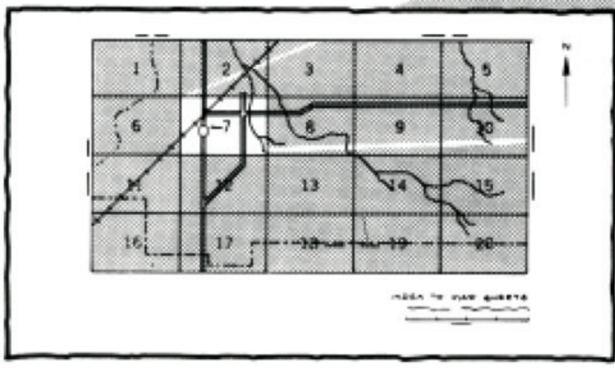
# SOIL SURVEY OF

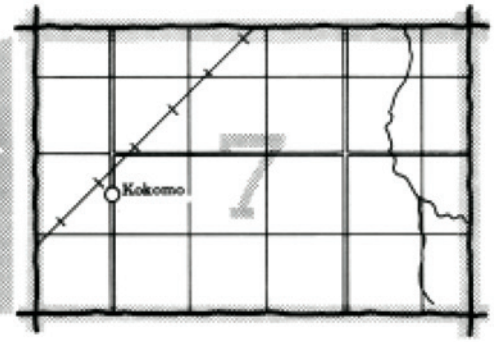
# Sedgwick County, Kansas

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

# HOW TO USE

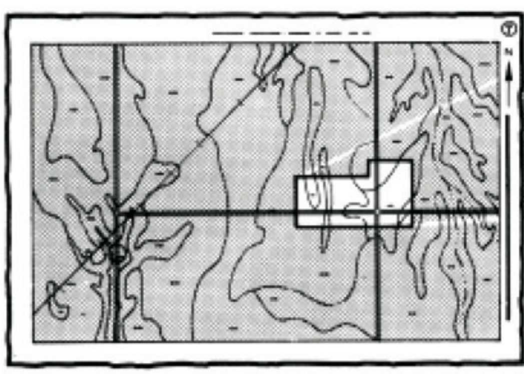
**1.** Locate your area of interest on the "Index to Map Sheets"

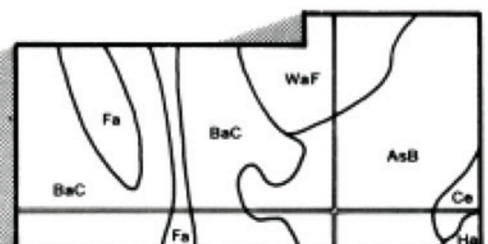




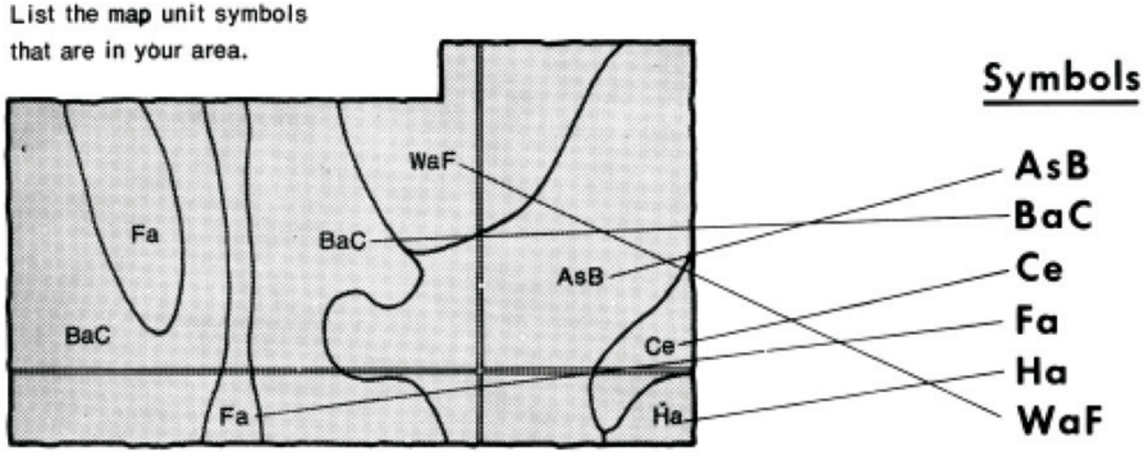

**2.** Note the number of the map sheet and turn to that sheet.

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



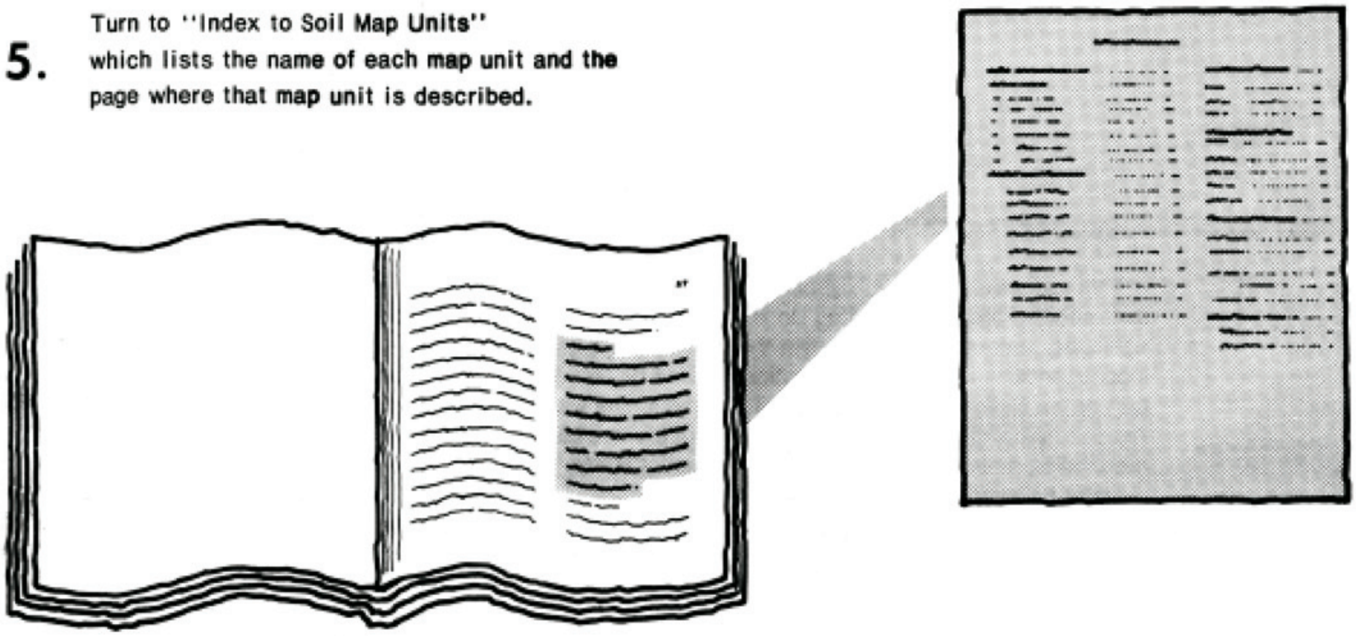



**4.** List the map unit symbols that are in your area.

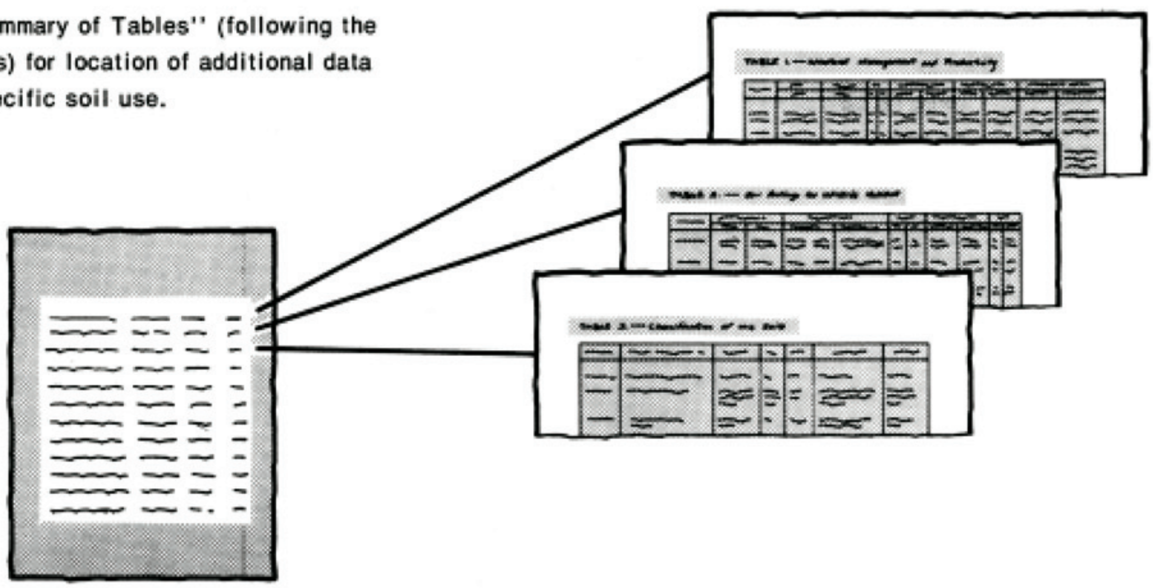


# THIS SOIL SURVEY

**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 1969-75. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1975. 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 Sedgwick County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can 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: Wheat and milo on Blanket silt loam, 1 to 3 percent slopes. The soil is terraced, farmed on the contour, and stubble mulched.**

# Contents



Issued April 1979

# Index to Soil Map Units

# Summary of Tables

# Foreword

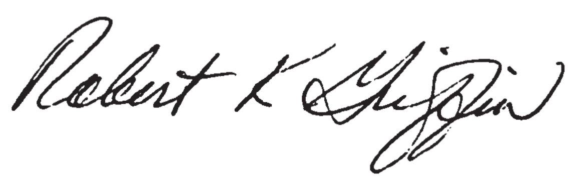
The Soil Survey of Sedgwick County, Kansas, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome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

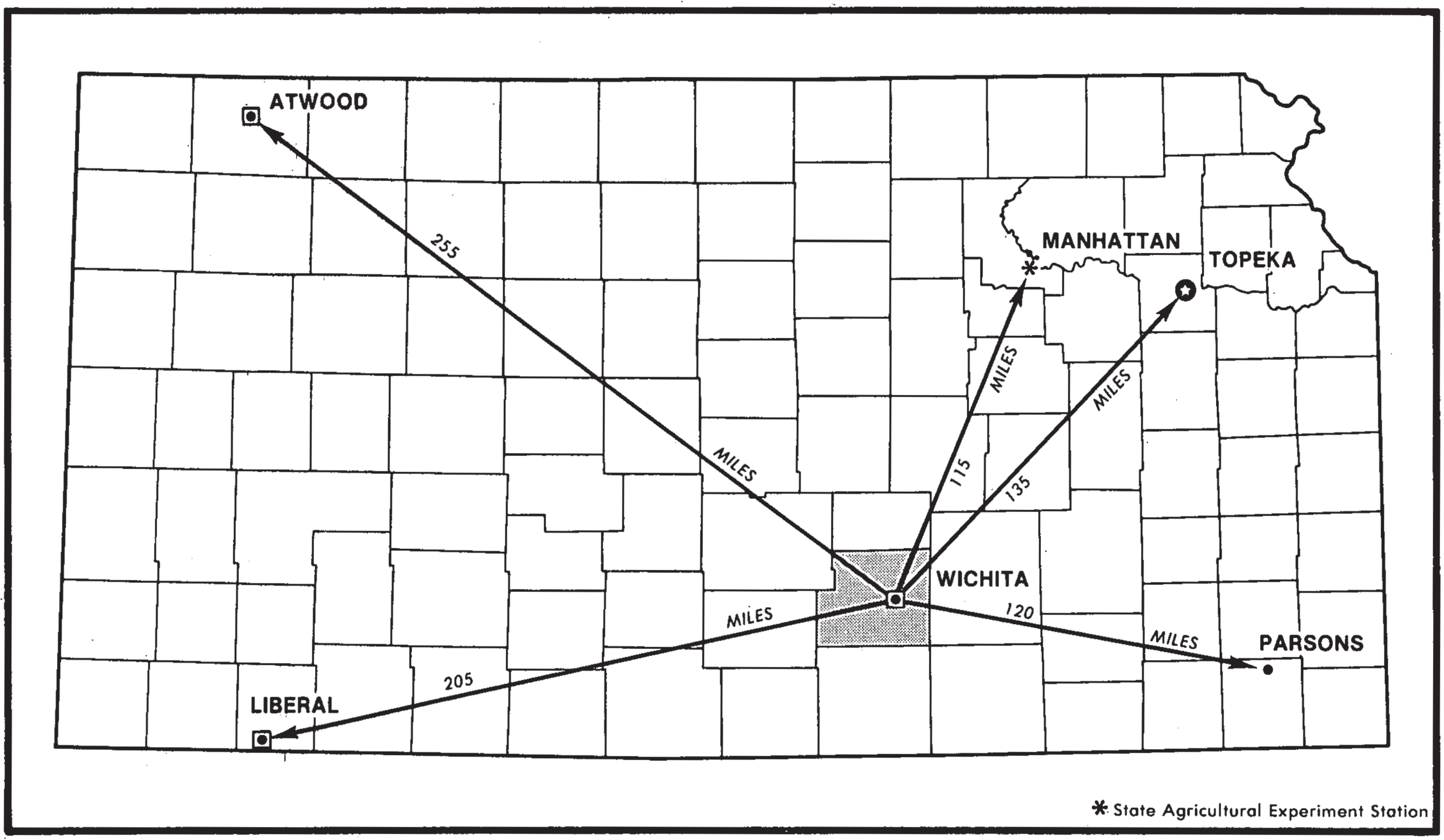
Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption 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.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.



Robert K. Griffin
State Conservationist
Soil Conservation Service




**Location of Sedgwick County in Kansas.**

# SOIL SURVEY OF SEDGWICK COUNTY, KANSAS

By Harold L. Penner and William A. Wehmueller, Soil Conservation Service

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

SEDGWICK COUNTY is in south-central Kansas (see facing page). It has a total of 1,008 square miles, or 645,120 acres. In 1870, the population of the county was 1,095; in 1970, it was 349,039. The population has increased rapidly during the past two decades. It is now about 15.7 percent of the population of Kansas. About 91 percent of the county's population is urban. Wichita, the county seat, has a population of 276,554.

The area now known as Sedgwick County became United States territory in 1803, as part of the Louisiana Purchase. The county was organized in 1870. It was named for Union General John Sedgwick. On March 25, 1870, the Wichita townsite plot was filed at El Dorado, the first county seat.

Except for the northeast corner, the county lies within the Arkansas River Lowlands section of the Central Lowland physiographic province (*3*). The topography is characterized by the extreme flatness of the broad Arkansas River Valley and the gently rolling slopes rising to the uplands adjacent to the valley. The highest point, about 1,540 feet above sea level, is on the west edge, about 5 miles southwest of Andale. The lowest point, about 1,220 feet above sea level, is where the Arkansas River flows out of the county to the south.

Drainage of the county is by way of the Arkansas River and its tributaries. The Arkansas River enters the county at the northwest corner, flows in a southeasterly direction to a point north of Wichita, where it turns south and flows out of the county near the southeast corner. The Little Arkansas River enters the county near the center of the north boundary, flows east-southeast, and joins the Arkansas River at Wichita. South of the Arkansas River, drainage is by Big Slough, Cowskin Creek, the Ninnescah River, and their tributaries. A narrow strip along the eastern edge of the county is drained by east-flowing tributaries of the Walnut River.

An extensive flood diversion system has been constructed around Wichita to alleviate recurrent flooding of urban areas by the Little Arkansas and Arkansas Rivers and their tributaries.

## General nature of the county

This section gives general information concerning the county. It describes natural resources, industry, farming, and climate.

### Natural resources

Soil is the most important natural resource in the county. Livestock that graze the grassland and crops produced on farms are marketable products that are affected by the soil.

Ground water is an important mineral resource of the county (*3*). Most water used in the county is ground water. The principal source of the ground water is the unconsolidated deposits underlying the Arkansas Valley, where well yields of a few gallons per minute to over 2,000 gallons per minute are readily obtained. The chemical quality of the ground water ranges from moderately hard to extremely hard, depending on the source of the water. Ground water in the Arkansas Valley is generally of moderate hardness, but locally it contains undesirable quantities of dissolved salt and iron. Water from the Permian rocks is generally extremely hard and of limited use because of its high content of chloride and sulfate ions.

