development in the State. Many early settlers made the "run" on the opening of the Cherokee Strip in Oklahoma from Wellington and Caldwell. The Old Texas Trail entered Kansas about 2 miles south of Caldwell. Here the cattle drives concentrated for an overnight stop at the crossing of Bluff Creek. The marks of the trail can still be seen in places.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. 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; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

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

The areas shown on a detailed soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units for the detailed soil map are discussed in the section "Soil maps for detailed planning"; map units (associations) for the general soil map are discussed in the section "General soil map for broad land use planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices 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 is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, associations that have a distinct pattern of soils and of relief and drainage. Each association 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 unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it 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 kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

1. Bethany-Kirkland-Tabler association

Deep, nearly level and gently sloping, well drained and moderately well drained silt loams and silty clay loams on uplands

This association consists principally of nearly level and gently sloping soils on broad plains. In small areas the slopes are short and occur along intermittent drainageways (fig. 1).

This association makes up about 56 percent of the county. About 43 percent of the association is Bethany soils, 20 percent is Kirkland soils, and 7 percent is Tabler soils. Minor soils make up the remaining 30 percent.

Bethany soils are nearly level and gently sloping and are on broad plains and side slopes. They are well drained. The surface layer is dark grayish brown silt loam about 17 inches thick. The subsoil is dark grayish brown to brown, very firm clay to a depth of more than 60 inches.

Kirkland soils are nearly level and gently sloping and are on broad plains and side slopes next to drainageways. They are well drained. The surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is dark grayish brown to reddish brown, very firm clay to a depth of more than 60 inches.

Tabler soils are nearly level and are in slightly concave areas. They are moderately well drained. The surface layer is dark gray silty clay loam about 9 inches thick. The subsoil is dark gray and gray, very firm clay to a depth of more than 60 inches.

The minor soils in this association are in the Corbin, Farnum, Milan, Pond Creek, Rosehill, and Waurika series. The Corbin, Farnum, Milan, and Pond Creek soils are in positions similar to those of Bethany and Kirkland soils. The Rosehill soils are on short slopes next to drainageways. The Waurika soils, like the Tabler soils, are in depressions.

Most of this association is in wheat and grain sorghums. Other small grains and alfalfa are also grown in this associaton. Some small areas are used for range.

Most crops on soils of this association respond to fertilizer. On the nearly level soils, practices are needed to maintain fertility, tilth, and the content of organic matter. The hazard of water erosion is slight to moderate on the gently sloping soils, and it can be controlled by use of conservation measures.

2. Farnum-Vanoss-Bethany association

Deep, nearly level to sloping, well drained loams and silt loams on uplands

In this association are nearly level and gently sloping soils on broad plains and sloping soils on relatively narrow side slopes. The association is on uplands near the Arkansas and Ninnescah Rivers (fig. 2).

This association makes up about 7 percent of the county. Farnum soils make up about 31 percent of the association, Vanoss soils make up about 30 percent, and Bethany soils make up about 29 percent. Minor soils make up the remaining 10 percent.

Farnum soils are nearly level to sloping and are on side slopes and broad plains. The surface layer is dark grayish brown loam about 11 inches thick. The subsoil is dark brown, firm clay loam about 29 inches thick. The underlying material is brown sandy clay loam.

Vanoss soils are gently sloping and sloping and are typically on side slopes. In some places they are nearly level and are on foot slopes and ridgetops. The surface layer is brown silt loam about 16 inches thick. The subsoil is brown, friable clay loam to a depth of more than 60 inches.

Bethany soils are nearly level and gently sloping and are on broad plains. The surface layer is dark grayish brown silt loam about 17 inches thick. The subsoil is dark grayish brown to brown, very firm clay to a depth of more than 60 inches.

The minor soils in this association are in the Brewer, Dale, Kirkland, Milan, and Tabler series. The Tabler and Kirkland soils are clayey and are nearly level and slightly concave. The Milan soils are in positions similar to those of Farnum soils, but their color is redder than that of Farnum soils. The Brewer and Dale soils are on terraces and flood plains.

Most of this association is cultivated. Wheat is the principal crop. Minor acreages are used for alfalfa, sorghums, and soybeans, and some small areas are used for native range.

Fertility is high, but most crops respond to fertilizer and good management. Management is needed on the nearly level soils to maintain fertility and content of organic matter. Surface drainage of the nearly level soils is needed in some places. The gently sloping soils have a moderate water erosion hazard that can be controlled by use of proper conservation measures.

3. Owens-Rosehill-Renfrow association

Shallow to deep, gently sloping to steep, well drained clay loams on uplands

This association consists of gently sloping and sloping soils on wide ridgetops and side slopes and strongly sloping to steep soils on short side slopes. This association generally is in dissected areas parallel to the major streams in the county (fig. 3).

The association makes up about 7 percent of the county. Owens soils make up about 30 percent of the association, Rosehill soils make up about 28 percent, and Renfrow soils make up about 26 percent. Minor soils make up the remaining 16 percent of the association.

Owens soils are shallow and gently sloping to steep. They are on the lower one-half to lower one-third of the side slopes. Their surface layer is dark grayish brown clay loam about 4 inches thick. The subsoil is light brownish gray, very firm silty clay about 16 inches thick. The underlying material is light gray calcareous shale.

Rosehill soils are moderately deep and gently sloping and sloping. They are on the upper one-half to upper two-thirds of side slopes. Rosehill soils are mostly in the eastern half of the county. The surface layer is dark grayish brown clay loam about 10 inches thick. The next layer is light olive brown, very firm clay about 19 inches thick. The underlying material is light olive brown clay. Soft clayey shale is at a depth of 40 inches.

Renfrow soils are deep and gently sloping and sloping. They are on relatively wide ridgetops and side slopes. Renfrow soils are mostly in the western half of the county. The surface layer is dark reddish gray and reddish brown clay loam about 12 inches thick. The subsoil is reddish brown and red, very firm clay to a depth of more than 60 inches.

The minor soils in this association are in the Bethany, Kirkland, Milan, Pond Creek, and Elandco series. The Bethany and Kirkland soils are on broad, gently sloping ridgetops and side slopes. The Milan and Pond Creek soils are on nearly level and gently sloping ridgetops. The Elandco soils are on flood plains.

Most of the acreage of the gently sloping Rosehill and Renfrow soils in this association is cultivated, and wheat and grain sorghums are the main crops. About half of the acreage of the sloping Rosehill and Renfrow soils is cultivated to wheat and grain sorghum. The rest is in native range. Most of the acreage of the Owens soils is used for native range.

Fertility is low to medium. Available water capacity is low to very low. Crops generally respond to fertilizer. Good management is needed for maintaining fertility, tilth, and content of organic matter. The gently sloping and sloping soils have a moderate to severe hazard of water erosion. Conservation practices to control erosion and conserve water are needed on these soils.

4. Farnum-Shellabarger-Milan association

Deep, nearly level to sloping, well drained loams and sandy loams on uplands

This association consists of nearly level soils on broad plains, nearly level soils in relatively narrow areas on ridgetops, gently sloping soils in broad areas and on short side slopes, and sloping soils generally on short, complex side slopes.

This association makes up about 15 percent of the county. Farnum soils make up about 30 percent of the association, Shellabarger soils make up about 30 percent, and Milan soils make up about 30 percent. Minor soils make up the remaining 10 percent.

Farnum soils are nearly level to sloping. The nearly level and gently sloping soils are on broad plains and side slopes. The sloping soils are on short side slopes. The surface layer is dark grayish brown loam about 11 inches thick. The subsoil is dark brown, firm clay loam about 29 inches thick. The underlying material is brown sandy clay loam.

Shellabarger soils are gently sloping and sloping. They are on narrow ridgetops and short side slopes. The surface layer is brown sandy loam about 11 inches thick. The subsoil is reddish brown, friable fine sandy loam and sandy clay loam about 27 inches thick. The underlying material is yellowish red sandy loam.

Milan soils are nearly level to sloping. The nearly level and gently sloping soils are on broad plains and side slopes. The sloping soils are on short side slopes. The surface layer is dark grayish brown loam about 10 inches thick. The subsoil is dark brown to red, firm and very firm clay loam and sandy clay loam about 38 inches thick. The underlying material is yellowish red sandy clay loam.

The minor soils in this association are in the Bethany, Carwile, Kirkland, Rosehill, Tabler, and Vanoss series. The Bethany, Kirkland, and Vanoss soils are in broad, nearly level areas and on gently sloping side slopes. The Carwile and Tabler soils are in nearly level to slightly concave areas. Rosehill soils are on short side slopes next to drainageways.

Most of this association is cultivated. Wheat and grain sorghums are the principal crops. Some of the sloping areas are used for native range.

Fertility is medium to high, but most crops respond to fertilizer. Good management is needed on the nearly level soils for maintaining fertility, tilth, and content of organic matter. The gently sloping and sloping soils have a moderate to severe hazard of water erosion that can be controlled by use of proper conservation measures.

5. Canadian-Dale-Reinach association

Deep, nearly level, well drained sandy loams, silt loams and silty clay loams on low terraces and flood plains

This association consists of nearly level soils along the Ninnescah and Arkansas Rivers. The Canadian soils generally are nearer to the streams than Dale and Reinach soils (fig. 4).

This association makes up about 7 percent of the county. Canadian soils make up about 30 percent of the association, Dale soils make up about 30 percent, and Reinach soils make up about 30 percent. Minor soils make up the remaining 10 percent.

Canadian soils are on low terraces. The surface layer is grayish brown sandy loam about 10 inches thick. The subsoil is pale brown and yellowish brown, very friable sandy loam about 30 inches thick. The underlying material is reddish yellow loamy sand.

Dale soils are on low terraces and flood plains. The surface layer is dark grayish brown and very dark grayish brown silt loam about 24 inches thick. The subsoil is brown, firm silt loam about 10 inches thick. The underlying material is dark brown silt loam.

Reinach soils are on low terraces and flood plains. The surface layer is brown silt loam about 13 inches thick. The subsoil is brown, friable silt loam about 17 inches thick. The underlying material is light brown silt loam.

Minor soils in this association are in the Brewer, Lesho, Lincoln, Elandco, Pratt, and Tivoli series. Brewer soils are on low terraces. Lesho, Lincoln, and Elandco soils are on flood plains next to the streams. The Pratt and Tivoli soils occupy sand hills adjacent to the major streams.

Most of this association is in small grains, sorghums, alfalfa, and soybeans. The soils are well suited to alfalfa, and more alfalfa is grown in this association than in any other in the county.

Most crops on soils of this association respond to fertilizer. Lime generally is not required for wheat, sorghum, or soybeans, but it is required in places for alfalfa. Good management is needed for maintaining fertility, tilth, and content of organic matter. The hazard of soil blowing is slight to moderate on the Canadian soils, and practices are needed to control soil blowing. Most soils of this association are occasionally flooded. Floods are usually short and do not cause severe erosion or major damage to growing crops.

6. Elandco-Brewer-Reinach association

Deep, nearly level, well drained and moderately well drained silt loams and silty clay loams on low terraces and flood plains

This association consists of nearly level soils along the major streams in the county.

This association makes up about 8 percent of the county. Elandco soils make up about 50 percent of the association, Brewer soils make up 20 percent, and Reinach soils make up 12 percent. Minor soils make up the remaining 18 percent.

Elandco soils are on flood plains and low terraces throughout the county. The surface layer is very dark grayish brown silty clay loam about 45 inches thick. The underlying material is brown silty clay loam.

Brewer soils are on low terraces and flood plains. These soils are mostly in the eastern half of the county along Slate and Shoo Fly Creeks. The surface layer is very dark gray silty clay loam about 14 inches thick. The subsoil is very dark gray to dark grayish brown, very firm silty clay to a depth of more than 60 inches.

Reinach soils are on low terraces and flood plains. These soils are mostly in the western half of the county along the Chikaskia River and Fall and Bluff Creeks. The surface layer is brown silt loam about 13 inches thick. The subsoil is brown, friable silt loam about 17 inches thick. The underlying material is light brown silt loam.

Minor soils in this association are in the Crisfield, Lincoln, Dale, Pratt, and Tivoli series. The Crisfield, Lincoln, and Dale soils are on flood plains and low terraces next to the streams. The Pratt and Tivoli soils occupy sand hills adjacent to the Chikaskia River.

Most of this association is cultivated, and wheat and grain sorghums are the principal crops. Small areas are in alfalfa. The minor sandy soils are used primarily for range. Shrubs and trees are adjacent to the stream channels.

Most crops on soils of this association respond to fertilizer, good management, and proper tillage. The soils have medium to high fertility. Flooding is rare to frequent. Water erosion and damage to crops may occur during floods. Little can be done on an individual basis to prevent flooding. Major works of improvement, including levee construction and watershed protection by use of large or small water impoundment structures, would diminish the flooding hazard.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil map represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a similar profile make up a *soil series.* Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Milan series, for example, was named for the town of Milan in Sumner County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Milan loam, 1 to 3 percent slopes, is one of several phases within the Milan series.

Some map units in the survey area are made up of two or more dominant kinds of soil. Such map units are called soil complexes and undifferentiated groups.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Brewer complex is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Dale and Reinach silt loams is an undifferentiated group in this survey area.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. The Shale outcrop part of the Owens-Shale outcrop complex is the only such delineated area in this county. Some areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Requirements for sewage disposal can be obtained from the local Board of Health. Requirements for protecting built-up areas from flooding can be obtained from the State Division of Water Resources.

Ba—Bethany silt loam, 0 to 1 percent slopes. This is deep, nearly level, well drained soil on uplands. It occupies broad plains.

Typically, the surface layer is dark grayish brown silt loam about 17 inches thick; in most places it ranges from 14 to 19 inches in thickness. The subsoil is very firm clay that extends to a depth more than 60 inches; the upper part is dark grayish brown, and the middle part is dark brown and contains small calcareous concretions. Below a depth of about 48 inches the subsoil typically is brown and has common, coarse, distinct, yellowish red mottles and a few calcareous concretions. In some places the surface layer is less than 10 inches thick; in other places it is more than 19 inches thick.

Permeability is slow, and available water capacity is high. Runoff is slow, and fertility is high. The surface layer ranges from medium acid to neutral. The subsoil is neutral or mildly alkaline in the upper part and mildly alkaline or moderately alkaline in the lower part. The surface layer is friable and is easily tilled through a fairly wide range in moisture content. The subsoil has a high shrink-swell potential.

Most areas of this soil are in wheat, sorghum, and alfalfa. The soil has good potential for crops, rangeland, pasture, and windbreaks.

This soil is well suited to small grains, sorghum, and alfalfa. The main concerns of management are maintaining fertility, tilth, and organic matter content. Effective practices for conserving moisture are keeping tillage to a minimum and properly using crop residues. There is little or no erosion hazard.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has a high shrink-swell potential in the subsoil. If engineering structures are built on this soil, they should be designed to prevent damage caused by the shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel; and providing drainage outlets and expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tank systems often fail because of the slow permeability. This soil is suitable for leveling for flood irrigation if adequate water is available. Capability unit I-1; Loamy Upland range site.

Bb—Bethany silt loam, 1 to 3 percent slopes. This is a deep, gently sloping, well drained soil on uplands. It occupies broad side slopes.

Typically, the surface layer is dark grayish brown silt loam about 17 inches thick; in most places it ranges from 14 to 19 inches in thickness. The subsoil is very firm clay that extends to a depth of more than 60 inches; the upper part is dark grayish brown, and the middle part is dark brown and contains small calcareous concretions. Below a depth of about 48 inches the subsoil typically is brown and has common, coarse, distinct, yellowish red mottles and a few calcareous concretions. In some places the lower part of the subsoil does not have mottles. In places the surface layer is less than 14 inches thick, and in places it is more than 19 inches thick.

Included in mapping are small areas of Renfrow, Farnum, and Pond Creek soils that make up about 5 percent of the mapped acreage. These included areas are in the same positions as Bethany soils.

Permeability is slow, and available water capacity is high. Runoff is medium, and fertility is high. The surface layer ranges from medium acid to neutral. The subsoil is neutral or mildly alkaline in the upper part and mildly alkaline or moderately alkaline in the lower part. The surface layer is friable and is easily tilled through a fairly wide range in moisture content. The subsoil has a high shrink-swell potential.

Most areas of this soil are in wheat, sorghum, and alfalfa. The soil has good potential for crops, rangeland, pasture, and windbreaks.

This soil is well suited to small grains, sorghum, and alfalfa. There is a moderate hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Proper use of fertilizer and crop residues helps to maintain fertility, organic matter content, and tilth.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has a high shrink-swell potential in the subsoil. If engineering structures are built on this soil, they should be designed to prevent damage caused by shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel; and providing drainage outlets and expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tank systems often fail because of the slow permeability. This soil is suitable for bench leveling for flood irrigation if adequate water is available. Capability unit IIe-1; Loamy Upland range site.

Br—Brewer silty clay loam (0 to 2 percent slopes). This is a deep, nearly level, moderately well drained soil in broad areas on low terraces and flood plains. It is rarely flooded.

Typically, the surface layer is very dark gray silty clay loam about 14 inches thick; over most of the area it ranges from about 10 to 15 inches in thickness. The subsoil is very firm silty clay that extends to a depth of more than 60 inches; the upper part is very dark gray, the middle part is very dark grayish brown, and the lower part is dark grayish brown. In about 10 percent of the area the surface layer is silty clay or it is silty clay loam less than 10 inches thick.

Permeability is slow, and available water capacity is high. Runoff is slow, and fertility is medium. The surface layer is slightly acid or neutral. The subsoil is neutral or mildly alkaline in the upper part and neutral to moderately alkaline in the lower part. The surface layer has a moderate shrink-swell potential, and the subsoil has a high shrink-swell potential. The surface layer is friable, but tillage should be performed only under optimum moisture conditions.

Most areas of this soil are farmed. Wheat is the principal crop. Smaller acreages are used for soybeans, sorghum, and alfalfa. This soil has good potential for crops, rangeland, rangeland wildlife habitat, pasture, and windbreaks.

This soil is well suited to small grains, soybeans, sorghum, and alfalfa. It has a slight hazard of flooding, and crop damage is slight. The hazard of flooding and the slow permeability moderately limit the choice of crops and the time of tillage operations. Tilling when the soil is too wet or too dry causes the soil to be cloddy. Minimum tillage operations performed at optimum moisture conditions and proper use of crop residues help to maintain tilth, content of organic matter, and fertility.

This soil is well suited to rangeland. It receives extra moisture as runoff from nearby higher areas and from flooding. Grazing when the soil is too wet causes surface compaction and poor tilth. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to urban uses such as homes, buildings, and streets and as a source of roadfill because of the flooding hazard and the high shrink-swell potential in the subsoil. If engineering structures are built on this soil, they should be designed to prevent damage caused by the shrinking and swelling and by flooding. Some treatment methods are using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Areas should be protected from flooding. Sewage lagoons or central sewage systems can be used for waste disposal. Septic tank systems often fail because of the slow permeability. This soil is suitable for leveling for irrigation if adequate drainage is provided. Capability unit I-2; Loamy Lowland range site.

Bs—Brewer complex (0 to 2 percent slopes). This complex consists of deep, nearly level, moderately well drained soils on low terraces and flood plains. These soils are rarely flooded. This complex is 55 to 85 percent Brewer silty clay loam and 15 to 45 percent salt-affected soils. Individual areas of this mapping unit are small, and they generally occur away from the stream.

Typically, the Brewer soil has a very dark gray silty clay loam surface layer about 14 inches thick; it ranges from 10 to 15 inches in thickness. The subsoil is very firm silty clay that extends to a depth of more than 60 inches; the upper part is very dark gray, the middle part is very dark grayish brown, and the lower part is dark grayish brown. White crystalline materials are in the subsoil in some places.

Typically, the salt-affected soils have a light-colored surface layer 2 to 5 inches thick that forms a crust when dry but puddles after heavy rain; the texture is silty clay loam or clay loam. The subsoil is silty clay that is massive or has weak, blocky structure. In most places the subsoil contains white crystalline salts. The amount and distribution of salts and alkali vary (fig. 5).

Permeability is slow, and available water capacity is high. Runoff is slow. Fertility is medium in the Brewer soil and low in the salt-affected soil. The surface layer has a moderate shrink-swell potential, and the subsoil has a high shink-swell potential.

Most of this complex is cultivated. Some formerly cultivated areas are idle. This complex has only poor potential for crops, windbreaks, and most engineering uses. It has only fair potential for rangeland and pasture and good potential for open-land and rangeland wildlife habitat.

Moderately salt-tolerant crops such as barley, grain sorghum, and rye are the principal crops. Wheat and alfalfa are poorly suited. Crop growth is uneven because of the variability of the soils. Crop growth is poor in the salt-affected areas, which are difficult to till and do not dry out readily. Returning all crop residues to the salt-affected soils and adding other organic matter help to keep the salt-affected areas from spreading. Tilling when the soils are too wet or too dry causes them to be cloddy. This complex also has a slight hazard of flooding; crop damage is slight.

These soils are moderately well suited to rangeland. Moisture is increased in these soils by runoff from nearby higher areas and by flooding. Grazing when the soils are too wet causes surface compaction and poor tilth. Grass growth is uneven because of the variability of the soils. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, proper placement of salt and water, and restricted use during wet periods help to keep the grass and soils in good condition.

These soils are poorly suited to windbreaks. Trees grow well on Brewer silty clay loam once they are established. However, trees in the salt-affected areas grow poorly even if they survive. Growth is variable because of the variability of the soils.

These soils are poorly suited to homesites, building sites, streets, and other urban uses, as a source of roadfill, because of the flooding hazard and the high shrink-swell potential in the subsoil. If engineering structures are built, they should be placed on the Brewer soil, and they should be designed to withstand the damaging effects of shrinking and swelling and flooding. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel; and providing drainage outlets and expansion joints. The areas should be protected from flooding. The salt-affected soils contain soluble salts in the subsoil that corrode metal. They are also poorly suited for lawns. Septic tank systems often fail because of the slow permeability, but sewage lagoons or a central sewage system can be used for waste disposal. Capability unit IVs-1; Brewer soil in Loamy Lowland range site, salt-affected soils in Saline Lowland range site.

Ca—Canadian sandy loam (0 to 1 percent slopes). This is a deep, nearly level, well drained soil on stream terraces. It is in long, narrow strips along streams, but it is high enough that it is rarely flooded, about once in 5 to 10 years.

Typically, the surface layer is grayish brown sandy loam about 10 inches thick. The subsoil is very friable sandy loam about 30 inches thick; the upper part is pale brown, and the lower part is light yellowish brown. The substratum is reddish yellow loamy fine sand. In some places the soil is redder. In some areas it is more sandy below the surface layer. In some places the surface layer is loamy fine sand 2 to 8 inches thick.

Included in mapping are small areas of Lesho and Dale soils in similar positions. These soils make up about 10 percent of the mapping unit. They contain more clay in the solum than Canadian soils, and Lesho soils are somewhat poorly drained.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is slow, and fertility is medium. The solum is slightly acid or neutral. The surface layer is very friable and is easily tilled through a wide range in moisture content. This soil has a low shrink-swell potential.

Most areas of this soil are cultivated. Wheat and sorghum are the principal crops, and some alfalfa is grown. This soil has good potential for crops, rangeland, rangeland wildlife habitat, pasture, and windbreaks. It has good to poor potential for recreation and engineering uses.

This soil is well suited to small grains, sorghum, and alfalfa. It has a slight to moderate hazard of soil blowing on cultivated areas during short periods of the year when there is no plant cover. There is also a slight hazard of erosion from flooding. Crop damage from flooding is slight. Proper use of crop residues and minimum tillage help to control soil blowing and conserve moisture.

This soil is well suited to rangeland. It receives extra moisture from adjacent upland soils or from flooding. Overgrazing reduces the protective plant cover and causes deterioration of the plant community. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the hazard of flooding. It is a good source of topsoil. If this soil is to be used for building sites, the areas should be protected from flooding. It is suitable for leveling for flood irrigation or for sprinkler irrigation. Capability unit I-2; Sandy Lowland range site.

Cc—Carwile soils (0 to 1 percent slopes). This undifferentiated group consists of deep, nearly level, somewhat poorly drained soils on uplands. It occupies small depressional areas that are roughly circular.

Typically, the surface layer is grayish brown fine sandy loam or clay loam about 10 inches thick; it ranges from 8 to 20 inches in thickness. The subsoil is very firm clay about 29 inches thick and is light brownish gray mottled with strong brown. The substratum is light brownish gray sandy clay loam.

Included in mapping are about 10 percent Shellabarger soils, 5 percent Farnum soils, and 5 percent Milan soils. These soils are in higher, convex areas. They are well drained and have a less clayey subsoil than Carwile soils.

Permeability is slow, and available water capacity is moderate. Runoff is slow, and fertility is medium. The solum is slightly acid or neutral. The surface layer is friable. The subsoil has a high shrink-swell potential. This soil has a perched water table in wet seasons.

About two-thirds of the acreage of this undifferentiated group is used for wheat and sorghum. The rest is used for pasture and range. The soils have good potential for crops, rangeland, and pasture but only fair potential for windbreaks. They have poor potential for recreation and engineering uses.

These soils are well suited to small grains and sorghum. Alfalfa does not grow well because of soil wetness. Excessive wetness is a moderate hazard. These soils are saturated with water at some time during most years. During wet weather, water is sometimes ponded on the surface for several days. Planting and harvesting are often delayed, and crops are drowned in some years. In areas that have a fine sandy loam surface layer, there is a slight to moderate hazard of soil blowing during short periods of the year when there is little or no plant cover. Surface drainage is possible in some places where suitable outlets are available. Minimum tillage and proper use of crop residues help to control soil blowing.

These soils are well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

These soils are moderately well suited to windbreaks. The clayey subsoil releases moisture slowly. The main problem is excessive wetness. Survival in low areas where water ponds is likely to be poor. Draining these areas is helpful. Rainfall is likely to be irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

These soils are poorly suited to most urban uses, including building sites, because of the high shrink-swell potential in the subsoil and wetness. If engineering structures are built they need to be designed to prevent damage caused by the shrinking and swelling. Drainage needs to be provided. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel; providing drainage outlets; and including expansion joints. Areas should be protected from runoff from adjacent areas. Septic tank systems often fail because of slow permeability and seasonal wetness. Sewage lagoons or a central sewage system can be used for waste disposal. These soils are suitable for leveling for irrigation if adequate drainage is provided. The included areas of Shellabarger sandy loam, Farnum loam, and Milan loam are better suited to most engineering uses than Carwile soils. Capability unit IIw-1; Sandy range site.

Cr—Corbin silt loam (0 to 2 percent slopes). This is a deep, nearly level, well drained soil on uplands. It typically is in broad areas, but some areas are small and irregular in shape.

Typically, the surface layer is dark grayish brown silt loam about 16 inches thick; it ranges from 12 to 16 inches in thickness. The subsoil is about 32 inches thick; the upper part is brown, friable silty clay loam, and the lower part is dark brown, very firm clay. The substratum is brown silty clay loam that has a few small calcareous concretions. In some places the depth to the clay portion of the subsoil is less than 20 inches. In some areas the subsoil is less clayey than it is in the typical profile.

Permeability is moderate in the upper part of the subsoil and slow in the lower part. Available water capacity is high. Runoff is slow, and fertility is high. The surface layer ranges from medium acid to neutral, and the subsoil is slightly acid or neutral. The surface layer is friable and easily tilled through a fairly wide range in moisture content. The lower part of the subsoil has a high shrink-swell potential.

This soil is mostly in wheat and sorghum. It has good potential for crops, rangeland, rangeland wildlife habitat, pasture, and windbreaks.

This soil is well suited to small grains, sorghum, and alfalfa. The main concerns of management are maintaining fertility, tilth, and organic matter content. Effective practices for conserving moisture are keeping tillage to a minimum and properly using crop residues. Generally there is little or no erosion hazard, but in a few places where slopes are long there is a slight hazard of water erosion.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has a moderate shrink-swell potential in the upper part of the subsoil and a high shrink-swell potential in the lower part of the subsoil. If engineering structures are built on this soil, they should be designed to withstand the damaging effects of shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel; providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system can be used for waste disposal. Septic tank systems often fail because of the slow permeability. This soil is suitable for leveling for flood irrigation if adequate water is available. Capability unit I-1; Loamy Upland range site.

Cs—Crisfield sandy loam (0 to 2 percent slopes). This is a deep, nearly level, well drained soil on low terraces. It is in long, narrow strips along streams, but it is high enough that it is only flooded about once in 5 to 10 years.

Typically, the surface layer is brown sandy loam about 14 inches thick; it ranges from 10 to 20 inches in thickness. The subsoil is reddish brown, friable sandy loam about 36 inches thick. The substratum is yellowish red sandy loam. In some areas the soil is more sandy below the surface layer.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is slow, and fertility is medium. The solum ranges from medium acid to neutral. The surface layer is friable and easily tilled through a wide range in moisture content. This soil has a low shrink-swell potential.

This soil is mostly in wheat and sorghum; some small areas are used for range. This soil has good potential for crops, rangeland, rangeland wildlife habitat, pasture, and windbreaks. It has good to poor potential for recreation and engineering uses.

This soil is well suited to small grains, sorghum, and alfalfa. It has a moderate hazard of soil blowing in cultivated areas during short periods of the year when there is little or no plant cover. Also, there is a slight hazard of flooding, but floods are usually short and do little or no damage to crops. Proper use of crop residues and minimum tillage help to control soil blowing and conserve moisture.

This soil is well suited to rangeland. It receives extra moisture because of runoff from adjacent upland soils and flooding. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the hazard of flooding. If it is to be used for this purpose, the area should be protected from flooding. This soil is a good source of topsoil. It is suitable for leveling for flood irrigation or for sprinkler irrigation. Capability unit I-2; Sandy Lowland range site.

Da—Dale silt loam, 2 to 8 percent slopes. This is a deep, sloping, well drained soil on escarpments between flood plains and low terraces. It is also along intermittent drainageways and swales on flood plains and low terraces. Areas are relatively narrow and typically are 250 to 500 feet wide. Most areas are rarely flooded.

Typically, the surface layer is silt loam about 24 inches thick; the upper part is dark grayish brown, and the lower part is very dark grayish brown. The surface layer ranges from 12 to 30 inches in thickness. The subsoil is brown to dark brown, friable silt loam about 10 inches thick. The substratum is brown to dark brown silt loam. In some places the soil is fine sandy loam throughout.

Permeability is moderate, and available water capacity is high. Runoff is rapid, and fertility is medium. The surface layer ranges from slightly acid to mildly alkaline, and the subsoil ranges from slightly acid to moderately alkaline. The surface layer is friable and easily tilled through a fairly wide range in moisture content. This soil has a moderate shrink-swell potential.

This soil is mostly in wheat, sorghum, and alfalfa. Some steeper, more narrow areas are idle. This soil has good potential for crops, rangeland, pasture, and windbreaks. It has good potential for open-land and rangeland wildlife habitat and good to poor potential for recreation. It has good to poor potential for engineering uses.

This soil is moderately well suited to small grains, sorghum, and alfalfa. The hazard of water erosion is severe if the soil is cultivated and not protected. Deep gullies extending back from the slope into adjoining soils frequently develop when erosion continues. Terracing is impractical in most places because of short slopes. Diversion terraces built on adjoining soils help to control gullies. Tillage operations and planting on the contour help to control erosion. Returning all crop residue to the soil and adding manure help to improve tilth and maintain organic matter content. Crop damage from flooding is slight.