Other mineral resources of Sedgwick County are oil and gas, salt, gypsum, and sand and gravel.

Oil was first discovered in the county in 1928. Development in the county has continued, and in 1960 oil and gas were produced from 631 wells.

Salt deposits in the Wellington Formation of early Permian age underlie the western half of the county. The deposits range in thickness from a feather edge near the center of the county to about 300 feet along the western edge. Salt is extracted for use as a raw material by a chemical company near Wichita.

Gypsum and anhydrate are in the Wellington Formation east of the Arkansas River Valley. A gypsum deposit northeast of Mulvane was worked commercially from 1899 to 1901, but there has been no commercial production of gypsum in the county since that time.

Sand and gravel deposits of Pleistocene age, which underlie about one-third of the county, have been worked commercially for many years. Most of the pits are near the Arkansas and Little Arkansas Rivers, where the overburden is thin. The water table is shallow adjacent to the rivers, and the sand and gravel is quarried hydraulically. These deposits are used extensively for concrete aggregate and as road metal.

## Industry

The metropolitan area of Wichita is the most heavily industrialized area in the State and is the most important transportation and distribution center. The area is nationally prominent in the manufacture of military and private aircraft. Other important industries include the production and refining of petroleum products, chemical manufacture, milling and storage of grain, meat packing, metal fabrication, and the manufacture of foundry products.

## Farming

Probably the most reliable record of early farming methods and statistics dates back to the year 1873, when the Sedgwick County Agricultural Society was organized. During the following year there was to be an agricultural exhibit, but because of the drought and grasshopper infestation there was nothing to exhibit. In fact, the county had to accept outside aid. In 1875, the crops were bountiful, but in 1876 the grasshoppers again caused considerable damage. In 1882 the number of bushels of grain harvested was 5,332,320, of which 3,665,610 was corn. Some of the early crops grown in the county were winter wheat, rye, spring wheat, corn, barley, oats, buckwheat, Irish potatoes, sweet potatoes, sorghum, castor beans, cotton, flax, tobacco, broom corn, millet, timothy, and clover.

Wheat and sorghum are better suited to the climate of the county than most other crops. They are the main crops, but alfalfa, corn, oats, barley, rye, and soybeans and orchards and vegetable crops are grown to some extent. According to the biennial report of the Kansas State Board of Agriculture, the main crops harvested in Sedgwick County in 1974 were wheat, 252,200 acres; grain sorghum, 64,900 acres dryland and 4,700 acres irrigated; corn, 650 acres dryland and 4,140 acres irrigated; soybeans, 8,000 acres; sorghum for silage, 9,600 acres; barley, 3,900 acres; and alfalfa hay, 28,800 acres. There were 2,834,600 pounds of apples and 1,534,000 pounds of peaches produced the same year.

Livestock is an important source of income in Sedgwick County. Of the kinds of livestock raised, beef and dairy cattle are the most important sources of income. According to the biennial report of the Kansas State Board of Agriculture, there were about 19,300 beef cattle, 7,200 milk cows, 25,600 hogs, 17,600 sheep and lambs, and 150,000 chickens on farms in the county in 1974.

Most of the towns have facilities for handling and storing grain. Railroads provide a means of transporting grain to terminal elevators and of transporting grain, livestock, and livestock products to markets to the east and west. The Federal and State highways that cross the county provide access to markets by truck.

## Climate

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

Sedgwick County has a typical continental climate, as would be expected of a location in the interior of a large land mass in the middle latitudes. Such a climate is characterized by large daily and annual variations in temperature. Winters are cold because air frequently moves in from the polar regions, but they last only from December through February. Warm summer temperatures last for about 6 months every year, and the transition seasons, spring and fall, are short. The warm temperatures provide a long growing season for crops in the county.

Sedgwick County is generally along the western edge of the flow of moisture-laden air from the Gulf of Mexico. Shifts in this current produce a large range in the amount of precipitation received. Precipitation is heaviest from May through September. A large part of it falls as late evening or nighttime thunderstorms. Precipitation in dry years is marginal for farming, and even in wet years prolonged periods without rain often produce stress in crops.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Wichita for the period 1954 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 33.3 degrees F, and the average daily minimum temperature is 23.0 degrees. The lowest temperature on record, which occurred at Wichita on February 12, 1899, is minus 22 degrees. In summer the average temperature is 78.9 degrees, and the average daily maximum temperature is 90.1 degrees. The highest recorded temperature, which occurred on August 12, 1936, is 114 degrees.

The average annual precipitation is 28.93 inches. Of this total, 21.26 inches, or 73 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 12.75 inches. The heaviest 1-day rainfall during the period of record was 7.99 inches at Wichita on September 7, 1911.

Average seasonal snowfall is 15.4 inches. The greatest snow depth at any one time during the period of record was 40 inches during the winter of 1911-12. On the average, 17 days have at least 1 inch of snow on the ground. The snow usually does not stay on the ground more than 3 days in succession.

The prevailing wind is usually from the south, but in February it is northerly. Average annual windspeed is 13 miles per hour; it is highest, 15 miles per hour, in March and April. The percent of possible sunshine averages 77 in summer and 61 in winter.

Tornadoes and severe thunderstorms occur occasionally in Sedgwick County. These storms are usually local in extent and of short duration so that the risk of damage is small. Hail falls during the warmer part of the year, but it is infrequent and local in extent. Crop damage by hail is less in this part of the State than it is further west.

## 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 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 are discussed in the sections "General soil map for broad land-use planning" and "Soil maps for detailed 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, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit 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.

### Map unit descriptions

#### 1. Lesho-Lincoln-Canadian

*Soils that are shallow to deep over sand; are nearly level and somewhat poorly drained, well drained, and somewhat excessively drained; have a sandy substratum; and formed in alluvial sediments*

This nearly level map unit is on flood plains and terraces (fig. 1). It occupies about 8 percent of the county. It is about 25 percent Lesho soils; 20 percent Lincoln soils; 20 percent Canadian soils; and 35 percent well drained Elandco, Naron, and Pratt soils, poorly drained Plevna soils, and somewhat poorly drained Waldeck soils.

In most places Lesho soils are slightly lower in elevation than Lincoln and Canadian soils. Lesho soils are somewhat poorly drained, Lincoln soils are somewhat excessively drained, and Canadian soils are well drained. Lesho and Lincoln soils have a loam surface layer and a seasonal high water table. Canadian soils have a fine sandy loam surface layer and do not have a water table within 6 feet of the surface.

This map unit is used for range and cultivated crops. Most of the range is in poor to fair condition. Lincoln and Lesho soils are used primarily as range, and Canadian soils are dominantly used as cropland. The principal crops planted on Canadian soils are grain sorghum and wheat. Wetness and soil blowing are the main limitations if these soils are used for farming and for most other purposes. Also, flooding is common on the Lesho and Lincoln soils.

Only the Canadian soils in this map unit have good potential for cultivated farm crops and specialty crops and fair potential for urban uses. Wetness and flooding are such severe limitations and are so difficult to overcome that the potential of Lesho and Lincoln soils for farm crops and residential and other urban uses is poor. The potential for development of wetland wildlife habitat is very poor to fair.

## 2. Naron-Farnum-Carwile

*Deep, nearly level, well drained and somewhat poorly drained soils that have a loamy subsoil; formed in old alluvial sediments*

These nearly level soils parallel the Arkansas River. They are in terrace positions above flood plain soils and below upland soils.

This map unit occupies about 9 percent of the county. It is about 40 percent Naron soils; 25 percent Farnum loam, sandy substratum; 25 percent Carwile soils; and 10 percent somewhat poorly drained Drummond soils, well drained Farnum soils, and moderately well drained Tabler soils.

In most places Naron soils and Farnum loam, sandy substratum, are slightly higher in elevation than Carwile soils. They are well drained, whereas Carwile soils are somewhat poorly drained. Naron and Carwile soils have a fine sandy loam surface layer, and Farnum loam, sandy substratum, has a loam surface layer. Carwile soils have a seasonal high water table.

This map unit is used mainly for cultivated crops. Wheat and grain sorghum are the principal crops. If irrigation water is available, corn, soybeans, and alfalfa are grown. In wet years alfalfa on the Carwile soils is damaged or completely drowned out. Carwile soils have good potential for cultivated crops if they are adequately drained. Crops that mature in spring are best suited to Farnum loam, sandy substratum, because this soil does not have the capacity to store large reserves of water during periods of drought. The potential for development of openland wildlife habitat is good.

## 3. Elandco-Canadian

*Deep, nearly level, well drained soils that have a loamy subsoil; formed in alluvial sediments*

This nearly level map unit is on flood plains and low terraces (fig. 2). It occupies about 8 percent of the county. It is about 45 percent Elandco soils; 30 percent Canadian soils; and 25 percent somewhat poorly drained Lesho soils, somewhat excessively drained Lincoln soils, poorly drained Plevna soils, moderately well drained Tabler soils, and somewhat poorly drained Waldeck soils.

Elandco and Canadian soils are at about the same level on the landscape, but the occasionally flooded and frequently flooded Elandco soils are at lower elevations. Both soils are well drained. Elandco soils have a surface layer of silt loam, and Canadian soils have a surface layer of fine sandy loam.

This map unit is used mainly for cultivated crops. Wheat, grain sorghum, and alfalfa are the principal crops. Some areas where good-quality water is available are irrigated. Orchards, corn, and vegetables are irrigated.

Flooding and soil blowing are the main hazards. In the city of Wichita the soils are protected by the Wichita-Valley Center floodway. The potential for urban uses in this area is good. In areas that are not protected against flooding, the potential for urban uses is poor to fair. The potential for development of openland wildlife habitat is good.

## 4. Goessel-Tabler-Farnum

*Deep, nearly level and gently sloping, moderately well drained and well drained soils that have a clayey or loamy subsoil; formed in old alluvial sediments*

These nearly level to gently sloping soils are east of the Little Arkansas River and north of the city of Wichita. They are on terraces and uplands (fig. 3).

This map unit occupies about 9 percent of the county. It is about 30 percent Goessel soils; 25 percent Tabler soils; 25 percent Farnum soils; and 20 percent well drained Blanket, Elandco, Irwin, and Rosehill soils.

In most places Farnum soils are slightly higher on the landscape than Goessel and Tabler soils. Goessel and Tabler soils are moderately well drained, and Farnum soils are well drained. Goessel soils have a silty clay surface layer, Tabler soils have a silty clay loam surface layer, and Farnum soils have a loam surface layer. Goessel and Tabler soils have a high shrink-swell potential, and Farnum soils have a moderate shrink-swell potential.

This map unit is used mainly for cultivated crops. Wheat, grain sorghum, alfalfa, and soybeans are the principal crops. A few small areas are used as range, and a few areas are seeded to bromegrass or fescue and used as pasture.

In most areas of Goessel and Tabler soils, some type of surface drainage is needed to realize the maximum crop potential. Some slopes are long enough and sloping enough to require a terrace system. The high shrink-swell potential of the Goessel and Tabler soils is a severe limitation for urban uses. The potential for development of open wildlife habitat is fair to good.

## 5. Irwin-Goessel-Rosehill

*Deep and moderately deep, nearly level to sloping, moderately well drained and well drained soils that have a clayey subsoil; formed in old alluvial sediments and shale residuum*

These nearly level to sloping soils are on uplands in the eastern part of the county. They formed dominantly in clayey alluvial sediments, but in some small areas they formed in shale residuum (fig. 4).

This map unit occupies about 17 percent of the county. It is about 35 percent Irwin soils, 25 percent Goessel soils, 20 percent Rosehill soils, and 20 percent well drained Blanket, Clime, Elandco, and Farnum soils and moderately well drained Tabler soils.

In most places Goessel soils are on the more nearly level parts of the landscape, and Irwin and Rosehill soils are in the more sloping areas. Irwin and Rosehill soils are well drained, and Goessel soils are moderately well drained. Goessel and Rosehill soils have a silty clay surface layer, and Irwin soils have a silty clay loam surface layer.

This map unit is used mainly for cultivated crops. The soils are best suited to small grain because droughtiness is a factor in most years, especially in July and August. Wheat and grain sorghum are the principal crops. Some alfalfa and soybeans are occasionally grown. Most range is in poor to fair condition because most grazing areas are small and have been continuously overused. Most farms are the cash-grain type or are general farms on which some livestock is raised.

If adequately protected against erosion, this map unit has fair to good potential for cultivated crops. The hazard of erosion can be overcome by a terrace system and a selection of crops that include small grain and legumes. The high shrink-swell potential of the major soils is such a severe limitation and is so difficult to overcome that the potential for residential and other urban uses is poor. The potential for development of open wildlife habitat is fair to good.

### 6. Shellabarger-Milan-Renfrow

*Deep, gently sloping and sloping, well drained soils that have a loamy or clayey subsoil; formed in old alluvial sediments and shaly clay residuum*

These gently sloping and sloping soils are on uplands in the southwestern part of the county adjoining the Ninnescah River drainage system (fig. 5).

This map unit occupies about 9 percent of the county. It is about 25 percent Shellabarger soils; 25 percent Milan soils; 20 percent Renfrow soils; and 30 percent well drained Blanket, Canadian, Farnum, Naron, Owens, and Vernon soils, moderately well drained Tabler soils, somewhat poorly drained Carwile soils, and poorly drained Plevna soils.

In most places Shellabarger soils occupy the more sloping part of the landscape, whereas Milan soils occupy the intermediate parts of the landscape and Renfrow occupy foot slopes. All the soils are well drained. Shellabarger soils have a sandy loam surface layer, Milan soils have a loam surface layer, and Renfrow soils have a silty clay loam surface layer.

This map unit is used mainly for crops, but some small areas are still in native range. The range is dominantly in areas of Renfrow, Owens, and Vernon soils. The soils in this map unit are subject to soil blowing and water erosion. They have fair to good potential for cultivated farm crops if conservation practices protect them against erosion. Shellabarger and Milan soils have slight to moderate limitations for urban and residential development. The potential for development of openland wildlife habitat is good.

### 7. Renfrow-Blanket-Owens

*Deep and shallow, nearly level to strongly sloping, well drained soils that have a clayey subsoil; formed in clay shale residuum and old clayey alluvial sediments*

These nearly level to strongly sloping soils are on uplands in the western part of the county, in the Ninnescah River watershed. Renfrow and Owens soils formed in clayey shale residuum, and Blanket soils formed in old clayey alluvial sediments (fig. 5).

This map unit occupies about 5 percent of the county. It is about 50 percent Renfrow soils; 30 percent Blanket soils; 10 percent Owens soils; and 10 percent well drained Milan and Vernon soils, moderately well drained Tabler soils, and somewhat poorly drained Carwile soils.

Owens soils are typically on the strongly sloping parts of the landscape, Renfrow soils are typically in the gently sloping areas, and Blanket soils are in the nearly level areas. Renfrow soils have a silty clay loam surface layer, Blanket soils have a silt loam surface layer, and Owens soils have a clay loam surface layer.

This map unit is used mainly for crops. Most of the acreage is used for wheat and grain sorghum. Some areas, especially areas of Owens soils, are used as range. Erosion and droughtiness are the main limitations of these soils for farming and for most other purposes.

This map unit has poor to good potential for cultivated farm crops. Protection against erosion is needed. Owens soils are better suited to native grass range than to other uses. Good range management is needed on the shallow Owens soils to control erosion and keep the range in good condition. Nearly all the farms are the cash-grain type or cattle farms. The potential for development of openland wildlife habitat is fair to good.

### 8. Blanket-Farnum-Vanoss

*Deep, nearly level to sloping, well drained soils that have a loamy or clayey subsoil; formed in old clayey, silty, and loamy sediments*

This map unit occupies uplands in the central third of the county (fig. 6). It makes up about 35 percent of the county. It is about 35 percent Blanket soils; 30 percent Farnum soils; 15 percent Vanoss soils; and 20 percent well drained Elandco and Milan soils, moderately well drained Tabler soils, and somewhat poorly drained Drummond and Waurika soils.

Blanket soils typically are on the nearly level and gently sloping parts of the landscape. Farnum soils typically are on gently sloping parts, and Vanoss soils typically are on the gently sloping and sloping parts of the landscape. Blanket and Vanoss soils have a silt loam surface layer, and Farnum soils have a loam surface layer.

This map unit is used mainly for crops. Wheat and grain sorghum are the main crops. Some small areas are used as range and pasture. The soils are well suited to all dryland crops and grasses commonly grown in the county. Shortages of moisture may be a limitation, and in places there is not enough ground water for irrigation. Water erosion is a hazard in the gently sloping and sloping areas. Flooding sometimes occurs along drainageways. Most farms are the cash-grain type, but some are dairies and others are general farms on which some livestock is raised.

If adequately protected against erosion, this map unit has good potential for cultivated farm crops. Erosion is the main limitation of these soils for farming and for most other purposes. This map unit has slight and moderate limitations for urban and residential development. The potential for development of openland wildlife habitat is good.

## Broad land-use considerations

Deciding which land should be used for urban development is an important issue in the survey area. Each year a considerable acreage is developed for urban uses in Wichita, Derby, Clearwater, Goddard, and other cities in the county. An estimated 90,000 acres, or nearly 14 percent of the survey area, is urban or built-up land. The general soil map is most helpful in planning the general outline of urban areas; it cannot be used for the selection of sites for specific urban structures. In general, the soils that have good potential for cultivated crops also have good potential for urban development. The data about specific soils in this survey can be helpful in planning future land-use patterns.

Areas where the soils are so unfavorable that urban development is impossible are not extensive. Large areas of the Lesho-Lincoln-Canadian map unit, however, are on flood plains where flooding and a high water table are severe limitations. Also, urban development is very costly on the clayey soils in the Goessel-Tabler-Farnum and Irwin-Goessel-Rosehill map units. The shrink-swell potential is high in these soils.

In large areas of the county are soils that can be developed for urban uses at a low cost. These areas include parts of the Blanket-Farnum-Vanoss map unit that are not on flood plains, the Shellabarger-Milan-Renfrow map unit, and the Naron-Farnum-Carwile map unit. The excellent potential of these map units for farming should not be overlooked when broad land uses are considered.

Vegetables and other specialty crops are uniquely suited to parts of the Naron-Farnum-Carwile map unit if proper drainage systems are installed where needed. Also good for such crops are parts of the Lesho-Lincoln-Canadian and the Blanket-Farnum-Vanoss map units. These soils are well drained and warm up earlier in spring than the more clayey, wetter soils. Where bedrock is not too shallow, nurseries are also well suited to these well drained soils.

# 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 maps 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 profiles that are alike or almost alike 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. Milan and Rosehill, for example, are the names of two soil series.

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, Irwin silty clay loam, 2 to 6 percent slopes, eroded, is one of three phases within the Irwin series.

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. Pits is an example. Some of these 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.

**Aa—Albion-Shellabarger sandy loams, 1 to 4 percent slopes.** This map unit consists of gently sloping to undulating, well drained and somewhat excessively drained soils on uplands. Individual areas of this unit range from 20 to 240 acres in size. They are 60 to 75 percent Albion soils and 25 to 40 percent Shellabarger soils. Albion soils are on the ridges of the undulations, and Shellabarger soils are on the middle and lower parts of the undulations. The two soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Albion soil has a surface layer of brown sandy loam about 9 inches thick. The subsoil is about 17 inches thick. The upper part is reddish brown, friable sandy loam; the lower part is reddish brown, friable coarse sandy loam. The substratum is yellowish red sand. In places, scattered pebbles as much as 1 inch in diameter are throughout the profile.

Typically, the Shellabarger soil has a surface layer of dark brown sandy loam about 10 inches thick. The subsoil is about 30 inches thick. The upper part is dark reddish brown, friable sandy loam; the lower part is yellowish red, firm sandy clay loam. The substratum is yellowish red sand.

Included with these soils in mapping are small areas of Milan, Pratt, and Vernon soils, which make up 5 to 15 percent of the unit. Milan soils have a clay loam subsoil, Pratt soils are sandy, and Vernon soils have a clayey subsoil. Pratt soils are on the steeper parts of the landscape, Milan soils are in concave areas, and Vernon soils are at the base of some slopes.

Permeability is moderately rapid in the Albion soil and moderate in the Shellabarger soil. Available water capacity is low in the Albion soil and moderate in the Shellabarger soil. Both soils are sandy. Crops on Albion soil frequently are under stress during periods of drought. The surface layer is slightly acid to medium acid. The root zone of the Albion soil is restricted by the sand substratum.

Most areas of this unit are cultivated to wheat and sorghum. Soil blowing and water erosion are hazards if these soils are cultivated. Minimum tillage and winter cover crops help prevent excessive soil loss. A few areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and helps control soil blowing.

The use of these soils as pastureland or hayland is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in condition.

These soils are well suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

These soils are suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoon. Similar treatment is needed in pond reservoir areas. These soils have slight to moderate limitations if they are used for recreational purposes. Capability unit IIIe-6; Sandy range site.

**Ab—Albion and Shellabarger sandy loams, 7 to 15 percent slopes.** This map unit consists of strongly sloping to rolling, well drained and somewhat excessively drained soils on uplands. Individual areas of this unit range from 20 to 60 acres in size and typically occur as long, narrow bands where terraces or uplands break to alluvial plains. Each of the principal components makes up 40 to 80 percent of the areas, and either may be dominant. Albion soils are typically on the narrow ridges or on the steeper parts of slopes, and Shellabarger soils are on the middle parts of slopes and on foot slopes. The two soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Albion soil has a surface layer of brown sandy loam about 8 inches thick. The subsoil is about 17 inches thick. The upper part is reddish brown, friable sandy loam; the lower part is reddish brown, friable coarse sandy loam. The substratum is yellowish red sand. In places, scattered pebbles as much as 1 inch in diameter are throughout the profile.

Typically, the Shellabarger soil has a surface layer of dark brown sandy loam about 10 inches thick. The subsoil is about 30 inches thick. The upper part is dark reddish brown, friable sandy loam; the lower part is yellowish red, firm sandy clay loam. The substratum is yellowish red sandy loam.

Included with these soils in mapping are small areas of Milan and Vernon soils, which make up 5 to 15 percent of the unit. Milan soils have more clay in the subsoil, and Vernon soils have a clayey and silty shale substratum at a depth of 20 to 40 inches. Milan soils are adjacent to the drainageways that dissect the unit, and Vernon soils are typically at the base of some slopes and adjacent to some drainageways.

Permeability is moderately rapid in the Albion soil and moderate in the Shellabarger soil. Available water capacity is low in the Albion soil and moderate in the Shellabarger soil. Both soils are sandy. The surface layer is slightly acid to medium acid. The root zone of the Albion soil is restricted by the sand substratum.

Nearly all areas of this unit are in native grass. If cultivated, these soils are subject to severe water erosion. They are well suited to native grass, but proper stocking rates and timely deferment of grazing are necessary to maintain the good quality of the grass.

These soils are well suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

Where slopes are more than 8 percent, limitations for building sites are moderate because of the slope and the erosion hazard. The erosion hazard can be minimized by avoiding excessive stripping of soil and by resodding bare areas as soon as possible. Sewage lagoons and pond reservoir areas can seep unless a sealer is used. These soils have slight to severe limitations for recreational areas, depending on the slope. Capability unit VIe-1; Sandy range site.

**Ba—Blanket silt loam, 0 to 1 percent slopes.** This nearly level, well drained soil is on broad upland divides and in upland valleys. Individual areas of this unit are irregular in shape and range from 40 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 14 inches thick. The subsoil is silty clay about 32 inches thick. The upper part is dark grayish brown and firm; the next part is grayish brown and very firm; the lower part is brown and very firm. The substratum to a depth of 60 inches is light brown silty clay loam that is mottled with yellowish brown and has few soft masses and threads of calcium carbonate.

Included with this soil in mapping are small areas of moderately well drained Tabler soils and somewhat poorly drained Waurika soils in shallow depressions and drainageways. These soils make up 10 to 15 percent of the unit.

Water and air move through this soil at a moderately slow rate, and runoff from cultivated areas is very slow. Available water capacity is high. Reaction ranges from slightly acid to mildly alkaline in the surface layer. Natural fertility is high, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. Root growth is not restricted by any type of compacted layer.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor to fair potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In a few areas slopes are long enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases water infiltration.

The use of the soil as pastureland or hayland is effective in maintaining fertility and good tilth. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

This soil is suitable for building sites, but the moderate shrink-swell potential and low strength adversely affect construction. The slow percolation rate is a severe limitation if the soil is used for septic tank absorption fields. This limitation can be overcome, to a degree, by increasing the size of the filter field. The soil has slight limitations if it is used for sewage lagoons. It has slight to moderate limitations if used for recreational areas. Capability unit I-2; Loamy Upland range site.

**Bb—Blanket silt loam, 1 to 3 percent slopes.** This gently sloping, well drained soil is on upland valley side slopes and upland ridges. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 12 inches thick. The subsoil is silty clay about 30 inches thick. The upper part is dark grayish brown and firm; the next part is grayish brown and very firm; the lower part is brown and very firm. The substratum to a depth of 60 inches is light brown silty clay loam that is mottled with yellowish brown and has few soft masses, films, and threads of calcium carbonate.

Included with this soil in mapping are small areas of Farnum, Irwin, and Vanoss soils. Any one or all three of these soils can occur near the edges of this unit. They make up 5 to 15 percent of the unit. Farnum soils are more sandy than this Blanket soil, Irwin soils are less gradational between the surface layer and subsoil and do not decrease appreciably in clay content in the lower part, and Vanoss soils are less clayey.

Water and air move through this soil at a moderately slow rate, and runoff from cultivated areas is slow. Available water capacity is high. Reaction ranges from slightly acid to mildly alkaline in the surface layer. Natural fertility is high, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. Root growth is not impeded by any type of restrictive layer. In some small eroded areas, which are identified on the soil map by a spot symbol, the surface layer is about 7 inches thick. In these areas, runoff is medium and rills are common.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor to fair potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion. Minimum tillage and minimum use of row crops help prevent excessive soil loss. Most areas should be terraced and farmed on the contour. Returning crop residue to the soil improves fertility and increases water infiltration.

The use of the soil as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

This soil is suitable for building sites, but the moderate shrink-swell potential and low strength adversely affect construction. The slow percolation rate is a severe limitation if the soil is used for septic tank absorption fields. This limitation can be overcome, to a degree, by increasing the size of the filter field. The soil has slight limitations if it is used for sewage lagoons. It has slight to moderate limitations if used for recreational purposes. Capability unit IIe-2; Loamy Upland range site.

**Ca—Canadian fine sandy loam.** This nearly level, well drained soil is on low terraces that are rarely flooded. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is brown fine sandy loam about 20 inches thick. The subsoil is about 15 inches of brown, very friable sandy loam. The substratum to a depth of 60 inches is light brown sandy loam.

Included with this soil in mapping are small areas of well drained Naron soils and somewhat poorly drained Waldeck soils. The Naron soils occupy narrow ridges, and the Waldeck soils are in narrow drainageways. The Naron and Waldeck soils make up about 5 to 10 percent of the unit.

Water and air move through this soil at a moderately rapid rate, and runoff is slow. Available water capacity is moderate. Reaction is slightly acid or neutral in the surface layer and ranges from slightly acid to moderately alkaline in the subsoil. Natural fertility is medium, but the organic-matter content in the surface layer is frequently low because of winnowing and tillage practices. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to wheat and milo and to grasses and legumes for hay and pasture. If irrigated, it is well suited to corn, soybeans, alfalfa, orchards, and truck crops. Minimum tillage and winter cover crops help to control soil blowing. Returning crop residue to the soil or regularly adding other organic material helps to maintain the content of organic matter, reduce crusting, and increase water retention.

This soil is well suited to trees grown as windbreaks and environmental plantings and to orchards and truck crops. Seeds, cuttings, and seedlings survive and grow well if the soil is irrigated and competing vegetation is controlled or removed. Competing vegetation can be controlled by site preparation and spraying.

This soil is suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used and if areas are protected against flooding. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. The soil has slight to severe limitations for recreational areas, depending on the frequency of flooding. Capability unit I-1; Sandy range site.

**Cb—Canadian-Waldeck fine sandy loams.** This map unit consists of nearly level to gently undulating, well drained and somewhat poorly drained soils on flood plains and low terraces that are rarely flooded. Individual areas of this unit range from 40 to several hundred acres in size and are from 60 to 80 percent Canadian soils and 20 to 35 percent Waldeck soils. Canadian soils have plane or convex surfaces. Waldeck soils are in swales, drainageways, and low-lying areas. The two soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Canadian soil has a surface layer of brown fine sandy loam about 20 inches thick. The subsoil is about 15 inches of brown, very friable sandy loam. The substratum is light brown sandy loam.

Typically, the Waldeck soil has a surface layer of dark gray sandy loam about 14 inches thick. The next layer is about 13 inches of light brownish gray, very friable sandy loam with common, medium, distinct, yellowish brown mottles. The substratum is pale brown coarse sand with common, medium, distinct mottles of yellowish brown.

Included with these soils in mapping are small areas of Naron soils and Farnum loam, sandy substratum. These included soils make up 5 to 20 percent of the unit. They contain more clay in the subsoil than the Canadian and Waldeck soils are are on similar landscapes.

Permeability is moderately rapid in these Canadian and Waldeck soils. The Waldeck soil has a water table that fluctuates between depths of 2 and 8 feet. Available water capacity in both soils is moderate. Runoff is slow on both soils. Reaction is slightly acid in the surface layer of the Canadian soil and mildly alkaline in the surface layer of the Waldeck soil. The root zone is moderately deep in the Waldeck soil and deep in the Canadian soil.

Most areas of these soils are cultivated to wheat and sorghum. Orchards and truck crops are common where irrigation water is available. A few areas are used for horticultural crops and sod. The soils have good potential for range and pasture, for trees and shrubs grown as windbreaks and environmental plantings, and for some engineering uses. If these soils are cultivated, maintaining an adequate vegetative cover and ground mulch helps prevent excessive soil losses caused by soil blowing and improves the moisture supplying capacity.

If these soils are protected from flooding, they are suitable for building site development and for onsite waste disposal. Proper design and proper installation procedures are needed. The soils lack sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. The Waldeck soil has severe limitations for sanitary facilities and community development. The main limitation is the high water table. Little can be done to lower the water table.

The Waldeck soil has favorable characteristics for excavated ponds. Both soils have slight to moderate limitations if they are used for recreational purposes. Capability unit I-1; Canadian soil in Sandy range site, Waldeck soil in Subirrigated range site.

**Cc—Carwile fine sandy loam.** This nearly level, somewhat poorly drained soil is on uplands. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark brown fine sandy loam about 18 inches thick. The subsoil is about 42 inches thick. The upper part is dark grayish brown, firm clay loam with strong brown mottles; the lower part is dark grayish brown clay loam with common strong brown mottles.

Included with this soil in mapping are small areas of moderately well drained Tabler soils, somewhat poorly drained Drummond soils, and well drained Farnum soils. The Tabler soils are better drained than this Carwile soil. The Drummond soils occupy shallow depressions, and the Farnum soils occupy narrow ridges at a slightly higher elevation. These included areas make up 10 to 20 percent of the unit.

Water and air move through this soil at a slow rate, and runoff is slow or ponded. Unless the soil is drained, a water table is at or near the surface for short periods during winter and spring. Available water capacity is high. Reaction ranges from slightly acid to moderately alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is medium, and organic-matter content is moderately low. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. When the subsoil becomes saturated, however, the surface layer is slow to dry and fieldwork may be delayed.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor potential for most engineering uses.

This soil is suited to corn, soybeans, sorghum, and small grain and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, crop loss is a hazard because the surface can be ponded unless the soil is artificially drained. Alfalfa is especially susceptible to drowning in these ponded areas. If the soil is bare late in winter and early in spring, soil blowing can be a hazard. Minimum tillage and winter cover crops help prevent excessive soil blowing.

The use of soil as pastureland or hayland is also effective in controlling soil blowing. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

This soil has poor potential for building sites unless areas are artificially drained and the clayey subsoil is stabilized. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. This soil is not well suited to septic tank filter fields because of wetness and slow permeability. If the soil is used for sewage lagoons, onsite evaluation is needed because the substratum may be too porous below a depth of 60 inches.

This soil has severe limitations if it is used for recreational purposes. Artificial drainage is needed to alleviate surface ponding. Capability unit IIw-1; Sandy range site.

**Cd—Clark-Ost clay loams, 1 to 4 percent slopes.** This map unit consists of gently sloping, well drained soils on uplands. Most areas are dissected by shallow drainageways. Small depressions are in some areas. Individual areas of this unit range from 10 to 100 acres in size and are from 55 to 75 percent Clark soils and 15 to 25 percent Ost soils. Typically, Clark soils are on convex undulations and Ost soils are in plane or depressional areas. The two soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Clark soil has a surface layer of very dark gray clay loam about 11 inches thick. The next layer is about 13 inches thick. The upper part is brown, very firm clay loam containing common lime concretions; the lower part is grayish brown, very firm clay loam that is about 20 percent soft masses of lime and lime concretions. The substratum to a depth of 60 inches is light brownish gray clay loam that is about 30 percent lime.