This soil is well suited to rangeland. It receives extra moisture because of runoff from adjacent soils or flooding. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is well suited to windbreaks; however, there is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigating of trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the hazard of flooding. If it is to be used for this purpose, the area should be protected from flooding. This soil is a good source of topsoil. Capability unit IIIe-1; Loamy Lowland range site.

Dr—Dale and Reinach silt loams (0 to 1 percent slopes). This undifferentiated group consists of deep, nearly level, well drained soils on low terraces and flood plains. Most areas are rarely flooded. The soils of this unit generally are in long, narrow areas parallel to streams. They occur individually or in combination in the mapped areas. Some areas are almost entirely either Dale silt loam or Reinach silt loam; others are divided either in equal or unequal proportions. In some places the soil is silty clay loam throughout.

Typically, the Dale soil has a silt loam surface layer about 24 inches thick; the upper part is dark grayish brown and the lower part is very dark grayish brown; the surface layer ranges from 12 to 30 inches in thickness. The subsoil is brown to dark brown, friable silt loam about 10 inches thick. The substratum is brown to dark brown silt loam.

Typically, the Reinach soil has a brown to dark brown silt loam surface layer about 13 inches thick; the surface layer ranges from 13 to 25 inches in thickness. The subsoil is brown to dark brown, friable silt loam about 17 inches thick. The substratum is light brown silt loam that is calcareous.

Permeability is moderate in both soils, and available water capacity is high in the Dale soil and very high in the Reinach soil. Runoff is slow, and fertility is high. The surface layer of the Dale soil ranges from slightly acid to mildly alkaline, and the subsoil ranges from slightly acid to moderately alkaline. The surface layer of the Reinach soil is slightly acid or neutral, and the subsoil ranges from neutral to moderately alkaline. The surface layer of both soils is friable and easily tilled through a fairly wide range in moisture content. The Dale soil has moderate shrink-swell potential, and the Reinach soil has low shrink-swell potential.

These soils are nearly all cultivated to wheat, sorghum, and alfalfa. The soils have good potential for crops, rangeland, pasture, and windbreaks; for open-land and rangeland wildlife habitat; and for recreation. They have good to poor potential for engineering uses.

These soils are well suited to small grains, sorghum, and alfalfa. The main concerns of management are maintaining fertility, tilth, and content of organic matter. Properly using crop residues and keeping tillage to a minimum help to accomplish these objectives, as well as conserve moisture. There is little or no erosion hazard. Most areas are rarely flooded, and crop damage from flooding is slight.

These soils are well suited to rangeland. They receive extra moisture from adjacent upland soils or from flooding. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

These soils are well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents. These soils are well suited to fruit trees (fig. 6).

These soils are poorly suited to building sites because of the hazard of flooding. If they are to be used for this purpose, the areas should be protected from flooding. The soils are a good source of topsoil. They are suitable for leveling for irrigation. Capability unit I-2; Loamy Lowland range site.

Ea—Elandco silty clay loam (0 to 1 percent slopes). This is a deep, nearly level, well drained soil on low terraces and flood plains. It generally is in long, narrow areas parallel to streams. Most areas are rarely flooded.

Typically, the surface layer is very dark grayish brown silty clay loam about 45 inches thick; it ranges from 20 to 50 inches in thickness. The underlying material is brown silty clay loam. In some places the texture is silt loam throughout. In a few places the soil is calcareous above a depth of 10 inches.

Included in mapping are about 5 percent Brewer soils and about 5 percent Reinach soils in similar positions.

Permeability is moderate, and available water capacity is high. Runoff is slow, and fertility is high. The surface layer is slightly acid or neutral. The subsoil ranges from slightly acid to moderately alkaline. The surface layer is friable and fairly easily tilled. The soil has a moderate shrink-swell potential.

Most areas of this soil are in wheat, sorghum, soybeans, and alfalfa. This soil has good potential for crops, rangeland, rangeland wildlife habitat, pasture, and windbreaks. It has only fair potential for recreation and fair to poor potential for most engineering uses.

This soil is well suited to small grains, sorghum, soybeans, and alfalfa. The main concerns of management are maintaining fertility, tilth, and content of organic matter. Properly using crop residues and keeping tillage to a minimum help to accomplish these objectives, as well as to conserve moisture. There is little or no erosion hazard. Most areas are rarely flooded, and crop damage is slight.

This soil is well suited to rangeland. It receives extra moisture because of runoff from adjacent upland soils or because of flooding. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the hazard of flooding. If it is to be used for this purpose, the area should be protected from flooding. This soil is suitable for leveling for flood irrigation. Capability unit I-2; Loamy Lowland range site.

Ec—Elandco silt loam, frequently flooded (0 to 2 percent slopes). This is a deep, nearly level, well drained soil on flood plains. It is along intermittent drainageways in areas 100 to 450 feet wide and a few hundred feet to more than a mile long. These areas are frequently flooded.

Typically, the surface layer is very dark grayish brown silt loam about 45 inches thick; it ranges from 20 to 50 inches in thickness, and it is silt loam, loam, silty clay loam, or clay loam. The underlying material is brown to dark brown loam. In some areas the soil is silty clay loam throughout; in some areas it has a silty clay loam surface layer and a silty clay subsoil.

Permeability is moderate, and available water capacity is high. Runoff is slow, and fertility is high. The surface layer ranges from medium acid to mildly alkaline, and the subsoil ranges from slightly acid to moderately alkaline. This soil has a moderate shrink-swell potential.

Most areas of this soil are used for rangeland or pasture. A few small areas are cultivated. This soil has poor potential for crops but good potential for rangeland, pasture, and windbreaks. It has fair potential for open-land, wetland, and rangeland wildlife habitat. It has poor potential for recreation and for most engineering uses.

This soil is better suited to rangeland than it is to other uses. It receives extra moisture because of runoff from adjacent upland soils and flooding. Frequent flooding and the resulting scouring and deposition make it very difficult to farm. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Fences are hard to maintain because of the frequent flooding. Trees, brush, and weeds tend to invade rangeland on this soil. Proper stocking rates, deferred-rotation grazing, proper placement of salt and water, and control of undesirable vegetation help to keep the grass in good to excellent condition. Sites for ponds are plentiful in areas adjacent to upland soils.

This soil is well suited to windbreaks. Frequent flooding and the resulting scouring and deposition can damage young windbreaks. Older trees catch debris in the floodwaters. This soil receives extra moisture because of runoff from adjacent upland soils and flooding. Despite this, rainfall during part of the growing season is likely to be inadequate for maximum growth of trees, and irrigation helps to promote growth. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to recreation and most urban uses because of the hazard of flooding. If it is used for these purposes the area should be protected from flooding. This soil is a good source of topsoil. Capability unit Vw-1; Loamy Lowland range site.

Fa—Farnum loam, 0 to 1 percent slopes. This is a deep, nearly level, well drained soil on uplands. It occupies broad plains.

Typically, the surface layer is dark grayish brown loam about 11 inches thick; it ranges from 8 to 13 inches in thickness. The subsoil is brown to dark brown, firm clay loam about 29 inches thick. In some places it is more clayey or redder. The substratum is brown sandy clay loam.

Permeability is moderately slow, and available water capacity is high. Runoff is slow, and fertility is high. The surface layer is slightly acid or neutral, and the subsoil ranges from slightly acid to mildly alkaline. The surface layer is friable and easily tilled through a fairly wide range in moisture content. The subsoil has a moderate shrink-swell potential.

Most areas of this soil are in wheat and sorghum. This soil has good potential for crops, rangeland, hay and pasture (fig. 7), and windbreaks. It has good potential for open-land and rangeland wildlife habitat. It has good to fair potential for recreation and for most engineering uses.

This soil is well suited to small grains, sorghum, and alfalfa. The main concerns of management are maintaining fertility, tilth, and organic matter content. Effective practices for conserving moisture are keeping tillage to a minimum and properly using crop residues. There is little or no erosion hazard.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites because of the moderate shrink-swell potential in the subsoil. Design should prevent damage caused by shrinking and swelling. This soil is a good source of topsoil. Sewage lagoons or a central sewage system can be used for waste disposal. Septic tank systems are subject to failure because of the moderately slow permeability. This soil is suitable for leveling for irrigation if adequate water is available. Capability unit I-1; Loamy Upland range site.

Fb—Farnum loam, 1 to 3 percent slopes. This is a deep, gently sloping, well drained soil on uplands. It occupies broad side slopes.

Typically, the surface layer is dark grayish brown loam about 11 inches thick; it ranges from 8 to 13 inches in thickness. The subsoil is brown to dark brown, firm clay loam about 29 inches thick. The substratum is brown sandy clay loam. In some places the subsoil is more clayey or redder. In some areas the soil has a sandy loam subsoil.

Permeability is moderately slow, and available water capacity is high. Runoff is medium, and fertility is high. The surface layer is slightly acid or neutral, and the subsoil ranges from slightly acid to mildly alkaline. The surface layer is friable and easily tilled through a fairly wide range in moisture content. The subsoil has a moderate shrink-swell potential.

Most areas of this soil are in wheat and sorghum. This soil has good potential for crops, rangeland, pasture, and windbreaks. It has good potential for open-land and rangeland wildlife habitat. It has good to fair potential for recreation and for most engineering uses.

This soil is well suited to small grains, sorghum, and alfalfa. The hazard of water erosion is moderate if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Proper use of fertilizer and crop residues helps to maintain fertility, organic matter content, and tilth.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites because of the moderate shrink-swell potential in the subsoil. Design should prevent damage caused by shrinking and swelling. This soil is a good source of topsoil. Sewage lagoons or a central sewage system can be used for waste disposal. Septic tanks are subject to failure because of the moderately slow permeability. This soil is suitable for bench leveling for irrigation if adequate water is available. Capability unit IIe-1; Loamy Upland range site.

Fc—Farnum loam, 3 to 6 percent slopes. This is a deep, sloping, well drained soil on uplands. It typically is on short side slopes.

Typically, the surface layer is dark grayish brown loam about 11 inches thick; it ranges from 8 to 13 inches in thickness. The subsoil is brown to dark brown, firm clay loam about 29 inches thick. In some places, however, the subsoil is reddish. The substratum is brown sandy clay loam. In some areas this soil has a sandy loam surface layer, and in places it has a sandy clay loam subsoil.

Included in mapping are about 5 percent soils that are similar to Farnum soils but have shale at a depth of 30 to 45 inches. These areas are typically in the lower part of delineations.

Permeability is moderately slow, and available water capacity is high. Runoff is rapid, and fertility is high. The surface layer is slightly acid or neutral, and the subsoil ranges from slightly acid to mildly alkaline. The surface layer is friable and easily tilled through a fairly wide range in moisture content. The subsoil has a moderate shrink-swell potential.

About 70 percent of the acreage of this soil is in wheat and sorghum, and the rest is rangeland. The soil has good potential for crops, rangeland, pasture, and windbreaks. It has good potential for open-land and rangeland wildlife habitat. It has good to fair potential for recreation and for most engineering uses.

This soil is moderately well suited to small grains, sorghum, and alfalfa. There is a severe hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Proper use of fertilizer and crop residues helps to maintain fertility, organic matter content, and tilth and conserves moisture.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is well suited to windbreaks; however, there is a severe hazard of water erosion while a windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigating the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building site development because of the moderate shrink-swell potential in the subsoil. Buildings should be designed to withstand the effects of shrinking and swelling. This soil is a good source of topsoil. Septic tank systems are subject to failure because of the moderately slow permeability. This soil is not well suited to sewage lagoons because of the slope. The slope can be modified according to design, or a central sewage system can be used. Capability unit IIIe-1; Loamy Upland range site.

Fd—Farnum loam, 2 to 6 percent slopes, eroded. This is a deep, sloping, well drained soil on uplands. It typically is on short side slopes along intermittent drainageways, but some delineations are relatively large areas on irregular side slopes.

Typically, the surface layer is dark grayish brown loam about 5 inches thick; in most places it ranges from 4 to 7 inches in thickness. The original surface layer has been thinned by erosion, and material from the subsoil has been mixed into the plow layer. The subsoil is brown to dark brown, firm clay loam about 29 inches thick. The substratum is brown sandy clay loam. In some places the surface layer is 8 to 13 inches thick. In some areas the subsoil is redder, and in some areas it is sandy clay loam.

Included in mapping are about 5 percent soils that are similar to Farnum soils but have shale at a depth of 20 to 36 inches. These areas are typically in the lower part of delineations.

Permeability is moderately slow, and available water capacity is high. Runoff is rapid, and fertility is high. The surface layer is slightly acid or neutral, and the subsoil ranges from slightly acid to mildly alkaline. The surface layer is friable and fairly easily tilled through a fairly wide range in moisture content.

About 80 percent of the acreage of this soil is in wheat and sorghum. The rest is formerly cultivated land that is idle or has been reseeded to native grass. This soil has good potential for rangeland and pasture and fair potential for crops and windbreaks. It has good potential for open-land and rangeland wildlife habitat. It has good to fair potential for recreation and for most engineering uses.

This soil is moderately well suited to small grains and alfalfa and poorly suited to sorghum. There is a very severe hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Returning all crop residue to the soil and adding manure help to improve tilth and maintain organic matter content. Including a legume in the rotation is beneficial.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces the ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is moderately well suited to windbreaks; however, there is a very severe hazard of water erosion while the windbreaks are being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building site development because of the moderate shrink-swell potential in the subsoil. Buildings should be designed to withstand the effects of shrinking and swelling. This soil is not a good source of topsoil, because the surface layer is thin. Septic tank systems are subject to failure because of the moderately slow permeability. This soil is not well suited to sewage lagoons because of the slope. The slope can be modified by design, or a central sewage system can be used. Capability unit IIIe-5; Loamy Upland range site.

Ka—Kirkland silt loam, 0 to 1 percent slopes. This is a deep, nearly level, well drained soil on broad plains of uplands.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick; in most places thickness ranges from 8 to 14 inches. The subsoil is very firm clay that extends to a depth of more than 60 inches; the upper part is dark grayish brown, and the next part is brown to dark brown and has a few small calcareous concretions. Below a depth of about 48 inches the subsoil is reddish brown and has a few small calcareous concretions. In some places the surface layer is 14 to 19 inches thick.

Permeability is very slow, and available water capacity is moderate. Runoff is slow, and fertility is medium. Reaction of the surface layer ranges from medium acid to neutral. The subsoil ranges from neutral to moderately alkaline. The surface layer is friable and easily tilled through a fairly wide range in moisture content. The subsoil has a high shrink-swell potential.

Most areas of this soil are in wheat and sorghum. This soil has good potential for crops, rangeland, and pasture but only fair potential for windbreaks. It has good potential for open-land and rangeland wildlife habitat. It has good to poor potential for recreation and engineering uses.

This soil is well suited to small grains, sorghum (fig. 8), and alfalfa. The clayey subsoil is a moderate limitation for crops. The main concerns of management are maintaining fertility, tilth, and organic matter content. Crops grown on this soil are sometimes damaged by too much moisture during periods of excessive rainfall. Surface drainage is needed in places, and good management of crop residue is needed to keep the surface layer porous and to help prevent crusting. There is little or no erosion hazard.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive grasses to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is moderately well suited to windbreaks. The clayey subsoil releases moisture slowly. Water collects in some low areas during periods of excessive rainfall, and in places trees are damaged in these areas. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the high shrink-swell potential of the subsoil. If engineering structures are built on this soil, they should be designed to withstand the effects of shrinking and swelling. Some ways to do this are using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tank systems often fail because of the very slow permeability. Capability unit IIs-1; Clay Upland range site.

Kb—Kirkland silt loam, 1 to 3 percent slopes. This is a deep, gently sloping, well drained soil on uplands on broad side slopes.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick; in most places it ranges from 8 to 14 inches in thickness. The subsoil is very firm clay to a depth of more than 60 inches; the upper part is dark grayish brown, and the next part is brown to dark brown and has a few small calcareous concretions. Below a depth of about 48 inches the subsoil is reddish brown and has a few small calcareous concretions. In some places the surface layer is 14 to 19 inches thick, and in a few places the surface layer is 4 to 7 inches thick.

Permeability is very slow, and available water capacity is moderate. Runoff and fertility are medium. Reaction of the surface layer ranges from medium acid to neutral. The subsoil ranges from neutral to moderately alkaline. The surface layer is friable and easily tilled through a fairly wide range in moisture content. The subsoil has a high shrink-swell potential.

Most areas of this soil are in wheat and sorghum. This soil has good potential for crops, rangeland, and pasture and fair potential for windbreaks. It has good potential for open-land and rangeland wildlife habitat. It has good to poor potential for recreation and engineering uses.

This soil is moderately well suited to small grains, sorghum, and alfalfa. The clayey subsoil releases moisture slowly. There is a severe hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Good management of crop residue is needed to keep the surface layer porous and to help prevent crusting.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is moderately well suited to windbreaks. The clayey subsoil releases moisture slowly. There is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the high shrink-swell potential of the subsoil. Engineering structures built on this soil should be designed to withstand the effects of shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tanks often fail because of the very slow permeability. Capability unit IIIe-2; Clay Upland range site.

Kc—Kirkland silty clay loam, 1 to 3 percent slopes, eroded. This is a deep, gently sloping, well drained soil on uplands in narrow areas along intermittent drainageways.

Typically, the surface layer is very dark grayish brown silty clay loam about 5 inches thick; in most places it ranges from 4 to 7 inches in thickness. The original surface layer has been thinned by erosion, and material from the subsoil has been mixed into the plow layer. The subsoil is very firm clay to a depth of more than 60 inches; the upper part is dark grayish brown, and the next part is brown to dark brown and has a few small calcareous concretions. Below a depth of about 48 inches the subsoil is reddish brown and has a few small calcareous concretions. In some places the surface layer is 8 to 14 inches thick.

Permeability is very slow, and available water capacity is moderate. Runoff and fertility are medium. Reaction of the surface layer ranges from medium acid to neutral. The subsoil ranges from neutral to moderately alkaline. The surface layer is friable, but tillage is limited to a narrow range of moisture conditions. The subsoil has a high shrink-swell potential.

Most areas of this soil are in wheat and sorghum. The soil has good potential for rangeland and pasture but only fair potential for crops and windbreaks. It has good potential for open-land and rangeland wildlife habitat. Potential for recreation and engineering uses is fair to poor.

This soil is moderately well suited to small grains and alfalfa and poorly suited to sorghum. The clayey subsoil releases moisture slowly. There is a very severe hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Returning all crop residue to the soil and adding manure help to improve tilth and organic matter content. Including a legume in the rotation is beneficial.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces the ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is moderately well suited to windbreaks. The clayey subsoil releases moisture slowly. There is a very severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. During part of the growing season rainfall is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the high shrink-swell potential in the subsoil. If engineering structures are built on this soil, they should be designed to withstand the effects of shrinking and swelling. Some ways to do this are using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tanks often fail because of the very slow permeability. Capability unit IVe-2; Clay Upland range site.

Lo—Lesho clay loam (0 to 1 percent slopes). This is a deep, nearly level, somewhat poorly drained soil on flood plains along the major streams in the county. Areas are occasionally flooded.

Typically, the surface layer is dark grayish brown clay loam about 17 inches thick; the lower part has fine, distinct, brown to dark brown mottles and is calcareous. The next layer is pale brown clay loam about 13 inches thick. It is calcareous and has common, coarse, distinct, brownish yellow mottles. The underlying material is calcareous light yellowish brown loamy fine sand and fine sand. In some areas the soil is well drained and is sandy loam, silt loam, or silty clay loam throughout.

Permeability is moderately slow, and available water capacity is moderate to high. Runoff is slow, and fertility is medium. The surface layer is mildly alkaline or moderately alkaline, and the rest of the soil ranges from mildly alkaline to strongly alkaline. The surface layer is friable and is fairly easily tilled through a fairly wide range in moisture content. The surface layer has moderate shrink-swell potential, and the substratum has low shrink-swell potential. The water table fluctuates between depths of about 2 and 6 feet.

Most areas of this soil are in wheat, sorghum, and soybeans. The soil has good potential for crops, rangeland, pasture, and windbreaks. It has good potential for woodland and wetland wildlife habitat but only fair potential for open-land wildlife habitat. It has poor potential for recreation and for most engineering uses.

This soil is moderately well suited to small grains, sorghum, soybeans, and alfalfa. Wetness, both from the occasional flooding and from the water table, is a severe limitation. Alfalfa, particularly, grows poorly because of the excess wetness. Little can be done on an individual basis to control wetness. Major works of improvement, such as levees, dams, and a network of drainage ditches would help to control flooding and lower the water table. Proper use of crop residues and a minimum of tillage help to maintain fertility and tilth.

This soil is well suited to rangeland. The water table is within reach of grass roots. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of flooding and the high water table. If this soil is used for this purpose, the areas should be protected from flooding and the soil should be drained. The substratum is a fair source of sand. This soil is suitable for leveling for irrigation if adequate drainage is provided. Capability unit IIIw-1; Subirrigated range site.

Ls—Lincoln soils (0 to 1 percent slopes). This undifferentiated group consists of deep, nearly level, somewhat excesively drained soils on flood plains. These soils are frequently flooded. They are principally along the Arkansas River in strips a few hundred feet wide.

Typically, the surface layer is brown loamy fine sand about 10 inches thick; it ranges from 8 to 15 inches in thickness, and it is mainly loamy fine sand but contains some fine sand, loam, or clay loam strata, usually less than 5 inches thick. The substratum is reddish yellow fine sand that is calcareous and contains strata, 1/2 inch to 5 inches thick, that are darker colored and have finer texture. In some places the profile is noncalcareous above a depth of 40 inches. In some areas the profile is fine sand throughout and is noncalcareous.

Permeability is rapid, and available water capacity is low. Runoff is slow, and fertility is low. The soil is mildly alkaline or moderately alkaline. It has a low shrink-swell potential.

These soils are mostly idle, but they are used for rangeland in some places. The soils have poor potential for crops and windbreaks and only fair potential for rangeland and pasture. They have poor potential for wildlife habitat, recreation, and engineering uses.

Low fertility, low available water capacity, the hazard of soil blowing, and frequent flooding make these soils very difficult to farm.

These soils are better suited to rangeland than to other uses. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Fences are hard to maintain because of the frequent floods. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition. Trees and brush have a tendency to invade rangeland.

These soils are poorly suited to recreation and urban uses because of the hazard of flooding. If the soils are used for building sites, areas should be protected from flooding. These soils are a fair source of sand. Capability unit Vw-1; Sandy Lowland range site.

Ma—Milan loam, 0 to 1 percent slopes. This is a deep, nearly level, well drained soil on uplands. It is mainly on ridges in relatively narrow strips, but a few areas are broad and smooth.

Typically, the surface layer is dark grayish brown loam about 10 inches thick; it ranges from 7 to 14 inches in thickness. The subsoil is about 38 inches thick; the upper part is dark brown, firm clay loam, the middle part is dark reddish gray, very firm clay loam, and the lower part is red, firm sandy clay loam. The substratum is yellowish red sandy clay loam. In some places the subsoil is browner than it is in the typical profile, and in some areas it is sandy clay loam throughout.

Permeability is moderately slow, and available water capacity is high. Runoff is slow, and fertility is medium. The surface layer and the upper part of the subsoil are medium acid or slightly acid. The middle and lower parts of the subsoil range from medium acid to neutral. The surface layer is friable and easily tilled through a fairly wide range of moisture content. The subsoil has moderate shrink-swell potential.

Most areas of this soil are in wheat and sorghum. This soil has good potential for crops, rangeland, pasture, and windbreaks. It has good potential for open-land wildlife habitat but only fair potential for rangeland wildlife habitat. Potential for recreation and for most engineering uses is good to fair.

This soil is well suited to small grains, sorghum, and alfalfa. The main concerns of management are maintaining fertility, tilth, and organic matter content. Effective practices for conserving moisture are keeping tillage to a minimum and properly using crop residues. There is little or no erosion hazard.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites because of the moderate shrink-swell potential in the subsoil. Buildings should be designed to withstand the effects of shrinking and swelling. This soil is a fair source of topsoil. Sewage lagoons or a central sewage system can be used for waste disposal. Septic tank systems are subject to failure because of the moderately slow permeability. This soil is suitable for leveling for irrigation if adequate water is available. Capability unit I-1; Loamy Upland range site.

Mb—Milan loam, 1 to 3 percent slopes. This is a deep, gently sloping, well drained soil on uplands. It occupies broad side slopes.

Typically, the surface layer is dark grayish brown loam about 10 inches thick; it ranges from 7 to 14 inches in thickness. The subsoil is about 38 inches thick. The upper part is dark brown, firm clay loam; the middle part is dark reddish gray, very firm clay loam; and the lower part is red, firm sandy clay loam. The substratum is yellowish red sandy clay loam. In some places the subsoil is browner than indicated for the typical profile, and in some areas it is sandy clay loam throughout.

Permeability is moderately slow, and available water capacity is high. Runoff and fertility are medium. The surface layer and the upper part of the subsoil are medium acid or slightly acid. The middle and lower parts of the subsoil range from medium acid to neutral. The surface layer is friable and easily tilled through a fairly wide range in moisture content. The subsoil has a moderate shrink-swell potential.

Most areas of this soil are in wheat and sorghum. This soil has good potential for crops, rangeland, pasture, and windbreaks. It has good potential for open-land wildlife habitat but only fair potential for rangeland wildlife habitat. Potential for recreation and for most engineering uses is good to fair.

This soil is well suited to small grains, sorghum, and alfalfa. There is a moderate hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Proper use of fertilizer and crop residues helps to maintain fertility, organic matter content, and tilth.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites because of the moderate shrink-swell potential of the subsoil. Design should prevent damage caused by shrinking and swelling. This soil is a fair source of topsoil. Sewage lagoons or a central sewage system can be used for waste disposal. Septic tank systems are subject to failure because of the moderately slow permeability. This soil is suitable for bench leveling for irrigation if adequate water is available. Capability unit IIe-1; Loamy Upland range site.

Mc—Milan loam, 3 to 6 percent slopes. This is a deep, sloping, well drained soil on uplands. It typically is on short side slopes.

Typically, the surface layer is dark grayish brown loam about 10 inches thick; it ranges from 7 to 14 inches in thickness. The subsoil is about 38 inches thick. The upper part is dark brown, firm clay loam; the middle part is dark reddish gray, very firm clay loam; and the lower part is red, firm sandy clay loam. The substratum is yellowish red sandy clay loam. In some places the subsoil is browner then indicated for the typical profile, and in some areas it is sandy clay loam throughout.

Permeability is moderately slow, and available water capacity is high. Runoff is medium to rapid, and fertility is medium. The surface layer and the upper part of the subsoil are medium acid or slightly acid. The middle and lower parts of the subsoil range from medium acid to neutral. The surface layer is friable and easily tilled through a fairly wide range in moisture content. The subsoil has moderate shrink-swell potential.

About 70 percent of the acreage of this soil is in wheat and sorghum, and the rest is rangeland. This soil has good potential for crops, rangeland, pasture, and windbreaks. It has good potential for open-land wildlife habitat but only fair potential for rangeland wildlife habitat. Potential for recreation and for most engineering uses is good to fair.

This soil is moderately well suited to small grains, sorghum, and alfalfa. There is a severe hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Proper use of fertilizer and crop residues helps to maintain fertility, organic matter content, and tilth and conserves moisture.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is well suited to windbreaks; however, there is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites because of the moderate shrink-swell potential in the subsoil. Design should prevent damage caused by shrinking and swelling. This soil is a fair source of topsoil. Septic tank systems are subject to failure because of the moderately slow permeability. The size of the lateral field can be increased to help infiltration of effluent. This soil is not well suited to sewage lagoons because of slope. Capability unit IIIe-1; Loamy Upland range site.

Md—Milan loam, 3 to 6 percent slopes, eroded. This is a deep, sloping, well drained soil on uplands. It typically is on short side slopes along intermittent drainageways, but some delineations are relatively large areas on irregular side slopes.

Typically, the surface layer is brown to dark brown loam about 5 inches thick; it ranges from 4 to 7 inches in thickness in most places and is clay loam in a few places. The original surface layer has been thinned by erosion, and material from the subsoil has been mixed into the plow layer. The subsoil is about 34 inches thick; the upper part is dark reddish gray, very firm clay loam, and the lower part is red, firm sandy clay loam. The substratum is yellowish red sandy clay loam. In some places the surface layer is 7 to 14 inches thick. In some areas the soil has a browner subsoil, and in some areas the subsoil is sandy clay loam throughout.

Permeability is moderately slow, and available water capacity is high. Runoff is medium to rapid, and fertility is medium. The surface layer is medium acid or slightly acid. The subsoil ranges from medium acid to neutral. The surface layer is friable and fairly easily tilled through a fairly wide range in moisture content. The subsoil has a moderate shrink-swell potential.

Most areas of this soil are in wheat and sorghum. This soil has good potential for rangeland and pasture but only fair potential for crops and windbreaks. It has good potential for open-land wildlife habitat but only fair potential for rangeland wildlife habitat. Potential for recreation and for most engineering uses is good to fair.

This soil is moderately well suited to small grains and alfalfa and poorly suited to sorghum. There is a very severe hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Returning all crop residue to the soil and adding manure help to improve tilth and organic matter content. Including a legume in the rotation is beneficial.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces the ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is moderately well suited to windbreaks. There is a very severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites because of the moderate shrink-swell potential in the subsoil. Buildings should be designed to withstand the effects of shrinking and swelling. This soil is not a good source of topsoil, because the surface layer is thin. Septic tank systems are subject to failure because of the moderately slow permeability. The size of the lateral field can be increased to help infiltration. This soil is not well suited to sewage lagoons because of the slope. Capability unit IIIe-5; Loamy Upland range site.

On—Owens clay loam, 1 to 3 percent slopes. This is a shallow, gently sloping, well drained soil on upland side slopes. It typically occurs on the upper one-third of the side slope. Slopes are mostly convex.

Typically, the surface layer is dark grayish brown clay loam about 4 inches thick. The subsoil is light brownish gray, very firm silty clay. Bedrock of mixed clayey shale and limestone is at a depth of 20 inches. In places this soil is reddish brown throughout.

Included with this soil in mapping, and making up about 25 percent of the mapping unit, are small intermingled areas of Kirkland, Renfrow, and Rosehill soils. Areas of these included soils are generally 2 acres or less in size. The Kirkland and Renfrow soils are 40 or more inches deep over shale. The Rosehill soils are 20 to 40 inches deep over shale.

Permeability is very slow, and runoff is rapid. Available water capacity is very low. Tilth is poor, and the surface tends to crust and puddle after hard rains. This soil has high shrink-swell potential. Depth to shale bedrock ranges from 10 to 20 inches. Fertility is low. The surface layer is mildly alkaline, and the underlying material is moderately alkaline.

Most areas of this soil are used for rangeland. This soil has poor potential for cultivated crops and for most urban and engineering uses. The hazard of erosion is very severe if the soil is cultivated and not protected. Its best potential is for range and pasture.

This soil is poorly suited to most commonly grown cultivated crops because of the hazard of erosion, depth to bedrock, droughtiness, and low fertility. Terracing, minimum tillage, carefully selected cropping systems, and fertilizer help to reduce runoff and control erosion in cultivated areas.

This soil is better suited to rangeland than to other uses. Major concerns of range management are the hazard of erosion and the very low available water supply. The soils are somewhat droughty because of their very low available water capacity and rapid runoff. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover and cause deterioration of the plant community: the taller, more desirable grasses are replaced by less productive short grasses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is poorly suited to windbreaks. The clayey subsoil releases moisture slowly, and the shallow depth over shale restricts the rooting depth of trees. Young trees need considerable care and management if they are to grow.