Typically, the Ost soil has a surface layer of very dark grayish brown clay loam about 7 inches thick. The subsoil is about 12 inches thick. The upper part is brown, very firm clay loam; the lower part is brown, firm, calcareous clay loam. The substratum to a depth of 60 inches is brown, calcareous clay loam that is about 35 percent lime.

Included with these soils in mapping are small areas of Blanket soils, which make up 5 to 15 percent of the unit. Blanket soils have a thicker surface layer than these Clark and Ost soils and do not have the high concentration of lime characteristic of the Clark and Ost soils. Also, Blanket soils are on smoother landscapes.

Permeability is moderate through the Clark soil and moderately slow through the Ost soil. Available water capacity in both soils is high. The shrink-swell potential of both soils is moderate. Reaction is mildly alkaline or moderately alkaline throughout the Clark soil. It is slightly acid to neutral in the surface layer of Ost soil and neutral to moderately alkaline in the subsoil.

These soils are suited to small grain and sorghum and to grasses and legumes for hay and pasture. Unless irrigated, they are not well suited to corn and soybeans because these crops are frequently affected by drought at critical stages in their development. The high content of lime in the Clark soil causes some chlorosis in sorghum.

If these soils are used for cultivated crops, there is a hazard of erosion. Minimum tillage, winter cover crops, terraces, and waterways help prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of these soils as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This map unit is suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

The Clark and Ost soils have moderate limitations for building site developments. Areas used for these purposes should be stabilized. Dwellings and small buildings should be constructed and designed to prevent structural damage caused by the shrinking and swelling of the soils. The Clark soil is suitable for onsite waste disposal if proper design and proper installation procedures are used. The Ost soil has severe limitations if used as a septic tank absorption field. Limitations are slight on both soils for sewage lagoon construction.

These soils lack sufficient strength and stability to support vehicular traffic. This limitation can be overcome by strengthening or replacing the base material. The soils have moderate limitations if they are used for recreational purposes. Capability unit IIIe-1; Clark soil in Limy Upland range site, Ost soil in Loamy Upland range site.

**Ce—Clime silty clay, 3 to 6 percent slopes.** This sloping, well drained soil is on upland ridges and side slopes. Most areas are dissected by shallow drainageways. Individual areas of this unit range from 15 to 80 acres in size.

Typically, the surface layer is very dark grayish brown silty clay about 8 inches thick. The subsoil is light olive brown, very firm, calcareous silty clay about 18 inches thick. Clayey, calcareous, platy shale is at a depth of 26 inches. In places where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is light olive brown.

Included with this soil in mapping are small areas of well drained Rosehill soils. These soils are in the more gently sloping areas of the unit.

Water and air move through this soil at a slow rate, and runoff from cultivated areas is rapid. Reaction is moderately alkaline throughout the profile. The surface layer is firm, is difficult to till, crusts on drying, and has a narrow range in moisture content for optimum tillage. Available water capacity is low, and plants are frequently affected by periods of drought.

About half of the acreage of this soil is in native grass, and half is in cultivated small grain and sorghum. The soil has fair potential for range and rangeland wildlife. It has fair potential for farming and trees and shrubs and poor potential for most engineering uses.

This soil is best suited to small grain and range. The major problems of range management are related to the hazard of erosion and the low available water supply. The soil is somewhat droughty because of the low available water capacity and the water losses by runoff. Maintaining an adequate vegetative cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduces the protective vegetative cover and causes 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 keep the range and soil in good condition. Potential pond reservoir sites are adequate.

This soil is moderately well suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling of the soil. The underlying shale beds are somewhat soft and are slip prone. Artificial drainage should be provided around the buildings to keep the soil and the shale from becoming saturated.

Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sewage lagoons can be used for onsite waste disposal. Suitable sites for lagoons can be located on some foot slopes where the soil is deeper and less sloping or in areas where the shale is rippable to the desired depth. It may be necessary to seal lagoons with clay if the excavations penetrate the shale beds. This soil has moderate to severe limitations if it is used for recreational purposes. Capability unit IVe-1; Limy Upland range site.

**Ea—Elandco silt loam.** This nearly level, well drained soil is on low terraces. Flooding is rare. Individual areas of this unit are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is about 40 inches thick. It is dark grayish brown silt loam. The underlying material to a depth of 60 inches is dark grayish brown silt loam.

Included with this soil in mapping are areas of moderately well drained Tabler soils, well drained Vanoss soils, and somewhat poorly drained Lesho soils. The Vanoss soils occupy narrow, convex ridges. The nearly level Tabler soils are on flats near backwater areas, and the Lesho soils occupy the lows adjacent to small drainageways. Included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is slow. Available water capacity is high. Reaction ranges from slightly acid to moderately alkaline below the surface layer and varies widely in the surface layer as a result of local liming practices. Natural fertility and organic-matter content are high. The surface layer is very friable and can be easily tilled throughout a wide range of moisture content. Root growth is not impaired by any restrictive layer within a depth of 60 inches.

Most areas of this soil are in a variety of crops. The soil has good potential for crops, hay, pasture, and trees. If protected against flooding, it has fair to good potential for most engineering uses. Most areas are protected against flooding.

This soil is suited to corn, soybeans, small grain, and orchards and to grasses and legumes for hay and pasture. Minimum tillage and winter cover crops help maintain good tilth and the organic-matter content. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

If this soil is used as pastureland or hayland, overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings and to orchards. It is especially well suited if rainfall can be supplemented by timely irrigation. The most common orchard crops are peaches, cherries, and apples. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Competing vegetation can be controlled by site preparation and by spraying, cutting, or girdling. There are no hazards or limitations to be concerned about when planting or harvesting trees.

If protected against flooding, this soil is suitable for building site development and for onsite waste disposal. Proper design and proper installation procedures are needed. The moderate percolation rate is a problem if the soil is used for septic tank absorption fields, but this can be overcome in most places by increasing the size of the absorption area. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoon. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit I-1; Loamy Lowland range site.

**Eb—Elandco silt loam, occasionally flooded.** This nearly level, well drained soil is on flood plains. Flooding is a hazard, occurring on an average of about once in 3 years. Individual areas of this unit are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is dark grayish brown, very friable silt loam about 40 inches thick. The underlying material to a depth of 60 inches is dark grayish brown silt loam.

Included with this soil in mapping are small areas of somewhat poorly drained Lesho soils in areas that are lower on the landscape and are typically adjacent to drainageways. These soils make up 2 to 10 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is slow. Available water capacity is high. Reaction is slightly acid or neutral in the surface layer and ranges from slightly acid to moderately alkaline below the surface layer. Natural fertility and organic-matter content are high. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. Root growth is not impaired by any restrictive layer within a depth of 60 inches.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has severe limitations for most engineering uses.

This soil is suited to corn, soybeans, small grain, and orchards and to grasses and legumes for hay and pasture. Mimimum tillage helps maintain good tilth, and winter cover crops help maintain good tilth and the content of organic matter. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

If this soil is used as pastureland or hayland, overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings and to orchards. It is especially well suited if rainfall can be supplemented by timely irrigation. The most common orchard crops are peaches, cherries, and apples. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Competing vegetation can be controlled by site preparation and by spraying, cutting, or girdling. The main hazard when planting or harvesting trees is the occasional flooding.

This soil has poor potential for building site development and waste disposal. Installing a diking system, a flood-control structure, or a combination of these is the only way that this potential can be improved. This soil has slight to severe limitations if it is used for recreational purposes. Capability unit IIw-2; Loamy Lowland range site.

**Ec—Elandco silt loam, frequently flooded.** This nearly level and gently sloping, well drained soil is on narrow flood plains that are cut by meandering stream channels (fig. 7). Flooding is frequent, occurring about once each year. Individual areas of this unit are typically narrow but continuous and range in width from 200 to about 500 feet. Most areas are inaccessible to most farm machinery. Many of these areas are in upland drainageways.

Typically, the surface layer is dark grayish brown, very friable silt loam about 40 inches thick. The underlying material to a depth of 60 inches is dark grayish brown silt loam.

Included with this soil in mapping are small areas of somewhat poorly drained Lesho soils, which are typically in low areas between stream meanders. These soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is moderate. Available water capacity is high. Reaction is slightly acid or neutral in the surface layer and ranges from slightly acid to moderately alkaline below the surface layer. Natural fertility and organic-matter content are high. Root growth is not restricted within a depth of 60 inches.

This soil is best suited to range. Most areas are in native range because of the frequent flooding. The condition of the range is mostly poor to fair because of continual overgrazing. If the soil is used for range or hayland, overgrazing or grazing when the soil is too wet causes surface compaction. Proper stocking rates, pasture rotation, timely deferment of grazing, periodic resting, and restricted use during wet periods help to keep the range in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. The main hazard when planting or harvesting trees is the frequent flooding. Potential pond reservoir sites are adequate.

This soil has good potential for grass and trees and fair potential for woodland wildlife habitat. It has poor potential for other wildlife habitat and for most engineering purposes because flooding is frequent. Limitations for recreational purposes are slight to severe. Capability unit Vw-3; Loamy Lowland range site.

**Fa—Farnum loam, 0 to 1 percent slopes.** This nearly level, well drained soil is on terraces and uplands. Individual areas of this unit are irregular in shape and range from 20 to 100 acres in size.

Typically, the surface layer is brown loam about 14 inches thick. The subsoil is about 32 inches thick. The upper part is brown, firm clay loam; the next part is brown, very firm clay loam; and the lower part is brown to dark brown, very firm clay loam. The substratum to a depth of about 60 inches is brown to dark brown clay loam (fig. 8).

Included with this soil in mapping are small areas of moderately well drained Tabler soils and somewhat poorly drained Carwile soils in shallow depressions. These soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderately slow rate, and runoff is slow. Available water capacity is high. Reaction ranges from medium acid to neutral in the surface layer and from neutral to moderately alkaline in the subsoil. Natural fertility and organic-matter content are high. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees and poor to fair potential for most engineering uses.

This soil is suited to small grain, sorghum, soybeans, and corn and to grasses and legumes for hay and pasture. Minimum tillage and winter cover crops help maintain fertility and good tilth. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

If this soil is used as pastureland or hayland, overgrazing and untimely haying should be avoided. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. There are no hazards or limitations to be concerned about when planting or harvesting, especially if irrigation water is available.

This soil is suitable for building site development but has severe limitations for onsite waste disposal. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. The slow percolation rate is a problem if the soil is used for septic tank absorption fields, but this can be overcome in most places by increasing the size of the absorption area. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoon. This soil has slight to moderate limitations for recreational uses. Capability unit I-2; Loamy Upland range site.

**Fb—Farnum loam, 1 to 3 percent slopes.** This gently sloping, well drained soil is on uplands and terraces. Individual areas of this unit range from 20 to several hundred acres in size.

Typically, the surface layer is brown loam about 14 inches thick. The subsoil is about 32 inches thick. The upper part is brown, firm clay loam; the next part is brown, very firm clay loam; the lower part is brown to dark brown, very firm clay loam with a few lime concretions. The substratum to a depth of about 60 inches is brown to dark brown clay loam with a few soft masses and seams of lime.

Included with this soil in mapping are small areas of Blanket and Milan soils. The Blanket soils are in the more level areas, and the Milan soils are intermingled with the Farnum soil. Included areas make up about 10 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate, and runoff on cultivated fields is medium. Available water capacity is high. Reaction ranges from medium acid to neutral in the surface layer and from neutral to moderately alkaline in the subsoil. Natural fertility and organic-matter content are high. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor to fair potential for most engineering uses.

This soil is suited to small grain, sorghum, soybeans, and corn and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, erosion is a hazard. Minimum tillage, winter cover crops, terraces, and contour farming help prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of the soil as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. If irrigation water is available, there are no hazards or limitations to be concerned about when planting or harvesting.

This soil is suitable for building site development but has severe limitations for onsite waste disposal. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. The slow percolation rate is a problem if the soil is used for septic tank absorption fields, but this can be overcome by increasing the size of the absorption area. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoons. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIe-1; Loamy Upland range site.

**Fc—Farnum loam, sandy substratum, 0 to 1 percent slopes.** This nearly level, well drained soil is on terraces and uplands. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark grayish brown loam about 14 inches thick. The subsoil is about 26 inches thick. The upper part is brown, friable clay loam; the lower part is yellowish brown, friable sandy loam. The substratum to a depth of about 60 inches is medium sand. In places the lower part of the subsoil is mottled, calcareous, or both.

Included with this soil in mapping are small areas of somewhat poorly drained Lesho soils and well drained Farnum soils. The Lesho soils occupy shallow depressions and drainageways. The Farnum soils occupy small areas intermingled with this Farnum soil. Included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderately slow rate, and runoff is slow. Available water capacity is moderate. Reaction ranges from medium acid to neutral in the surface layer and from neutral to moderately alkaline in the subsoil. Natural fertility and organic-matter content are high. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. Root growth is restricted by loose sand below a depth of about 40 inches. Occasionally, the water table rises to within about 40 inches of the surface, but in most years depth to the water table exceeds 6 feet.

Most areas of this soil are farmed. Many areas have been leveled and irrigated. The soil has good potential for crops, hay, pasture, and trees. It has fair potential for most engineering uses.

This soil is suited to small grain, sorghum, and grass. If the soil is irrigated, corn, soybeans, and alfalfa are well suited. If corn, soybeans, and alfalfa are grown under dryland conditions, they are frequently affected by drought at critical stages in their development. Minimum tillage and winter cover crops help maintain good soil tilth. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water storage.

The use of this soil as pastureland or hayland is effective in keeping the soil in good condition. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This map unit is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if the soil is irrigated and competing vegetation is controlled or removed. Under dryland conditions, weed control and mulch are needed.

This soil is suitable for building site development but has severe limitations for onsite waste disposal. The ground water level should be checked locally to ensure that there is no danger of contamination. The laterals should be laid at a lower than normal depth to take advantage of the sandy substratum. Care should be taken, however, to ensure that the ground water does not become contaminated.

This soil lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Seepage from lagoons is very probable. Unless some type of sealer is used to seal the lagoons, the risk of contaminating ground water is considerable. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIs-2; Loamy Upland range site.

**Ga—Goessel silty clay, 0 to 1 percent slopes.** This level or nearly level, moderately well drained soil is on alluvial terraces. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is about 5 inches of very dark gray silty clay. The next layer is very firm silty clay about 55 inches thick. The upper part is mixed very dark gray and dark grayish brown; the lower part is dark gray. In places the lower part is mottled with strong brown or yellowish brown.

Included with this soil in mapping are small areas of moderately well drained Tabler soils that are intermingled with the Goessel soil. These soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff is slow to very slow. Available water capacity is moderate. Reaction is slightly acid or neutral in the surface layer and mildly alkaline or moderately alkaline below the surface layer. Natural fertility is medium, and organic-matter content is moderate. The surface layer is very firm, and it shrinks and cracks when dry and swells when moist. It is difficult to till. If the surface layer is worked when moist, a crust that retards plant germination forms. Root growth is restricted by the shrinking and swelling of the heavy silty clay.

Most areas of this soil are farmed. The soil has fair potential for cultivated crops, hay, pasture, and trees. It has poor potential for most engineering uses.

This soil is suited to small grain, sorghum, and soybeans and to corn for ensilage and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, some type of surface drainage should be provided in most areas. A system of bedding or open ditches is generally needed to adequately drain this soil. Minimum tillage and winter cover crops help maintain soil tilth. Returning crop residue to the soil or regularly adding other organic material maintains fertility, reduces crusting, and increases water infiltration.

If this soil is used as pastureland or hayland, grazing when the soil is wet should be limited because it results in surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however, will survive only under good management that includes control of competing vegetation. Surface crusting, shrinking and swelling, and wetness are problems in the management of this soil.

This soil has severe limitations for building sites. The main problem is the shrink-swell potential. The risk of structural damage caused by shrinking and swelling can be reduced if basement walls, foundations, and footings for dwellings and small buildings are properly designed and reinforced and drain tiles are installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to sewage lagoons. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. This soil has severe limitations if it is used for recreational purposes. Capability unit IIs-1; Clay Upland range site.

**Gb—Goessel silty clay, 1 to 2 percent slopes.** This nearly level to gently sloping, moderately well drained soil is on terraces and uplands. Individual areas of this unit are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is about 5 inches of very dark gray silty clay. The next layer is very firm silty clay about 55 inches thick. The upper part is mixed very dark gray and dark grayish brown; the lower part is dark gray. In places the lower part is mottled with strong brown or yellowish brown.

Included with this soil in mapping are small areas of well drained Irwin and Rosehill soils and moderately well drained Tabler soils. The Irwin soils typically occupy the steeper slopes, and the Rosehill and Tabler soils occupy the lower slopes adjacent to some of the drainageways. These included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff is slow to medium. Available water capacity is moderate. Reaction is slightly acid or neutral in the surface layer and mildly alkaline or moderately alkaline below the surface layer. Natural fertility is medium, and organic-matter content is moderate. The surface layer is very firm, and it shrinks and cracks when dry and swells when moist. It is difficult to till. If the surface layer is worked when moist, a crust that retards plant germination forms. Root growth is restricted by the shrinking and swelling of the heavy silty clay.

Most areas of this soil are farmed. The soil has fair potential for cultivated crops, hay, pasture, and trees.

This soil is suited to small grain, sorghum, and soybeans and to corn for silage and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, minimum tillage and winter cover crops maintain tilth. If slopes are long enough, a terrace system and contour farming help to reduce the risk of erosion and increase water infiltration. Returning crop residue to the soil or regularly adding other organic material maintains fertility, reduces crusting, and increases water infiltration.

This map unit is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however, will survive only under good management that includes the control of competing vegetation. Surface crusting, shrinking and swelling, and droughtiness are problems in the management of this soil.

This soil has severe limitations for building sites. The main problem is the shrink-swell potential. The risk of structural damage caused by shrinking and swelling can be reduced if basement walls, foundations, and footings are properly designed and reinforced and drain tiles are installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to sewage lagoons. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. This soil has severe limitations if it is used for recreational purposes. Capability unit IIIe-1; Clay Upland range site.

**Ia—Irwin silty clay loam, 1 to 3 percent slopes.** This gently sloping, well drained soil is on convex ridgetops, knolls and uneven side slopes. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 12 inches thick. The subsoil is very firm silty clay about 40 inches thick. The upper part is dark brown to brown; the lower part is brown. The substratum to a depth of 60 inches is brown silty clay. In places the upper part of the subsoil is redder.

Included with this soil in mapping are small areas of well drained Rosehill soils and moderately well drained Goessel and Tabler soils. The Goessel and Tabler soils are typically on the most nearly level part of the landscape. The Rosehill soils occupy areas adjacent to the drainageways. Included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff from cultivated areas is medium. Available water capacity is moderate to high. Reaction ranges from medium acid to neutral in the surface layer and from slightly acid to mildly alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains, especially in areas where the plow layer contains subsoil material. Root growth is somewhat restricted by the clayey subsoil.

Most areas of this soil are farmed. The soil has fair potential for cultivated crops and good potential for hay, pasture, and trees. It has poor potential for most engineering uses.

This soil is moderately well suited to corn, sorghum, and soybeans. It is well suited to small grain and alfalfa, and to grasses for hay and pasture. If the soil is used for cultivated crops, damage by erosion is a hazard. Minimum tillage, winter cover crops, terraces, and contour farming help to protect the soil against erosion. Proper management of crop residue and green manure crops also help control erosion, maintain and improve organic-matter content and tilth, and increase water infiltration.

The use of the soil as pastureland or hayland is very effective in controlling erosion. Overgrazing should be avoided. Grazing when the soil is too wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This map unit is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however, will survive only under good management that includes control of competing vegetation.

This soil has severe limitations for building sites. The main problem is the shrink-swell potential. The risk of structural damage caused by shrinking and swelling can be reduced if basement walls, foundations, and footings are properly designed and reinforced and drain tiles are installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to sewage lagoons. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area.

This soil has severe to moderate limitations for recreation development because permeability in the subsoil is very slow. It has severe limitations for camp areas and playgrounds, and it has moderate limitations for picnic areas and paths and trails because the surface layer is too clayey. Capability unit IIIe-1; Clay Upland range site.

**Ib—Irwin silty clay loam, 3 to 6 percent slopes.** This sloping, well drained soil is on side slopes adjacent to moderately broad ridgetops. Individual areas are oblong and irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is very firm silty clay about 40 inches thick. The upper part is dark brown to brown; the lower part is brown. The substratum to a depth of 60 inches is brown silty clay. In places the upper part of the subsoil is redder.

Included with this soil in mapping are small, long and narrow areas of well drained Clime and Rosehill soils. These soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff from cultivated areas is rapid. Available water capacity is moderate to high. Reaction ranges from medium acid to neutral in the surface layer and from slightly acid to mildly alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after a hard rain, especially in areas where the plow layer contains subsoil material. Root growth is somewhat restricted by the clayey subsoil.

About half of the acreage of this soil is farmed, and half is in native range. The soil has fair potential for cultivated crops and good potential for hay, pasture, and trees. It has poor potential for most engineering uses.

This soil is moderately well suited to corn, sorghum, and soybeans. It is well suited to small grain and alfalfa and to grasses for hay and pasture. If the soil is used for cultivated crops, damage by erosion is a hazard. Minimum tillage, winter cover crops, terraces, and contour farming help to protect this soil from erosion. Proper management of crop residue and green manure crops help control erosion, maintain and improve organic-matter content and tilth, and increase water infiltration.

The use of the soil as range, pastureland, or hayland is very effective in controlling erosion. Overgrazing should be avoided. Grazing when the soil is too wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This map unit is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however, will survive only under good management that includes control of competing vegetation.

This soil has severe limitations for building sites. The main problem is the shrink-swell potential. The risk of structural damage caused by shrinking and swelling can be reduced if basement walls, foundations, and footings are properly designed and reinforced and drain tiles are installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to lagoons. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. This soil has slight to severe limitations if it is used for recreational purposes. Capability unit IIIe-9; Clay Upland range site.

**Ic—Irwin silty clay loam, 2 to 6 percent slopes, eroded.** This gently sloping and sloping, well drained soil is on side slopes adjacent to moderately broad ridgetops. Individual areas are narrow and irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is dark grayish brown heavy silty clay loam about 5 inches thick. The subsoil is very firm silty clay about 40 inches thick. The upper part is dark brown to brown; the lower part is brown. The substratum to a depth of 60 inches is brown silty clay. In places the upper part of the subsoil is redder. In areas where the upper part of the subsoil has been mixed with the surface layer by plowing, the surface layer is brown silty clay loam to silty clay.

Included with this soil in mapping are small, long and narrow areas of well drained Clime and Rosehill soils. These soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff is rapid. Available water capacity is moderate. Reaction ranges from medium acid to neutral in the surface layer and from slightly acid to mildly alkaline in the subsoil. Natural fertility and organic-matter content are low because of the loss of surface soil through erosion. The surface layer is firm and is difficult to till. It tends to crust or puddle after hard rains, especially in areas where the plow layer contains subsoil material. Root growth is restricted by the silty clay subsoil.

About half of the acreage of this soil is farmed, and half is pasture or range. This soil is suited to small grain and to grasses and legumes for hay and pasture.

If the soil is used for cultivated crops, there is a hazard of further erosion damage. Minimum tillage, winter cover crops, and terrace systems help prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of the soil as pastureland, range, or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture or range in good condition.

This map unit is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however, will survive only under good management that includes the control of competing vegetation. Surface crusting, shrinking and swelling, and droughtiness are problems in the management of this soil.

This soil has severe limitations for building sites. The main problem is the shrink-swell potential. The risk of structural damage caused by shrinking and swelling can be reduced if basement walls, foundations, and footings are properly designed and reinforced and drain tiles are installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to lagoons. Local roads should be graded to shed water, and suitable material should be hauled in from outside the area. This soil has moderate to severe limitations if it is used for recreational purposes. Capability unit IVe-2; Clay Upland range site.

**La—Lesho loam.** This nearly level, somewhat poorly drained soil is on flood plains and low stream terraces. Flooding is occasional, occurring about once every 3 years. Individual areas of this unit are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is about 27 inches thick. The upper part is very dark grayish brown loam; the lower part is dark grayish brown, friable loam with distinct, dark brown mottles. The substratum is grayish brown fine sand.

Included with this soil in mapping are small areas of poorly drained Plevna soils and somewhat poorly drained Waldeck soils. The Plevna soils typically occur on the lower levels adjacent to the drainageways. The Waldeck soils are intermingled with the Lesho soil in some areas. The Plevna and Waldeck soils make up 5 to 15 percent of the unit. Slick spots are common on this soil.

Water and air move through this soil at a moderately slow rate, and runoff is slow. Available water capacity is moderate. Reaction ranges from mildly alkaline to strongly alkaline. Natural fertility and organic-matter content are high. The water table usually fluctuates between depths of 3 and 6 feet. It rises to within 2 feet of the surface in some years. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. Root growth is restricted by the fine sand substratum at a depth of about 27 inches.

About two-thirds of the acreage of this soil is farmed, and the rest is in grass. The soil has fair potential for most crops, grasses, and trees. It has poor potential for most engineering uses.

This soil is suited to small grain, sorghum, corn, soybeans, and trees and to grasses for hay or pasture. The main problems in managing this soil are wetness and flooding. Alfalfa is generally short lived because the high water table frequently drowns the crop. Frequently, fieldwork must be delayed because of wetness. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

About one-third of the acreage of this soil is used for pasture or range. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. In places where overgrazing has continued, the invasion of Russian-olive is a serious problem. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the grass and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. A few small areas are in native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Problems to be concerned about when planting or harvesting trees are wetness and flooding.

This map unit has severe limitations for building sites. The main problems are wetness and flooding. The risk of structural damage and excessive seepage can be reduced if basement walls, foundations, and footings for dwellings and small buildings are properly designed and drain tiles and sumps are used. Sanitary facilities should be connected to sewers, or sewage should be piped to adjacent areas that are suitable for lagoons. Local roads should be graded to shed water and elevated. Base material should be hauled in from outside of the area.

This soil has favorable characteristics for excavated ponds that are aquifer fed. It has moderate to severe limitations if it is used for recreational purposes. Capability unit IIIw-1; Subirrigated range site.

**Lb—Lincoln soils.** These nearly level and gently sloping, somewhat excessively drained soils are on flood plains adjacent to major stream channels. Flooding is frequent, occurring about once each year. Individual areas of this unit are typically narrow, but are continuous. They range in size from 10 to about 80 acres.

Typically, the surface layer is dark brown loam about 8 inches thick. The substratum to a depth of about 60 inches is brown fine and medium sand with strata of dark brown clay loam. The surface layer ranges from fine sand to clay loam. In places it is noncalcareous.

Included with these soils in mapping are small areas of Canadian, Elandco, Plevna, Pratt, Tivoli, and Waldeck soils. Canadian and Elandco soils occur as remnants of former landscapes. Pratt and Tivoli soils are on undulations or hummocks. Plevna and Waldeck soils are in shallow depressions and drainageways. Included areas make up 15 to 45 percent of the unit.

Water and air move through these soils at a rapid rate, and runoff is slow. Available water capacity is low. Reaction is generally moderately alkaline throughout, but in some areas the upper 10 inches contains no lime and is mildly alkaline. Natural fertility and organic-matter are low. Root growth is restricted by the sand substratum.

Nearly all areas of these soils are in native range because of frequent flooding and droughtiness. The condition of the range is mostly poor to fair, and there are many woody invaders. These soils have fair to good potential for grass and trees.

These soils are best suited to range. If the soils are used as range or hayland, overgrazing should be avoided. Proper stocking rates, pasture rotation, timely deferment of grazing, periodic resting, and restricted use during wet periods help to keep the grass and soil in good condition.

These soils are well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. The main hazard when planting or harvesting trees is flooding. The soils have fair potential for openland wildlife habitat.

These soils have severe limitations for building sites. The main problems are wetness and flooding. Sanitary facilities should be connected to sewers, or sewage should be piped to adjacent areas that are suitable for lagoons. If these soils are used for road building, limitations are severe because of flooding and wetness. The soils have severe limitations if they are used for recreational purposes. Capability unit Vw-3; Sandy Lowland range site.

**Ma—Milan loam, 1 to 3 percent slopes.** This gently sloping, well drained soil is on uplands. Individual areas of this unit are irregular in shape and range from about 20 to several hundred acres in size.

Typically, the surface layer is brown loam about 11 inches thick. The subsoil is about 33 inches thick. The upper part is reddish brown, firm clay loam; the lower part is dark red, friable clay loam. The substratum to a depth of 60 inches is yellowish red clay loam.

Included with this soil in mapping are small areas of Farnum, Renfrow, and Shellabarger soils. The Farnum soils occupy shallow depressions and drainageways. The Renfrow soils occupy foot slopes. The Shellabarger soils are on narrow, convex ridges and on some sharp slope breaks. These included areas make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate, and runoff is medium on cultivated fields. Available water capacity is high. Reaction is medium acid or slightly acid in the surface layer and ranges from medium acid to neutral in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor to fair potential for most engineering uses.

This soil is well suited to small grain, sorghum, soybeans, and corn and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, erosion is a hazard. Minimum tillage, winter cover crops, terraces, and contour farming help prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of the soil as pastureland or hayland is an effective means of controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. There are no hazards or limitations to be concerned about when planting or harvesting if irrigation water is available.

This soil has moderate limitations for building site development and for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. The moderate percolation rate should present few problems for septic tank absorption fields. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIe-1; Loamy Upland range site.

**Mb—Milan loam, 3 to 6 percent slopes.** This sloping, well drained soil is on uplands. Individual areas of this unit are narrow and long and range from 15 to 60 acres in size.

Typically, the surface layer is brown loam about 8 inches thick. The subsoil is about 33 inches thick. The upper part is reddish brown, firm clay loam; the lower part is dark red, friable clay loam. The substratum to a depth of 60 inches is yellowish red clay loam.

Included with this soil in mapping are small areas of Farnum, Renfrow, and Shellabarger soils. The Farnum soils occupy areas near drainageways, the Renfrow soils occupy foot slopes, and the Shellabarger soils are on narrow ridgetops. These included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderately slow rate, and runoff is medium on cultivated fields. Available water capacity is high. Reaction is medium acid or slightly acid in the surface layer and ranges from medium acid to neutral in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor to fair potential for most engineering uses.

This soil is well suited to small grain, sorghum, soybeans, trees, and corn and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, the erosion hazard is severe. Minimum tillage, winter cover crops, terraces, and contour farming help prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of the soil as pastureland or hayland is an effective means of controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, seedlings survive and grow well if competing vegetation is controlled or removed. There are no hazards or limitations to be concerned about when planting or harvesting if irrigation water is available.

This soil has moderate limitations for building site development because of low shear strength. It is suitable for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. The moderate percolation rate should present few problems for septic tank absorption fields. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIIe-2; Loamy Upland range site.

**Mc—Milan clay loam, 2 to 6 percent slopes, eroded.** This gently sloping and sloping, well drained soil is on uplands. Individual areas of this unit are irregularly shaped and range from 10 to 30 acres in size.

Typically, the surface layer is brown clay loam about 6 inches thick. The subsoil is about 33 inches thick. The upper part is reddish brown, firm clay loam; the lower part is dark red, friable clay loam. The substratum to a depth of 60 inches is yellowish red clay loam. In places where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown clay loam.

Included with this soil in mapping are small areas of Farnum, Renfrow, and Shellabarger soils. The Farnum soils occupy areas near drainageways, the Renfrow soils occupy foot slopes, and the Shellabarger soils are on narrow ridgetops. These included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderately slow rate, and runoff is medium on cultivated fields. Available water capacity is high. Reaction is medium acid or slightly acid in the surface layer and ranges from medium acid to neutral in the subsoil. Natural fertility is medium, but organic-matter content is moderately low because of the loss of surface soil through erosion. The surface layer is firm and tends to crust or puddle after hard rains, especially in areas where the plow layer contains subsoil material.

Most areas of this soil are farmed. The soil has fair potential for cultivated crops and good potential for hay, pasture, and trees. It has poor to fair potential for most engineering uses.

If this soil is used for cultivated crops, there is a hazard of further erosion damage. Minimum tillage, winter cover crops, and grassed waterways help control further soil loss. A few areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of the soil as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. If erosion is controlled and irrigation water is available, there are few limitations to be concerned about when planting or harvesting.

This soil has moderate limitations for building site development because of low shear strength. It is suitable for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIIe-5; Loamy Upland range site.

**Na—Naron fine sandy loam.** This nearly level and very gently sloping, well drained soil is on uplands and terraces. Individual areas of this unit are irregularly shaped and range from 20 to several hundred acres in size.

Typically, the surface layer is dark grayish brown fine sandy loam about 8 inches thick. The subsoil is about 42 inches thick. The upper part is dark grayish brown, friable fine sandy loam; the next part is dark brown, friable sandy clay loam; the lower part is brown to yellowish brown, very friable sandy clay loam and sandy loam. The substratum to a depth of 60 inches is light yellowish brown medium and fine sand.