This soil is severely limited for most urban uses because it is very slowly permeable, has high shrink-swell potential, and has shale bedrock at a depth of 10 to 20 inches. If the soil is used as a construction site, development of the site should be on the contour if possible. Removal of vegetation should be held to a minimum, and temporary plant cover should be established quickly in denuded areas. Buildings should be designed to withstand the effects of shrinking and swelling. Capability unit IVe-3; Clay Upland range site.

Oo—Owens clay loam, 3 to 8 percent slopes. This is a shallow, sloping to strongly sloping, well drained soil on upland side slopes. It typically is on the lower two-thirds of the slope.

Typically, the surface layer is dark grayish brown clay loam about 4 inches thick. The subsoil is light brownish gray, very firm silty clay. Bedrock of mixed clayey shale and limestone is at a depth of 20 inches. In places this soil is reddish brown throughout.

Included with this soil in mapping are small intermingled areas of Renfrow and Rosehill soils. The Renfrow soils are more than 40 inches deep over bedrock. Rosehill soils are 20 to 40 inches deep over bedrock. Also included in this mapping unit are small areas, generally an acre or less in size, of shale outcrops, and small areas of soils that are less than 10 inches deep over bedrock. Included areas make up about 35 percent of this mapping unit.

This soil has very slow permeability. Runoff is rapid. Available water capacity is very low. This soil has a high shrink-swell potential. Depth to shale bedrock ranges from 10 to 20 inches. Natural fertility is low. The surface layer is mildly alkaline, and the underlying material is moderately alkaline.

Most areas of this soil are used for rangeland. This soil has poor potential for cultivated crops and for most urban and engineering uses.

This unit is better suited to rangeland than to other uses. Major concerns of range management are the hazard of erosion and the very low available water capacity. This soil is droughty because of the very low available water capacity and rapid runoff. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover and cause deterioration of the plant community. The taller, more desirable grasses are then replaced by less productive short grasses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is poorly suited to windbreaks. The clayey soil releases moisture slowly, and the shallow depth over shale restricts the rooting depth of trees. Water erosion is also a hazard. Young trees need considerable care if they are to grow.

This soil is severely limited for most urban and engineering uses because it is very slowly permeable, has a high shrink-swell potential, has bedrock at a depth of 10 to 20 inches, and is sloping to strongly sloping. If the soil is used as a construction site, development of the site should be on the contour if possible. Removal of vegetation should be held to a minimum. Buildings should be designed to withstand the effects of shrinking and swelling. Capability unit VIe-1; Clay Upland range site.

Op—Owens-Elandco complex, 0 to 25 percent slopes. This complex is in upland drainageways. It consists of shallow, well drained, gently sloping to steep soils on side slopes and deep, well drained, nearly level soils on narrow valley floors. The areas range in width from about 250 to 1,000 feet. Depth from the top of the side slopes to the valley floor is between 10 and 30 feet. This complex is about 60 to 70 percent Owens soils and about 25 to 35 percent Elandco soils. The Owens soils are on the broken side slopes, and the Elandco soils are on the narrow valley floors. Areas of the soils are so intricately mixed, or so small in size, that it is not practical to separate them in mapping.

Typically, the Owens soils have a dark grayish brown clay loam surface layer about 4 inches thick. The subsoil is light brownish gray, very firm silty clay. Bedrock of mixed clayey shale and limestone is at a depth of about 20 inches. In many places these soils are reddish brown throughout.

Typically, the Elandco soils have a very dark grayish brown silty clay loam surface layer about 45 inches thick. The underlying material is brown silty clay loam.

Included with these soils in mapping and making up about 5 percent of the unit are small areas of Shale outcrops. These Shale outcrops are on the steeper points and breaks of the side slopes.

The Owens soils have very slow permeability and rapid runoff. The Elandco soils have moderate permeability and slow runoff. Available water capacity is very low in the Owens soils and high in the Elandco soils. The Owens soils have high shrink-swell potential, and the Elandco soils have moderate shrink-swell potential. The Owens soils have shale bedrock at a depth of 10 to 20 inches. The natural fertility is low for the Owens soils and high for the Elandco soils. Reaction is neutral to moderately alkaline throughout the soils.

Nearly all of the acreage of this complex is used for rangeland. In some places the Elandco soils are cultivated. Soils in this unit have good potential for rangeland. They have poor potential for crops and most urban and engineering uses.

The Elandco soils can be cultivated in some areas, but commonly these areas are small and intermingled with steeper and shallower soils that are not suited to cultivation.

These soils are better suited to rangeland than to other uses. Major concerns of range management are the hazard of erosion and the very low available water supply of the Owens soils. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing reduce the protective plant cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

The Owens soils are poorly suited to windbreaks. The clayey subsoil releases moisture slowly, and the shallow depth over shale restricts the rooting depth of trees. The Elandco soils are well suited to windbreaks; however, the frequent flooding can damage young trees.

These soils are poorly suited to most urban and engineering uses because of the very slow permeability, the high shrink-swell potential, and the steep slopes of both the Owens and Elandco soils; the depth to shale in the Owens soils; and the frequent flooding of the Elandco soils. If these soils are used for building sites, buildings should be designed to withstand the effects of shrinking and swelling. The Elandco soils should be protected from flooding. Capability unit VIe-2; Owens soil in Clay Upland range site, and Elandco soil in Loamy Lowland range site.

Or—Owens-Renfrow complex, 2 to 6 percent slopes, eroded. This complex consists of gently sloping to sloping, well drained soils on irregularly shaped side slopes of uplands that have been eroded. Owens soils make up 40 to 70 percent of the unit, and Renfrow soils make up about 30 to 60 percent of the unit. Areas of the soils are so intricately mixed, or so small in size, that it is not practical to separate them in mapping.

Typically, the Owens soils have a surface layer that is dark grayish brown clay loam about 4 inches thick; it ranges from 3 to 6 inches in thickness over most of the area. The subsoil is light brownish gray, very firm silty clay. Bedrock of mixed clayey shale and limestone is at a depth of about 17 inches. In some places the surface layer has been mixed with material from the underlying horizon. The mixing has resulted in a finer textured surface layer. In places the soil is reddish brown throughout.

Typically, the Renfrow soils have a surface layer which is dark reddish gray clay loam in the upper part and reddish brown clay loam in the lower part; it ranges from 6 to 12 inches in thickness over most of the area. The subsoil is reddish brown and red, very firm clay more than 50 inches thick. Red and gray shale is at a depth of more than 60 inches. In some places the soil is grayer throughout than indicated for the typical profile.

Included with this unit in mapping were small intermingled areas of soils that are less than 10 inches deep over shale and soils that are 20 to 40 inches deep over shale. These included soils make up about 10 to 25 percent of the acreage.

These soils are very slowly permeable and have rapid runoff. The available water capacity is very low in the Owens soils and low to moderate in the Renfrow soils. The surface layer of these soils tends to crust or puddle after hard rains, especially where the surface layer has been mixed with material from underlying horizons. The shrink-swell potential of these soils is high. Depth to shale ranges from 10 to 20 inches in the Owens soils and is more than 60 inches in the Renfrow soils. Reaction is slightly acid to moderately alkaline throughout the soils.

Most of the acreage of these soils remains in cultivation even though there is a severe hazard of continued erosion. The soils have good to fair potential for pasture and rangeland and good potential for wildlife habitat. They have poor potential for most urban and engineering uses.

These soils are poorly suited to most commonly grown cultivated crops because of the hazard of erosion, depth to bedrock in the Owens soils, and droughtiness. Terraces, minimum tillage, carefully selected cropping systems, and fertilizer help to reduce runoff, conserve moisture, and control further erosion in cultivated areas.

These soils are better suited to rangeland and pasture than to other uses. Major concerns of range or pasture management are related to the hazard of erosion and the low available water capacity. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing reduce the plant cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range or pasture and the soil in good condition.

These soils are poorly suited to windbreaks. The clayey subsoil releases moisture slowly, and the shallowness of the Owens soils restricts the rooting depth of trees. Young trees need considerable care if they are to grow. Water erosion is a severe hazard while the windbreak is being established.

These soils are poorly suited to most urban and engineering uses because of the very slow permeability and the high shrink-swell potential. If the soils are used as construction sites, development should be on the contour if possible. Removal of vegetation should be held to a minimum and temporary plant cover should be established quickly in denuded areas. Design of buildings should prevent damage caused by shrinking and swelling. Capability unit IVe-3; Clay Upland range site.

Os—Owens-Shale outcrop complex, 8 to 25 percent slopes. This complex (fig. 12) consists of strongly sloping to steep Owens clay loam and Shale outcrop on side slopes. Typically, these side slopes are escarpments or the banks of narrow drainage channels. In most places the side slopes are 250 to 500 feet wide. Individual areas of this unit are about 50 to 60 percent Owens clay loam and about 40 to 50 percent Shale outcrop. Areas of the Owens soil and the Shale outcrop are so intricately mixed, or so small in size, that it is not practical to separate them in mapping.

Typically, the Owens soil has a dark grayish brown clay loam surface layer about 4 inches thick. The subsoil is light brownish gray, very firm silty clay. Bedrock of mixed clayey shale and limestone is at a depth of about 20 inches. In places the soil is reddish brown throughout. In other places the soil is less than 10 inches deep over shale.

The Shale outcrop is reddish brown to olive, weakly consolidated, slightly weathered shale.

The Owens soil has very slow permeability. Runoff is rapid. Available water capacity is very low. This soil has a high shrink-swell potential. Depth to shale bedrock ranges from 10 to 20 inches. Natural fertility is low. The surface layer is mildly alkaline, and the underlying material is moderately alkaline.

A sparse growth of tall grasses, annual forbs, and woody shrubs grows on the Owens part of the complex and in cracks in the shale. This complex has poor potential for cultivated crops, pasture, rangeland, and engineering and urban uses.

The Owens soil is better suited to rangeland than to other uses (fig. 9). Major concerns of range management are the hazard of erosion and the very low available water capacity. This soil is droughty because of the very low available water capacity and rapid runoff. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover and cause deterioration of the plant community. Under these conditions the taller, more desirable grasses are replaced by less productive short grasses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

The Owens soil is poorly suited to windbreaks. The shallow depth of soil material over shale restricts or prohibits growth of tree roots.

The Owens soil is severely limited for most urban and engineering uses because it is very slowly permeable, has a high shrink-swell potential, has bedrock within 20 inches of the surface, and is strongly sloping to steep. Extensive land shaping is necessary if this soil is used for building sites. Buildings should be designed to prevent damage caused by shrinking and swelling. Capability unit VIIs-1; Owens soil in Clay Upland range site, and Shale outcrop not assigned to a range site.

Pa—Pond Creek silt loam, 0 to 1 percent slopes. This is a deep, nearly level, well drained soil in broad areas on uplands. Some narrow areas are on the tops of ridges.

Typically, the surface layer is dark brown silt loam about 13 inches thick. The upper part of the subsoil is dark brown, friable light silty clay loam; the next part is dark brown, firm clay loam; and the lower part is reddish brown, friable light clay loam. A few small lime concretions are in the subsoil. The underlying material is reddish brown silty clay loam. In some places the subsoil is more clayey.

Included with this soil in mapping are small intermingled areas of Kirkland and Tabler soils. The Kirkland soils have a more clayey subsoil. Tabler soils have a subsoil that is more clayey and is grayer than the one in this Pond soil. These included soils have similar slopes and are in similar positions. They make up about 5 percent of the unit.

Permeability is moderately slow, and runoff is slow. Available water capacity is very high. The surface layer is friable and easily tilled. Natural fertility is high. The surface layer ranges from medium acid to neutral, and the subsoil ranges from slightly acid to moderately alkaline. The shrink-swell potential of the subsoil is moderate.

Most areas of this soil are cultivated. This soil has good potential for all crops commonly grown in the county and for range, pasture, and windbreaks. It has poor to fair potential for most urban, engineering, and recreational uses.

This soil is well suited to all crops commonly grown in the county. There are few or no hazards when this unit is used for cultivated crops. Proper use of fertilizer and crop residue management help to maintain fertility, organic matter content, and tilth.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites and recreational developments. Dwellings should be designed and constructed to prevent structural damage caused by shrinking and swelling of the soil. These soils have severe limitations for septic tank absorption fields because of the moderately slow permeability; however, there are only slight limitations for construction of sewage lagoons. Increasing the size of the absorption area of septic tank filter fields helps to overcome the limitation of moderately slow permeability. Capability unit I-1; Loamy Upland range site.

Pb—Pond Creek silt loam, 1 to 3 percent slopes. This is a deep, gently sloping, well drained soil in broad areas on smooth uplands. In some places the soil is gently sloping on short side slopes. Areas of this soil are irregular in shape and range from about 50 acres to several hundred acres in size.

Typically, the surface layer is dark brown silt loam about 13 inches thick. The upper part of the subsoil is dark brown, friable light silty clay loam; the next part is dark brown, firm clay loam; and the lower part is reddish brown, friable light clay loam. A few small lime concretions are in the subsoil. The underlying material is reddish brown silty clay loam. In some places the subsoil is more clayey than is indicated in the typical profile.

Included with this soil in mapping are small intermingled areas of Milan soils that have more sand in the subsoil. These included soils have similar slopes and are in similar positions, and they make up about 5 percent of the unit.

Permeability is moderately slow, and runoff is medium. Available water capacity is very high. Natural fertility is high. The surface layer ranges from medium acid to neutral, and the subsoil ranges from slightly acid to moderately alkaline. The surface layer is friable and easily tilled. The shrink-swell potential of the subsoil is moderate.

Most areas of this soil are cultivated. A small acreage is used for rangeland. This soil has good potential for all crops commonly grown in the county and for rangeland, pasture, and hay. It has poor to fair potential for most urban, engineering, and recreational uses.

This soil is well suited to all crops commonly grown in the county. These soils are easily tilled, but maintenance of tilth and fertility is required. Soils in this unit have a moderate erosion hazard. Terraces and contour farming help to control erosion. Proper management of crop residues and use of fertilizer help to maintain fertility, organic matter content, and tilth.

Range management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil losses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites and recreational developments. Dwellings should be designed and constructed to prevent structural damage caused by shrinking and swelling of the soil. This soil has severe limitations for septic tank absorption fields because of the moderately slow permeability. There are moderate limitations for construction of sewage lagoons because of slope. Increasing the size of the absorption area of septic tank filter fields helps to overcome the limitation of moderately slow permeability. Capability unit IIe-1; Loamy Upland range site.

Pc—Pond Creek silt loam, 3 to 6 percent slopes. This is a deep, sloping, well drained soil on short, convex upland side slopes. Areas of this soil are irregular in shape and range from about 10 acres to about 100 acres in size.

Typically, the surface layer is dark brown silt loam about 13 inches thick. The upper part of the subsoil is dark brown, friable light silty clay loam; the next part is dark brown, firm clay loam; and the lower part is reddish brown, friable light clay loam. A few small lime concretions are in the subsoil. The underlying material is reddish brown silty clay loam.

Included with this soil in mapping are small intermingled areas of Milan soils that have more sand in the subsoil than this Pond soil. Also included are areas of a soil that has a reddish brown surface layer and a less clayey subsoil. These included soils have similar slopes and are in similar positions, and they make up about 20 percent of the unit.

Permeability is moderately slow, and runoff is slow. Available water capacity is very high. The surface layer is friable and easily tilled. Natural fertility is high. The surface layer ranges from medium acid to neutral, and the subsoil ranges from slightly acid to moderately alkaline. The shrink-swell potential of the subsoil is moderate.

Most areas of this soil are cultivated. A small acreage is used for range. This soil has good potential for all crops commonly grown in the county and for range, pasture, and hay. It has poor to fair potential for most urban, engineering, and recreational uses.

This soil is well suited to all crops commonly grown in the county. If the soil is cultivated and not protected, the hazard of water erosion is severe. Control of erosion and maintenance of tilth and fertility are the main concerns of management. Terraces and contour farming are needed to help to control erosion. Proper management of crop residues and use of fertilizer help to maintain fertility, organic matter content, and tilth.

Rangeland management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil losses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and the soil in good condition.

This soil is well suited to windbreaks; however, there is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites and recreational developments because of the shrink-swell potential, moderately slow permeability, and slope. There are severe limitations for septic tank absorption fields because of permeability and moderate limitations for sewage lagoons because of slope. If this soil is used for building sites, buildings should be designed in such a way that damage from shrinking and swelling will be avoided. Increasing the size of the absorption area for septic tank filter fields will help to overcome the limitation of slow permeability. Capabilty unit IIIe-1; Loamy Upland range site.

Pd—Pond Creek silty clay loam, 2 to 6 percent slopes, eroded. This is a deep, gently sloping to sloping, well drained soil on short upland side slopes along intermittent drainageways. Individual areas of this soil are irregular in shape and range from about 5 to 50 acres in size.

Typically, the surface layer is dark brown silty clay loam about 7 inches thick; it ranges from 6 to 10 inches in thickness over most of the area. Part of the original surface layer has been removed by erosion, and material from the subsoil has been mixed with the remaining surface layer by plowing. The upper part of the subsoil is dark brown, friable light silty clay loam; the next part is dark brown, firm clay loam; and the lower part is reddish brown, friable light clay loam. A few small lime concretions are in the subsoil. The underlying material is reddish brown silty clay loam.

Included with this soil in mapping are small intermingled areas of eroded Milan soils that have more sand in the subsoil than this soil. Also included are areas of a soil that has a reddish brown surface layer and a less clayey subsoil. These included soils have similar slopes and are in similar positions. They make up about 20 percent of the unit.

Permeability is moderately slow, and runoff is slow. Available water capacity is very high. In areas where material from the subsoil has been mixed with the surface layer, the surface tends to crust and puddle. The shrink-swell potential of the subsoil is moderate. Natural fertility is high. The surface layer ranges from medium acid to neutral, and the subsoil ranges from slightly acid to moderately alkaline.

Most areas of this soil are cultivated. A small acreage has been seeded back to grass and is used for rangeland. This soil has good potential for most crops commonly grown in the county and for rangeland, pasture, and hay. It has only poor to fair potential for most urban, engineering, and recreational uses.

This soil is suited to most crops commonly grown in the county. If the soil is cultivated and not protected, the hazard of further erosion is severe. Control of erosion and maintenance of tilth and fertility are the main concerns of management. Terraces and contour farming are needed to help to control erosion. Proper management of crop residues and use of fertilizer help to maintain fertility, organic matter content, and tilth.

Rangeland management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil losses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is moderately well suited to windbreaks. There is a very severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites and recreational developments because of the shrink-swell potential, moderately slow permeability, and slope. There are severe limitations for septic tank absorption fields because of permeability and moderate limitations for sewage lagoons because of slope. If this soil is used for building sites, the buildings should be designed in such a way that damage from shrinking and swelling will be avoided. Increasing the size of the absorption area for septic tank filter fields helps to overcome the limitation of slow permeability. Capability unit IIIe-5; Loamy Upland range site.

Px—Pratt loamy fine sand, undulating. This is a deep, gently sloping, well drained soil on undulating uplands. Individual areas of this soil are irregular in shape. Slopes range from 3 to 8 percent.

Typically, the surface layer is pinkish gray loamy fine sand about 14 inches thick. The subsoil is brown, very friable loamy fine sand that is slightly more clayey than the surface layer and is about 24 inches thick. The underlying material is strong brown fine sand. In places the surface layer and underlying material are fine sand.

Included with this soil in mapping are small areas of Carwile and Shellabarger soils. Carwile soils are in depressions between ridges; they have a clayey subsoil and are somewhat poorly drained. Shellabarger soils have the same slopes and are in similar positions, but they contain more clay in the subsoil. These included soils make up about 5 percent of the unit.

Permeability is rapid, and runoff is slow. The available water capacity is low. Natural fertility is medium, and reaction ranges from medium acid to neutral throughout the soil.

About one-half of the acreage of this soil is cultivated, and the rest is used for rangeland. This soil has good to fair potential for most crops grown in the county and good potential for rangeland. The potential for most urban and engineering uses is only fair to poor.

This soil is suited to most crops commonly grown in the county. If the soil is cultivated and not protected, the hazard of soil blowing is severe. Controlling soil blowing and conserving soil moisture are the main concerns of management. Keeping plant cover on the soils when the hazard of soil blowing is most severe is effective in controlling soil blowing and conserving moisture. Also needed are wind stripcropping, stubble mulching, and field windbreaks.

This soil is also well suited to rangeland. Major concerns of rangeland management are the hazard of soil blowing and the low available water capacity. Maintaining adequate plant cover and ground mulch helps to prevent soil blowing and conserves moisture. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the rangeland vegetation and soil in good condition.

This soil is well suited to windbreaks; however, there is a severe hazard of soil blowing while a windbreak is being established. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has severe limitations for most sanitary facilities because of the rapid permeability; however, there are only slight limitations for septic tank absorption fields. In some places there may be a hazard of polluting underground water. Capability unit IIIe-3; Sands range site.

Ra—Renfrow complex, 1 to 3 percent slopes. This complex consists of deep, gently sloping, well drained soils on upland side slopes. Individual areas of this complex range from about 20 acres to several hundred acres in size and are irregular in shape.

Typically, the surface layer is about 12 inches thick; the upper part is dark reddish gray clay loam, and the lower part is reddish brown clay loam. The subsoil is reddish brown and red, very firm clay more than 50 inches thick; in most places this layer contains fragments of shale in the lower part. Red and gray shale is at a depth of more than 60 inches. In about 30 percent of the area the depth to shale ranges from 20 to 60 inches. In other places the soil is grayer in color throughout.

Included with this unit in mapping are small intermingled areas of Owens soils. The Owens soils are 10 to 20 inches deep over shale bedrock. Also included are soils that are less than 10 inches deep over bedrock. These included soils have similar slopes and are in similar positions, and they make up about 25 percent of the acreage.

The soils are very slowly permeable. Runoff is medium. Available water capacity is low to moderate. Tilth is poor; clods form and structure is destroyed if the soils are worked when too wet or too dry. Natural fertility is medium, and reaction is slightly acid to moderately alkaline throughout the soil. The shrink-swell potential is high.

Most areas of this complex are cultivated. The soils have fair potential for crops. They have good potential for rangeland, pasture, and wildlife habitat. They have poor potential for most urban and engineering uses.

These soils are suited to most crops commonly grown in the county. Yields of alfalfa and other summer-maturing crops are often reduced because of the low to moderate available water capacity. There is a severe hazard of erosion where the soils are cultivated and not protected. The main concerns of management are controlling erosion and maintaining tilth. Terraces and contour farming help to control erosion. Tilling when moisture conditions are most favorable helps to keep the soil in good tilth. Minimum tillage, carefully selected cropping systems, and fertilizer help to conserve moisture and maintain organic matter content, fertility, and tilth.

These soils are well suited to rangeland. Major concerns of rangeland management are the hazard of erosion and the low available water supply. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

These soils are well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

These soils are poorly suited to use as building sites because of the high shrink-swell potential and very slow permeability. Structures should be designed to prevent damage caused by shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tanks often fail because of the very slow permeability. Removal of vegetation should be held to a minimum, and temporary plant cover should be established quickly in bare areas. Capability unit IIIe-2; Clay Upland range site.

Ro—Rosehill clay loam, 1 to 3 percent slopes. This is a moderately deep, gently sloping, well drained soil on upland side slopes. Individual areas are irregular in shape and range from about 20 acres to several hundred acres in size.

Typically, the surface layer is dark grayish brown clay loam about 10 inches thick. The next layer is light olive brown, very firm clay. The underlying material is light olive brown clay. Clayey shale and limestone are at a depth of about 40 inches. In some places the material below the surface layer is dark brown, and depth to shale is more than 40 inches.

Included with this soil in mapping are small intermingled areas of Owens soils. These soils have shale bedrock at a depth of less than 20 inches. They have similar slopes and are in similar positions, and they make up about 5 percent of the acreage.

This soil has very slow permeability and medium runoff. Available water capacity is low. Tilth is poor, and the surface tends to crust and puddle after hard rains. Natural fertility is medium, and reaction ranges from neutral to moderately alkaline throughout the soil. The shrink-swell potential is high. Depth to bedrock ranges from 20 to 40 inches.

Most areas of this soil are cultivated. This soil has only fair potential for most crops grown in the county. The potential for range, pasture, hay, and wildlife habitat is good to fair. The soil has poor potential for most urban and engineering uses.

This soil is suited to most crops commonly grown in the county. The yields of alfalfa and other summer-maturing crops are often low because of the low available water capacity. The main concerns of management are controlling erosion, conserving moisture, and maintaining tilth. Terraces and contour farming help to control erosion. Proper crop residue management and use of fertilizer help to maintain fertility, organic matter content, and tilth.

This soil is well suited to rangeland. Major concerns of rangeland management are the hazard of erosion and the low available water capacity. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is severely limited for most urban uses because it is very slowly permeable, has a high shrink-swell potential, and has shale bedrock at a depth of 20 to 40 inches. Structures should be designed to prevent damage caused by shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tanks often fail because of the very slow permeability. If the soil is used as a construction site, development of the site should be on the contour wherever possible. Removal of vegetation should be held to a minimum, and temporary plant cover should be established quickly in denuded areas. Capability unit IIIe-2; Clay Upland range site.

Rs—Rosehill clay loam, 3 to 6 percent slopes. This is a moderately deep, sloping, well drained soil on upland side slopes. Individual areas are irregular in shape.

Typically, the surface layer is dark grayish brown clay loam about 8 inches thick. The next layer is light olive brown, very firm clay about 19 inches thick. The underlying material is light olive brown clay. Clayey shale is at a depth of about 40 inches.

Included with this soil in mapping are small intermingled areas of Owens soils. These soils have shale bedrock at a depth of less than 20 inches. They have similar slopes and are in similar positions, and they make up about 5 percent of the unit.

This soil has very slow permeability and medium runoff. Available water capacity is low. Tilth is poor, and the surface tends to crust and puddle. Natural fertility is medium, and reaction ranges from neutral to moderately alkaline throughout the soil. The shrink-swell potential is high. Depth to shale bedrock ranges from 20 to 40 inches.

Most areas of this soil are cultivated. This soil has only fair potential for most crops grown in the county. The potential for range, pasture, hay, and wildlife habitat is good to fair. The soil has poor potential for most urban and engineering uses.

This soil is suited to most crops grown in the county. The yields of alfalfa and other summer-maturing crops are often low because of the low available water capacity. Erosion is a severe hazard when these soils are cultivated and not protected. The main concerns of management are controlling erosion, conserving moisture, and maintaining tilth. Terraces and contour farming help to control erosion. Proper crop residue management and fertilizer help to maintain fertility, organic matter content, and tilth.

This soil is well suited to rangeland. Major concerns of rangeland management are the hazard of erosion and the low available water capacity. Maintaining adequate vegetative cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is well suited to windbreaks; however, there is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is severely limited for most urban and engineering uses because it is very slowly permeable, has a high shrink-swell potential, and has shale bedrock at a depth of 20 to 40 inches. Structures should be designed to prevent damage caused by shrinking and swelling. Some of the ways to do this are using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tanks often fail because of the very slow permeability. If the soil is used for a construction site, development of the site should be on the contour wherever possible. Removal of vegetation should be held to a minimum, and temporary plant cover should be established quickly in denuded areas. Capability unit IIIe-6; Clay Upland range site.

Rx—Rosehill clay loam, 2 to 6 percent slopes, eroded. This is a moderately deep, gently sloping to sloping, well drained soil on upland side slopes. Individual areas are irregular in shape.

Typically, the surface layer is dark grayish brown clay loam about 5 inches thick; it ranges from 4 to 7 inches in thickness over most of the area. Part of the original surface layer has been removed by erosion, and material from the next layer has been mixed with the remaining surface layer by plowing. The next layer is light olive brown, very firm clay about 19 inches thick. The underlying material is light olive brown clay. Clayey shale is at a depth of about 36 inches.

Included with this soil in mapping are small intermingled areas of Owens soils and shale outcrops. The Owens soils have shale bedrock at a depth of less than 20 inches. They have similar slopes and are in similar positions. Shale outcrops are on some of the steeper points and breaks. These included areas make up about 5 percent of the acreage.

This soil has very slow permeability and medium runoff. Available water capacity is low. Tilth is poor, and the surface tends to crust and puddle. Natural fertility is medium, and reaction ranges from neutral to moderately alkaline throughout the soil. The shrink-swell potential is high. Depth to shale bedrock ranges from 20 to 40 inches.

Most areas of this soil are cultivated. This soil has fair to poor potential for cultivated crops. The potential for rangeland, pasture, hay, and wildlife habitat is good to fair. The soil has only poor potential for most urban and engineering uses.

This soil is poorly suited to most commonly grown cultivated crops because of the severe hazard of continued erosion and the low available water capacity. The main concerns of management are controlling erosion, conserving moisture, and maintaining tilth. Terracing, contour farming, minimum tillage, carefully selected cropping systems, and fertilizer help to reduce runoff, conserve moisture, maintain fertility, organic matter content, and tilth, and control further erosion.

This soil is well suited to rangeland. Major concerns of rangeland management are the hazard of erosion and the low available water capacity. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing the amount of runoff. Overstocking and overgrazing the rangeland reduce the protective plant cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is moderately well suited to windbreaks. There is a very severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is severely limited for most urban uses because it is very slowly permeable, has a high shrink-swell potential, and has shale bedrock at a depth of 20 to 40 inches. Structures should be designed to prevent damage caused by shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tank systems often fail because of the very slow permeability. If the soil is used as a construction site, development of the site should be on the contour wherever possible. Removal of vegetation should be held to a minimum, and temporary plant cover needs to be established quickly in denuded areas. Capability unit IVe-4; Clay Upland range site.

Sa—Shellabarger sandy loam, 1 to 3 percent slopes. This is a deep, well drained, gently sloping soil on long and short side slopes. Individual areas of this soil are irregular in shape and range from about 20 acres to several hundred acres in size.

Typically, the surface layer is brown sandy loam about 11 inches thick. The upper part of the subsoil is reddish brown, friable fine sandy loam, and the lower part is reddish brown, friable sandy clay loam. The underlying material is yellowish red heavy sandy loam. In some places the subsoil contains more clay than is indicated for the typical profile. In other places the subsoil is dark brown and also contains more clay.

Included with this soil in mapping are small intermingled areas of Pratt and Carwile soils. Carwile soils are in nearby depressions, are somewhat poorly drained, and have a more clayey subsoil. Pratt soils have more sand in the subsoil, and have similar slopes and are in similar positions. In some places there are inclusions of soils that are similar to Shellabarger soils but that have shale at a depth of 20 to 40 inches. These included soils make up about 15 percent of the unit.

This soil has moderate permeability and medium runoff. The available water capacity is moderate to high. Natural fertility is medium, and crops respond well to fertilizer. Reaction ranges from slightly acid to mildly alkaline in the surface layer and subsoil. The shrink-swell potential is low.

Most areas of this soil are cultivated. This soil has good potential for all crops commonly grown in the county and for rangeland, wildlife habitat, pasture, hay, and most urban and engineering uses.

This soil is well suited to all crops commonly grown in the county. There is a moderate hazard of water erosion when this soil is cultivated and a slight to moderate hazard of soil blowing in spring and fall. The main concerns of management are controlling erosion and maintaining fertility and tilth. Terraces and contour farming help to control erosion. Stripcropping and stubble-mulch tillage help to reduce soil blowing, increase water intake, and maintain good tilth.

This soil is also well suited to rangeland, but the hazard of erosion is a major concern. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduces the protective plant cover. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is well suited to windbreaks; however, there is a hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is suitable for building sites and for onsite waste disposal if proper design and installation procedures are used. Seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoon. If the soil is used as a construction site, development of the site should be on the contour wherever possible. Removal of vegetation should be held to a minimum, and temporary plant cover should be established quickly in denuded areas. Capability unit IIe-2; Sandy range site.

Sb—Shellabarger sandy loam, 3 to 6 percent slopes. This is a deep, well drained, sloping soil on long and short side slopes. Individual areas of this soil are irregular in shape and range from about 10 acres to several hundred acres in size.

Typically, the surface layer is brown sandy loam about 11 inches thick. The upper part of the subsoil is reddish brown, friable fine sandy loam, and the lower part is reddish brown, friable sandy clay loam. The underlying material is yellowish red heavy sandy loam. In some places the subsoil contains more clay than is indicated for the typical profile. In other places the subsoil is dark brown and also contains more clay.

Included with this soil in mapping are small intermingled areas of Pratt soils. The Pratt soils contain more sand in the subsoil, and they have similar slopes and are in similar positions. These included soils make up about 5 percent of the unit.

This soil has moderate permeability and medium runoff. The available water capacity is moderate to high. Natural fertility is medium, and crops respond well to fertilizer. Reaction ranges from slightly acid to mildly alkaline in the surface layer and subsoil. The shrink-swell potential is low.

Most areas of this soil are cultivated. This soil has good potential for all crops commonly grown in the county, range, wildlife habitat, pasture, hay, and most urban and engineering uses.

This soil is moderately well suited to all crops commonly grown in the county. There is a severe hazard of water erosion when this soil is cultivated and a moderate to severe hazard of soil blowing in spring and fall. The main concerns of management are controlling erosion and maintaining fertility and tilth. Terraces and contour farming help to control water erosion. Stripcropping, crop residue management, and fertilizer help to conserve moisture and maintain organic matter content, fertility, and tilth.

This unit is also well suited to rangeland, but the hazard of erosion is a major concern. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is well suited to windbreaks; however, there is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is suitable for building sites and for onsite waste disposal if proper design and installation procedures are used. Seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoon. If the soil is used as a construction site, development of the site should be on the contour wherever possible. Removal of vegetation should be held to a minimum, and temporary plant cover should be established quickly in denuded areas. Capability unit IIIe-4; Sandy range site.

Sc—Shellabarger sandy loam, 3 to 6 percent slopes, eroded. This is a deep, well drained, sloping soil on long and short side slopes. In many places it is on the sides of intermittent drainageways. Individual areas of this soil are irregular in shape and range from about 10 to 90 acres in size.

Typically, the surface layer is brown sandy loam 4 to 7 inches thick. The surface layer has been thinned by erosion, and plowing has mixed material from the subsoil with the remaining material of the surface layer. The upper part of the subsoil is reddish brown, friable fine sandy loam, and the lower part is reddish brown, friable sandy clay loam. The underlying material is yellowish red heavy sandy loam. In some places the subsoil contains more clay. In other places the subsoil is dark brown and is more clayey.

This soil has moderate permeability and medium runoff. The available water capacity is moderate to high. Fertility is generally low because nutrients have been washed away with the soil. Reaction ranges from slightly acid to mildly alkaline in the surface layer and subsoil. The shrink-swell potential is low.

Most areas of this soil are cultivated. This soil has only fair potential for most crops commonly grown in the county. It has good potential for range, pasture, and wildlife habitat and for most urban and engineering uses.

This soil is moderately well suited to most crops commonly grown in the county. There is a severe hazard of continued erosion when this soil is cultivated. There is a moderate to severe hazard of soil blowing in spring and fall. The main concerns of management are controlling erosion and maintaining fertility and tilth. Terraces and contour farming help to control water erosion. Stripcropping, crop residue management, and fertilizer help to conserve moisture and maintain organic matter content, fertility, and tilth.

This unit is also well suited to rangeland, but the hazard of erosion is a major concern. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the rangeland vegetation and soil in good condition.

This soil is moderately well suited to windbreaks. There is very severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This unit is suitable for building sites and for onsite waste disposal if proper design and installation procedures are used. Seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoon. If the soil is used as a construction site, development of the site should be on the contour wherever possible. Removal of vegetation should be held to a minimum, and temporary plant cover needs to be established quickly in denuded areas. Capability unit IIIe-7; Sandy range site.

Ta—Tabler silty clay loam (0 to 1 percent slopes). This is a deep, moderately well drained, nearly level soil on uplands. Individual areas of this soil are irregular in shape and range from about 20 acres to several hundred acres in size.

Typically, the surface layer is dark gray silty clay loam about 9 inches thick. The subsoil is dark gray and gray, very firm clay about 50 inches thick. In places the subsoil is reddish brown, and in places there is a subsurface layer of light gray silt loam.

Included with this soil in mapping are small intermingled areas of Bethany soils, in which the surface layer is thicker and the subsoil is dark brown. These soils have similar slopes and are in similar positions, and they make up about 5 percent of the unit.

This soil has very slow permeability. Runoff is slow (fig. 10). The available water capacity is moderate. Tilth is poor; clods form and structure is destroyed if the soil is worked when too wet or too dry. Natural fertility is medium. The surface layer is medium acid, and the subsoil is neutral to moderately alkaline. The subsoil has a high shrink-swell potential.

Most areas of this soil are cultivated. This soil has good potential for most crops grown in the county and for range, pasture, hay, and wildlife habitat. It has poor potential for most urban and engineering uses.

This soil is well suited to most crops commonly grown in the county. The main concerns of management are maintaining tilth, organic matter content, and fertility. Tilling when moisture conditions are most favorable helps to keep the soil in good tilth. Minimum tillage, carefully selected cropping systems, and fertilizer help to conserve moisture and maintain organic matter content, fertility, and tilth.

This soil is well suited to rangeland. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and restricted use during wet periods help to keep the rangeland vegetation and soil in good condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is severely limited for most urban and engineering uses because it is very slowly permeable and has a high shrink-swell potential. If the soil is used as a construction site, the structure should be designed to prevent damage caused by shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tank systems often fail because of the very slow permeability. Capability unit IIs-1; Clay Upland range site.

Tv—Tivoli fine sand, hilly. This is a deep, rolling to hilly, excessively drained soil on hilly uplands. The hills range from 6 to 30 feet in height and from 100 feet to several hundred feet in diameter. Slopes range from 8 to 20 percent.

Typically, the surface layer is brown fine sand about 7 inches thick. The underlying material is light yellowish brown, loose fine sand about 53 inches thick. In some places the texture is loamy fine sand to a depth of about 30 inches.

This soil has rapid permeability and very slow runoff. The available water capacity is low. Natural fertility is low, and reaction is slightly acid to mildly alkaline. The shrink-swell potential is low.

Most areas of this soil are in range. This soil has poor potential for cultivated crops. The hazard of soil blowing is severe when the soil is cultivated and unprotected. This soil has poor to fair potential for most urban and engineering uses.

This soil is better suited to rangeland than to other uses. Major concerns of range management are the hazard of soil blowing and the low available water capacity. Maintaining adequate plant cover and ground mulch helps to prevent soil blowing and conserve moisture. Overstocking and overgrazing the range reduce the protective plant cover and cause deterioration of the plant community. The taller, more desirable grasses are then replaced by less productive short grasses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is moderately well suited to windbreaks, but there is a very severe hazard of soil blowing while the windbreak is being established. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is severely limited for onsite waste disposal and construction sites because of the rapid permeability and the steep slopes. This soil is a good source for roadfill and a fair source for sand. Capability unit VIIe-1; Sands range site.

Us—Ustifluvents, channeled (0 to 30 percent slopes). This map unit consists of soils in deeply entrenched channels cut by perennial streams and the steep banks along these streams. It ranges from 100 to 400 feet in width. Depth from the stream channel to the top of the bank ranges from 20 to 50 feet.

Texture of these soils ranges from sandy loam to clay loam. The soils are well drained. Permeability and available water capacity are moderate. Runoff is rapid, and fertility is medium. A significant part of this mapping unit is flooded during times of high streamflow. During each flood, material is deposited in some areas and removed from others.

Most areas of this mapping unit are idle; some areas are used for limited grazing and wildlife habitat. These soils have good potential for woodland wildlife habitat. They have fair potential for rangeland and poor potential for crops, pasture, windbreaks, recreation, and engineering uses.

Trees and shrubs are the principal vegetation. Shrubs and low branches of trees provide browse for deer. Canada wildrye, Virginia wildrye, and other shade-tolerant, cool-season grasses grow under the canopy of the trees and provide limited grazing. Cutting trees and shrubs reduces the canopy and increases growth of grass. Fences are hard to maintain because of the frequent floods.

The banks are too steep for cultivation or for planting of pasture. These soils are flooded too frequently and are too steep for recreation and urban uses. Capability unit VIIw-1; range site not assigned.

Va—Vanoss silt loam, 0 to 1 percent slopes. This is a deep, nearly level, well drained soil that is typically on terraces at the foot of side slopes. In a few places it is at the crest of side slopes.

Typically, the surface layer is brown silt loam about 16 inches thick. The subsoil is brown, friable clay loam to a depth of more than 60 inches. In some places the subsoil contains more clay.

Included with this soil in mapping are small intermingled areas of Milan soils. The Milan soils have more sand in the subsoil than this Vanoss soil. They have similar slopes and are in similar positions. They make up about 5 percent of the mapping unit.

This soil has moderate permeability. Runoff is slow. Available water capacity is high. The surface is friable and easily tilled. Natural fertility is high, and reaction is slightly acid to neutral. The shrink-swell potential is moderate.

Most areas of this soil are cultivated. This soil has good potential for crops, rangeland, pasture, hay, windbreaks, and wildlife habitat. It has fair potential for most urban and engineering uses.

This soil is well suited to all crops commonly grown in the county. There are few limitations. The main concerns of management are maintaining tilth, organic matter content, and fertility. Tilling when moisture conditions are most favorable helps to keep the soil in good tilth. Minimum tillage, carefully selected cropping systems, and fertilizer help to conserve moisture and maintain organic matter content, fertility, and tilth.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites. Buildings should be designed and constructed to prevent structural damage caused by shrinking and swelling of the soil. The soil is suited to onsite waste disposal if proper design and installation procedures are used. Seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoon. Capability unit I-1; Loamy Upland range site.

Vb—Vanoss silt loam, 1 to 3 percent slopes. This is a deep, gently sloping, well drained soil that is typically on side slopes bordering low terraces.

Typically, the surface layer is brown silt loam about 16 inches thick. The subsoil is brown, friable clay loam to a depth of more than 60 inches (fig. 11). In some places the subsoil contains more clay. In other places the surface layer and the upper part of the subsoil are dark brown.

Included with this soil in mapping are small intermingled areas of Milan soils. These soils have more sand in the subsoil. They have similar slopes and are in similar positions, and they make up about 5 percent of the mapping unit.

This soil has moderate permeability. Runoff is medium. Available water capacity is high. The surface is friable and easily tilled. Natural fertility is high, and reaction is slightly acid to neutral. The shrink-swell potential is moderate.

Most areas of this soil are cultivated. A small acreage is used for rangeland. This soil has good potential for crops, rangeland, pasture, hay, windbreaks, and wildlife habitat. It has only fair potential for most urban and engineering uses.

This soil is well suited to all crops commonly grown in the county. These soils are easily tilled, but maintenance of tilth and fertility is required. There is a moderate hazard of water erosion when the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Minimum tillage, carefully selected cropping systems, and fertilizer help to conserve moisture and maintain organic matter content, fertility, and tilth.

Rangeland management that maintains adequate plant cover and ground mulch helps to prevent excessive soil losses and conserve moisture. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the rangeland vegetation and soil in good condition.

This soil is well suited to windbreaks, but there is a hazard of water erosion while a windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites. Buildings should be designed and constructed to prevent structural damage caused by shrinking and swelling of the soil. The soil is suited to onsite waste disposal if proper design and installation procedures are used. Seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoon. Capability unit IIe-1; Loamy Upland range site.

Vc—Vanoss silt loam, 3 to 6 percent slopes. This is a deep, sloping, well drained soil on side slopes that border low terraces. In some places it is on either side of intermittent drainageways cut into the side slopes.

Typically, the surface layer is brown silt loam about 16 inches thick. The subsoil is brown, friable clay loam to a depth of more than 60 inches. In some places the surface layer has been eroded and is only 4 to 8 inches thick. In other places the surface layer and the upper part of the subsoil are dark brown.

Included with this soil in mapping are small intermingled areas of Milan soils. The Milan soils have more sand in the subsoil than this Vanoss soil. They have similar slopes and are in similar positions, and they make up about 5 percent of the mapping unit.

This soil has moderate permeability. Runoff is medium. Available water capacity is high. The surface layer is friable and easily tilled. Natural fertility is high, and reaction is slightly acid to neutral. The shrink-swell potential is moderate.

Most areas of this soil are cultivated. This soil has good potential for crops, range, pasture, hay, windbreaks, and wildlife habitat. It has fair potential for most urban and engineering uses.

This soil is suited to most crops commonly grown in the county. There is a severe hazard of water erosion when the soil is cultivated and not protected. The main concerns of management are controlling erosion and maintaining tilth and fertility. Terraces and contour farming are needed to help to control erosion. Minimum tillage, carefully selected cropping systems, and fertilizer help to conserve moisture and maintain organic matter content, fertility, and tilth.

This soil is well suited to rangeland. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and conserve moisture. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the rangeland vegetation and soil in good condition.

This soil is well suited to windbreaks; however, there is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites. Buildings should be designed and constructed to prevent structural damage caused by shrinking and swelling of the soil. The soil is suited to onsite waste disposal if proper design and installation procedures are used. Seepage from sewage lagoons can be prevented by a special treatment that seals the bottom of the lagoon. Capability unit IIIe-1; Loamy Upland range site.

Wa—Waurika silt loam (0 to 1 percent slopes). This is a deep, nearly level, somewhat poorly drained soil on uplands. Individual areas are irregular in shape. This soil is slightly concave in places.

Typically, the surface layer is gray silt loam about 11 inches thick. The subsurface layer is light gray silt loam about 3 inches thick. The subsoil is very dark gray, very firm clay about 26 inches thick. The underlying material is grayish brown and gray heavy clay loam. In some places there is not a subsurface layer and the subsoil is reddish brown.

This soil has very slow permeability. Runoff is slow. The available water capacity is moderate. Tilth is poor, and the surface has a tendency to crust and puddle. Natural fertility is medium. The surface layer ranges from medium acid to neutral, and the subsoil is neutral to moderately alkaline. The subsoil has a high shrink-swell potential.

Most areas of this soil are cultivated. This soil has good potential for crops, rangeland, pasture, hay, windbreaks, and wildlife habitat. The potential for most urban and engineering uses is poor.

This soil is suited to most crops commonly grown in the county. Surface drainage is needed in some places. During wet periods, water is sometimes ponded on the surface and remains for several days. Planting and harvesting are often delayed, and crops sometimes drown. The main concerns of management are maintaining tilth, organic matter content, and fertility. Tilling when moisture conditions are most favorable helps to keep the soil in good tilth. Minimum tillage, carefully selected cropping systems, and fertilizer help to maintain organic matter content, fertility, and tilth.

This soil is well suited to rangeland. Overgrazing or grazing when the soil is too wet causes surface compaction. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and restricted use during wet periods help to keep the rangeland vegetation and soil in good condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. The main concern is excessive wetness. Survival in low areas where water ponds is likely to be poor. Draining these areas if possible promotes tree growth. Rainfall is likely to be irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is severely limited for most urban and engineering uses because it is very slowly permeable, is somewhat poorly drained, and has a high shrink-swell potential. If the soil is used as a construction site, surface drainage is needed in places and the building should be designed to prevent damage caused by shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tank systems often fail because of the very slow permeability. Capability unit IIw-1; Clay Upland range site.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, and as sites for buildings, highways and other transportation systems, sanitary facilities, parks and other recreation facilities, and wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

EARL J. BONDY, agronomist, Soil Conservation Service, assisted in preparing this section.

The major management concerns when using the soils for crops and pasture are described in this section. In addition, the crops and pasture plants best adapted to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and predicted yields of the main crops, hay, and pasture are presented for each soil.

This section provides information about the overall agricultural potential and needed practices in the survey area for those in the agribusiness sector—equipment dealers, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section, "Soil maps for detailed planning." This information should be referred to when planning management systems for individual fields or farms.

Approximately 550,000 acres in Sumner County was used for crops and pasture in 1967, according to the Conservation Needs Inventory. The 1973 Kansas Farm Facts shows 407,000 acres in close grown crops, mainly wheat. Sumner County has been the leading wheat producing county in Kansas each of the last 10 years. Other crops produced were 44,000 acres of sorghum, 9,000 acres of soybeans, and 22,000 acres of alfalfa. In 1967, 70,000 acres was in summer fallow.

The acreage of wheat has increased over the past 10 years, while the acreage of grain sorghum has declined. Also, in recent years the acreage of summer fallow has dropped considerably. The acreage of alfalfa has remained constant over several years. Sumner County ranks high in the State in barley production, but the crop amounts to only 14,000 acres.

Only 2,000 acres was in tame pasture in 1967, but tame pasture has increased in the last 2 or 3 years.

The potential of the soils in Sumner County for increased production of food and fiber is good. A large portion of this increase will come from the crop production on the approximately 70,000 acres that has been in summer fallow. Food production could also be increased by extending the latest crop production technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology.

There was an increase of only 200 acres of urban and built-up land in the county from 1958 to 1967.

Soil erosion is the major problem on about 50 percent of the cropland in Sumner County. If slope is more than 1 percent, erosion is a hazard. Bethany, Farnum, Milan, and Kirkland are the principal soils used for crops in the county.

Loss of the surface layer through erosion is damaging for two reasons: first, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer, and second, soil erosion on farmland results in sediment entering streams. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as the Bethany, Kirkland, Renfrow, and Tabler. Control of erosion minimizes the pollution of streams by sediment and improves quality of water for municipal use, for recreation, and for fish and wildlife.

In many sloping fields, preparing a good seedbed and tilling are difficult on clayey spots because the original friable surface layer has been eroded away. Such spots are common in areas of moderately eroded Kirkland soils.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps a plant cover on the soil for extended periods can hold soil erosion losses to amounts that will not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion on sloping land and also provide nitrogen and improve tilth for the following crop.

Terracing and contour tillage are not practical on some soils, because slopes are short and irregular and the surface layer is coarse textured and moderately coarse textured. On these soils, cropping systems that provide substantial plant cover are required to control soil blowing and water erosion. Leaving crop residues on the surface either by minimum tillage or by stubble mulching helps to increase infiltration and reduce the hazards of runoff and water erosion. The extra cover is essential to help prevent soil blowing during periods of crop production. Minimum tillage for sorghum and other row crops is becoming more common in Sumner County. It is effective in reducing erosion on sloping land and can be adapted to most soils in the survey area.

Terraces and diversions reduce the length of slopes and reduce runoff and erosion. They are most practical on deep, well drained soils that have uniform, regular slopes. This includes practically all soils except the coarse textured and moderately coarse textured soils.

Contour tillage is rarely used by itself but is a companion practice along with terraces. Contouring is best suited to soils with smooth, uniform slopes where terracing is applicable.

Soil blowing is a hazard on the coarse textured and moderately coarse textured Canadian, Carwile, Shellabarger, and Pratt soils. Soil blowing can damage these soils if they are bare of vegetation or surface mulch. Maintaining plant cover, surface mulch, or a rough surface through proper tillage minimizes soil blowing on these soils.

Information for the design of erosion control practices for each kind of soil is contained in the Field Office Technical Guide, which is available in local offices of the Soil Conservation Service.

Soil drainage is needed on less than 1 percent of the acreage used for crops and pasture in the survey area. Soils like the Waurika and Carwile are somewhat poorly drained and very slowly permeable; crops on these soils are likely to be damaged in some years. Shallow open drains connecting one pothole with another will help to improve drainage on these soils.

Soil fertility is naturally low on Owens soil but is medium or high on the remaining arable soils in the county. The soils range from medium acid to mildly alkaline in reaction. Soils such as Bethany, Corbin, Crisfield, Kirkland, Milan, Elandco, Shellabarger, Vanoss, and Waurika soils may be medium acid and need an application of ground limestone to raise the reaction (pH) sufficiently for good growth of alfalfa and other crops that grow well only on nearly neutral soils. On all soils additions of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous.

Most of the soils used for crops in the survey area have a silt loam or loam surface layer. Some are lower in content of organic matter than others. Generally, the structure of such soils is weak, and intense rainfall causes the formation of a crust on the surface. The crust is hard when dry and is nearly impervious to water. Once the crust forms, it reduces infiltration and increases runoff. Regular additions of crop residues, manure, and other organic material can help to improve soil structure and to reduce crust formation. Leaving residues on the surface will also help to prevent the formation of such a crust.

Field crops suited to the soils and climate of the survey area include many that are not commonly grown. Sunflowers, potatoes, and similar crops can be grown if economic conditions become favorable. Rye, barley, oats, and corn can be grown, and grass seed could be produced from smooth brome and fescue.

Deep soils that are well drained and that warm up early in spring are especially well suited to many vegetables and small fruits. In the survey area these are Farnum, Milan, Pond Creek, and Vanoss soils on uplands and Canadian, Dale, and Reinach soils on terraces and flood plains.

Most of the well drained soils in the survey area are suitable for orchards and nursery plants. Soils in low positions where frost is frequent and air drainage is poor generally are poorly suited to early vegetables, small fruits, and orchards.

Latest information and suggestions for growing crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes climatically suited to the area and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; 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 residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils 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 included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classification

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

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; they are defined as follows:

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

Class VIII soils and landforms 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 too cold or too 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, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, I-1 or IIw-1. The capability units is identified in the description of each soil map unit in the section "Soil maps for detailed planning."

Rangeland

ARNOLD G. MENDENHALL, range conservationist, Soil Conservation Service, assisted in preparing this section.

Rangeland is land on which the natural, or climax, vegetation is composed principally of native grasses, grasslike plants, forbs, and shrubs which are valuable for grazing by livestock. Range management is the wise use of rangelands to produce forage for livestock and to provide habitat for wildlife, clean water, recreation, esthetic values, and related uses.

In Sumner County, livestock and livestock products account for about 28 percent of the agricultural income. The number of beef cows that calved in the county ranged from 24,000 to 27,000 in a recent 3-year period (*6*, *7*).

Most livestock forage is produced on rangeland. Supplemental feed comes from crops and their byproducts. Rangeland makes up about 20 percent of the county, or about 146,000 acres.

The rangeland in Sumner County varies considerably in the kinds and amounts of native plants produced. The range managers or operators need to know the capabilities of different kinds of rangeland before they can manage it properly.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 6 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominately grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 6.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture 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.

Potential production refers to the amount of vegetation that can be expected to grow annually on well-managed rangeland that is supporting the potential natural plant community. 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 are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife. Plant species that have special value for livestock forage are mentioned in the description of each soil mapping unit.

Common plant names of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. Because only major species are listed, percentages do not necessarily total 100. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluaton of the present condition of the range vegetation in relation to its potential. 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. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, 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.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from winds and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection (fig. 13).

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

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

Table 7 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soils in 20 years. The estimates in table 7, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

CLIFTON E. DEAL, civil engineer, Soil Conservation Service, assisted in preparation of this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this section are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to: (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 8 shows, for each kind of soil, the degree and kind of limitations for building site development; table 9, for sanitary facilities; and table 11, for water management. Table 10 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

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

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 8. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by the soil wetness of a high seasonal water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 8 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation. Requirements for protecting built-up areas from flooding can be obtained from the State Division of Water Resources.

Local roads and streets referred to in table 8 have an all-weather surface that can carry light to medium traffic all year. They consist of subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Requirements for sewage disposal can be obtained from the local Board of Health. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

Percolation tests are performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at minimum absorptive capacity.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table could be installed or the size of the absorption field could be increased so that performance is satisfactory.

Sewage lagoon areas are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold 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. Soils that are very high in organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is solid waste (refuse) and soil material that is placed in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness may be a limitation because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Unless otherwise stated, the limitations in table 9 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

Soils rated *good* have more than 40 inches of friable loamy material. They are either free of stones or have very few stones, are low in content of gravel and other coarse fragments, and have gentle slopes. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy or firm loamy or clayey soils, soils in which the suitable material is only 20 to 40 inches thick, or soils that have an appreciable amount of gravel or stones.

Soils rated *poor* are very sandy soils, very firm clayey soils, soils having suitable layers less than 20 inches thick, soils having a large amount of gravel or stones, steep soils, or poorly drained soils.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 10 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 14 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor.*

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in tables 14 and 15.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability, texture, depth to bedrock, hardpan, or other layers that affect the rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

JACK WALSTROM, biologist, Soil Conservation Service, assisted in preparing this section.

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the 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 12 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 9, and interpretations for dwellings without basements and for local roads and streets, given in table 8.

Camp areas require such site preparation as shaping and leveling for 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 for this use 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 camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as 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 will 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 or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

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

Wildlife habitat

ROBERT J. HIGGINS, biologist, Soil Conservation Service, assisted in preparing this section.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 13, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and 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* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

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

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, wheat, oats, and barley. The major soil properties 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.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, lovegrass, bromegrass, clover, and alfalfa. Major soil properties 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.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluestem, goldenrod, beggarweed, wheatgrass, and grama. Major soil properties 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.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Examples of native plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated good are Russian-olive, autumn-olive, and crabapple. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Examples are pine, spruce, fir, cedar, and juniper. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are mountainmahogany, bitterbrush, snowberry, and big sagebrush. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, and cordgrass and rushes, sedges, and reeds. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are marshes, waterfowl feeding areas, and ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Open-land wildlife habitat 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 kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Woodland wildlife habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, grey fox, raccoon, deer, and bear.

Wetland wildlife habitat consists of open, marshy or swampy, shallow-water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Rangeland wildlife habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include antelope, white-tailed deer, desert mule deer, sage grouse, meadowlark, and lark bunting.

The soils of Sumner County provide suitable habitat for many kinds of animals and birds. The most important game birds are ducks, geese, ring-neck pheasant, and bobwhite quail. Alluvial soils along the Arkansas River, South Fork of the Ninnescah River, the Chikaskia River, and Bluff, Fall, and Slate Creeks produce habitat for deer, raccoon, squirrel, muskrat, opossum, and songbirds.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots; determine the pH, or reaction, of the soil; and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classification, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 14 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area. These estimates are presented as ranges in values most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 14 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 14 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 soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*). In table 14 soils in the survey area are classified according to both systems.

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, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 17. The estimated classification, without group index numbers, is given in table 14.

Also in table 14 the percentage, by weight, of cobbles or the rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted in table 14.

Physical and chemical properties

Table 15 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity 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 the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 15. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

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

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing 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, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing 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, but crops can be grown if measures to control soil blowing 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, and 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, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 16 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received 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 chiefly of deep, well drained to excessively drained sands or gravels. 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 that have a layer that impedes the downward movement of water or soils that have 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 clay soils 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 is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

The *high water table* is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 16 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. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to assure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Test data

Table 17 contains engineering test data for some of the major soil series in Sumner County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If the soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the optimum moisture content is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed maximum dry density. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material as has been explained for table 14.

Classification of the soils

In this section, the soil series recognized in the survey area are described, the current system of classifying soils is defined, and the soils in the area are classified according to the current system.

Soil series and morphology

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

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*9*). Unless otherwise noted, colors described are for dry soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or mapping units, of each soil series are described in the section "Soil maps for detailed planning."

Bethany series

The Bethany series consists of deep, well drained, slowly permeable soils on uplands. These soils formed in old alluvium and loess. Slope ranges from 0 to 3 percent.

Bethany soils are similar to Corbin, Kirkland, and Pond Creek soils and commonly are adjacent to Corbin, Kirkland, Pond Creek, Tabler, and Waurika soils on the landscape. Corbin soils are less clayey in the upper part of the argillic horizon. Kirkland and Tabler soils have a more abrupt texture change between the A and B horizons. Tabler soils also have a less brown Bt horizon. Pond Creek soils have a fine-silty control section. Waurika soils have an A2 horizon.

Typical pedon of Bethany silt loam, 1 to 3 percent slopes, 1,300 feet north and 150 feet east of the southwest corner of section 32, T. 32 S., R. 2 E.:

A1—0 to 8 inches; dark grayish brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, friable; slightly acid; gradual boundary.

A3—8 to 17 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; strong fine granular structure; slightly hard, friable; neutral; gradual boundary.

B21t—17 to 37 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; strong medium blocky structure; very hard, very firm; thick continuous clay films; neutral; abrupt boundary.

B22t—37 to 48 inches; dark brown (10YR 4/3) clay, dark brown (10YR 3/3) moist; moderate medium blocky structure; very hard, very firm; mildly alkaline; small hard calcareous concretions; gradual boundary.

B23t—48 to 60 inches; brown (7.5YR 5/3) clay, dark brown (7.5YR 4/4) moist; common coarse distinct yellowish red (5YR 5/6) mottles; moderate medium and coarse blocky structure; very hard, very firm; moderately alkaline; few small calcareous concretions.

The solum is more than 60 inches thick. The mollic epipedon is more than 20 inches thick and extends into the argillic horizon in most pedons.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. Reaction ranges from medium acid to neutral. The B21t horizon has hue of 7.5YR or 10YR, value of 4 or 5 (2 to 4 moist), and chroma of 2 or 3. It is heavy silty clay loam, silty clay, or light clay. Reaction is neutral or mildly alkaline. The B22t horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 to 4. It is silty clay or clay. Reaction is mildly alkaline or moderately alkaline. The B23t horizon typically has hue of 7.5YR or 10YR, but hue is 5YR in some places. Value is 4 or 5, and chroma is 2 to 6. The B23t horizon is silty clay or clay. Reaction is mildly alkaline or moderately alkaline. The Bt horizon is 40 to 48 percent clay.

Brewer series

The Brewer series consists of deep, moderately well drained, slowly permeable soils on low terraces and flood plains. These soils formed in clayey alluvium. Slope ranges from 0 to 2 percent.

Brewer soils are similar to Dale and Tabler soils and are adjacent to Dale soils on the landscape. Dale soils do not have an argillic horizon and are less clayey. Tabler soils are on uplands and have vertic properties.

Typical pedon of Brewer silty clay loam, 1,300 feet south and 350 feet east of the northwest corner of section 5, T. 32 S., R. 1 E.:

A1—0 to 14 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium granular structure; slightly hard, friable; slightly acid; clear boundary.

B21t—14 to 32 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; moderate medium and coarse blocky structure; very hard, very firm; thick continuous clay films; neutral; gradual boundary.

B22t—32 to 50 inches; very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; moderate coarse blocky structure; very hard, very firm; moderately alkaline; gradual boundary.

B3—50 to 60 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak coarse blocky structure; very hard, very firm; moderately alkaline.

The solum ranges from 50 to 60 inches in thickness. The mollic epipedon is more than 20 inches thick and extends into the argillic horizon in most pedons.

The A horizon has hue of 10YR, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. Reaction is slightly acid or neutral. The B2 horizon has hue of 10YR, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is silty clay and averages 40 to 45 percent clay. Reaction ranges from neutral to moderately alkaline. The B3 horizon has hue of 7.5YR or 10YR, value of 3 to 6 (2 to 5 moist), and chroma of 1 or 2. Reaction ranges from neutral to moderately alkaline.

Canadian series

The Canadian series consists of deep, well drained, moderately rapidly permeable soils on low terraces and flood plains. These soils formed in loamy alluvium. Slope ranges from 0 to 1 percent.