Included with this soil in mapping are small areas of Canadian and Farnum soils. The Canadian soils are slightly lower on the landscape than this Naron soil, and the Farnum soils occupy areas on similar landscapes. These included areas make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate to moderately rapid rate, and runoff is slow. Available water capacity is moderate. Reaction ranges from medium acid to neutral in the surface layer and in the subsoil. Natural fertility is medium, but organic-matter content in cultivated fields is moderately low because of winnowing. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to wheat and milo and to grasses and legumes for hay and pasture. If irrigated, it is well suited to corn, sorghum, alfalfa, orchards, and truck crops. Minimum tillage and winter cover crops help control soil blowing. Returning crop residue to the soil or regularly adding other organic material maintains the content of organic matter, reduces crusting, and increases water retention.

This soil is well suited to trees grown as windbreaks and environmental plantings and to orchards and truck crops. Seeds, cuttings, and seedlings survive and grow well if the soil is irrigated and competing vegetation is controlled or removed. Competing vegetation can be controlled by site preparation and spraying.

This soil is suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight limitations if it is used for recreational areas. Capability unit I-1; Sandy range site.

**Oc—Owens clay loam, 1 to 3 percent slopes.** This gently sloping, well drained soil is on convex ridgetops, knolls, and short, uneven side slopes. Individual areas are oblong and irregularly shaped and range from 5 to 30 acres in size.

Typically, the surface layer is reddish brown clay loam about 7 inches thick. The subsoil is about 8 inches thick. It is reddish brown, very firm silty clay. The substratum is calcareous, platy, clayey shale. In places scattered shale fragments are throughout the surface layer and subsoil. In areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown silty clay.

Included with this soil in mapping are small areas of Vernon and Renfrow soils on foot slopes and in drainageways. These soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff from cultivated areas is very rapid. Available water capacity is very low. Reaction ranges from neutral to moderately alkaline in the surface layer and is moderately alkaline in the subsoil. Natural fertility and organic-matter content are low. The surface layer is firm and difficult to cultivate. It crusts and puddles after rains. Root growth is restricted below a depth of 15 inches by the shale substratum.

Most areas of this soil are used as range. A few areas are used for wheat. The soil has good potential for grass and poor potential for cultivated crops, trees, and most engineering uses.

This soil is poorly suited to most cultivated crops. If the soil is cultivated, wheat is the best crop to plant. In years of average moisture or better, fair wheat yields can be expected. The soil cannot store enough water for crops during their peak period of consumption. If the soil is used for cultivated crops, minimum tillage, winter cover crops, terraces, and contour farming help control erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is best suited to range. The major problems of range management are related to the available water supply. The soil is droughty because of the very low available water capacity and the water losses by runoff. Maintaining an adequate plant cover and ground mulch helps 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. 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 keep the range and soil in good condition.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling. Artificial drainage should be provided around the buildings to keep the soil and shale from becoming saturated. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sewage lagoons should be used for onsite waste disposal. Suitable sites for lagoons generally can be located in some areas of deeper soil. This soil has severe limitations if it is used for recreational purposes. Capability unit IVe-3; Red Clay Prairie range site.

**Od—Owens-Rock outcrop complex, 3 to 10 percent slopes.** This map unit consists of Rock outcrop and sloping and strongly sloping, well drained soils on upland ridges and side slopes. Most areas are dissected by shallow drainageways. Individual areas of this unit are oblong and range from 10 to 160 acres in size. They are 50 to 60 percent Owens soils and 20 to 40 percent shale outcrop. The Owens soils are on ridgetops and side slopes. The shale outcrop is adjacent to the drainageways and sharp slope breaks. The soils and the Rock outcrop are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Owens soil has a surface layer of reddish brown clay loam about 7 inches thick. The subsoil is reddish brown, very firm silty clay about 8 inches thick. The substratum is calcareous, platy clayey shale.

Typically, the Rock outcrop is exposed shale that dominantly is red but is also gray, green, and yellow. The shale is moderately alkaline, fine grained, and platy.

Included with this unit in mapping are small areas of Vernon soils on foot slopes and in depressional areas. These soils make up 5 to 15 percent of the unit.

Permeability is very slow through the Owens soil. Available water capacity is very low. This soil contains a fine, elastic clay that holds some of the soil moisture under too much tension to be extracted by plant roots. Runoff is rapid. The soil shrinks and swells markedly upon drying and wetting. Reaction is dominantly moderately alkaline, but in places the surface layer is neutral. Fertility and organic-matter content are low. The root zone extends to the shale bedrock.

Most areas of this unit remain in native grass and are used for grazing. The unit has fair potential for range and poor potential for rangeland wildlife habitat. It has poor potential for farming, for trees and shrubs, and for most engineering uses.

This unit is best suited to range. The major problems of range management are related to the available water supply. The soil is droughty because of the very low available water capacity and the water losses by runoff. Maintaining an adequate plant cover and ground mulch helps prevent excessive soil losses and improves the water 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 keep the range and soil in good condition.

If buildings are constructed on this unit, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling. Artificial drainage should be provided around the buildings to keep the soil and shale from becoming saturated. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sewage lagoons should be used for onsite waste disposal. Suitable sites for lagoons generally can be located on some of the deeper soils adjacent to this unit. This unit has severe limitations if it is used for recreational purposes. Capability unit VIe-2; Owens part in Red Clay Prairie range site.

**Pa—Pits.** This map unit is in areas where the soil has been excavated and the substratum has been used for sand or gravel. The excavated areas are on uplands, terraces, and flood plains. Most pits are excavated to a depth of 15 feet or more. The entire solum is removed, and the water table or the sand substratum is exposed. In some areas shale bedrock is exposed. Most pits are dominantly water and piles of sand. Soil blowing, very low fertility, unstable slopes, and a high water table are the principal hazards for any type of land use. Some pits are used for recreational facilities and fish ponds. A typical pit is in the NE1/4NE1/4 section 14, T. 25 S., R. 2 W. Not assigned to a capability unit or range site.

**Pb—Plevna fine sandy loam.** This nearly level, poorly drained soil is on flood plains and in depressions in subirrigated valleys. It is adjacent to drainageways. Flooding is frequent, occurring about once every year. Individual areas of this unit are narrow and range from 15 to 120 acres in size.

Typically, the surface layer is about 20 inches thick. The upper part is very dark gray fine sandy loam; the lower part is dark gray sandy loam. The subsoil is about 15 inches of grayish brown, very friable sandy loam with distinct mottles. The substratum to a depth of 60 inches is grayish brown loamy sand or fine sand.

Included with this soil in mapping are small areas of Lincoln and Waldeck soils. The Lincoln soils occupy areas of more recent deposition, and the Waldeck soils are better drained than this Plevna soil.

Water and air move through this soil at a moderately rapid rate. The ground water table is 1 1/2 to 3 feet below the surface during much of the growing season. It rises to within a few inches of the surface during wet periods and drops to about 4 feet late in summer and early in autumn. Available water capacity is moderate. Reaction ranges from neutral to moderately alkaline throughout the profile. Natural fertility and organic-matter content are high. Root growth is restricted below a depth of 35 inches by the saturated loamy sand.

Most areas of this soil remain in native grass (fig. 9) and are used for grazing and hay. The soil has good potential for range, trees and shrubs, and wetland wildlife habitat. It has poor potential for farming and for most engineering uses.

This soil is best suited to range. The major problems of range management are wetness and flooding. Because of subirrigation, Russian-olive and willows frequently invade. Unless a tall grass cover is maintained, woody shrubs and trees invade. Management that prevents overstocking and overgrazing maintains a tall grass cover. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help keep the soil and range in good condition. This soil is a favorable site for excavated ponds that are aquifer fed.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. The main problems to be concerned about when planting and harvesting trees are flooding and wetness.

This soil has severe limitations if used for building sites, roads, septic tank absorption fields, lagoons, and recreational areas. The main problems in managing the soil are wetness, a fluctuating high water table, and flooding. Capability unit VIw-1; Subirrigated range site.

**Pc—Pratt loamy fine sand, undulating.** This undulating, well drained soil is on erosional uplands. Individual areas of this unit are irregular in shape and range from 15 to 80 acres in size. Slope ranges from 1 to 5 percent.

Typically, the surface layer is grayish brown loamy fine sand about 18 inches thick. The subsoil is brown, very friable loamy fine sand about 18 inches thick. The substratum to a depth of about 60 inches is light brown fine sand.

Included with this soil in mapping are small areas of somewhat poorly drained Carwile soils and excessively drained Tivoli soils. The Carwile soils occupy shallow depressions, and the Tivoli soils are on narrow, convex knolls and short, uneven side slopes. These included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a rapid rate, and runoff is slow. Available water capacity is low. Reaction ranges from medium acid to neutral in the surface layer and subsoil and is slightly acid or neutral in the substratum. Natural fertility and organic-matter content are low. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for most cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

The low available water capacity and soil blowing are the main problems in managing this soil. Under dryland conditions, the soil is suited to wheat, grain sorghum, grasses, and trees. If irrigation water is available, it is well suited to alfalfa and forage sorghum. If the soil is used for cultivated crops, the hazard of soil blowing is severe. Minimum tillage and winter cover crops help prevent excessive soil loss. A few areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and maintains the organic-matter content. Wind stripcropping helps prevent excessive soil blowing.

The use of the soil as range, pastureland, or hayland is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the grass and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings if water is available. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed, especially for the first few years when there is competition for moisture. Because this soil can store only a small amount of moisture, any practice that conserves moisture enhances the survival of the trees.

This soil is suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used. Onsite inspection is needed to determine whether contamination of ground water is a hazard. The soil is a good source for roadfill material. If used for sewage lagoon areas, it has severe limitations because of excessive seepage, which is difficult to overcome. If the soil were used for a lagoon, the entire wetted area would have to be sealed. This soil has moderate limitations if it is used for recreational purposes. Capability unit IIIe-4; Sands range site.

**Pd—Pratt-Tivoli complex, rolling.** This map unit consists of rolling, well drained and excessively drained soils on uplands. In most areas it is parallel to the major rivers of the county. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 20 to 160 acres in size. They are about 55 to 75 percent Pratt soils and 25 to 45 percent Tivoli soils.

The Pratt soils typically are on convex, mid and lower side slopes and on the broader ridgetops. The Tivoli soils typically are on narrow, convex ridges and sharp slope breaks. The two soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping. Slope ranges from 5 to 30 percent.

Typically, the Pratt soil has a surface layer of grayish brown loamy fine sand about 18 inches thick. The subsoil is brown, very friable loamy fine sand about 18 inches thick. The substratum to a depth of 60 inches is light brown fine sand. In places the darkened surface layer is thicker.

Typically, the Tivoli soil has a surface layer of brown loamy fine sand about 10 inches thick. The underlying material to a depth of 60 inches is light brown fine sand. In places the surface layer is fine sand.

Included with these soils in mapping are small areas of nearly level Lincoln soils on the flood plains that are commonly adjacent to this unit. These included soils make up 5 to 10 percent of the unit.

Permeability is rapid and available water capacity is low in the Pratt and Tivoli soils. Runoff is slow on the Pratt soil and very slow on the Tivoli soil. The Pratt soil is medium acid to neutral throughout. It is low in fertility and organic-matter content. The surface layer of the Tivoli soil is slightly acid to mildly alkaline, and the underlying material is slightly acid to moderately alkaline. The Tivoli soil is low in fertility and very low in organic-matter content.

Most areas of these soils remain in native grass and are used for grazing. The soils have fair to good potential for range and poor to fair potential for rangeland wildlife habitat. They have poor potential for farming, good potential for trees and shrubs, and poor potential for most engineering uses.

This unit is best suited to range. Most of the range is in fair condition and has an abundance of woody increasers. The major problems are related to the hazard of soil blowing and the available water supply. The soils are somewhat droughty because of the low available water capacity. Maintaining an adequate plant cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity. Overstocking and overgrazing the range reduces the protective cover and causes deterioration of the plant community. Under these conditions, the taller, more desirable grasses are replaced by less productive short grasses and forbs. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help keep the range and soils in good condition. Potential pond reservoir sites are very limited because of seepage.

These soils are too steep for use as cropland and should be tilled only when reseeding is needed. If the soils are tilled for reseeding of grasses, timely use of minimum tillage is necessary to help prevent severe erosion. Seeds should be planted early enough to establish good ground cover before the end of the growing season. Nurse crops can be used to provide cover late in fall and in winter until the grasses become established.

These soils are suited to trees and shrubs grown as windbreaks and environmental plantings if competitive vegetation is removed or controlled. The hazard of erosion is a moderate limitation for these uses. Also, steep slopes limit the use of heavy equipment. These limitations can be overcome to some extent by proper managment of ground cover to help control erosion.

If dwellings are built on these soils, as much plant cover as possible should be maintained to help control erosion. Also, cutbanks can cave in. The soils have moderate limitations for onsite waste disposal if proper design and proper installation procedures are used. The effluent, however, can pollute underground water. The soils have severe limitations for sewage lagoon areas because of excessive seepage. They are a good source of roadfill material. They have moderate to severe limitations for recreation development because of steepness of slope and sandy texture. Capability unit VIe-1; Sands range site.

**Ra—Renfrow silty clay loam, 1 to 3 percent slopes.** This gently sloping, well drained soil is on convex ridgetops, knolls, and uneven side slopes. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is brown silty clay loam about 9 inches thick. The subsoil is about 41 inches thick. The upper part is dark reddish brown, very firm silty clay loam; the next part is dusky red and dark reddish brown, extremely firm silty clay; the lower part is reddish brown, very firm silty clay with many shale fragments. The underlying material is red silty and clayey shale.

Included with this soil in mapping are small areas of Owens and Vernon soils. These soils are on knolls and short, uneven side slopes. They make up 5 to 15 percent of the unit.

Water and air move though this soil at a very slow rate, and runoff from cultivated areas is medium. Available water capacity is moderate. Reaction is slightly acid or neutral in the surface layer and ranges from slightly acid to moderately alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled. It tends, however, to crust or puddle after hard rains, especially in areas where the plow layer contains subsoil material. Root growth is restricted by shaly clay in the lower part of the subsoil.

Most areas of this soil are farmed. The soil has fair potential for cultivated crops and good potential for hay, pasture, and trees. It has poor potential for most engineering uses.

This soil is moderately well suited to corn, sorghum, and soybeans and well suited to small grain and to alfalfa and grasses for hay and pasture. If the soil is used for cultivated crops, damage by erosion is a hazard. Minimum tillage, winter cover crops, terraces, and contour farming help to protect this soil against erosion. Proper management of crop residue and green manure crops help control erosion, maintain and improve organic-matter content and tilth, and increase water infiltration.

The use of the soil as pastureland or hayland is very effective in controlling erosion. Overgrazing should be avoided. Grazing when the soil is too wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the grass and soil in good condition.

This unit is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however, survive only under good management that includes control of competing vegetation.

This soil has severe limitations for building sites. The main problem is the shrink-swell potential of the soil. The risk of structural damage caused by shrinking and swelling can be reduced if basement walls, foundations, and footings are properly designed and reinforced and drain tiles are installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to lagoons. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area.

This soil has moderate to severe limitations for most types of recreational development because the subsoil is very slowly permeable. It has few limitations, however, for pond development. Capability unit IIIe-3; Red Clay Prairie range site.

**Rb—Renfrow silty clay loam, 3 to 6 percent slopes.** This sloping, well drained soil is on uneven side slopes. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 15 to 60 acres in size.

Typically, the surface layer is brown silty clay loam about 7 inches thick. The subsoil is about 41 inches thick. The upper part is dark reddish brown, very firm silty clay loam; the next part is dusky red and dark reddish brown, extremely firm silty clay; the lower part is reddish brown, very firm silty clay with many shale fragments. The underlying material is red silty and clayey shale. In some areas where the plow layer is mixed with the upper part of the subsoil, the surface layer is dark reddish brown.

Included with this soil in mapping are small areas of Owens and Vernon soils. These soils are on knolls and in drainageways. They make up 10 to 20 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff from cultivated areas is rapid. Available water capacity is moderate. Reaction is slightly acid or neutral in the surface layer and ranges from slightly acid to moderately alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends, however, to crust or puddle after a hard rain, especially in areas where the plow layer contains subsoil material. Root growth is restricted by the clayey subsoil.

About half of the acreage of this soil is farmed, and half is in native range. The soil has fair potential for cultivated crops and good potential for grasses and trees. It has poor potential for most engineering uses.