Canadian soils are similar to Crisfield soils and commonly are adjacent to Lincoln and Lesho soils on the landscape. Crisfield soils have B and C horizons with hue of 5YR or redder. Lincoln soils lack a mollic epipedon and are coarser textured. Lesho soils have finer textured A and B horizons underlain by sandy layers.

Typical pedon of Canadian sandy loam 1,000 feet south and 2,340 feet west of the northeast corner of section 3, T. 30 S., R. 1 E.:

A1—0 to 10 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; gradual boundary.

B2—10 to 28 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; moderate fine and medium granular structure; soft, very friable; slightly acid; gradual boundary.

B3—28 to 40 inches; light yellowish brown (10YR 6/4) light sandy loam, yellowish brown (10YR 5/4) moist; weak fine granular structure; soft, very friable; neutral; gradual boundary.

C—40 to 60 inches; reddish yellow (7.5YR 6/6) loamy fine sand, strong brown (7.5YR 5/6) moist; massive; soft, very friable; neutral.

The solum ranges from 30 to 40 inches in thickness. The mollic epipedon ranges from 8 to 16 inches in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is sandy loam or fine sandy loam. Reaction is slightly acid or neutral. The B horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is sandy loam or fine sandy loam. Reaction is slightly acid or neutral. The C horizon has hue of 10YR or 7.5YR, value of 5 to 7 and chroma of 3 to 6. It is sandy loam, fine sandy loam, loamy sand, or loamy fine sand. Reaction ranges from slightly acid to moderately alkaline.

Carwile series

The Carwile series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in old alluvium and eolian sediments. Slope ranges from 0 to 1 percent.

Carwile soils are similar to Tabler soils and are adjacent to Pratt soils on the landscape. Tabler soils have less sand and have a thicker mollic epipedon. Pratt soils have more sand throughout and are well drained.

Typical pedon of Carwile fine sandy loam in an area of Carwile soils 1,800 feet west and 800 feet north of the southeast corner of section 20, T. 31 S., R. 4 W.:

A1—0 to 10 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable; slightly acid; clear boundary.

B2t—10 to 39 inches; light brownish gray (10YR 6/2) clay, dark grayish brown (10YR 4/2) moist; common medium distinct strong brown mottles; moderate medium blocky structure; very hard, very firm; thick continuous clay films; neutral; gradual boundary.

C—39 to 60 inches; light brownish gray (10YR 6/2) heavy sandy clay loam, dark grayish brown (10YR 4/2) moist; common coarse distinct mottles; massive; very hard, very firm; neutral.

The solum ranges from 35 inches to more than 60 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 1 or 2. It is fine sandy loam or clay loam. Reaction is slightly acid or neutral. The B horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 1 or 2. It is clay, clay loam, or sandy clay loam. Reaction is slightly acid or neutral. The C horizon has hue of 10YR or 2.5YR, value of 4 to 6, and chroma of 1 or 2. It is sandy clay loam, clay loam, or clay. Reaction ranges from neutral to moderately alkaline.

Corbin series

The Corbin series consists of deep, well drained soils on uplands. These soils are moderately permeable in the upper part and slowly permeable in the lower part. They formed in loess and old alluvium. Slope ranges from 0 to 2 percent.

Corbin soils are similar to Bethany and Pond Creek soils and commonly are adjacent to Bethany, Kirkland, Pond Creek, and Tabler soils on the landscape. Bethany, Kirkland, and Tabler soils all have more clay in the upper part of the argillic horizon. Pond Creek soils have less clay in the lower part of the argillic horizon.

Typical pedon of Corbin silt loam 2,140 feet north and 200 feet west of the southeast corner of section 7, T. 35 S., R. 3 W.:

A1—0 to 16 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; soft, very friable; slightly acid; gradual boundary.

B21t—16 to 29 inches; brown (7.5YR 5/3) silty clay loam, dark brown (7.5YR 3/3) moist; moderate medium and fine subangular blocky structure; slightly hard, friable; slightly acid; clear boundary.

IIB22t—29 to 48 inches; dark brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate to strong coarse blocky structure; very hard, very firm; neutral; clear boundary.

IIC—48 to 60 inches; brown (7.5YR 5/4) silty clay loam, brown (7.5YR 4/4) moist; structureless; slightly hard, friable; mildly alkaline; a few small hard calcareous concretions.

The solum ranges from 40 to 70 inches in thickness. The mollic epipedon is more than 20 inches thick and extends into the argillic horizon in most pedons.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. Reaction ranges from medium acid to neutral. The B2t horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. Reaction is slightly acid or neutral. The IIBt horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2. It is silty clay or clay. Reaction is slightly acid or neutral. The IIC horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4. It is silty clay loam or silty clay. Reaction ranges from slightly acid to mildly alkaline.

Crisfield series

The Crisfield series consists of deep, well drained, moderately rapidly permeable soils on low terraces. These soils formed in loamy alluvium. Slope ranges from 0 to 2 percent.

Crisfield soils are similar to Canadian soils and are commonly adjacent to Lincoln and Pratt soils on the landscape. Canadian soils do not have hue of 5YR in the B horizon. Lincoln and Pratt soils lack a mollic epipedon and are more sandy throughout. Pratt soils are on uplands.

Typical pedon of Crisfield sandy loam 1,900 feet west and 250 feet north of the southeast corner of section 17, T. 32 S., R. 4 W.:

A1—0 to 14 inches; brown (7.5YR 4/2) sandy loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; soft, friable; slightly acid; gradual boundary.

B2—14 to 30 inches; reddish brown (5YR 5/3) heavy sandy loam, reddish brown (5YR 4/3) moist; moderate medium and coarse granular structure; slightly hard, friable; slightly acid; gradual boundary.

B3—30 to 50 inches; reddish brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4) moist; weak fine granular structure; soft, friable; neutral; diffuse boundary.

C—50 to 60 inches; yellowish red (5YR 5/6) sandy loam, yellowish red (5YR 4/6) moist; massive; loose, very friable; neutral.

The solum ranges from 40 to 60 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness. Reaction ranges from medium acid to neutral throughout.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 (3 moist), and chroma of 2 or 3. It is sandy loam or fine sandy loam. The B horizon has hue of 5YR, value of 4 to 6, and chroma of 3 to 6. It is sandy loam or fine sandy loam. The C horizon has hue of 5YR or 2.5YR, value of 4 to 6 and chroma of 3 to 6. It is sandy loam, fine sandy loam, loamy fine sand, loamy sand, or sand. In some pedons more silty or clayey layers are below a depth of 40 inches.

Dale series

The Dale series consists of deep, well drained, moderately permeable soils on low terraces and flood plains. These soils formed in silty alluvium. Slope ranges from 0 to 8 percent.

Dale soils are similar to Brewer, Lesho, Elandco, and Reinach soils and are commonly adjacent to these soils on the landscape. Brewer soils have an argillic horizon. Lesho soils have sandy lower horizons. Reinach soils are less clayey. Elandco soils are stratified.

Typical pedon of Dale silt loam in an area of Dale and Reinach silt loams 950 feet south and 65 feet east of the northwest corner of section 33, T. 34 S., R. 4 W.:

A11—0 to 13 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; friable, soft; slightly acid; gradual boundary.

A12—13 to 24 inches; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; friable, slightly hard; neutral; gradual boundary.

B2—24 to 34 inches; brown (7.5YR 4/3) silt loam, dark brown (7.5YR 3/3) moist; moderate fine subangular blocky and coarse granular structure; friable, slightly hard; neutral; gradual boundary.

C—34 to 60 inches; dark brown (7.5YR 4/3) heavy silt loam, dark brown (7.5YR 3/3) moist; mostly massive but some very weak fine subangular blocky structure; firm, hard; moderately alkaline.

The solum ranges from 30 to 60 inches in thickness. The mollic epipedon is more than 20 inches thick and extends into the B2 horizon in some pedons.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. It is silt loam or silty clay loam. Reaction is slightly acid to mildly alkaline. The B horizon has hue of 10YR to 5YR, value of 3 to 5, and chroma of 2 to 4. It is silty clay loam, silt loam, or loam. Reaction ranges from slightly acid to moderately alkaline. The C horizon has hue of 10YR to 5YR, value of 4 to 6, and chroma of 3 to 6. It is silty clay loam, silt loam, or loam. Reaction is neutral to moderately alkaline.

Elandco series

The Elandco series consists of deep, well drained, moderately permeable soils on low terraces and flood plains. These soils formed in loamy alluvium. Slope ranges from 0 to 2 percent.

Elandco soils are similar to Dale and Reinach soils and Ustifluvents. They are commonly adjacent to these soils on the landscape. Dale and Reinach soils are less stratified. Ustifluvents lack a mollic epipedon, are highly stratified, and occur on the broken banks of entrenched streams.

Typical pedon of Elandco silty clay loam 1,320 feet north and 150 feet west of the southeast corner of section 22, T. 32 S., R. 1 W.:

A11—0 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; slightly acid; diffuse boundary.

A12—16 to 45 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium and coarse granular structure and weak fine subangular blocky; hard, firm; slightly acid; gradual boundary.

C—45 to 60 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; weak coarse granular structure; hard, friable; mildly alkaline.

The solum ranges from 20 to 50 inches in thickness. The mollic epipedon is more than 20 inches thick.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. It is silty clay loam or silt loam. Reaction ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR, value of 3 to 5, and chroma of 2 to 4. It is silty clay loam, silt loam, or loam. Reaction is neutral to moderately alkaline.

Farnum series

The Farnum series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in old alluvial outwash. Slope ranges from 0 to 6 percent.

Farnum soils are similar to Milan and Shellabarger soils and are commonly adjacent to Milan and Shellabarger soils on the landscape. Milan and Shellabarger soils have a mollic epipedon less than 20 inches thick and have an argillic horizon of redder hue.

Typical pedon of Farnum loam, 1 to 3 percent slopes, 1,500 feet east and 130 feet north of the southwest corner of section 19, T. 32 S., R. 2 W.:

A1—0 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; soft, friable; slightly acid; gradual boundary.

B1—11 to 16 inches; dark brown (7.5YR 4/2) light clay loam, dark brown (7.5YR 3/2) moist; moderate coarse granular structure and fine subangular blocky; slightly hard, firm; slightly acid; clear boundary.

B2t—16 to 40 inches; dark brown (7.5YR 4/3) clay loam, dark brown (7.5YR 3/3) moist; moderate medium blocky structure; thin continuous clay films; hard, firm; neutral; gradual boundary.

C—40 to 60 inches; brown (7.5YR 5/3) heavy sandy clay loam, brown (7.5YR 4/3) moist; massive; hard, firm; neutral.

The solum ranges from 32 inches to more than 60 inches. The mollic epipedon is more than 20 inches thick and extends into the argillic horizon in most pedons.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. Reaction is slightly acid or neutral. The B horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 to 4. It is clay loam that is less than 35 percent clay. Reaction is neutral or mildly alkaline. The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 to 5. It is clay loam or sandy clay loam. Reaction is neutral or mildly alkaline.

Kirkland series

The Kirkland series consists of deep, well drained, very slowly permeable soils on uplands. These soils formed in old alluvium. Slope ranges from 0 to 3 percent.

Kirkland soils are similar to Bethany, Renfrow, Tabler, and Waurika soils and are commonly adjacent to Bethany, Corbin, Tabler, and Waurika soils on the landscape. Bethany, Corbin, and Tabler soils lack an abrupt texture change between the A and B horizons. Renfrow soils have a mollic epipedon less than 20 inches thick. Tabler soils lack redder hue in the B and C horizons. Waurika soils have an A2 horizon.

Typical pedon of Kirkland silt loam, 1 to 3 percent slopes, 2,100 feet south and 100 feet west of the northeast corner of section 6, T. 33 S., R. 1 W.:

A1—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable; medium acid; clear boundary.

B21t—9 to 27 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; strong medium and coarse blocky structure; very hard, very firm; neutral; gradual boundary.

B22t—27 to 48 inches; dark brown (7.5YR 4/2) light clay, dark brown (7.5YR 3/2) moist; few coarse distinct dark brown (7.5YR 4/4) mottles; weak coarse blocky structure; very hard, very firm; moderately alkaline; few small calcareous concretions; diffuse boundary.

B23t—48 to 60 inches; reddish brown (5YR 5/5) clay, reddish brown (5YR 4/4) moist; weak medium blocky structure; very hard, very firm; moderately alkaline; few small calcareous concretions.

The solum is more than 60 inches thick. The mollic epipedon is more than 20 inches thick and extends into the argillic horizon.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly silt loam but is silty clay loam in some pedons. Reaction ranges from medium acid to neutral. The B21t and B22t horizons have hue of 7.5YR or 10YR, value of 3 to 5 (2 to 4 moist), and chroma of 2 to 4. They are clay or silty clay. The B21t horizon is neutral or mildly alkaline, and the B22t horizon ranges from neutral to moderately alkaline. The B23t horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 to 5. It is clay or silty clay. Reaction ranges from neutral to moderately alkaline.

Lesho series

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

Lesho soils are similar to Dale soils and are commonly adjacent to Canadian, Dale, and Lincoln soils on the landscape. Dale and Canadian soils lack the contrasting sandy lower horizons. Lincoln soils are sandy throughout.

Typical pedon of Lesho clay loam 1,800 feet north and 650 feet west of the southeast corner of section 25, T. 30 S., R. 1 E.:

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; very weak fine granular structure; soft, friable; mildly alkaline; clear boundary.

A12—10 to 17 inches; dark grayish brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) moist; common fine distinct mottles of dark brown (7.5YR 4/4) and grayish brown (10YR 5/2) moist; moderate medium granular structure; slightly hard, friable; slight effervescence; moderately alkaline; gradual boundary.

C—17 to 30 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; common coarse distinct mottles of brownish yellow (10YR 6/6); weak fine subangular blocky structure; soft, friable; strong effervescence; moderately alkaline; gradual boundary.

IIC—30 to 60 inches; light yellowish brown (10YR 6/4) loamy fine sand and fine sand, yellowish brown (10YR 5/4) moist; single grained; strong effervescence; moderately alkaline.

The solum and the mollic epipedon range from 10 to 20 inches in thickness. Depth to the IIC horizon ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 3 to 5, and chroma of 2 or 3. It is dominantly clay loam but ranges to loam and silty clay loam. Reaction is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR, value of 5 or 6, and chroma of 2 to 6. It typically has mottles with chroma of 2 to 6. It is dominantly clay loam but ranges to silty clay loam. Reaction ranges from mildly alkaline to moderately alkaline. The IIC horizon has hue of 7.5YR to 2.5Y, value of 5 to 7, and chroma of 3 to 6. It is loamy fine sand or sand. Reaction ranges from mildly alkaline to strongly alkaline.

Lincoln series

The Lincoln series consists of deep, somewhat excessively drained, rapidly permeable soils on flood plains. These soils formed in sandy alluvium. Slope ranges from 0 to 1 percent.

Lincoln soils are similar to Pratt and Tivoli soils and are commonly adjacent to Canadian, Crisfield, and Lesho soils. Pratt and Tivoli soils formed in eolian materials on uplands. Canadian, Crisfield, and Lesho soils all have a less sandy solum.

Typical pedon of Lincoln loamy fine sand in an area of Lincoln soils 4,000 feet east and 100 feet south of the northwest corner of section 18, T. 30 S., R. 2 E.:

A1—0 to 10 inches; brown (7.5YR 5/3) loamy fine sand, dark brown (7.5YR 4/3) moist; weak fine granular structure; loose, very friable; moderately alkaline; clear boundary.

C—10 to 60 inches; reddish yellow (7.5YR 6/6) fine sand, strong brown (7.5YR 5/6) moist; single grained; contains thin strata of fine textured material; loose both dry and moist; slightly effervescent; moderately alkaline.

The solum ranges from 8 to 15 inches in thickness.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 7 (3 to 6 moist), and chroma of 2 to 4. It is dominantly loamy fine sand but ranges to fine sand. Reaction is mildly or moderately alkaline. The C horizon has hue of 5YR to 10YR, value of 6 to 8, and chroma of 4 to 6. It is loamy fine sand or fine sand.

Milan series

The Milan series consists of deep, well drained, moderately slowly permeable soils on uplands. These formed in old alluvial outwash. Slope ranges from 0 to 6 percent.

Milan soils are similar to Farnum, Shellabarger, and Vanoss soils and are commonly adjacent to these soils on the landscape. Farnum soils have a mollic epipedon more than 20 inches thick and have less red hue. Shellabarger soils have coarser texture. Vanoss soils have fine-silty texture.

Typical pedon of Milan loam, 1 to 3 percent slopes, 2,000 feet north and 300 feet west of the southeast corner of section 14, T. 32 S., R. 3 W.:

A1—0 to 10 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard friable; few pebbles as large as 3/4 inch in diameter; medium acid; clear boundary.

B1—10 to 14 inches; dark brown (7.5YR 4/2) light clay loam, dark brown (7.5YR 3/2) moist; moderate medium and coarse granular structure; hard, firm; few pebbles; slightly acid gradual boundary.

B2t—14 to 34 inches; dark reddish gray (5YR 4/2) clay loam, dark reddish brown (5YR 3/2) moist; moderate to strong medium and coarse blocky stucture; extremely hard, very firm; ped surfaces have dark stains and thick continuous clay films; few pebbles; neutral; gradual boundary.

B3—34 to 48 inches; red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; moderate medium blocky structure; hard, firm; few pebbles; neutral; gradual boundary.

C—48 to 70 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; massive; hard, friable; many pebbles; neutral.

The solum ranges from 30 inches to more than 60 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness. As much as 10 percent of the soil volume is coarse sand and gravel as large as 1 inch in diameter.

The A horizon has hue of 5YR to 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly loam but ranges to sandy loam or fine sandy loam. Reaction is medium acid or slightly acid. The B2 horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 4 to 7. It is clay loam or sandy clay loam and averages between 27 and 35 percent clay. Reaction is medium acid to neutral. The C horizon has colors and reaction within the ranges of the B2 horizon. It typically has more coarse sand and gravel and is less clayey than the B horizon.

Owens series

The Owens series consists of shallow, well drained, very slowly permeable soils on uplands. These soils formed in materials weathered from clayey shale. Slope ranges from 1 to 25 percent.

Owens soils are similar to Renfrow and Rosehill soils and are commonly adjacent to Renfrow and Rosehill soils on the landscape. Renfrow and Rosehill soils have a thicker solum. Renfrow soils have an argillic horizon, and Rosehill soils have less red hue.

Typical pedon of Owens clay loam, 3 to 8 percent slopes, 1,400 feet north and 150 feet west of the southeast corner of section 3, T. 35 S., R. 1 W.:

A1—0 to 4 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; very hard, firm; few small black concretions; mildly alkaline; gradual boundary.

B2ca—4 to 20 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate fine and medium subangular blocky and blocky structure; very hard, very firm; moderately alkaline; calcareous; small concretions of calcium carbonate; clear boundary.

C—20 to 22 inches; light gray (5Y 7/2) weakly consolidated shale.

The solum ranges from 12 to 20 inches in thickness. It is moderately alkaline.

The A horizon has a hue of 5YR to 2.5Y, value of 4 to 6 (2 to 4 moist), and chroma of 2 to 4. It is dominantly clay loam but ranges to clay and silty clay. The B2 horizon has hue of 5YR to 2.5Y, value of 4 to 7 (3 to 6 moist), and chroma of 2 to 6. It is silty clay, clay, or clay loam and ranges from 35 to 50 percent clay. The C horizon has hue of 5YR to 5Y, value of 4 to 8, and chroma of 2 to 6. It is shaly clay, clayey shale, or weakly consolidated shale. Thin layers of fractured limestone are in some pedons.

Pond Creek series

The Pond Creek series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in loess and old alluvium. Slope ranges from 0 to 6 percent.

Pond Creek soils are similar to Bethany, Corbin, and Vanoss soils and are commonly adjacent to Bethany and Corbin soils on the landscape. Bethany and Corbin soils have a fine-textured argillic horizon and have less red hue. Vanoss soils have a mollic epipedon less than 20 inches thick.

Typical pedon of Pond Creek silt loam, 1 to 3 percent slopes, 150 feet south and 75 feet west of the northeast corner of section 33, T. 34 S., R. 4 W.:

A1—0 to 13 inches; dark brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, friable; slightly acid; clear boundary.

B1—13 to 18 inches; dark brown (7.5YR 4/3) light silty clay loam, dark brown (7.5YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable; neutral; gradual boundary.

B2t—18 to 40 inches; dark brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate to strong medium subangular blocky structure; hard, firm; neutral; gradual boundary.

B3—40 to 50 inches; reddish brown (5YR 5/4) light clay loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable; neutral; a few small calcareous concretions; gradual boundary.

C—50 to 65 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; very weak subangular blocky structure to structureless (massive); slightly hard, friable; neutral; a few small calcareous concretions.

The solum ranges from 40 inches to more than 60 inches in thickness. The mollic epipedon is more than 20 inches thick and extends into the B horizon.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. Reaction is slightly acid or neutral. The B2 horizon has hue of 5YR to 10YR, value of 4 or 5 (2 to 4 moist), and chroma of 2 to 4. It is clay loam or silty clay loam, and it is 27 to 35 percent clay in the upper part and as much as 40 percent clay in the lower part. Reaction is slightly acid or neutral. The C horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 3 to 8. It is silty clay loam or clay loam. Reaction ranges from neutral to moderately alkaline.

Pratt series

The Pratt series consists of deep, well drained, rapidly permeable soils on uplands. These soils formed in sandy eolian deposits. Slope ranges from 3 to 8 percent.

Pratt soils are similar to Lincoln and Tivoli soils and are commonly adjacent to Carwile, Crisfield, and Tivoli soils on the landscape. Carwile soils are more clayey and somewhat poorly drained. Crisfield soils are less sandy and are on flood plains. Lincoln soils lack an orgillic horizon and are on flood plains. Tivoli soils lack an orgillic horizon. Typical pedon of Pratt loamy fine sand, undulating, 400 feet north and 1,600 feet east of the southwest corner of section 17, T. 32 S., R. 4 W.:

A1—0 to 14 inches; pinkish gray (7.5YR 6/2) loamy fine sand, brown (7.5YR 4/2) moist; very weak fine granular structure; soft, very friable; slightly acid; diffuse boundary.

B2t—14 to 38 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable; slightly acid; gradual boundary.

C—38 to 60 inches; strong brown (7.5YR 5/6) fine sand, strong brown (7.5YR 4/6) moist; structureless (single grained); loose; very friable; neutral.

The solum ranges from 24 to 50 inches in thickness. Reaction is slightly acid or neutral throughout.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is dominantly loamy fine sand but ranges to sand or fine sand. The B2 horizon has hue of 7.5YR or 10YR, value of 4 to 6 (4 or 5 moist), and chroma of 2 to 4. It is loamy sand or loamy fine sand and has 3 to 9 percent more clay than the A horizon. The C horizon has hue of 7.5YR or 10YR, value of 4 to 7 (3 to 6 moist), and chroma of 3 to 6. It is loamy fine sand, loamy sand, or sand.

Reinach series

The Reinach series consists of deep, well drained, moderately permeable soils on low terraces and flood plains. These soils formed in silty alluvium. Slope ranges from 0 to 1 percent.

Reinach soils are similar to Dale and Elandco soils and are commonly adjacent to Dale, Elandco, and Vanoss soils on the landscape. Dale soils are more clayey than Reinach soils. Elandco soils are more clayey than Reinach soils and are stratified and Vanoss soils are more clayey and are on uplands.

Typical pedon of Reinach silt loam in an area of Dale and Reinach silt loams 1,500 feet north and 150 feet east of the southwest corner of section 12, T. 35 S., R. 4 W.:

A1—0 to 13 inches; brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; soft, friable; slightly acid; gradual boundary.

B2—13 to 30 inches; brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; slightly hard, friable; neutral; gradual boundary.

C—30 to 60 inches; light brown (7.5YR 6/4) silt loam, brown (7.5YR 4/4) moist; massive; soft, friable; moderately alkaline; calcareous.

The solum ranges from 20 inches to more than 60 inches in thickness. The mollic epipedon is more than 20 inches thick and extends into the B horizon in most pedons.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. Reaction is slightly acid or neutral. The B2 horizon has hue of 7.5YR, value of 4 or 5 (2 to 4 moist), and chroma of 2 to 4. It is silt loam that is less than 18 percent clay. Reaction ranges from neutral to moderately alkaline. The C horizon has hue of 5YR or 7.5YR, value of 4 to 7, and chroma of 3 to 6. Reaction is mildly alkaline or moderately alkaline. Texture ranges from fine sandy loam to clay loam below a depth of 40 inches in some pedons.

Renfrow series

The Renfrow series consists of deep, well drained, very slowly permeable soils on uplands. These soils formed in material weathered from clayey shale. Slope ranges from 1 to 6 percent.

Renfrow soils are similar to Kirkland, Owens, and Rosehill soils and are commonly adjacent to Owens and Rosehill soils on the landscape. Kirkland soils have a mollic epipedon more than 20 inches thick. Owens soils are shallow over shale. In Rosehill soils, depth of shale is 20 to 40 inches; Rosehill soils have less red hue than Renfrow soils.

Typical pedon of Renfrow clay loam in an area of Renfrow complex, 1 to 3 percent slopes, 2,600 feet west and 300 feet north of the southeast corner of section 15, T. 31 S., R. 3 W.:

Ap—0 to 6 inches; dark reddish gray (5YR 4/2) clay loam, dark reddish brown (5YR 3/2) moist; moderate medium granular structure; hard, friable; slightly acid; clear boundary.

A12—6 to 12 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; strong fine subangular blocky structure and coarse granular; hard, firm; slightly acid; abrupt boundary.

B21t—12 to 27 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate medium and coarse blocky structure; very hard, very firm; neutral; few small calcium carbonate concretions; gradual boundary.

B22t—27 to 48 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist, moderate coarse blocky structure; extremely hard, very firm; mildly alkaline; gradual boundary.

B3—48 to 62 inches; red (2.5YR 5/6) clay, red (2.5YR 4/6) moist; part of the matrix is light reddish brown (2.5YR 6/4), reddish brown (2.5YR 5/4) moist; weak fine blocky structure; extremely hard, very firm; mildly alkaline; calcareous.

The solum is more than 60 inches thick. The mollic epipedon ranges from 8 to 12 inches in thickness. Reaction ranges from slightly acid to moderately alkaline throughout.

The A horizon has hue of 5YR to 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is dominantly clay loam but ranges to silt loam and silty clay loam. The B2t horizon has hue of 2.5YR or 5YR, value of 4 or 5 (3 or 4 moist), and chroma of 4 to 6. It is dominantly clay that is 40 to 50 percent clay, but silty clay, silty clay loam, and clay loam that are 35 to 60 percent clay are also included. The B3 horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 4 to 8. Texture is similar to that of the B2t horizon.

Rosehill series

The Rosehill series consists of moderately deep, well drained, very slowly permeable soils on uplands. These soils formed in material weathered from clayey shale. Slope ranges from 1 to 6 percent.

Rosehill soils are similar to Owens and Renfrow soils and are commonly adjacent to Owens and Renfrow soils on the landscape. Owens soils have shale at a depth of less than 20 inches. Renfrow soils lack shale above a depth of 40 inches.

Typical pedon of Rosehill clay loam, 3 to 6 percent slopes, 2,250 feet west and 50 feet south of the northeast corner of section 11, T. 35 S., R. 1 E.:

A1—0 to 10 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, firm; many roots; neutral; clear boundary.

AC—10 to 29 inches; light olive brown (2.5Y 5/3) clay, olive brown (2.5Y 4/3) moist; moderate medium blocky structure; very hard, very firm; few roots; neutral; few small hard calcareous concretions; clear boundary.

C1—29 to 40 inches; light olive brown (2.5Y 5/4) clay, common fine shale fragments, olive brown (2.5Y 4/4) moist; many distinct fine yellowish brown mottles; massive; extremely hard, very firm; moderately alkaline; calcareous; diffuse boundary.

C2—40 to 48 inches; olive brown soft clayey shale with seams of limestone.

The solum ranges from 20 to 40 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is clay loam or silty clay loam. Reaction is neutral or slightly acid. The AC horizon has hue of 10YR to 5Y, value of 5 to 7 (3 to 5 moist), and chroma of 2 to 4. It is clay or silty clay. Reaction ranges from neutral to moderately alkaline. The C horizon has hue of 2.5Y or 5Y, value of 4 to 7, and chroma of 2 to 4. It is clay or silty clay. Reaction is mildly alkaline or moderately alkaline.

Shellabarger series

The Shellabarger series consists of deep, well drained, moderately permeable soils on uplands. These soils formed on old alluvial outwash. Slope ranges from 1 to 6 percent.

Shellabarger soils are similar to Farnum and Milan soils and are commonly adjacent to these soils on the landscape. Farnum soils have a mollic epipedon more than 20 inches thick and have an argillic horizon that has less red hue. Milan soils have finer texture throughout.

Typical pedon of Shellabarger sandy loam, 1 to 3 percent slopes, 600 feet east and 250 feet south of the northwest corner of section 19, T. 32 S., R. 4 W.:

A1—0 to 11 inches; brown (7.5YR 5/2) sandy loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; gradual boundary.

B1—11 to 16 inches; reddish brown (5YR 5/3) heavy fine sandy loam, dark reddish brown (5YR 3/3) moist; weak fine granular structure; slightly hard, friable; slightly acid; clear boundary.

B2t—16 to 38 inches; reddish brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; moderate coarse granular structure and moderate fine subangular blocky; slightly hard, friable; slightly acid; diffuse boundary.

C—38 to 60 inches; yellowish red (5YR 5/6) heavy sandy loam, yellowish red (5YR 4/6) moist; massive and very weak granular structure; soft, very friable; neutral.

The solum ranges from 30 to 60 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR to 5YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly sandy loam but ranges to loamy sand. Reaction is medium acid or slightly acid. The B2t horizon has hue of 2.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 5. It is sandy clay loam or sandy loam and averages between 18 and 27 percent clay. Reaction is slightly acid or neutral. The C horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 4 to 6. It is sandy loam, loamy sand, or sand. Reaction is neutral or mildly alkaline.

Tabler series

The Tabler series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in loess and old alluvium. Slope ranges from 0 to 1 percent.

Tabler soils are similar to Brewer, Carwile, Kirkland, and Waurika soils and are commonly adjacent to Bethany, Corbin, Kirkland, and Waurika soils on the landscape. Brewer soils are on terraces and flood plains and lack vertic properties. Carwile soils have a thinner mollic epipedon and contain more sand. Bethany and Corbin soils have a more gradual texture change between the A and B horizons and have redder hue in the argillic horizon. Kirkland soils have an abrupt texture change between the A and B horizons and have redder hue in the B and C horizons. Waurika soils have an A2 horizon.

Typical pedon of Tabler silty clay loam 1,300 feet north and 350 feet west of the southeast corner of section 25, T. 31 S., R. 1 W.:

A1—0 to 9 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; medium acid; clear boundary.

B2t—9 to 40 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak to moderate medium and coarse blocky structure; extremely hard, very firm; neutral; gradual boundary.

B3t—40 to 60 inches; gray (10YR 6/1) clay, dark gray (10YR 4/1) moist; weak medium blocky structure; extremely hard, very firm; moderately alkaline; a few calcareous concretions.

The solum ranges from 40 to 60 inches in thickness. The mollic epipedon is more than 20 inches thick and extends into the B horizon.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam but ranges to silt loam. Reaction is slightly acid or neutral. The B2t horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is clay or silty clay. Reaction ranges from slightly acid to mildly alkaline. The B3t horizon has hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 1 to 3. It is clay, silty clay, or silty clay loam. Reaction ranges from neutral to moderately alkaline.

Tivoli series

The Tivoli series consists of deep, excessively drained, rapidly permeable soils on uplands. These soils formed in sandy eolian deposits. Slope ranges from 8 to 20 percent.

Tivoli soils are similar to Lincoln and Pratt soils and are commonly adjacent to Pratt soils on the landscape. Lincoln soils formed in sandy alluvium on flood plains. Pratt soils have an argillic horizon.

Typical pedon of Tivoli fine sand, hilly, 1,350 feet south and 400 feet east of the northwest corner of section 7, T. 32 S., R. 4 W.:

A1—0 to 7 inches; brown (10YR 5/3) fine sand, brown (10YR 4/3) moist; single grained; loose, very friable; slightly acid; gradual boundary.

C—7 to 60 inches; light yellowish brown (10YR 6/4) fine sand, yellowish brown (10YR 5/4) moist; single grained; loose both dry and moist; slightly acid.

The solum ranges from 4 to 10 inches in thickness. Reaction ranges from slightly acid to mildly alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It is dominantly fine sand but ranges to loamy fine sand. The C horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 3 to 6. It is fine sand or sand.

Vanoss series

The Vanoss series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loamy eolian and alluvial material. Slope ranges from 0 to 6 percent.

Vanoss soils are similar to Milan and Pond Creek soils and are commonly adjacent to Milan and Reinach soils on the landscape. Milan soils have fine-loamy texture. Pond Creek soils have a mollic epipedon more than 20 inches thick. Reinach soils are coarse silty and and are on terraces and flood plains.

Typical pedon of Vanoss silt loam, 1 to 3 percent slopes, 1,300 feet west and 60 feet north of the southeast corner of section 31, T. 31 S., R. 2 E.:

A1—0 to 16 inches; brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate medium and fine granular structure; soft, friable; medium acid; gradual boundary.

B2t—16 to 40 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable; slightly acid; diffuse boundary.

B3—40 to 60 inches; strong brown (7.5YR 5/6) clay loam, strong brown (7.5YR 4/6) moist; very weak fine subangular blocky structure; slightly hard, friable; neutral.

The solum ranges from 40 inches to more than 60 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly silt loam but ranges to loam. Reaction is slightly acid or medium acid. The B2t horizon has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 5. It is clay loam or silty clay loam and averages between 27 and 35 percent clay. The B3 horizon has hue of 7.5YR or 10YR, value of 4 to 7, and chroma of 3 to 8. It is dominantly clay loam but ranges to loam and silt loam. Reaction is slightly acid or neutral.

Waurika series

The Waurika series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in old alluvium and loess. Slope ranges from 0 to 1 percent.

Waurika soils are similar to Kirkland and Tabler soils and are commonly adjacent to Bethany, Kirkland, and Tabler soils on the landscape. Bethany, Kirkland, and Tabler soils lack an A2 horizon.

Typical pedon of Waurika silt loam 2,000 feet west and 300 feet north of the southeast corner of section 14, T. 35 S., R. 2 W.:

A1—0 to 11 inches; gray (10YR 5/1) silt loam, dark gray (10YR 4/1) moist; massive; soft, very friable; slightly acid; abrupt boundary.

A2—11 to 14 inches; light gray (10YR 6/1) silt loam, gray (10YR 5/1) moist; massive, porous; slightly hard, friable; slightly acid; abrupt boundary.

B2t—14 to 40 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; common distinct mottles of brown to dark brown; weak coarse and medium blocky structure; very hard, very firm; mildly alkaline; few small calcareous concretions in lower part; gradual boundary.

C—40 to 60 inches; grayish brown (10YR 5/2) and gray (10YR 5/1) heavy clay loam, dark grayish brown (10YR 4/2) and dark gray (10YR 4/1) moist; massive; hard, firm; mildly alkaline.

The solum ranges from 30 inches to more than 60 inches in thickness. The mollic epipedon includes the upper part of the argillic horizon in most pedons.

The A1 horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 to 3 moist), and chroma of 1 or 2. Reaction ranges from medium acid to neutral. The A2 horizon is similar to the A1 but has value of 4 to 6 (3 to 5 moist). The B2t horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. It is clay and averages between 40 and 50 percent clay. Reaction is neutral to moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 2 to 4. It ranges from clay loam to clay. Reaction is mildly alkaline or moderately alkaline.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (*8*, *10*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 18, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

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

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Argiaquolls (*Argi*, meaning argillic horizons, plus *aquoll*, the suborder of Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceeding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Argiaquolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine, mixed, thermic, Typic Argiaquolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the soils

In this section, the processes of soil formation are discussed and related to the soils in the survey area.

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic forces. The characteristics of the soil at any given point are determined by the five factors of soil formation. These factors are the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

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

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

All of these factors are important, but in different locations and under different conditions, some factors influence the formation of soils more than others.

The five factors are interdependent: each modifies the effect of the others. Climate and vegetation are the active forces that change the parent material and gradually form a soil. Relief, mainly through its control of runoff, influences the effect of climate and vegetation.

Parent material

The soils of Sumner County formed in at least five different parent materials. The parent materials are eolian sands, outwash sediments, loess, alluvium, and Permian shales.

Soils that formed in wind deposited (eolian) sands are principally along the Ninnescah, Arkansas, and Chikaskia Rivers. The principal soils that formed in these materials are in the Pratt and Tivoli series.

Outwash sediment from Pleistocene deposits of Nebraskan age are poorly sorted sands, silt, and clays. The principal soils that formed in these materials are soils of the Farnum, Milan, and Shellabarger series.

Loessal deposits are silty materials carried by wind. In most of the county there is only a thin layer of loess on the surface of soils that formed in other parent materials. The principal soils that have a surface layer of loessal origin are the Bethany, Corbin, Kirkland, Tabler, Waurika, and Vanoss.

Alluvium of variable texture is deposited on terraces and flood plains of streams throughout the county. The principal soils forming in this material are the Brewer, Dale, Canadian, and Reinach. Textures of the soils are the same as textures of the materials transported and deposited by the streams. Generally the materials on flood plains and terraces of the Arkansas, Chikaskia, and Ninnescah Rivers are coarse sand and gravel in the substratum and medium to coarse textured materials in the surface layer and subsoil. The principal soils are the Dale, Reinach, and Canadian. On flood plains and terraces of Bluff Creek and Fall Creek, the alluvium is silty and the principal soils are Dale and Reinach silt loams. On flood plains of Slate Creek and Shoo Fly Creek the alluvium is mostly clayey and soils of the Brewer and Dale series formed.

Shales of Permian age occur principally in the east-central, south-central, southwestern, and central parts of the county. Soils of the Renfrow, Owens, Rosehill, and Kirkland series formed in these materials.

Climate

Climate has an important role in formation of soils of Sumner County. Precipitation, temperature, and wind do not vary greatly from one part of the county to another, but their interaction on different types of soil materials have had various effects.

Moisture enters different soils at different rates, depending in part at least on the soil texture. The moisture dissolves soluble materials and moves these materials downward. As the moisture moves it carries fine particles of soil and deposits them in the lower layers. As this process continues the soil forms a B horizon, or layer of accumulation.

Variations in temperature and wind affect different soils in different ways. The sandy soils soon dry out and start to blow during seasons of high temperatures and high winds. The finer textured soils may retain more of their moisture and be less subject to blowing. The sandy soils that are subject to soil blowing may soon completely lose the surface layer. Soils that have not been eroded by wind action may have received accumulations of soil material from the wind.

Plant and animal life

Plants and animals are soil-forming factors. Plants decay and add organic matter to the soil. Burrowing animals mix the soil material. Micro-organisms aid in the breakdown of plants to soil humus.

Relief

Slope or general topography influences soil development because it controls runoff and resultant erosion, vegetation, and, to a lesser extent, temperature. If the soil is steep and not permeable enough to absorb the precipitation, it is subject to erosion if not protected. The soil may never develop as thick a surface layer as less sloping soils. The vegetation may not grow on the steep slopes because of reduced water infiltration and reduced nutrient availability. Soils on north-facing slopes may not have temperature favorable for plants as early in the spring as those on south-facing slopes. The reduced amount of organic matter from less plant production may result in less organic matter being added to the soil.

Time

The time required to produce a particular kind of soil is governed by many factors. The kind of material in which the soil develops may be the most important factor. Soil develops more rapidly in the silty alluvium parent material of the Reinach and Dale soils than in the clayey shale parent material of the Renfrow soils, if all other factors are equal. In general the soils that formed in alluvium and the sandy Pratt and Tivoli soils are the youngest in Sumner County. The oldest soils are the upland soils that have a clayey B horizon, such as Bethany, Kirkland, and Tabler.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

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

Area reclaim. 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 mapping 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—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

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

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

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 coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

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.

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

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

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

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running 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 a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather 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. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming 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.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks 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 from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

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.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

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.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

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.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the 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 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water forms subsurface tunnels or pipelike cavities in 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.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent*, *good*, *fair*, and *poor*. The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

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.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

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.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature 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 other plant and animal life characteristics of the soil are largely confined to the solum.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. 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."

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 it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt*, *silt loam*, *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. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Illustrations

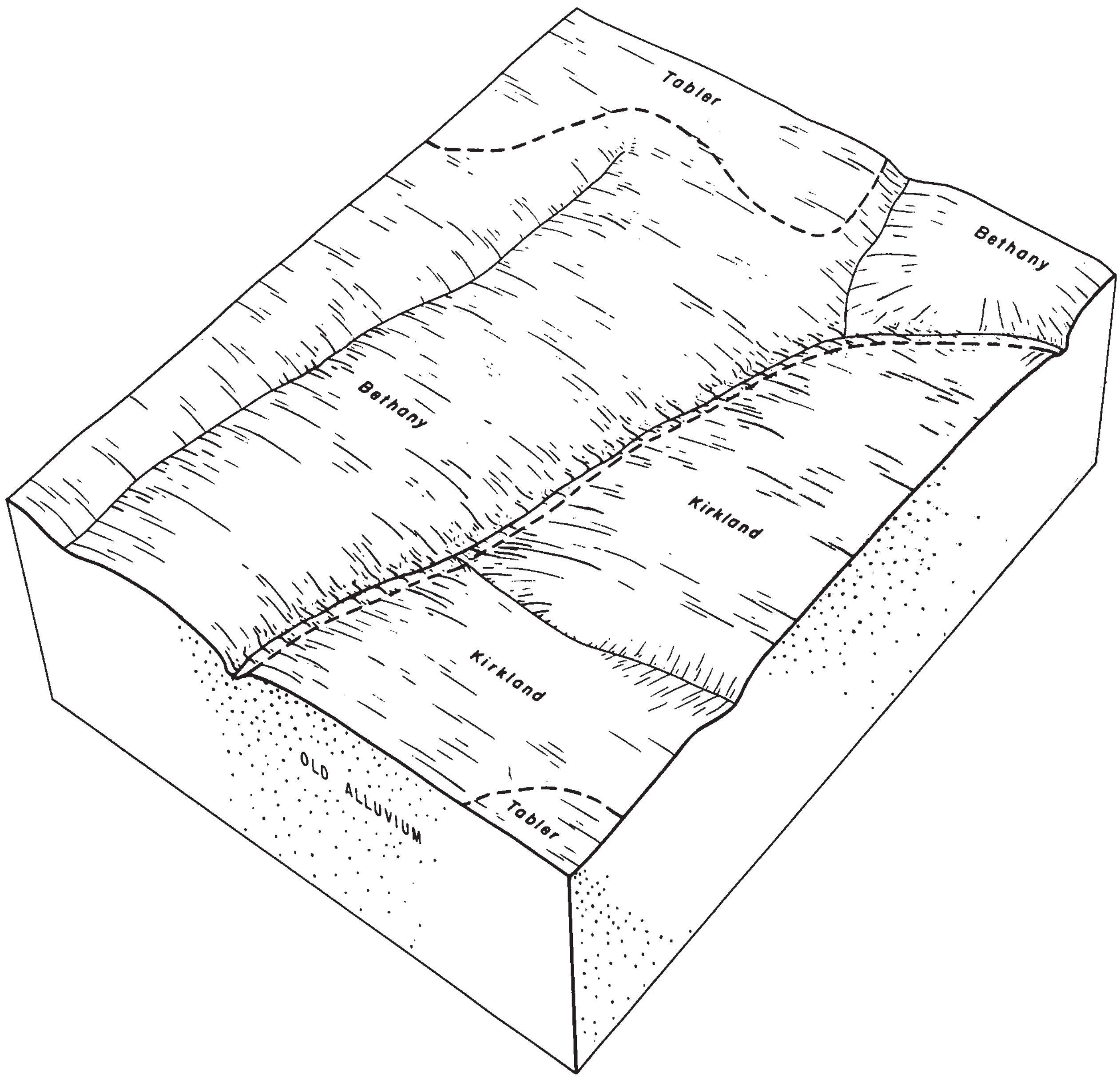

Figure 1.—Typical pattern of soils in the Bethany-Kirkland-Tabler association.

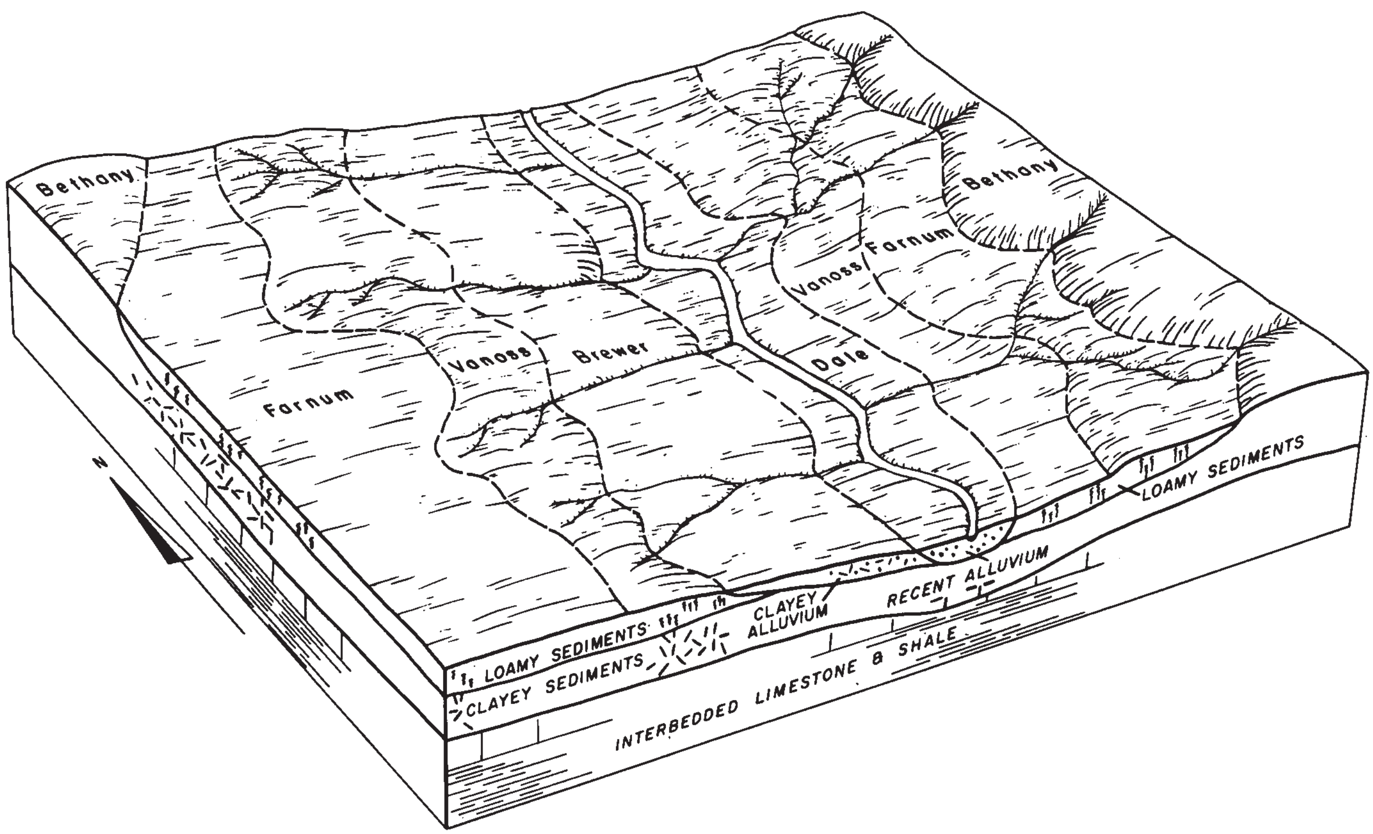

Figure 2.—Typical pattern of soils in the Farum-Vanoss-Bethany association.

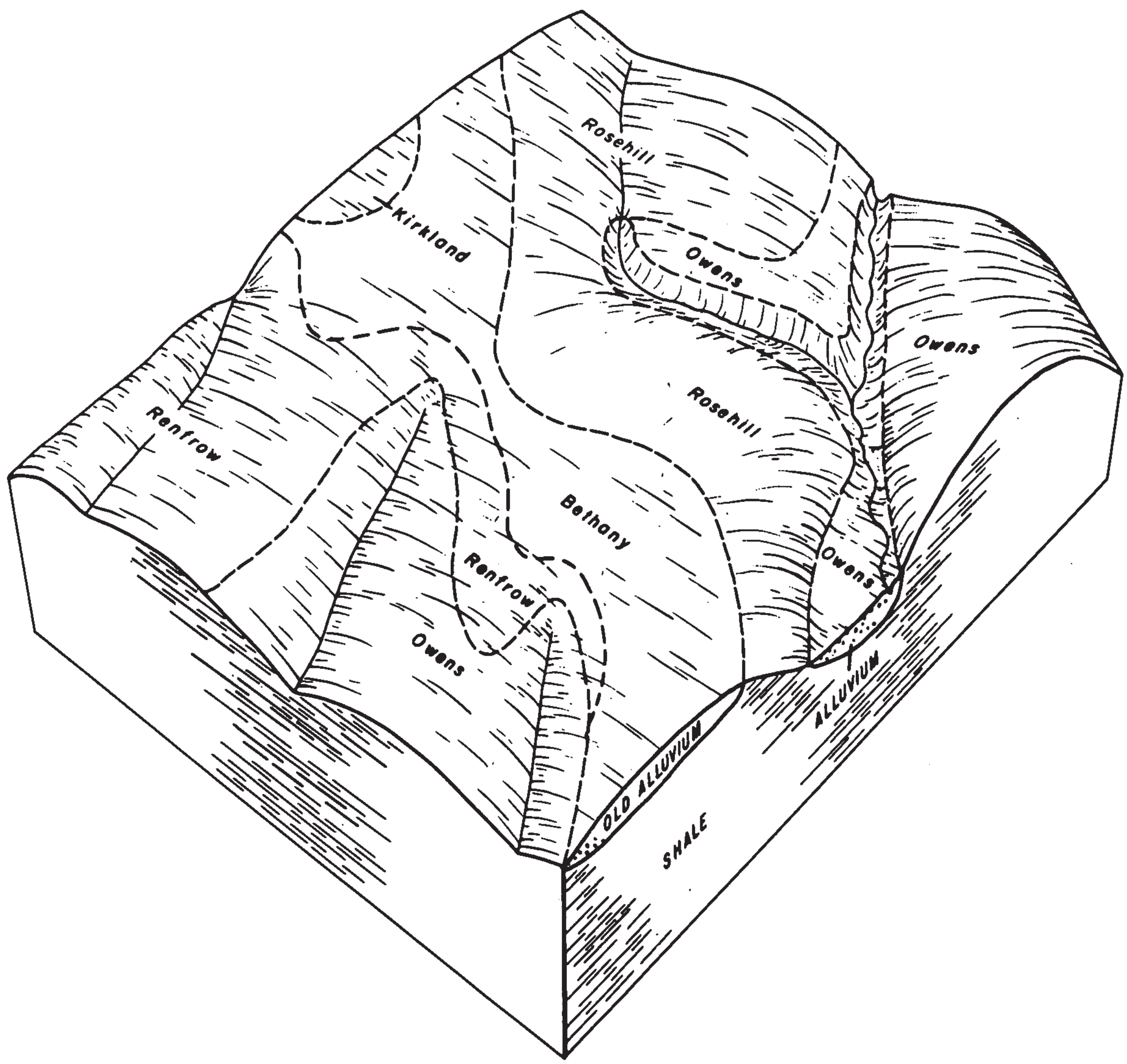

Figure 3.—Typical pattern of soils in the Owens-Rosehill-Renfrow association.

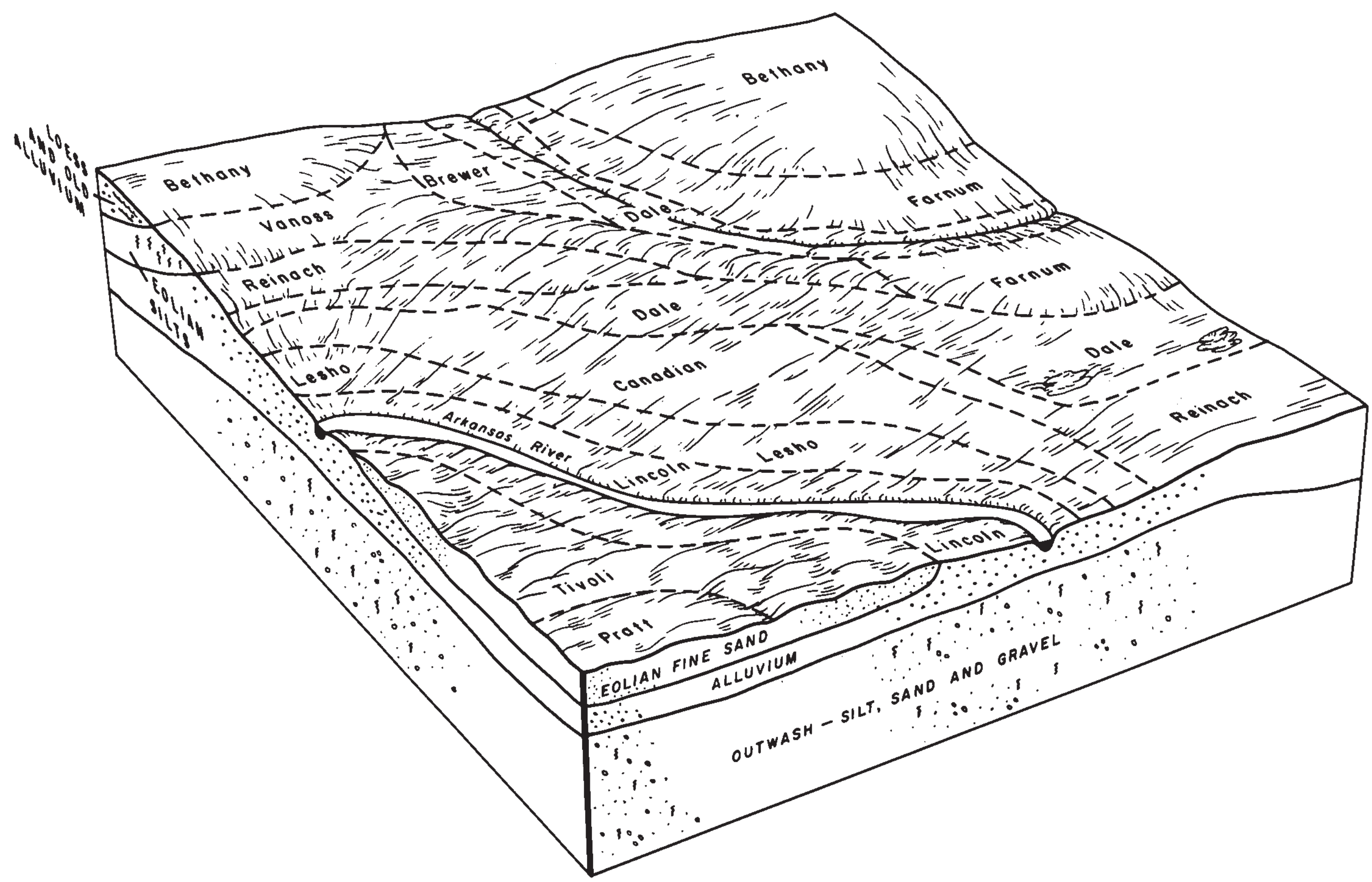

Figure 4.—Pattern of soils in northeastern Sumner County in the Arkansas River Valley and adjacent uplands.

Figure 5.—Salt-affected soils in an area of Brewer complex.

Figure 6.—Peach orchard on Dale and Reinach silt loams.

Figure 7.—Bales of sudangrass hay on Farnum loam, 0 to 1 percent slopes.

Figure 8.—Sorghum for silage on Kirkland silt loam, 0 to 1 percent slopes.

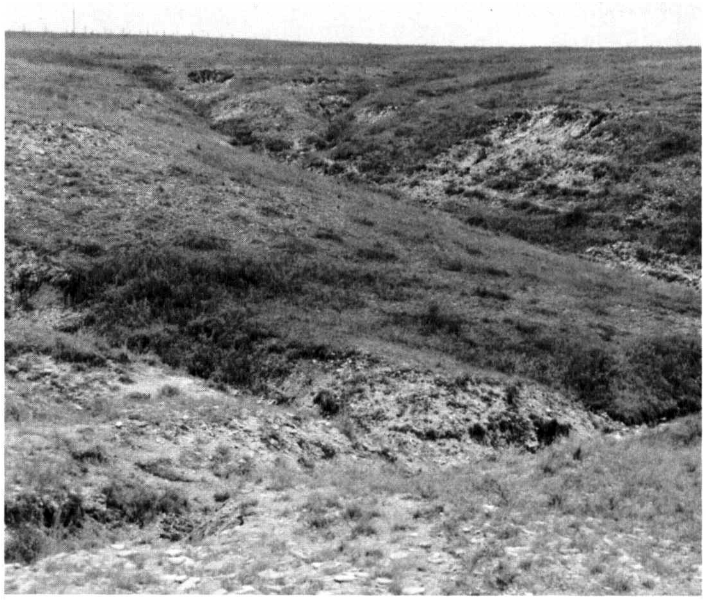

Figure 9.—Native range on Owens-Shale outcrop complex, 8 to 25 percent slopes.

Figure 10.—Water ponded on Tabler silty clay loam.

Figure 11.—Profile of Vanoss silt loam, 1 to 3 percent slopes.

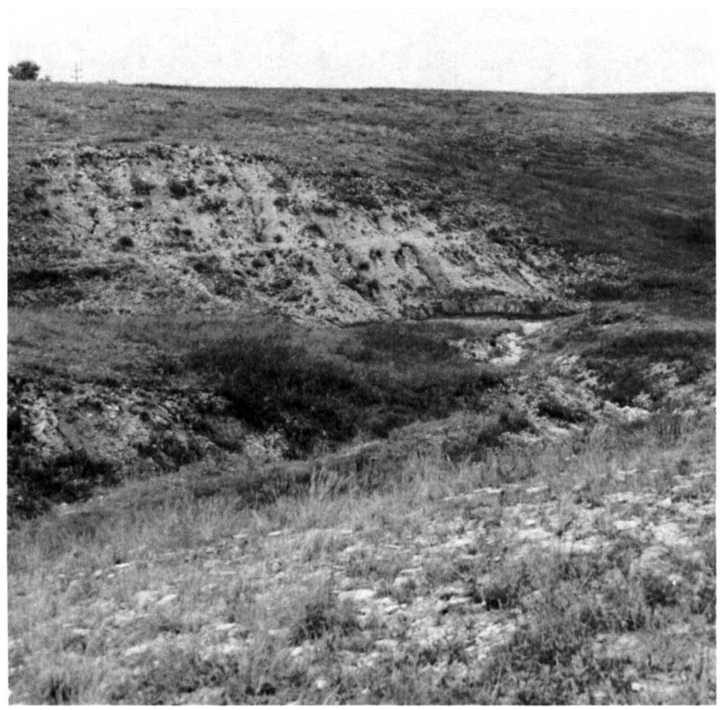

Figure 12.—Range on Owens-Shale outcrop complex, 8 to 25 percent slopes.

Figure 13.—Windbreak of coniferous and broadleaf species on Shellabarger sandy loam, 1 to 3 percent slopes.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data are from Wellington, Kansas, 1941-70]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	In	In	In		In
January---	44.7	22.8	70	-5	0.89	0.37	1.11	2	4.0
February--	50.8	27.2	75	4	1.20	0.42	1.96	2	2.8
March-----	58.3	33.4	85	6	1.80	0.94	2.96	4	2.5
April-----	71.2	46.0	91	25	3.51	1.35	6.23	4	0.2
May-------	79.5	55.2	98	33	4.13	1.43	6.64	6	0
June------	88.6	64.8	102	46	5.41	2.57	7.39	7	0
July------	93.6	69.2	106	53	4.16	2.14	5.78	6	0
August----	93.4	68.2	109	51	3.56	1.80	4.65	5	0
September-	84.6	59.6	102	39	3.73	0.96	6.57	6	0
October---	74.1	48.4	94	26	2.67	0.61	4.89	4	0
November--	58.9	34.8	79	11	1.53	0.02	2.69	2	1.0
December--	47.5	26.1	70	-1	1.36	0.40	2.54	3	3.3
Year---	70.4	46.3	109	-5	33.95	24.50	41.42	51	13.8

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Temperature[1]		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than-----	April 7	April 15	April 27
2 years in 10 later than-----	April 2	April 10	April 22
5 years in 10 later than-----	March 24	April 3	April 12
First freezing temperature in fall:			
1 year in 10 earlier than---	November 3	October 20	October 13
2 years in 10 earlier than---	November 7	October 25	October 17
5 years in 10 earlier than---	November 17	November 5	October 27

[1]Recorded in the period 1941-70 at Wellington, Kansas.

TABLE 3.--GROWING SEASON LENGTH

Probability	Daily minimum temperature during growing season[1]		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	217	199	179
8 years in 10	224	206	185
5 years in 10	239	218	199
2 years in 10	254	231	211
1 year in 10	261	238	218

[1]Recorded in the period 1941-70 at Wellington, Kansas.