This soil is moderately well suited to sorghum, soybeans, and corn and well suited to small grain and alfalfa and to grasses for hay and pasture. If the soil is used for cultivated crops, damage by erosion is a hazard. Minimum tillage, winter cover crops, terraces, and contour farming help to control erosion, maintain and improve organic-matter content and tilth, and increase water infiltration.

The use of the soil as range, pastureland, or hayland is very effective in controlling erosion. Overgrazing should be avoided. Grazing when the soil is too wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This unit is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however, survive only under good management that includes control of competing vegetation.

This soil has severe limitations for building sites. The main problem is the shrink-swell potential of the soil. The risk of structural damage caused by shrinking and swelling can be reduced if basement walls, foundations, and footings are properly designed and reinforced and drain tiles are installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to lagoons. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. This soil has moderate to severe limitations if it is used for recreational purposes. Capability unit IVe-1; Red Clay Prairie range site.

**Rc—Renfrow-Owens clay loams, 1 to 4 percent slopes.** This map unit consists of gently sloping, well drained soils on upland ridges and side slopes. Most areas are dissected by shallow drainageways. Individual areas of this unit are irregular in shape and range from 20 to 80 acres in size. They are 50 to 65 percent Renfrow soils and 20 to 35 percent Owens soils.

The Renfrow soils are on plane or convex, mid and lower side slopes and on the broader ridgetops. The Owens soils are on narrow, convex ridges; sharp slope breaks; and in some drainageways. The two soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Renfrow soil has a surface layer of brown silty clay loam about 9 inches thick. The subsoil is about 41 inches thick. The upper part is dark reddish brown, very firm silty clay loam; the next part is dusky red and dark reddish brown, extremely firm silty clay; the lower part is reddish brown, very firm silty clay with many shale fragments. The underlying material is red silty and clayey shale.

Typically, the Owens soil has a reddish brown clay loam surface layer about 7 inches thick. The subsoil is about 8 inches thick. It is reddish brown, very firm silty clay. The substratum is calcareous platy clayey shale. In places scattered shale fragments are throughout the solum. In areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown silty clay.

Included with these soils in mapping are small areas of Milan and Vernon soils and shale outcrop. The Milan soils occupy ridgetops and colluvial slopes where the soil mantle is thicker than 60 inches. The Vernon soils are 20 to 40 inches deep over shale and occupy concave foot slopes. The shale outcrop occupies some of the steeper points, breaks, and side slopes. Included areas make up 5 to 15 percent of the unit.

Permeability is very slow in the Renfrow and Owens soils. Available water capacity is moderate in the Renfrow soil and very low in the Owens soil. Both soils contain a fine, elastic type of clay that holds some of the soil moisture under too much tension to be extracted by plant roots. Runoff is medium. Both soils shrink and swell markedly upon drying and wetting. The surface layer of the Renfrow soil is slightly acid or neutral, and the subsoil ranges from slightly acid to moderately alkaline. The surface layer of the Owens soil ranges from neutral to moderately alkaline, and the subsoil is moderately alkaline. Natural fertility is medium in the Renfrow soil and low in the Owens soil. Organic-matter content is moderate in the Renfrow soil and low in the Owens soil. The root zone extends to shale bedrock.

Most areas of these soils remain in native grass and are used for grazing. A few areas are used for wheat and grain sorghum. The soils have fair to good potential for range. They have poor to fair potential for farming, trees and shrubs, and most engineering uses.

If these soils are cultivated, erosion is a hazard. Minimum tillage and winter cover crops help prevent excessive soil loss. A few areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material and planting a minimum of row crops improve fertility, reduce crusting, and increase water infiltration.

These soils are best suited to range. The major problems of range management are related to the hazard of erosion and the very low available water supply in the Owens soil. Maintaining an adequate plant cover and ground mulch helps 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. 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 keep the range and soil in good condition. Potential pond reservoir sites are adequate.

If buildings are constructed on these soils, foundations and footings should be designed to reduce the risk of structure damage caused by shrinking and swelling of the soils. Artificial drainage should be provided around the buildings to keep the soils and shale from becoming saturated.

Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sewage lagoons should be used for onsite waste disposal. Suitable sites for lagoons can be located on some of the deeper, less sloping soils on foot slopes or on the broader ridgetops. If these soils are used for recreational purposes, they have moderate to severe limitations. Capability unit IIIe-3; Red Clay Prairie range site.

**Rd—Rosehill silty clay, 1 to 3 percent slopes.** This gently sloping, well drained soil is on convex upland divides and uneven side slopes. Individual areas of this unit are irregular in shape and range from 15 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown silty clay about 8 inches thick. The next layer is very firm silty clay about 22 inches thick. The upper part is dark grayish brown; the lower part is grayish brown and very dark grayish brown. The substratum is dark gray and light yellowish brown, calcareous shaly clay. In places the surface layer is calcareous.

Included with this soil in mapping are small areas of Clime, Goessel, Irwin, and Tabler soils. The Clime soils occupy short slopes. The nearly level Goessel and Tabler soils occupy shallow depressions. The Irwin soils occupy positions where the soil mantle is thicker on some ridgetops.

Water and air move through this soil at a very slow rate, and runoff is medium. Reaction is neutral or slightly acid in the surface layer and ranges from neutral to moderately alkaline below. Natural fertility is medium, and organic-matter content is moderate. The surface layer is very firm and difficult to till. It crusts when dry and has a narrow range of moisture content for optimum tillage. Available water capacity is low, and plants are frequently affected during periods of drought.

Most areas of this soil are used for small grain and sorghum. The soil has fair potential for farming and for trees and shrubs and poor potential for most engineering uses.

This unit is best suited to range and to small grain or other spring-maturing crops. The major problems of range management are related to the hazard of erosion and the available water supply. The soil is somewhat droughty because of the low available water capacity and the water losses by runoff. Maintaining an adequate plant cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduces the protective plant cover and causes 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 keep the range and soil in good condition. Potential pond reservoir sites are adequate.

This unit is moderately well suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

If buildings are constructed on this soil, foundations and footings should be designed to reduce the risk of structure damage caused by shrinking and swelling. The underlying shale beds are somewhat soft and are slip prone. Artificial drainage should be provided around the buildings to keep the soils and shale from becoming saturated.

Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sewage lagoons can be used for onsite waste disposal. Suitable sites for lagoons can be located in some of the areas of deeper soil on foot slopes or in areas where the shale is rippable to the desired depth. Sealing lagoons with a clay blanket may be needed if the excavations penetrate the shale beds. This soil has severe limitations if it is used for recreational purposes. Capability unit IIIe-3; Clay Upland range site.

**Sa—Shellabarger sandy loam, 1 to 3 percent slopes.** This gently sloping, well drained soil is on convex ridgetops, knolls, and uneven side slopes. Individual areas of this unit are irregular in shape and range from 15 to several hundred acres in size.

Typically, the surface layer is dark brown sandy loam about 10 inches thick. The subsoil is about 30 inches thick. The upper part is dark reddish brown, friable sandy loam; the lower part is yellowish red, firm sandy clay loam. The substratum to a depth of about 60 inches is yellowish red sandy loam. In places the surface layer is loamy fine sand.

Included with this unit in mapping are small areas of well drained Albion and Milan soils. The Albion soils are typically on knobs or knolls. The Milan soils are on the lower foot slopes. These included areas make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff from cultivated areas is medium. Available water capacity is moderate. Reaction is slightly acid or medium acid in the surface layer and ranges from slightly acid to mildly alkaline in the subsoil. Natural fertility is medium, and organic-matter content in most cultivated fields is moderately low. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. It is subject to soil blowing if it is left bare in winter.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It also has good potential for specialized crops, such as melons and vegetables, if irrigation water is available. It has fair to good potential for most engineering uses.

This soil is suited to wheat and sorghum and to grasses and legumes for hay and pasture. If irrigation water is available, it is also suited to corn and soybeans. Minimum tillage, winter cover crops, and stripcropping help prevent excessive soil loss. A few areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases water retention.

The use of the soil as pastureland or rangeland is an effective way of controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the grass and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Suitable species, site preparation, and control of competing vegetation are needed for successful tree culture.

This soil is suitable for building site development and for on site waste disposal if proper design and proper installation procedures are used. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. Similar treatment is needed in pond reservoir areas. This soil has fair potential for roadfill because of low shear strength. It has slight limitations if it is used for recreational purposes. Capability unit IIe-3; Sandy range site.

**Sb—Shellabarger sandy loam, 3 to 6 percent slopes.** This sloping, well drained soil is on uneven side slopes. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 15 to 80 acres in size.

Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsoil is about 30 inches thick. The upper part is dark reddish brown, friable sandy loam; the lower part is yellowish red, firm sandy clay loam. The substratum to a depth of about 60 inches is yellowish red sandy loam. In places the surface layer is loamy fine sand. In some places where the plow layer has been mixed with the upper part of the subsoil, the surface layer is dark reddish brown.

Included with this soil in mapping are small areas of well drained Albion and Milan soils. The Albion soils are typically on ridges or knolls. The Milan soils are on some of the lower foot slopes and adjacent to some of the drainageways. These included areas make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff from cultivated areas is medium. Available water capacity is moderate. The surface layer is slightly acid or medium acid. The subsoil ranges from slightly acid to mildly alkaline. Natural fertility is medium, and organic-matter content in most cultivated fields is moderately low. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. It is subject to both soil blowing and water erosion unless it is protected.

About two-thirds of the acreage of this soil is farmed, and the rest is native range. The soil has good potential for cultivated crops, hay, pasture, and trees. It also has good potential for specialized crops, such as melons and vegetables, if irrigation water is available. It has fair to good potential for most engineering uses.

This soil is suited to wheat and sorghum and to grasses and legumes for hay and pasture. Minimum tillage, winter cover crops, and stripcropping help prevent excessive soil loss. A few areas have slopes that are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases water retention.

The use of the soil as pastureland or rangeland is an effective way of controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and a planned grazing system help to keep the grass and soil in good condition. The soil has fair potential for rangeland wildlife habitat.

This soil is well suited to trees grown as windbreaks and environmental plantings. Suitable species, site preparation, and control of competing vegetation are needed for successful tree culture.

This unit is suitable for building site development and for on site waste disposal if proper design and proper installation procedures are used. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. Similar treatment is needed in pond reservoir areas. This soil has fair potential for roadfill because of low shear strength. It has slight to moderate limitations if it is used for recreational purposes. Capability unit IIIe-8; Sandy range site.

**Sc—Shellabarger sandy loam, 3 to 6 percent slopes, eroded.** This sloping, well drained soil is on uneven side slopes. Individual areas of this unit are irregular in shape and range from 5 to 30 acres in size. A few gullies are in most areas.

Typically, the surface layer is dark brown sandy loam about 5 inches thick. The subsoil is about 30 inches thick. The upper part is dark reddish brown, friable sandy loam; the lower part is yellowish red, firm sandy clay loam. The substratum to a depth of about 60 inches is yellowish red sandy loam. In some places where the plow layer has been mixed with the upper part of the subsoil, the surface layer is dark reddish brown heavy sandy loam.

Included with this soil in mapping are small areas of well drained Albion and Milan soils. The Albion soils are typically on ridges and knolls. The Milan soils are on some of the lower foot slopes and adjacent to some of the drainageways. These included areas make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is medium. Available water capacity is moderate. Reaction is slightly acid or medium acid in the surface layer and ranges from slightly acid to mildly alkaline in the subsoil. Natural fertility is medium, but organic-matter content is moderately low because of the loss of surface soil through erosion. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains, especially in areas where the plow layer contains subsoil material.

Most areas of this soil are farmed. Wheat and sorghum are the principal crops. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to wheat and sorghum and to grasses and legumes for hay and pasture. Minimum tillage, winter cover crops, and stripcropping help prevent excessive soil loss. A few areas have slopes that are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases water retention.

The use of the soil as pastureland or rangeland is an effective way of controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and a planned grazing system help to keep the grass and soil in good condition. The soil has fair potential for rangeland wildlife habitat.

This unit is well suited to trees grown as windbreaks and environmental plantings. Suitable species, site preparation, and control of competing vegetation are needed for successful tree culture.

This soil is suitable for building site development and for on site waste disposal if proper design and proper installation procedures are used. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. Similar treatment is needed in pond reservoir areas. Because of low shear strength, this soil has only fair potential if used as roadfill material. It has slight to moderate limitations if used for recreational purposes. Capability unit IIIe-10; Sandy range site.

**Ta—Tabler silty clay loam.** This nearly level, moderately well drained soil is on broad upland divides and terraces. Individual areas of this unit are irregular in shape and range from 15 to several hundred acres in size.

Typically, the surface layer is dark gray silty clay loam about 9 inches thick. The subsoil is silty clay about 35 inches thick. The upper part is very dark gray and firm; the next part is dark grayish brown and very firm; the lower part is grayish brown and very firm. The substratum to a depth of 60 inches is grayish brown silty clay.

Included with this soil in mapping are small areas of Blanket, Farnum, Goessel, and Irwin soils. The Blanket, Farnum, and Irwin soils occupy some of the slightly convex areas. The Goessel soils occupy some of the slightly depressional areas. Included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff is slow. Available water capacity is moderate. Reaction ranges from medium acid to moderately alkaline in the surface layer and from slightly acid to moderately alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable. Because of the very slow permeability, however, the range in moisture content within which tillage is desirable is somewhat narrow. The surface layer tends to crust or puddle after hard rains, especially in areas where the plow layer contains subsoil material. Root growth is restricted by the silty clay subsoil.

Most areas of this soil are farmed. The soil has fair potential for cultivated crops and good potential for hay, pasture, and trees. It has poor potential for most engineering uses.

This soil is moderately well suited to corn, sorghum, and soybeans and is well suited to small grain and alfalfa and to grasses for hay or pasture. Although this soil can store a large amount of water, it releases the water slowly to plants. During extended dry periods, plants are frequently affected because they cannot get enough water. A few areas have slopes that are long enough to be terraced and farmed on the contour. The return of crop residue to the soil, minimum tillage, and winter cover crops improve fertility, reduce crusting, and increase water infiltration.

If this soil is used for pasture or range, proper stocking rates, pasture rotation, timely deferment of grazing, and a planned grazing system are needed.

This soil is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however survive only under good management that includes control of competing vegetation.

This soil has severe limitations for building sites. The main problem is the shrink-swell potential. The risk of structural damage caused by shrinking and swelling can be reduced if basement walls, foundations, and footings for dwellings and small buildings are properly designed and reinforced and drain tiles are installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to sewage lagoons. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. This soil has moderate to severe limitations if it is used for recreational purposes. Capability unit IIs-1; Clay Upland range site.

**Tb—Tabler-Drummond complex.** This map unit consists of nearly level, moderately well drained and somewhat poorly drained soils on terraces. Areas are mostly irregularly shaped and range from 5 to 200 acres in size. They are 30 to 40 percent Tabler soils, 30 to 40 percent Drummond soils, and 10 to 20 percent Farnum soils. The Tabler soils are typically on small ridges, and the Drummond soils are in small depressions. The Farnum soils are on the same general landscape but occupy narrow, convex ridges in places. The soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Tabler soil has a surface layer of dark gray silty clay loam about 9 inches thick. The subsoil is silty clay about 35 inches thick. The upper part is very dark gray and firm; the next part is dark grayish brown and very firm; the lower part is grayish brown and very firm. The substratum to a depth of 60 inches is grayish brown silty clay. In places the surface layer is silt loam.

Typically, the Drummond soil has a surface layer of dark grayish brown clay loam about 8 inches thick. The subsoil is about 40 inches thick. The upper part is grayish brown, very firm silty clay; the lower part is grayish brown, firm silty clay with many nests and threads of lime. The substratum to a depth of about 60 inches is very pale brown loam. The entire solum is affected by salt, and the estimated exchangeable sodium content ranges from 15 to 25 percent. In places the surface layer is silt loam or loam.

Included with these soils in mapping are small areas of Carwile soils in similar positions on the landscape. These included soils make up 5 to 10 percent of the unit.

Permeability is very slow in the Tabler and Drummond soils. Runoff is slow to very slow. Available water capacity is moderate. Both soils contain a fine, elastic type of clay that holds some of the soil moisture under too much tension to be extracted by plant roots. Both shrink and swell markedly upon drying and wetting. Reaction ranges from medium acid to moderately alkaline in the surface layer of the Tabler soil and from slightly acid to moderately alkaline in the subsoil. It ranges from slightly acid to moderately alkaline in the surface layer of the Drummond soil and from neutral to strongly alkaline in the subsoil. The salts content in the subsoil of the Drummond soil restricts root growth.