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

Map symbol	Soil name	Acres	Percent
Ba	Bethany silt loam, 0 to 1 percent slopes	112,330	14.8
Bb	Bethany silt loam, 1 to 3 percent slopes	80,050	10.5
Br	Brewer silty clay loam	15,130	2.0
Bs	Brewer complex	3,400	0.4
Ca	Canadian sandy loam	11,640	1.5
Cc	Carwile soils	11,890	1.6
Cr	Corbin silt loam	2,710	0.4
Cs	Crisfield sandy loam	2,250	0.3
Da	Dale silt loam, 2 to 8 percent slopes	1,770	0.2
Dr	Dale and Reinach silt loams	32,540	4.3
Ea	Elandco silty clay loam	37,410	4.9
Ec	Elandco silt loam, frequently flooded	9,890	1.3
Fa	Farnum loam, 0 to 1 percent slopes	36,750	4.8
Fb	Farnum loam, 1 to 3 percent slopes	56,960	7.5
Fc	Farnum loam, 3 to 6 percent slopes	2,740	0.4
Fd	Farnum loam, 2 to 6 percent slopes, eroded	2,000	0.3
Ka	Kirkland silt loam, 0 to 1 percent slopes	17,010	2.2
Kb	Kirkland silt loam, 1 to 3 percent slopes	58,240	7.7
Kc	Kirkland silty clay loam, 1 to 3 percent slopes, eroded	5,520	0.7
Lo	Lesho clay loam	3,590	0.5
Ls	Lincoln soils	6,480	0.9
Ma	Milan loam, 0 to 1 percent slopes	4,090	0.5
Mb	Milan loam, 1 to 3 percent slopes	50,570	6.7
Mc	Milan loam, 3 to 6 percent slopes	10,290	1.4
Md	Milan loam, 3 to 6 percent slopes, eroded	8,170	1.1
On	Owens clay loam, 1 to 3 percent slopes	3,520	0.5
Oo	Owens clay loam, 3 to 8 percent slopes	3,850	0.5
Op	Owens-Elandco complex, 0 to 25 percent slopes	5,690	0.7
Or	Owens-Renfrow complex, 2 to 6 percent slopes, eroded	1,370	0.2
Os	Owens-Shale outcrop complex, 8 to 25 percent slopes	1,580	0.2
Pa	Pond Creek silt loam, 0 to 1 percent slopes	1,340	0.2
Pb	Pond Creek silt loam, 1 to 3 percent slopes	4,580	0.6
Pc	Pond Creek silt loam, 3 to 6 percent slopes	980	0.1
Pd	Pond Creek silty clay loam, 2 to 6 percent slopes, eroded	2,320	0.3
Px	Pratt loamy fine sand, undulating	1,910	0.3
Ra	Renfrow complex, 1 to 3 percent slopes	26,990	3.6
Ro	Rosehill clay loam, 1 to 3 percent slopes	14,250	1.9
Rs	Rosehill clay loam, 3 to 6 percent slopes	7,970	1.0
Rx	Rosehill clay loam, 2 to 6 percent slopes, eroded	2,600	0.3
Sa	Shellabarger sandy loam, 1 to 3 percent slopes	22,600	3.0
Sb	Shellabarger sandy loam, 3 to 6 percent slopes	3,170	0.4
Sc	Shellabarger sandy loam, 3 to 6 percent slopes, eroded	1,470	0.2
Ta	Tabler silty clay loam	31,980	4.2
Tv	Tivoli fine sand, hilly	4,140	0.5
Us	Ustifluvents, channeled	6,090	0.8
Va	Vanoss silt loam, 0 to 1 percent slopes	5,410	0.7
Vb	Vanoss silt loam, 1 to 3 percent slopes	12,240	1.6
Vc	Vanoss silt loam, 3 to 6 percent slopes	3,570	0.5
Wa	Waurika silt loam	2,990	0.4
	Borrow areas	70	(1)
	Water (less than 40 acres)	2,998	0.4
	Gravel pits	70	(1)
	Total	759,168	100.0

[1]Less than 0.1 percent.

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

[All yields were estimated for a high level of management in 1974. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Grain sorghum	Wheat
	Bu	Bu
Bethany:		
Ba	55	35
Bb	50	32
Brewer:		
Br	55	32
[1]Bs	35	20
Canadian:		
Ca	50	---
Carwile:		
Cc	30	20
Corbin:		
Cr	50	33
Crisfield:		
Cs	50	30
Dale:		
Da	35	20
[1]Dr	55	35
Elandco:		
Ea	55	35
Ec	---	---
Farnum:		
Fa	55	35
Fb	53	32
Fc	49	30
Fd	45	27
Kirkland:		
Ka	42	28
Kb	38	25
Kc	30	20
Lesho:		
Lo	35	21
Lincoln:		
Ls	---	---
Milan:		
Ma	55	35
Mb	53	32
Mc	49	30
Md	45	27

See footnote at end of table.

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

Soil name and map symbol	Grain sorghum	Wheat
	Bu	Bu
Owens:		
On	---	13
Oo	---	---
[1]Op	---	---
[1]Or	20	13
[1]Os	---	---
Pond Creek:		
Pa	50	33
Pb	47	30
Pc	40	26
Pd	32	22
Pratt:		
Px	45	25
Renfrow:		
[1]Ra	34	25
Rosehill:		
Ro	38	26
Rs	35	24
Rx	31	20
Shellabarger:		
Sa	45	26
Sb	40	22
Sc	35	18
Tabler:		
Ta	40	27
Tivoli:		
Tv	---	---
Ustifluvents:		
[1]Us.		
Vanoss:		
Va	55	35
Vb	50	32
Vc	44	27
Waurika:		
Wa	36	23

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION

[Soils not listed are not in range sites; such soils can be used for grazing if grass cover is established]

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Bethany:					
Ba, Bb	Loamy upland	Favorable	5,000	Little bluestem	25
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Side-oats grama	5
				Blue grama	5
				Tall dropseed	5
				Dotted gayfeather	5
				Other trees	5
				Other perennial forbs	5
Brewer:					
Br	Loamy lowland	Favorable	8,000	Big bluestem	25
		Normal	6,000	Switchgrass	15
		Unfavorable	4,200	Indiangrass	15
				Prairie cordgrass	10
				Western wheatgrass	5
				Canada wildrye	5
				Perennial sunflower	5
				Goldenrod	5
				Sedges	5
				Other trees	10
[1]Bs:					
Brewer part	Loamy lowland	Favorable	8,000	Big bluestem	25
		Normal	6,000	Switchgrass	15
		Unfavorable	4,200	Indiangrass	15
				Prairie cordgrass	10
				Western wheatgrass	5
				Canada wildrye	5
				Perennial sunflower	5
				Goldenrod	5
				Sedges	5
				Other trees	10
Salt-affected part	Saline lowland	Favorable	5,500	Switchgrass	15
		Normal	4,500	Knotroot bristlegrass	15
		Unfavorable	3,500	Big bluestem	20
				Western wheatgrass	10
				Tall dropseed	10
				Illinois bundleflower	5
				Buffalograss	5
				Blue grama	5
				Saltgrass	5
				Other perennial forbs	10
Canadian:					
Ca	Sandy lowland	Favorable	7,000	Big bluestem	25
		Normal	5,500	Indiangrass	15
		Unfavorable	4,000	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Heath aster	5
				Sedges	5
				Other trees	10

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Carwile:					
Cc	Sandy	Favorable	5,000	Switchgrass	20
		Normal	3,800	Little bluestem	10
		Unfavorable	3,000	Indiangrass	15
				Sand bluestem	15
				Scribner panicum	5
				Canada wildrye	5
				Side-oats grama	5
				Other perennial grasses	10
				Other perennial forbs	10
				Other shrubs	5
Corbin:					
Cr	Loamy upland	Favorable	5,500	Big bluestem	30
		Normal	4,000	Little bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Western wheatgrass	5
				Side-oats grama	3
				Sedges	3
				Louisiana sagewort	3
				Blue grama	2
				Buffalograss	2
				Western ragweed	2
				Other perennial forbs	5
Crisfield:					
Cs	Sandy lowland	Favorable	7,000	Sand bluestem	35
		Normal	5,500	Indiangrass	15
		Unfavorable	4,000	Switchgrass	15
				Little bluestem	10
				Maximilian sunflower	10
				Canada wildrye	3
				Western wheatgrass	3
				Tall dropseed	1
				Blue grama	1
				Side-oats grama	1
				Purpletop	1
				Other perennial forbs	5
Dale:					
Da	Loamy lowland	Favorable	8,500	Big bluestem	30
		Normal	6,100	Indiangrass	15
		Unfavorable	4,500	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Heath aster	5
				Sedges	5
				Other trees	5
[1]Dr:					
Dale part	Loamy lowland	Favorable	8,500	Big bluestem	30
		Normal	6,100	Indiangrass	15
		Unfavorable	4,500	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Heath aster	5
				Sedges	5
				Other trees	5

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Compo-sition
			Lb/acre		Pct
Dale:					
Reinach part	Loamy lowland	Favorable	8,000	Big bluestem	30
		Normal	6,000	Indiangrass	15
		Unfavorable	4,000	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Heath aster	5
				Sedges	5
				Other trees	5
Elandco:					
Ea, Ec	Loamy lowland	Favorable	8,000	Big bluestem	25
		Normal	6,000	Indiangrass	15
		Unfavorable	4,000	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Sedges	5
				Prairie cordgrass	5
				Other perennial forbs	5
Farnum:					
Fa, Fb, Fc, Fd	Loamy upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Side-oats grama	5
				Tall dropseed	3
				Western wheatgrass	3
				Slimflower scurfpea	3
				Blue grama	2
				Canada wildrye	2
				Leadplant	2
				Maximilian sunflower	2
				Missouri goldenrod	2
				Buffalograss	1
Kirkland:					
Ka, Kb, Kc	Clay upland	Favorable	4,500	Little bluestem	25
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	5
				Buffalograss	5
				Goldenrod	5
				Other shrubs	5
				Leadplant	3
				Other perennial forbs	2
Lesho:					
Lo	Subirrigated	Favorable	9,000	Sand bluestem	15
		Normal	8,000	Indiangrass	15
		Unfavorable	7,000	Eastern gamagrass	15
				Switchgrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Tall dropseed	5
				Western wheatgrass	5
				Sedges	5
				Other shrubs	5
				Maximilian sunflower	5
				Other perennial forbs	5

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Lincoln:					
Ls	Sandy lowland	Favorable	4,000	Switchgrass	20
		Normal	3,000	Sand bluestem	15
		Unfavorable	2,000	Indiangrass	15
				Little bluestem	5
				Purpletop	5
				Maximilian sunflower	5
				Goldenrod	5
				Other trees	15
				Other perennial grasses	10
				Other perennial forbs	5
Milan:					
Ma, Mb, Mc, Md	Loamy upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Side-oats grama	5
				Tall dropseed	3
				Western wheatgrass	3
				Slimflower scurfpea	3
				Blue grama	2
				Canada wildrye	2
				Leadplant	2
				Maximilian sunflower	2
				Missouri goldenrod	2
				Buffalograss	1
Owens:					
On, Oo	Clay upland	Favorable	4,000	Big bluestem	15
		Normal	3,200	Switchgrass	20
		Unfavorable	2,500	Compassplant	15
				Little bluestem	20
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
				Catclaw sensitivebrier	5
				Other perennial forbs	5
[1]Op:					
Owens part	Clay upland	Favorable	4,000	Big bluestem	15
		Normal	3,200	Switchgrass	20
		Unfavorable	2,500	Compassplant	15
				Little bluestem	20
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
				Catclaw sensitivebrier	5
				Other perennial forbs	5
Elandco part	Loamy lowland	Favorable	8,000	Big bluestem	25
		Normal	6,000	Indiangrass	15
		Unfavorable	4,500	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Sedges	5
				Other trees	5
				Prairie cordgrass	5
				Other perennial forbs	5

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Owens:					
[1]Or:					
Owens part	Clay upland	Favorable	4,000	Big bluestem	15
		Normal	3,200	Switchgrass	20
		Unfavorable	2,500	Compassplant	15
				Little bluestem	20
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
				Catclaw sensitivebrier	5
				Other perennial forbs	5
Renfrow part	Clay upland	Favorable	4,500	Little bluestem	25
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	5
				Buffalograss	5
				Leadplant	5
				Goldenrod	5
				Other perennial forbs	5
[1]Os:					
Owens part	Clay upland	Favorable	4,000	Big bluestem	15
		Normal	3,200	Switchgrass	20
		Unfavorable	2,500	Compassplant	15
				Little bluestem	20
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
				Catclaw sensitivebrier	5
				Other perennial forbs	5
Shale outcrop part	Not assigned.				
Pond Creek:					
Pa, Pb, Pc, Pd	Loamy upland	Favorable	5,000	Little bluestem	25
		Normal	4,000	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Side-oats grama	5
				Blue grama	5
				Tall dropseed	5
				Prairieclover	5
				Dotted gayfeather	5
				Other shrubs	5
Pratt:					
Px	Sands	Favorable	4,500	Sand bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Sand lovegrass	10
				Switchgrass	5
				Blue grama	5
				Texas bluegrass	5
				Sand dropseed	5
				Western wheatgrass	3
				Western ragweed	3
				Sedges	2
				Louisiana sagewort	2
				Other perennial forbs	5

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Renfrow:					
[1]Ra	Clay upland	Favorable	4,000	Little bluestem	25
		Normal	2,800	Big bluestem	20
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	5
				Buffalograss	5
				Leadplant	5
				Goldenrod	5
				Coralberry	5
Rosehill:					
Ro, Rs, Rx	Clay upland	Favorable	4,500	Big bluestem	30
		Normal	3,000	Little bluestem	15
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	5
				Side-oats grama	5
				Tall dropseed	5
				Western wheatgrass	5
				Dotted gayfeather	5
				Leadplant	5
				Western ragweed	2
				Maximilian sunflower	3
				Other perennial forbs	5
Shellabarger:					
Sa, Sb, Sc	Sandy	Favorable	5,000	Sand bluestem	35
		Normal	3,500	Little bluestem	25
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	10
				Blue grama	2
				Roundhead lespedeza	2
				Chickasaw plum	2
				Sand dropseed	1
				Sand paspalum	1
				Louisiana sagewort	1
				Scribner panicum	1
				Other perennial forbs	5
Tabler:					
Ta	Clay upland	Favorable	4,000	Little bluestem	25
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	5
				Buffalograss	10
				Other perennial forbs	10
Tivoli:					
Tv	Sands	Favorable	4,000	Little bluestem	20
		Normal	3,000	Sand bluestem	20
		Unfavorable	2,000	Big sandreed	5
				Sand lovegrass	5
				Scribner panicum	5
				Sand dropseed	5
				Perennial lespedezas	5
				Other perennial forbs	5
				Other perennial grasses	10
				Other shrubs	5
				Switchgrass	10
				Indiangrass	5

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Vanoss:					
Va, Vb, Vc	Loamy upland	Favorable	5,500	Little bluestem	25
		Normal	4,000	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Side-oats grama	5
				Blue grama	5
				Tall dropseed	5
				Dotted gayfeather	5
				Slender lespedeza	3
				Roundhead lespedeza	2
				Other trees	5
Waurika:					
Wa	Clay upland	Favorable	3,500	Little bluestem	20
		Normal	2,300	Big bluestem	20
		Unfavorable	1,500	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	10
				Buffalograss	5
				Leadplant	5
				Goldenrod	5
				Other perennial forbs	5

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[Absence of an entry means the species is not rated for this soil]

Soil name and map symbol	Expected heights in feet of specified trees at 20 years of age								
	Osage-orange	Eastern cotton-wood	Eastern redcedar	Hackberry	Honey-locust	White mulberry	Ponderosa pine	Russian-olive	Siberian elm
Bethany:									
Ba, Bb	20	35	25	26	24	20	24	18	35
Brewer:									
Br, [1]Bs	20	50	25	30	26	22	--	--	35
Canadian:									
Ca	23	55	30	30	28	22	25	20	45
Carwile:									
Cc	18	45	25	22	20	15	--	--	25
Corbin:									
Cr	20	35	25	26	24	20	23	17	40
Crisfield:									
Cs	22	50	25	30	28	24	26	19	45
Dale:									
Da	23	55	30	30	30	24	24	20	45
[1]Dr:									
Dale part	23	55	30	30	30	24	24	20	45
Reinach part	23	50	30	30	30	22	25	20	45
Elandco:									
Ea	23	50	30	30	28	22	20	18	40
Ec	20	55	30	30	30	24	25	20	45
Farnum:									
Fa, Fb, Fc, Fd	19	35	25	25	24	15	20	17	37
Kirkland:									
Ka, Kb, Kc	18	35	25	25	24	18	20	17	40
Lesho:									
Lo	22	45	25	28	35	22	25	22	45
Lincoln:									
Ls	18	45	25	28	28	20	23	20	35
Milan:									
Ma, Mb, Mc, Md	19	35	25	25	24	15	20	18	38
Owens:									
On, Oo	12	--	17	18	16	15	--	15	20
[1]Op:									
Owens part	12	--	17	18	16	15	--	15	20
Elandco part	20	55	30	30	30	24	25	20	45
[1]Or:									
Owens part	12	--	17	18	16	15	--	15	20
Renfrow part	17	35	19	26	20	16	--	16	25
[1]Os:									
Owens part	12	--	17	18	16	15	--	15	20
Shale outcrop part	--	--	--	--	--	--	--	--	--

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Expected heights in feet of specified trees at 20 years of age								
	Osage-orange	Eastern cotton-wood	Eastern redcedar	Hackberry	Honey-locust	White mulberry	Ponderosa pine	Russian-olive	Siberian elm
Pond Creek: Pa, Pb, Pc, Pd	24	50	25	24	24	20	24	17	40
Pratt: Px	15	35	16	--	25	20	20	15	30
Renfrow: [1]Ra	17	35	19	26	20	16	--	16	25
Rosehill: Rx, Rs, Ro	15	--	17	25	20	15	--	16	23
Shellabarger: Sa, Sb, Sc	24	--	18	--	26	21	24	17	25
Tabler: Ta	18	40	20	22	20	21	--	--	35
Tivoli: Tv	10	25	15	--	18	17	--	15	25
Ustifluvents: [1]Us	18	50	25	30	28	24	24	19	42
Vanoss: Va, Vb, Vc	23	40	20	25	29	22	25	20	40
Waurika: Wa	16	40	20	20	20	20	--	--	35

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 8.--BUILDING SITE DEVELOPMENT

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Bethany:					
Ba, Bb	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Brewer:					
Br, [1]Bs	Severe: too clayey.	Severe: floods, shrink-swell, low strength.	Severe: floods, shrink-swell, low strength.	Severe: floods, shrink-swell, low strength.	Severe: shrink-swell, low strength.
Canadian:					
Ca	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.
Carwile:					
Cc	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: low strength, shrink-swell.
Corbin:					
Cr	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Crisfield:					
Cs	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.
Dale:					
Da	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: low strength, shrink-swell, floods.
[1]Dr:					
Dale part	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: low strength, shrink-swell, floods.
Reinach part	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: low strength, floods.
Elandco:					
Ea	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: low strength, shrink-swell, floods.
Ec	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Farnum:					
Fa, Fb, Fc, Fd	Moderate: too clayey.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Severe: low strength.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Kirkland:					
Ka, Kb, Kc	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Lesho:					
Lo	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Moderate: low strength, wetness, shrink-swell.
Lincoln:					
Ls	Severe: floods, cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Milan:					
Ma, Mb, Mc, Md	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Owens:					
On, Oo	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
[1]Op:					
Owens part	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell.
Elandco part	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
[1]Or:					
Owens part	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
Renfrow part	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
[1]Os:					
Owens part	Severe: too clayey, slope.	Severe: shrink-swell, slope.	Severe: shrink-swell, slope.	Severe: shrink-swell, slope.	Severe: shrink-swell, slope.
Shale outcrop part not rated.					
Pond Creek:					
Pa, Pb	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Pc, Pd	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: low strength.
Pratt:					
Px	Severe: too sandy, cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Renfrow:					
[1]Ra	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Rosehill:					
Rx, Rs, Ro	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Shellabarger:					
Sa	Slight	Slight	Slight	Slight	Moderate: low strength.
Sb, Sc	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength.
Tabler:					
Ta	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Tivoli:					
Tv	Severe: cutbanks cave, too sandy.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Ustifluvents:					
[1]Us	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, slope.	Severe: floods.
Vanoss:					
Va, Vb, Vc	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength, shrink-swell.
Waurika:					
Wa	Severe: wetness, too clayey.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: low strength, shrink-swell.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 9.--SANITARY FACILITIES

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Bethany:					
Ba, Bb	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
Brewer:					
Br, [1]Bs	Severe: percs slowly.	Slight	Severe: too clayey.	Moderate: floods.	Poor: hard to pack, too clayey.
Canadian:					
Ca	Moderate: floods.	Severe: seepage, floods.	Severe: seepage.	Severe: seepage.	Good.
Carwile:					
Cc	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: floods, too clayey.	Severe: wetness, floods.	Poor: thin layer.
Corbin:					
Cr	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey, thin layer.
Crisfield:					
Cs	Moderate: floods.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Dale:					
Da	Moderate: floods.	Moderate: seepage, slope.	Moderate: floods, too clayey.	Moderate: floods.	Good.
[1]Dr:					
Dale part	Moderate: floods.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Good.
Reinach part	Moderate: floods.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Good.
Elandco:					
Ea	Moderate: floods.	Moderate: seepage.	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Ec	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Fair: too clayey.
Farnum:					
Fa	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Fb, Fc, Fd	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Kirkland:					
Ka, Kb, Kc	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: thin layer, too clayey.
Lesho:					
Lo	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Fair: thin layer, area reclaim.

See footnote at end of table.

TABLE 9.--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
Lincoln:					
Ls	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Fair: too sandy.
Milan:					
Ma	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Mb, Mc, Md	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Owens:					
On, Oo	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, area reclaim.
[1]Op:					
Owens part	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, area reclaim.
Elandco part	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
[1]Or:					
Owens part	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, area reclaim.
Renfrow part	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: thin layer.
[1]Os:					
Owens part	Severe: percs slowly, slope.	Severe: slope.	Severe: too clayey, slope.	Severe: slope.	Poor: too clayey, area reclaim.
Shale outcrop part not rated.					
Pond Creek:					
Pa	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Pb, Pc, Pd	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Pratt:					
Px	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
Renfrow:					
[1]Ra	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: thin layer.
Rosehill:					
Ro, Rs, Rx	Severe: percs slowly, depth to rock.	Severe: depth to rock.	Severe: too clayey.	Slight	Poor: too clayey.
Shellabarger:					
Sa, Sb, Sc	Slight	Moderate: seepage.	Slight	Slight	Good.
Tabler:					
Ta	Severe: percs slowly, wetness.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: hard to pack, too clayey.

See footnote at end of table.

TABLE 9.--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
Tivoli:					
Tv	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Ustifluvents:					
[1]Us	Severe: floods.	Severe: floods, slope.	Severe: floods.	Severe: floods.	Poor: slope.
Vanoss:					
Va, Vb, Vc	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Waurika:					
Wa	Severe: percs slowly, wetness.	Slight	Severe: too clayey.	Severe: wetness.	Poor: thin layer.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 10.--CONSTRUCTION MATERIALS

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited"]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Bethany:				
Ba, Bb	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.
Brewer:				
Br, [1]Bs	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: too clayey.
Canadian:				
Ca	Fair: low strength.	Unsuited	Unsuited	Good.
Carwile:				
Cc	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: thin layer.
Corbin:				
Cr	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.
Crisfield:				
Cs	Fair: low strength.	Poor: excess fines.	Unsuited	Good.
Dale:				
Da	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Good.
[1]Dr:				
Dale part	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Good.
Reinach part	Fair: low strength.	Unsuited	Unsuited	Good.
Elandco:				
Ea	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
Ec	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Good.
Farnum:				
Fa, Fb, Fc, Fd	Poor: low strength.	Unsuited	Unsuited	Good.
Kirkland:				
Ka, Kb, Kc	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
Lesho:				
Lo	Fair: shrink-swell, low strength, wetness.	Fair: excess fines.	Unsuited	Fair: area reclaim.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Lincoln:				
Ls	Good	Fair	Unsuited	Poor: too sandy.
Milan:				
Ma, Mb, Mc, Md	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Owens:				
On, Oo	Poor: shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
[1]Op:				
Owens part	Poor: shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
Elandco part	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Good.
[1]Or:				
Owens part	Poor: shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
Renfrow part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey, thin layer.
[1]Os:				
Owens part	Poor: shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
Shale outcrop part not rated.				
Pond Creek:				
Pa, Pb, Pc, Pd	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Pratt:				
Px	Good	Fair: excess fines.	Unsuited	Poor: too sandy.
Renfrow:				
[1]Ra	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey, thin layer.
Rosehill:				
Ro, Rs, Rx	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey, thin layer.
Shellabarger:				
Sa, Sb, Sc	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Tabler:				
Ta	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.
Tivoli:				
Tv	Good	Fair: excess fines.	Unsuited	Poor: too sandy.
Ustifluvents:				
[1]Us	Fair: low strength.	Unsuited	Unsuited	

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Vanoss: Va, Vb, Vc	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Waurika: Wa	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 11.--WATER MANAGEMENT

["Seepage," and some of the other terms that describe restrictive soil features are defined in the Glossary]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Bethany:						
Ba, Bb	Favorable	Unstable fill, compressible.	Not needed	Slow intake	Percs slowly	Percs slowly.
Brewer:						
Br, [1]Bs	Favorable	Unstable fill, compressible.	Not needed	Slow intake	Percs slowly	Percs slowly.
Canadian:						
Ca	Seepage	Unstable fill	Not needed	Fast intake	Erodes easily	Erodes easily.
Carwile:						
Cc	Favorable	Unstable fill, compressible.	Percs slowly, floods, poor outlets.	Slow intake, wetness.	Not needed	Percs slowly, wetness.
Corbin:						
Cr	Favorable	Shrink-swell, low strength.	Favorable	Slow intake, slope.	Percs slowly	Percs slowly.
Crisfield:						
Cs	Seepage	Low strength, piping.	Not needed	Fast intake, floods.	Not needed	Favorable.
Dale:						
Da	Seepage	Unstable fill, piping, compressible.	Not needed	Erodes easily	Erodes easily	Erodes easily.
[1]Dr:						
Dale part	Seepage	Unstable fill, piping, compressible.	Not needed	Favorable	Not needed	Not needed.
Reinach part	Seepage	Unstable fill, compressible, piping.	Not needed	Favorable	Not needed	Not needed.
Elandco:						
Ea	Seepage	Unstable fill, piping, compressible.	Not needed	Favorable	Not needed	Favorable.
Ec	Seepage	Unstable fill, piping, compressible.	Not needed	Floods	Not needed	Favorable.
Farnum:						
Fa	Favorable	Low strength, shrink-swell.	Not needed	Slow intake	Favorable	Favorable.
Fb, Fc, Fd	Favorable	Low strength, shrink-swell.	Not needed	Slow intake, slope.	Favorable	Favorable.
Kirkland:						
Ka, Kb, Kc	Favorable	Compressible, piping.	Not needed	Slow intake	Percs slowly, piping.	Percs slowly.
Lesho:						
Lo	Favorable	Low strength, shrink-swell.	Floods, wetness.	Floods	Not needed	Favorable.
Lincoln:						
Ls	Seepage	Unstable fill, piping.	Floods	Seepage, fast intake.	Not needed	Favorable.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Milan:						
Ma	Favorable	Low strength, shrink-swell.	Not needed	Slow intake	Favorable	Favorable.
Mb, Mc, Md	Favorable	Low strength, shrink-swell.	Not needed	Slow intake, slope.	Favorable	Favorable.
Owens:						
On	Favorable	Compressible	Not needed	Droughty, percs slowly.	Rooting depth, percs slowly.	Droughty, erodes easily.
Oo	Favorable	Compressible	Not needed	Droughty, percs slowly.	Slope, rooting depth.	Droughty, erodes easily.
[1]Op:						
Owens part	Favorable	Compressible	Not needed	Droughty, percs slowly.	Slope, rooting depth.	Droughty, erodes easily.
Elandco part	Seepage	Unstable fill, compressible, piping.	Not needed	Floods	Not needed	Favorable.
[1]Or:						
Owens part	Favorable	Compressible	Not needed	Droughty, percs slowly.	Rooting depth, percs slowly.	Droughty, erodes easily.
Renfrow part	Favorable	Unstable fill, compressible.	Not needed	Erodes easily, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
[1]Os:						
Owens part	Favorable	Compressible	Not needed	Droughty, percs slowly.	Slope, rooting depth.	Droughty, erodes easily.
Shale outcrop part not rated.						
Pond Creek:						
Pa	Seepage	Unstable fill, piping.	Not needed	Favorable	Favorable	Favorable.
Pb, Pc, Pd	Seepage	Unstable fill, piping.	Not needed	Slope	Favorable	Favorable.
Pratt:						
Px	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, soil blowing, fast intake.	Too sandy, complex slope, soil blowing.	Soil blowing, droughty.
Renfrow:						
[1]Ra	Favorable	Unstable fill, compressible.	Not needed	Erodes easily, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Rosehill:						
Ro, Rs, Rx	Depth to rock	Low strength, shrink-swell.	Not needed	Slow intake, slope.	Depth to rock	Rooting depth.
Shellabarger:						
Sa, Sb, Sc	Seepage	Low strength, piping.	Not needed	Fast intake, slope, erodes easily.	Piping	Favorable.
Tabler:						
Ta	Favorable	Unstable fill, compressible.	Percs slowly	Slow intake	Percs slowly	Percs slowly.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Tivoli:						
Tv	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, erodes easily, droughty.	Complex slope, erodes easily, fast intake.	Erodes easily, droughty, seepage.
Ustifluvents:						
[1]Us	Favorable	Low strength	Floods	Slope, erodes easily.	Floods, slope.	Erodes easily, slope.
Vanoss:						
Va, Vb, Vc	Seepage	Unstable fill, low strength, piping.	Not needed	Favorable	Favorable	Favorable.
Waurika:						
Wa	Favorable	Compressible, unstable fill, shrink-swell.	Wetness	Wetness, slow intake.	Not needed	Not needed.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Bethany:				
Ba, Bb	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Brewer:				
Br, [1]Bs	Severe: floods.	Moderate: floods, too clayey.	Moderate: floods, too clayey, percs slowly.	Moderate: too clayey.
Canadian:				
Ca	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.
Carwile:				
Cc	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Corbin:				
Cr	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Crisfield:				
Cs	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.
Dale:				
Da	Moderate: floods.	Slight	Moderate: slopes.	Slight.
[1]Dr:				
Dale part	Moderate: floods.	Slight	Slight	Slight.
Reinach part	Moderate: floods.	Slight	Slight	Slight.
Elandco:				
Ea	Moderate: floods, too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
Ec	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods.
Farnum:				
Fa, Fb, Fc, Fd	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Kirkland:				
Ka, Kb	Severe: percs slowly.	Slight	Severe: percs slowly.	Slight.
Kc	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
Lesho:				
Lo	Severe: floods, wetness.	Moderate: floods, wetness.	Moderate: floods, wetness, percs slowly.	Moderate: wetness.
Lincoln:				
Ls	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Milan:				
Ma, Mb, Mc, Md	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Owens:				
On, Oo	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey.
[1]Op:				
Owens part	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: slope, too clayey.	Severe: too clayey.
Elandco part	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods.
[1]Or:				
Owens part	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey.
Renfrow part	Severe: percs slowly, too clayey.	Moderate: too clayey.	Severe: percs slowly, slope.	Moderate: too clayey.
[1]Os:				
Owens part	Severe: slope, too clayey.	Severe: slope, too clayey.	Severe: slope, too clayey.	Severe: too clayey.
Shale outcrop part not rated.				
Pond Creek:				
Pa	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Pb, Pc, Pd	Moderate: percs slowly.	Slight	Moderate: percs slowly, slope.	Slight.
Pratt:				
Px	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
Renfrow:				
[1]Ra	Severe: percs slowly, too clayey.	Moderate: too clayey.	Severe: percs slowly, slope.	Moderate: too clayey.
Rosehill:				
Ro, Rs, Rx	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
Shellabarger:				
Sa, Sb, Sc	Slight	Slight	Moderate: slope.	Slight.
Tabler:				
Ta	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
Tivoli:				
Tv	Severe: too sandy, dusty.	Severe: too sandy, dusty.	Severe: too sandy, dusty.	Severe: too sandy, dusty.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ustifluvents:				
[1]Us	Severe: floods.	Severe: floods.	Severe: floods, slope.	Severe: floods.
Vanoss:				
Va	Slight	Slight	Slight	Slight.
Vb, Vc	Slight	Slight	Moderate: slope.	Slight.
Waurika:				
Wa	Severe: wetness, percs slowly.	Moderate: wetness.	Severe: wetness, percs slowly.	Moderate: wetness.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor"]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Bethany:												
Ba, Bb	Good	Good	Fair	Fair	Poor	Fair	Poor	Very poor.	Good	Fair	Very poor.	Fair.
Brewer:												
Br, [1]Bs	Good	Good	Fair	Good	Poor	Good	Poor	Poor	Good	Good	Poor	Fair.
Canadian:												
Ca	Good	Good	Good	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Carwile:												
Cc	Fair	Good	Good	Fair	Poor	Good	Good	Fair	Good	Fair	Fair	Good.
Corbin:												
Cr	Good	Good	Fair	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Crisfield:												
Cs	Good	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Dale:												
Da	Fair	Good	Fair	Good	Poor	Good	Poor	Very poor.	Fair	Fair	Very poor.	Fair.
[1]Dr:												
Dale part	Good	Good	Fair	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Fair.
Reinach part	Good	Good	Good	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Elandco:												
Ea	Good	Good	Fair	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Fair.
Ec	Poor	Fair	Fair	Good	Poor	Good	Poor	Very poor.	Fair	Good	Very poor.	Fair.
Farnum:												
Fa, Fb	Good	Good	Good	Good	Poor	Fair	Fair	Poor	Good	Good	Poor	Fair.
Fc, Fd	Fair	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Kirkland:												
Ka, Kb, Kc	Good	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Lesho:												
Lo	Fair	Fair	Fair	Good	Poor	Fair	Fair	Fair	Fair	Good	Fair	Fair.
Lincoln:												
Ls	Poor	Fair	Fair	Poor	Very poor.	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.	Fair.
Milan:												
Ma, Mb	Good	Good	Good	Good	Poor	Fair	Fair	Poor	Good	Good	Poor	Fair.
Mc, Md	Fair	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.

See footnote at end of table.

TABLE 13.--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
Owens:												
On	Fair	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
Oo	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
[1]Op:												
Owens part	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
Elandco part	Poor	Fair	Fair	Good	Poor	Good	Poor	Very poor.	Fair	Good	Very poor.	Fair.
[1]Or:												
Owens part	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
Renfrow part	Good	Good	Fair	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
[1]Os:												
Owens part	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
Shale outcrop part not rated.												
Pond Creek:												
Pa, Pb, Pc, Pd	Good	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Pratt:												
Px	Fair	Good	Fair	Fair	Poor	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Renfrow:												
[1]Ra	Good	Good	Fair	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Rosehill:												
Ro, Rs, Rx	Fair	Good	Fair	Poor	Poor	Fair	Poor	Very poor.	Fair	Poor	Very poor.	Fair.
Shellabarger:												
Sa	Good	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Sb, Sc	Fair	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Tabler:												
Ta	Good	Good	Fair	Good	Good	Fair	Poor	Poor	Good	Good	Poor	Fair.
Tivoli:												
Tv	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Ustifluvents:												
[1]Us	Very poor.	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Vanoss:												
Va, Vb, Vc	Good	Good	Good	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Waurika:												
Wa	Fair	Good	Fair	Poor	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Fair.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means greater than]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Bethany:											
Ba, Bb	0-17	Silt loam	CL, ML	A-4, A-6	0	100	100	96-100	80-98	21-40	1-20
	17-60	Silty clay, clay, silty clay loam.	CL, CH	A-7, A-6	0	100	95-100	96-100	90-99	37-60	15-33
Brewer:											
Br, [1]Bs	0-14	Silty clay loam	CL	A-6, A-7	0	100	100	96-100	80-98	30-43	10-19
	14-60	Silty clay	CL, CH	A-6, A-7	0	100	100	96-100	80-99	37-70	16-38
Canadian:											
Ca	0-40	Sandy loam	SM, ML, SC	A-4	0	100	98-100	94-100	36-85	<31	[2]NP-10
	40-60	Loamy fine sand, fine sandy loam, sandy loam.	SM, ML, SC	A-4, A-2	0	100	98-100	90-100	15-85	<31	NP-10
Carwile:											
Cc	0-10	Fine sandy loam	ML, CL, CL-ML, SM	A-4	0	100	98-100	94-100	36-85	<30	NP-10
	10-39	Clay, clay loam, sandy clay.	CL, CH, SC	A-6, A-7	0	100	100	90-100	40-95	35-70	14-38
	39-60	Sandy clay loam, clay loam, clay.	CL, CH, SC	A-4, A-6, A-7	0	100	100	90-100	36-95	25-70	7-38
Corbin:											
Cr	0-16	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	90-100	75-100	25-35	5-15
	16-29	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-100	35-45	10-25
	29-48	Clay, silty clay	CH, CL	A-7-6	0	100	100	95-100	90-100	45-60	25-35
	48-60	Silty clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	85-100	35-45	12-25
Crisfield:											
Cs	0-60	Sandy loam	SM, ML	A-4	0	100	100	85-100	40-70	<26	NP-6
Dale:											
Da	0-24	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	65-98	27-43	7-20
	24-60	Silt loam, loam, silty clay loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100	65-98	27-43	7-20
[1]Dr:											
Dale part	0-24	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	65-98	27-43	7-20
	24-60	Silt loam, loam, silty clay loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100	65-98	27-43	7-20
Reinach part	0-60	Silt loam	CL, ML	A-4	0	100	100	94-100	51-97	<31	NP-10
Elandco:											
Ea	0-45	Silty clay loam	CL	A-6, A-7	0	100	100	96-100	85-98	30-43	8-20
	45-60	Silty clay loam, silt loam, loam.	CL, ML	A-4, A-6, A-7	0	100	100	96-100	75-98	30-43	7-20
Ec	0-45	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	85-98	24-43	5-20
	45-60	Silty clay loam, silt loam, loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100	75-98	27-43	5-20

See footnotes at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Farnum:											
Fa, Fb, Fc, Fd----	0-11	Loam------------	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-85	<30	5-15
	11-60	Clay loam, sandy clay loam.	SC, CL, CH	A-6, A-7-6	0	100	100	65-100	45-80	32-55	10-25
Kirkland:											
Ka, Kb------------	0-9	Silt loam-------	CL	A-4, A-6	0	100	100	96-100	80-98	30-40	8-19
	9-60	Silty clay, clay	CL, CH	A-7	0	100	100	96-100	90-99	41-65	18-38
Kc----------------	0-7	Silty clay loam-	CL	A-6	0	100	100	96-100	80-98	30-45	8-19
	7-60	Silty clay, clay	CL, CH	A-7	0	100	100	96-100	90-99	41-65	18-38
Lesho:											
Lo----------------	0-30	Clay loam-------	CL	A-6, A-7-6	0	100	100	95-100	65-85	30-45	8-25
	30-60	Loamy fine sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	30-85	5-45	---	NP
Lincoln:											
Ls----------------	0-10	Loamy fine sand-	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
	10-60	Fine sand, loamy fine sand.	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
Milan:											
Ma, Mb, Mc, Md----	0-10	Loam------------	CL-ML, CL	A-4, A-6	0	95-100	95-100	95-100	65-85	20-30	5-15
	10-60	Clay loam, sandy clay loam.	SC, CL, CH	A-6, A-7-6	0	95-100	95-100	65-100	45-80	35-55	11-27
Owens:											
On, Oo------------	0-4	Clay loam-------	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	4-20	Clay, silty clay, clay loam.	CL, CH	A-7-6	0-5	95-100	90-100	85-100	75-95	40-60	20-32
	20-22	Shale-----------	---	---	---	---	---	---	---	---	---
[1]Op:											
Owens part-------	0-4	Clay loam-------	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	4-20	Clay, silty clay, clay loam.	CL, CH	A-7-6	0-5	95-100	90-100	85-100	75-95	40-60	20-32
	20-22	Shale-----------	---	---	---	---	---	---	---	---	---
Elandco part-----	0-45	Silty clay loam	ML, CL	A-4, A-6, A-7	0	100	100	96-100	85-98	31-43	8-20
	45-60	Silty clay loam, clay loam, loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100	75-98	27-43	7-20
[1]Or:											
Owens part-------	0-4	Clay loam-------	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	4-20	Clay, silty clay, clay loam.	CL, CH	A-7-6	0-5	95-100	90-100	85-100	75-95	40-60	20-32
	20-22	Shale-----------	---	---	---	---	---	---	---	---	---
Renfrow part-----	0-12	Clay loam-------	CL	A-6, A-7	0	100	100	96-100	80-98	33-49	12-26
	12-60	Clay, silty clay, silty clay loam, clay loam.	CL, CH	A-6, A-7	0	100	100	96-100	80-99	37-70	15-38
[1]Os:											
Owens part-------	0-4	Clay loam-------	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	4-20	Clay, silty clay, clay loam.	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	20-22	Shale-----------	---	---	---	---	---	---	---	---	---

See footnotes at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Owens: Shale outcrop part not rated.											
Pond Creek: Pa, Pb, Pc	0-13	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	22-37	3-14
	13-60	Silty clay loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	96-100	65-98	30-43	7-20
Pd	0-7	Silty clay loam	CL, CL-ML	A-6	0	100	100	96-100	65-97	27-43	8-20
	7-60	Silty clay loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	96-100	65-98	30-43	7-20
Pratt: Px	0-14	Loamy fine sand	SM, SP-SM	A-2, A-3	0	100	95-100	70-100	7-35	---	NP
	14-38	Loamy fine sand, loamy sand.	SM, SM-SC	A-2, A-4	0	100	95-100	90-100	15-40	<20	NP-6
	38-60	Loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-35	---	NP
Renfrow: [1]Ra	0-12	Clay loam	CL	A-6, A-7	0	100	100	96-100	80-98	33-49	12-26
	12-60	Clay, silty clay, silty clay loam, clay loam.	CL, CH	A-6, A-7	0	100	100	96-100	80-99	37-70	15-38
Rosehill: Ro, Rs, Rx	0-10	Clay loam	CH, CL	A-7	0	100	100	95-100	90-100	40-55	20-30
	10-40	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-50
	40-48	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Shellabarger: Sa, Sb, Sc	0-11	Sandy loam	SM, ML	A-4, A-2	0	95-100	95-100	75-100	30-55	<30	NP-5
	11-38	Sandy clay loam, sandy loam.	SC, CL	A-4, A-6	0	95-100	95-100	70-90	35-55	25-40	8-25
	38-60	Sandy loam, loamy sand, sand.	SC, SM	A-2, A-4	0	70-100	70-100	50-80	10-40	<30	NP-5
Tabler: Ta	0-9	Silty clay loam	CL, CL-ML	A-6, A-7	0	100	100	96-100	80-98	20-40	3-18
	9-40	Silty clay, clay	CL, CH	A-7	0	100	100	96-100	90-99	41-65	18-35
	40-60	Silty clay, clay, silty clay loam.	CL, CH	A-7, A-6	0	96-100	96-100	92-100	80-99	33-60	13-33
Tivoli: Tv	0-7	Fine sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-100	5-35	---	NP
	7-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-98	5-20	---	NP
Ustifluvents: [1]Us	0-60	Variable	---	---	---	---	---	---	---	---	---
Vanoss: Va, Vb, Vc	0-16	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	65-95	22-37	2-14
	16-40	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-43	12-20
	40-60	Loam, silt loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	96-100	65-98	22-43	2-20

See footnotes at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--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	
Waurika:											
Wa----------------	0-14	Silt loam--------	CL, ML	A-4, A-6	0	100	100	96-100	80-95	22-37	3-14
	14-40	Clay, silty clay	CL, CH	A-7	0	95-100	95-100	90-100	80-98	41-66	20-40
	40-60	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0	90-100	90-100	85-100	80-98	38-55	16-30

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

[2]NP=nonplastic.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[Dashes indicate data were not available. The symbol < means less than; > means greater than. The erosion tolerance factor (T) is for the entire profile]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm						
Bethany:											
Ba, Bb	0-17	0.06-2.0	0.18-0.22	5.6-7.3	<2	Low	Low	Low	0.43	5	6
	17-60	0.06-0.20	0.14-0.18	6.6-8.4	<2	High	High	Low	0.37		
Brewer:											
Br, [1]Bs	0-14	0.2-0.6	0.15-0.24	6.1-7.3	2-16	Moderate	High	Low	0.43	5	7
	14-60	0.06-0.2	0.12-0.22	6.6-8.4	2-16	High	High	Low	0.37		
Canadian:											
Ca	0-40	2.0-6.0	0.11-0.20	6.1-7.3	<2	Low	Low	Low	0.20	5	3
	40-60	2.0-20	0.07-0.20	6.1-8.4	<2	Low	Low	Low	0.20		
Carwile:											
Cc	0-10	0.6-2.0	0.11-0.20	6.1-7.3	<2	Low	Moderate	Moderate	0.37	5	3
	10-39	0.06-0.2	0.12-0.20	6.1-7.3	<2	High	High	Low	0.37		
	39-60	0.2-2.0	0.12-0.20	6.6-8.4	<2	High	High	Low	0.32		
Corbin:											
Cr	0-16	0.6-2.0	0.19-0.24	5.6-7.3	<2	Low	Low	Low	0.37	5	6
	16-29	0.6-2.0	0.18-0.20	6.1-7.3	<2	Moderate	Low	Low	0.37		
	29-48	0.06-0.2	0.09-0.16	6.1-7.3	<2	High	High	Low	0.37		
	48-60	0.2-2.0	0.11-0.18	6.1-7.8	<2	Moderate	Moderate	Low	0.37		
Crisfield:											
Cs	0-60	2.0-6.0	0.13-0.18	5.6-7.3	<2	Low	Low	Low	0.20	5	3
Dale:											
Da	0-24	0.6-2.0	0.15-0.24	6.1-7.8	<2	Moderate	Moderate	Low	0.37	5	6
	24-60	0.6-2.0	0.15-0.24	6.6-8.4	<2	Moderate	Moderate	Low	0.37		
[1]Dr:											
Dale part	0-24	0.6-2.0	0.15-0.24	6.1-7.8	<2	Moderate	Moderate	Low	0.37	5	6
	24-60	0.6-2.0	0.15-0.24	6.1-8.4	<2	Moderate	Moderate	Low	0.37		
Reinach part	0-60	0.6-2.0	0.13-0.24	6.1-8.4	<2	Low	Low	Low	0.37	5	6
Elandco:											
Ea	0-45	0.6-2.0	0.15-0.24	5.6-7.8	<2	Moderate	Moderate	Low	0.37	5	7
	45-60	0.6-2.0	0.15-0.24	6.1-8.4	<2	Moderate	Moderate	Low	0.37		
Ec	0-45	0.6-2.0	0.15-0.24	5.6-7.8	<2	Moderate	Moderate	Low	0.37	5	6
	45-60	0.6-2.0	0.15-0.24	6.1-8.4	<2	Moderate	Moderate	Low	0.37		
Farnum:											
Fa, Fb, Fc, Fd	0-11	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low	Low	Low	0.37	5-4	6
	11-60	0.2-0.6	0.14-0.21	6.6-7.8	<2	Moderate	Moderate	Low	0.37		
Kirkland:											
Ka, Kb, Kc	0-9	0.6-2.0	0.15-0.24	5.6-7.3	<2	Low	Low	Low	0.49	5	6
	9-60	<0.06	0.12-0.18	6.6-8.4	<2	High	High	Low	0.37		
Lesho:											
Lo	0-30	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	High	Low	0.32	3	4L
	30-60	>2.0	0.02-0.10	7.4-9.0	<2	Low	Low	Low	0.17		
Lincoln:											
Ls	0-10	6.0-20	0.05-0.10	7.4-8.4	<2	Low	Low	Low	0.17	5	2
	10-60	6.0-20	0.05-0.10	7.9-8.4	<2	Low	Low	Low	0.17		
Milan:											
Ma, Mb, Mc, Md	0-10	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low	Low	Low	0.37	5-4	6
	10-60	0.2-0.6	0.14-0.21	5.6-7.3	<2	Moderate	Moderate	Low	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodi- bility group
	In	In/hr	In/in	pH	Mmhos/cm						
Owens:											
On, Oo-------------	0-4	<0.06	0.13-0.17	7.9-8.4	<2	High------	High-----	Low------	0.32	1	6
	4-20	<0.06	0.13-0.17	7.9-8.4	<2	High------	High-----	Low------	0.32		
	20-22	<0.06	0.03-0.08	7.9-8.4	<2	High------	High-----	Low------	0.32		
[1]Op:											
Owens part--------	0-4	<0.06	0.13-0.17	7.9-8.4	<2	High------	High-----	Low------	0.32	1	6
	4-20	<0.06	0.13-0.17	7.9-8.4	<2	High------	High-----	Low------	0.32		
	20-22	<0.06	0.03-0.08	7.9-8.4	<2	High------	High-----	Low------	0.32		
Elandco part-----	0-20	0.6-2.0	0.15-0.24	5.6-7.8	<2	Moderate--	Moderate-	Low------	0.37	5	6
	20-60	0.6-2.0	0.15-0.24	6.1-8.4	<2	Moderate--	Moderate-	Low------	0.37		
[1]Or:											
Owens part--------	0-4	<0.06	0.13-0.17	7.9-8.4	<2	High------	High-----	Low------	0.32	1	6
	4-20	<0.06	0.13-0.17	7.9-8.4	<2	High------	High-----	Low------	0.32		
	20-22	<0.06	0.03-0.08	7.9-8.4	<2	High------	High-----	Low------	0.32		
Renfrow part-----	0-12	0.2-0.6	0.15-0.22	6.1-7.8	<2	Moderate--	Moderate-	Low------	0.37	5	6
	12-60	<0.06	0.12-0.22	6.1-8.4	<2	High------	High-----	Low------	0.37		
[1]Os:											
Owens part--------	0-4	<0.06	0.13-0.17	7.9-8.4	<2	High------	High-----	Low------	0.32	1	6
	4-20	<0.06	0.13-0.17	7.9-8.4	<2	High------	High-----	Low------	0.32		
	20-22	<0.06	0.13-0.17	7.9-8.4	<2	High------	High-----	Low------	0.32		
Shale outcrop part not rated.											
Pond Creek:											
Pa, Pb, Pc, Pd----	0-13	0.6-2.0	0.15-0.20	6.1-7.3	<2	Low-------	Low------	Low------	0.37	5	---
	13-60	0.2-0.6	0.15-0.22	6.1-8.4	<2	Moderate--	Moderate-	Moderate-	0.37		
Pratt:											
Px----------------	0-14	6.0-20	0.10-0.13	6.1-7.3	<2	Low-------	Low------	Moderate-	0.17	5	2
	14-38	6.0-20	0.09-0.16	6.1-7.3	<2	Low-------	Low------	Low------	0.17		
	38-60	6.0-20	0.08-0.12	6.1-7.3	<2	Low-------	Low------	Low------	0.17		
Renfrow:											
[1]Ra---------------	0-12	0.2-0.6	0.15-0.22	6.1-7.8	<2	Moderate--	Moderate-	Low------	0.37	5	6
	12-60	<0.06	0.12-0.22	6.1-8.4	<2	High------	High-----	Low------	0.37		
Rosehill:											
Ro, Rs, Rx--------	0-10	<0.2	0.14-0.20	6.6-7.3	<2	High------	High-----	Low------	0.43	3	4
	10-40	<0.06	0.10-0.14	6.6-8.4	<2	High------	High-----	Low------	0.37		
	40-48	---	---	---	---	----------	---------	---------	---		
Shellabarger:											
Sa, Sb, Sc--------	0-11	0.6-2.0	0.13-0.21	5.6-6.5	<2	Low-------	Low------	Moderate-	0.24	5-4	3
	11-38	0.6-2.0	0.16-0.18	6.1-7.3	<2	Low-------	Low------	Moderate-	0.24		
	38-60	0.6-20.0	0.05-0.16	6.6-7.8	<2	Low-------	Low------	Low------	0.24		
Tabler:											
Ta----------------	0-9	0.2-0.6	0.15-0.24	6.1-7.3	<2	Low-------	Moderate-	Low------	0.49	5	---
	9-40	<0.06	0.12-0.18	6.1-7.8	<2	High------	High-----	Low------	0.37		
	40-60	<0.06	0.12-0.22	6.1-8.4	<2	High------	High-----	Low------	0.43		
Tivoli:											
Tv----------------	0-7	6.0-20.0	0.05-0.11	6.1-7.8	<2	Low-------	Low------	Low------	0.17	5	1
	7-60	6.0-20.0	0.02-0.06	6.1-7.8	<2	Low-------	Low------	Low------	0.17		
Ustifluvents:											
[1]Us---------------	0-60	---	---	---	---	----------	---------	---------	---	---	---

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Risk of corrosion		Erosion factors		Wind erodi- bility group
							Uncoated steel	Concrete	K	T	
	In	In/hr	In/in	pH	Mmhos/cm						
Vanoss:											
Va, Vb, Vc--------	0-16	0.6-2.0	0.15-0.20	5.6-6.5	<2	Low--------	Low------	Low------	0.37	5	6
	16-40	0.6-2.0	0.17-0.22	6.1-6.5	<2	Moderate--	Moderate-	Moderate-	0.37		
	40-60	0.6-2.0	0.16-0.21	6.1-7.3	<2	Low--------	Moderate-	Moderate-	0.37		
Waurika:											
Wa----------------	0-14	0.6-2.0	0.16-0.20	5.6-7.3	<2	Low--------	High-----	Low------	0.49	5	6
	14-40	<0.06	0.13-0.17	6.6-8.4	<2	High------	High-----	Moderate-	---		
	40-60	0.06-0.2	0.15-0.19	7.4-8.4	<2	Moderate--	High-----	Moderate-	---		

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 16.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. The symbol < means less than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			In	
Bethany:									
Ba, Bb	C	None	---	---	>6.0	---	---	>60	---
Brewer:									
Br, [1]Bs	C	Rare	---	---	>6.0	---	---	>60	---
Canadian:									
Ca	B	Rare	---	---	>6.0	---	---	>60	---
Carwile:									
Cc	D	Occasional	Brief to very long.	Apr-Oct	2.0-6.0	Apparent	Oct-Apr	>60	---
Corbin:									
Cr	B	None	---	---	>6.0	---	---	>60	---
Crisfield:									
Cs	B	Rare	---	---	>6.0	---	---	>60	---
Dale:									
Da	B	Rare	---	---	>6.0	---	---	>60	---
[1]Dr:									
Dale part	B	Rare	---	---	>6.0	---	---	>60	---
Reinach part	B	Rare	---	Mar-Aug	>6.0	---	---	>60	---
Elandco:									
Ea	B	Rare	---	---	>6.0	---	---	>60	---
Ec	B	Frequent	Very brief to brief.	Mar-Aug	>6.0	---	---	>60	---
Farnum:									
Fa, Fb, Fc, Fd	B	None	---	---	>6.0	---	---	>60	---
Kirkland:									
Ka, Kb, Kc	D	None	---	---	>6.0	---	---	>60	---
Lesho:									
Lo	C	Occasional	Very brief	Mar-Jul	2.0-6.0	Apparent	Jan-Dec	>60	---
Lincoln:									
Ls	A	Frequent	Very brief to brief.	Apr-Oct	5.0-8.0	Apparent	Nov-May	>60	---
Milan:									
Ma, Mb, Mc, Md	B	None	---	---	>6.0	---	---	>60	---
Owens:									
On, Oo	D	None	---	---	>6.0	---	---	10-20	Rippable
[1]Op:									
Owens part	D	None	---	---	>6.0	---	---	10-20	Rippable
Elandco part	B	Frequent	Very brief to brief.	Mar-Aug	>6.0	---	---	>60	---
[1]Or:									
Owens part	D	None	---	---	>6.0	---	---	10-20	Rippable

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			In	
Owens: Renfrow part	D	None	---	---	>6.0	---	---	>60	---
[1]Os: Owens part	D	None	---	---	>6.0	---	---	10-20	Rip-pable
Shale outcrop part not rated.									
Pond Creek: Pa, Pb, Pc, Pd	B	None	---	---	>6.0	---	---	>60	---
Pratt: Px	A	None	---	---	>6.0	---	---	>60	---
Renfrow: [1]Ra	D	None	---	---	>6.0	---	---	>60	---
Rosehill: Ro, Rs, Rx	D	None	---	---	>6.0	---	---	20-40	Rip-pable
Shellabarger: Sa, Sb, Sc	B	None	---	---	>6.0	---	---	>60	---
Tabler: Ta	D	None	---	---	2.5-3.5	Perched	Oct-Apr	>60	---
Tivoli: Tv	A	None	---	---	>6.0	---	---	>60	---
Ustifluvents: [1]Us	B	Frequent	Very brief to brief.	Jan-Dec	>6.0	---	---	>60	---
Vanoss: Va, Vb, Vc	B	None	---	---	>6.0	---	---	>60	---
Waurika: Wa	D	None	---	---	1.0-2.0	Perched	Mar-May	>60	---

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 17.--ENGINEERING TEST DATA

[Tests performed by the State Highway Commission of Kansas in accordance with standard procedures of the American Association of State Highway and Transportation Officials (AASHTO) except as stated in footnotes 1 and 2]

Soil name and location	Parent material	Report No.	Depth	Moisture density[1] Maximum	Moisture density[1] Optimum	Percentage passing sieve--[2] No. 10	Percentage passing sieve--[2] No. 40	Percentage passing sieve--[2] No. 200	Percentage smaller than--[2] 0.05 mm	Percentage smaller than--[2] 0.02 mm	Percentage smaller than--[2] 0.005 mm	Percentage smaller than--[2] 0.002 mm	Liquid limit	Plasticity index	Classification AASHTO[3]	Classification Unified[4]
			In	Lb/cu ft	Pct								Pct			
Dale silt loam: About 2,240 feet north and 130 feet west of the southeast corner of sec. 28, T. 34 S., R. 2 W. About 3 1/2 miles east of Caldwell city limits on U.S. 81 highway and 2 miles north. (Modal)	Alluvium.	S71-Kans 96-1-1	9-22	106	17	100	100	96	81	44	25	20	36	16	A-6 (10)	CL
		96-1-2	22-36	109	14	100	100	95	77	39	17	15	29	8	A-4 (8)	CL-ML
		96-1-3	50-65	109	14	99	99	91	73	27	13	11	37	15	A-6 (10)	CL
Bethany silt loam: About 1,850 feet south and 210 feet east of the northwest corner of sec. 29, T. 34 S., R. 2 W. About 1 1/2 miles east of Caldwell city limits on U.S. 81 highway and 2 miles north. (Modal)	Old alluvium and loess.	S71-Kans 96-2-1	8-16	102	19	100	99	93	87	56	32	27	37	16	A-6 (10)	CL
		96-2-2	24-45	101	21	100	100	96	92	71	48	41	50	30	A-7-6 (18)	CL
		96-2-3	45-60	103	20	100	98	87	78	52	34	25	41	21	A-7-6 (13)	CL
Brewer silty clay loam: 600 feet north and 200 feet east of the southwest corner of sec. 25, T. 32 S., R. 1 W. About 3/4 mile east of intersection of Botkin and Washington Streets in Wellington and 1 1/2 miles south. (Modal)	Alluvium.	S71-Kans 96-3-1	10-25	102	19	100	100	98	91	65	39	33	44	23	A-7-6 (14)	CL
		96-3-2	25-43	99	21	100	100	98	94	74	47	36	49	27	A-7-6 (17)	CL
		96-3-3	43-60	102	19	100	100	99	94	72	45	37	49	29	A-7-6 (17)	CL

See footnotes at end of table.

TABLE 17.--ENGINEERING TEST DATA--Continued

Soil name and location	Parent material	Report No.	Depth	Moisture density[1] Maximum	Optimum	Percentage passing sieve--[2] No. 10	No. 40	No. 200	Percentage smaller than--[2] 0.05 mm	0.02 mm	0.005 mm	0.002 mm	Liquid limit	Plasticity index	Classification AASHTO[3]	Unified[4]
			In	Lb/cu ft	Pct								Pct			
Rosehill clay loam: About 525 feet south and 85 feet east of the northwest corner of the northeast quarter of sec. 24, T. 31 S., R. 1 W. About 5 miles north of Wellington city limits on U.S. 81 highway and 1/2 mile east. (Nonmodal in B21t and B22t with regard to color. Nonmodal with regard to depth to shale)	Clayey shale.	S71-Kans 96-4-1	9-27	95	24	100	100	97	93	76	51	44	61	39	A-7-6 (20)	CH
		96-4-2	27-38	99	22	100	100	99	96	79	56	49	64	42	A-7-6 (20)	CH
		96-4-3	38-45	94	25	100	99	95	92	83	63	52	71	47	A-7-6 (20)	CH
		96-4-4	45-54	91	29	100	100	95	88	74	59	47	67	37	A-7-5 (20)	CH
Owens clay: About 200 feet south and 500 feet west of the northeast corner of the southeast quarter of sec. 16, T. 33 S., R. 1 E. (Nonmodal in surface layer with regard to sand content)	Clayey shale.	S71-Kans 96-5-1	0-6	100	21	100	98	94	89	68	49	39	48	25	A-7-6 (16)	CL
		96-5-2	6-18	104	20	100	94	88	83	70	47	29	44	21	A-7-6 (13)	CL
		96-5-3	18-26	110	18	99	97	97	95	91	67	42	39	17	A-6 (11)	CL

[1]Based on AASHTO Designation T99-61, Method A, (1) with the following variations: (1) all material is ovendried at 230° F; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

[2]Mechanical analyses according to AASHTO Designation T88-57 (1) with the following variations: (1) all material is ovendried at 230° F and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium silicate is used as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index by 2; the maximum time is 15 minutes, and the minimum time is 1 minute. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3]Based on AASHTO Designation M145-49 (1).

[4]Based on the Unified soil classification system (2). The SCS and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points from A-line to be given a borderline classification. An example of a borderline classification obtained by this use is CL-ML.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Bethany	Fine, mixed, thermic Pachic Paleustolls
Brewer	Fine, mixed, thermic Pachic Argiustolls
Canadian	Coarse-loamy, mixed, thermic Udic Haplustolls
Carwile	Fine, mixed, thermic Typic Argiaquolls
Corbin	Fine-silty, mixed, thermic Pachic Argiustolls
Crisfield	Coarse-loamy, mixed, thermic Udic Haplustolls
Dale	Fine-silty, mixed, thermic Pachic Haplustolls
Elandco	Fine-silty, mixed, thermic Cumulic Haplustolls
Farnum	Fine-loamy, mixed, thermic Pachic Argiustolls
Kirkland	Fine, mixed, thermic Udertic Paleustolls
Lesho	Fine-loamy over sandy or sandy-skeletal, mixed, thermic Fluvaquentic Haplustolls
Lincoln	Sandy, mixed, thermic Typic Ustifluvents
Milan	Fine-loamy, mixed, thermic Udic Argiustolls
Owens	Clayey, mixed, thermic, shallow Typic Ustochrepts
Pond Creek	Fine-silty, mixed, thermic Pachic Argiustolls
Pratt	Sandy, mixed, thermic Psammentic Haplustalfs
Reinach	Coarse-silty, mixed, thermic Pachic Haplustolls
Renfrow	Fine, mixed, thermic Udertic Paleustolls
Rosehill	Fine, montmorillonitic, mesic Udertic Haplustolls
Shellabarger	Fine-loamy, mixed, thermic Udic Argiustolls
Tabler	Fine, montmorillonitic, thermic Vertic Argiustolls
Tivoli	Mixed, thermic Typic Ustipsamments
Ustifluvents	Loamy, mixed, thermic Ustifluvents
Vanoss	Fine-silty, mixed, thermic Udic Argiustolls
Waurika	Fine, montmorillonitic, thermic Typic Argialbolls

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