About half of the acreage of these soils remains in native grass and is used for grazing. The rest is used for sorghum, wheat, and alfalfa. If cultivated, these soils crust badly after rains. Yields are very unpredictable and uneven. Some areas are irrigated and have been treated with applications of gypsum with some success. The soils have fair potential for range. They have poor potential for farming, for trees and shrubs, and for most engineering uses.

These soils are not well suited to cultivated crops because of the salinity. Alfalfa grows fairly well, but a good stand is difficult to establish. Barley, sorghum, and rye are moderately tolerant of salts and grow fairly well. Wheat is less tolerant of salts, and stands are generally thin and spotty. Working crop residue into the surface layer improves soil structure and helps prevent crusting.

The major problems of range management are related to maintaining a good stand of grass. Overgrazing and overstocking the range reduces the protective plant cover and causes 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 keep the range and soil in good condition.

If buildings are constructed on these soils, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling. If excavation material is used in yard grading, establishing yard grasses is difficult (fig. 10). Artificial drainage should be provided around the buildings to keep the soils from becoming saturated.

Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to adjacent areas that are suitable for lagoons. These soils have moderate to severe limitations if they are used for recreational purposes. Capability unit IVs-1; Tabler soil in Clay Upland range site, Drummond soil in Saline Lowland range site.

**Ua—Urban land-Canadian complex.** This map unit consists of Urban land and nearly level and very gently sloping, well drained Canadian soils on smooth terraces that are slightly undulating. Individual areas of this unit range from 80 to several hundred acres in size and are 50 to 70 percent Urban land and 20 to 30 percent Canadian soils. The Urban land and Canadian soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

The Urban land part of the unit is covered by streets, parking lots, and buildings and other structures that obscure or alter the soils so that identification is not feasible.

Typically, the Canadian soil has a surface layer of brown fine sandy loam about 20 inches thick. The subsoil is about 15 inches of brown, very friable light sandy loam. The substratum to a depth of 60 inches is light brown sandy loam. In places the subsoil is more clayey.

Most areas of this map unit are artificially drained through sewer systems, gutters, and, to a lesser extent, surface ditches.

Permeability is moderately rapid in the Canadian soil, and runoff is slow. Available water capacity is moderate. Reaction ranges from medium acid to neutral in the surface layer and from slightly acid to moderately alkaline in the subsoil. Natural fertility and organic-matter content are high. The shrink-swell potential is low.

The Canadian soil, or the open part of the map unit, is used for parks, open space, building sites, lawns, and gardens. It has good potential for lawns, vegetable and flower gardens, and trees and shrubs. Most areas are protected against flooding. Consequently, the soil has good potential for recreational areas and most engineering uses. Erosion generally is not a major problem on this unit unless the soil is disturbed and left bare for a considerable period or is used as a watercourse.

Because most areas are protected against flooding by the Wichita-Valley Center Flood Control Project, this unit has slight limitations for building site developments. Although limitations are only slight if the soil is used for septic tank filter fields, it is most desirable to connect sewer lines to commercial sewer systems if they are available. If sewage lagoons are constructed, seepage is a hazard in the borrow area. It can be prevented by special treatment to seal the lagoon.

The Canadian soil lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Onsite investigation is essential to properly evaluate and plan the development of specific sites. Not assigned to a capability unit or range site.

**Ub—Urban land-Elandco complex.** This map unit consists of Urban land and nearly level, well drained Elandco soils on smooth, flat terraces and flood plains. Individual areas of this unit range from 40 to several hundred acres in size and are 60 to 85 percent Urban land and 20 to 30 percent Elandco soils. The Urban land and Elandco soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

The Urban land part of the unit is covered by streets, parking lots, and buildings and other structures that obscure or alter the soils so that identification is not feasible.

Typically, the Elandco soil has a surface layer of dark grayish brown, very friable silt loam about 40 inches thick. The underlying material to a depth of 60 inches is dark grayish brown silt loam. In places the soil has been radically altered. Some of the lower areas have been filled or leveled during construction, and other small areas have been cut, built up, or smoothed.

Included with this unit in mapping are small areas of Canadian and Tabler soils, which make up to 10 to 20 percent of the unit. The well drained Canadian soils parallel the Arkansas River on levee positions. The moderately well drained Tabler soils are on the lower terraces.

Most areas of this map unit are artificially drained through sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches. Some of the low-lying areas are ponded by runoff from adjacent areas or parking lots.

Permeability is moderate through the Elandco soil, and runoff is slow. Available water capacity is high. Reaction ranges from slightly acid to moderately alkaline below the surface layer and varies widely in the surface layer as a result of local liming practices. Natural fertility and organic-matter content are high. The shrink-swell potential is low.

The Elandco soil, or the open part of the map unit, is used for parks, open space, building sites, lawns, and gardens. It has good potential for lawns, vegetable and flower gardens, and trees and shrubs. Most areas are protected against flooding by the Wichita-Valley Center Flood Control Project. As a result, the soil has good potential for recreational areas and most engineering uses. Some of the lower areas are ponded when storm drains cannot handle all the runoff from parking lots and buildings. Erosion generally is not a problem on this unit unless the soil is disturbed and left bare for a considerable period or is used as a watercourse.

The Elandco soil has slight limitations for building sites and recreational developments. All sanitary facilities should be connected to commercial sewers and treatment facilities if possible. If sewage lagoons are constructed, there is a hazard of seepage in deep cuts. This can be prevented by special treatment to seal the lagoon. The soil lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material.

If possible, the small included areas of Tabler soils should be avoided as building sites because of a high shrink-swell potential. Onsite investigation is essential to properly evaluate and plan the development of specific sites. Not assigned to a capability unit or range site.

**Uc—Urban land-Farnum complex, 0 to 3 percent slopes.** This map unit consists of Urban land and nearly level to gently sloping, well drained Farnum soils on terraces. Individual areas of this unit range from 80 to several hundred acres in size and are 60 to 75 percent Urban land and 20 to 30 percent Farnum soils. The Urban land and Farnum soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

The Urban land part of the unit is covered by streets, parking lots, and buildings and other structures that obscure or alter the soils so that identification is not feasible.

Typically, the Farnum soil has a surface layer of brown loam about 14 inches thick. The subsoil is about 32 inches thick. The upper part is brown, firm clay loam; the next part is brown, very firm clay loam; the lower part is brown to dark brown, very firm clay loam with calcium carbonate concretions. The substratum to a depth of 60 inches is brown to dark brown clay loam with a few nests and seams of lime. In places the soil has been radically altered. Some of the low areas have been filled or leveled during construction, and other small areas have been cut, built up, or smoothed.

Included with this unit in mapping are small areas of Irwin and Tabler soils, which make up 5 to 15 percent of the unit. The well drained Irwin soils occupy higher, convex areas on the landscape. The moderately well drained Tabler soils occupy nearly level to slightly depressional areas.

Most areas of this map unit are artificially drained through sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches.

Water and air move through the Farnum soil at a moderately slow rate. Runoff is slow to medium. Available water capacity is high. Reaction ranges from medium acid to neutral in the surface layer and from neutral to moderately alkaline in the subsoil. The shrink-swell potential of the subsoil is moderate.

The Farnum soil, or the open part of the map unit, is used for parks, open space, building sites, lawns, and gardens. It has good potential for lawns, vegetable and flower gardens, and trees and shrubs. It has fair to good potential for recreational areas and for most engineering uses.

The Farnum soil is well suited to grasses, flowers, vegetables, and trees and shrubs if irrigation water is available. Erosion generally is not a major problem on this unit unless the soil is disturbed and left bare for a considerable period or is used as a watercourse.

The Farnum soil has moderate limitations for building site development and slight limitations for recreational development. Areas used for buildings should be designed and constructed to allow for the moderate shrinking and swelling of the soil. All sanitary facilities should be connected to commercial sewers and treatment facilities. If commercial sewers are not available, sewage lagoons should be constructed. The upper layer of the Farnum soil should be replaced or covered with a suitable base material if local roads and streets are to function properly.

Where possible, the small included areas of Irwin and Tabler soils should be avoided for building sites and recreational areas because of their high shrink-swell potential. Onsite investigation is essential to properly evaluate and plan the development of specific sites. Not assigned to a capability unit or range site.

**Ud—Urban land-Irwin complex, 1 to 3 percent slopes.** This map unit consists of Urban land and gently sloping, well drained Irwin soils on uplands. Individual areas of this unit range from 80 to several hundred acres in size and are 60 to 75 percent Urban land and 20 to 30 percent Irwin soils. The Urban land and Irwin soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

The Urban land part of the unit is covered by streets, parking lots, buildings, and sports complexes and other structures that obscure or alter the soils so that identification is not feasible.

Typically, the Irwin soil has a dark grayish brown silty clay loam surface layer about 12 inches thick. The subsoil is very firm silty clay about 40 inches thick. The upper part is dark brown to brown; the lower part is brown. The substratum to a depth of 60 inches is brown silty clay. In places the upper part of the of the subsoil is redder. In some areas the soil has been radically altered. Some of the low areas have been filled or leveled during construction, and other small areas have been cut, built up, or smoothed.

Included with this unit in mapping are small areas of Farnum, Rosehill, and Tabler soils, which make up 10 to 15 percent of the unit. The loamy Farnum soils and the moderately deep Rosehill soils occupy higher, convex areas and lower side slopes. The moderately well drained Tabler soils occupy nearly level to slightly depressional areas.

Most areas of this map unit are artificially drained through sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches.

Permeability is very slow in the Irwin soil, and runoff is medium. Available water capacity is moderate. Reaction ranges from medium acid to neutral in the surface layer and from slightly acid to mildly alkaline in the subsoil. The shrink-swell potential is high.

The Irwin soil, or open part of the map unit, is used for parks, golf courses, open space, building sites, lawns, and gardens. It has poor to fair potential for lawns, vegetable and flower gardens, and trees and shrubs. It has poor potential for recreational uses and for most engineering uses. Perennial plants that are selected for planting should have a fairly high tolerance for droughtiness. Erosion can be a problem if the soil is left bare for a considerable period. Erosion can be controlled by proper grading, seeding of grass, and the use of mulch.

The Irwin soil has severe limitations for building sites and recreational development. Areas used for these purposes must be designed and constructed to allow for the high shrink-swell potential of the soil. All sanitary facilities should be connected to commercial sewers and treatment facilities. If these facilities are not available, it is possible to construct a properly designed sewage lagoon in the areas of Irwin soil.

Local roads should be graded to shed water, and suitable material should be hauled in from outside of the area because the Irwin soil lacks sufficient strength and stability to support vehicular traffic. Onsite investigation is essential to properly evaluate and plan the development of specific sites. Not assigned to a capability unit or range site.

**Ue—Urban land-Tabler complex.** This map unit consists of Urban land and nearly level, moderately well drained Tabler soils on smooth terraces. Individual areas of this unit range from 80 to several hundred acres in size and are 60 to 75 percent Urban land and 15 to 30 percent Tabler soils. The Urban land and Tabler soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

The Urban land part of the unit is covered by streets, parking lots, industries, and buildings and other structures that obscure or alter the soils so that identification is not feasible.

Typically, the Tabler soil has a surface layer of dark gray silty clay loam about 9 inches thick. The subsoil is silty clay about 35 inches thick. The upper part is very dark gray and firm; the next part is dark grayish brown and very firm; the lower part is grayish brown and very firm. The substratum to a depth of 60 inches is grayish brown silty clay. In places the soil has been radically altered. Some of the low areas have been filled or leveled during construction, and other areas have been cut, built up, or smoothed. In places the soil is more poorly drained and contains more sand.

Included with this unit in mapping are small areas of Farnum and Naron soils, which make up 10 to 20 percent of the unit. The well drained Naron soils occupy higher, convex areas on the landscape. The well drained Farnum soils are in slightly raised positions.

Most areas of this map unit are artificially drained through sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches. In some areas that are not drained, the water table is perched within a foot of the surface during wet periods, and some low-lying areas are ponded by runoff from adjacent areas, streets, and parking lots.

Permeability is very slow through the Tabler soil. Runoff is slow, and available water capacity is moderate. The surface layer of the Tabler soil ranges from medium acid to moderately alkaline, and the subsoil ranges from slightly acid to moderately alkaline. The shrink-swell potential is high.

The Tabler soil, or open part of the map unit, is used for parks, open space, building sites, lawns, and gardens. It has fair potential for lawns, vegetable and flower gardens, and trees and shrubs. It has poor potential for recreational areas and most engineering uses.

The Tabler soil is well suited to grasses, flowers, vegetables, and trees and shrubs if excess water is removed. Several methods of artificial drainage can be successfully used on this soil. Onsite investigation is needed to select the best method for a particular area. Perennial plants that are selected for planting should have a fairly high tolerance for wetness. Erosion generally is not a major problem on this unit unless the soil is disturbed and left bare for a considerable period or is used as a watercourse.

The limitations of the Tabler soil for building sites and recreational developments are severe. Areas used for these purposes must be artificially drained and protected from ponding. Dwellings and small buildings should be constructed without basements, and foundations and footings should be designed to reduce the risk of structural damage caused by shrinking and swelling. All sanitary facilities should be connected to commercial sewers and treatment facilities. If these facilities are not available, it is possible to construct a properly designed sewage lagoon in the areas of Tabler soil. The upper layer of this soil should be replaced or covered with a suitable base material if local roads and streets are to function properly.

If possible, the small included areas of Farnum and Naron soils should be selected for developing new parks and playgrounds. Onsite investigation is essential to properly evaluate and plan the development of specific sites. Not assigned to a capability unit or range site.

**Va—Vanoss silt loam, 0 to 1 percent slopes.** This nearly level, well drained soil is on narrow upland divides. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 15 to 100 acres in size.

Typically, the surface layer is brown silt loam about 15 inches thick. The subsoil is brown silty clay loam about 47 inches thick. The upper part is friable; the lower part is firm and very firm. In places the subsoil is redder.

Included with this soil in mapping are small areas of well drained Blanket and Farnum soils in shallow depressions and some of the drainageways. The Blanket soils contain more clay than this Vanoss soil, and the Farnum soils contain more sand. These included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is slow. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the surface layer and subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to small grain, sorghum, corn, and soybeans and to grasses and legumes for hay and pasture. Minimum tillage, winter cover crops, and the return of crop residue to the soil or the regular addition of other organic material improve fertility, reduce crusting, and increase water infiltration.

If this soil is used as pastureland or hayland, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed.

This soil is suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight limitations if it is used for recreational purposes. Capability unit I-2; Loamy Upland range site.

**Vb—Vanoss silt loam, 1 to 3 percent slopes.** This gently sloping, well drained soil is on uplands and terraces. Individual areas of this unit are irregular in shape and range from 15 to 160 acres in size.

Typically, the surface layer is brown silt loam about 13 inches thick. The subsoil is brown silty clay loam about 47 inches thick. The upper part is friable; the lower part is firm and very firm. In places the subsoil is redder.

Included with this soil in mapping are small areas of well drained Farnum and Milan soils in some of the slightly raised, convex positions or on some sloping terrace breaks. These soils contain more sand than this Vanoss soil. They make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is slow. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the surface layer and subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to small grain, sorghum, corn, and soybeans and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, erosion is a hazard. Minimum tillage and winter cover crops help prevent excessive soil loss. Most areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

If this soil is used as pastureland or hayland, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed.

This soil is suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight limitations if it is used for recreational development. Capability unit IIe-1; Loamy Upland range site.

**Vc—Vanoss silt loam, 3 to 6 percent slopes.** This sloping, well drained soil is on uplands and terraces. Individual areas are oblong and range from 20 to 140 acres in size.

Typically, the surface layer is brown silt loam about 10 inches thick. The subsoil is brown silty clay loam about 47 inches thick. The upper part is friable; the lower part is firm and very firm. In places the subsoil is redder.

Included with this soil in mapping are small areas of well drained Farnum and Milan soils on narrow ridgetops and adjacent to some drainageways. These soils contain more sand than this Vanoss soil. They make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff on cultivated fields is medium. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the surface layer and subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to small grain, sorghum, corn, trees, and soybeans and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, water erosion is a severe hazard. Minimum tillage and winter cover crops help prevent excessive soil loss. Most areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

If this soil is used as pastureland or hayland, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Trees planted on the contour grow better than those planted in straight rows. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed.

This soil is suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIIe-2; Loamy Upland range site.

**Vd—Vanoss silt loam, 3 to 6 percent slopes, eroded.** This sloping, well drained soil is on upland and terrace ridges and side slopes. Shallow drainageways and gullies dissect most areas. Individual areas of this unit range from 10 to 30 acres in size, and most are oblong.

Typically, the surface layer is brown silt loam about 6 inches thick. The subsoil is brown silty clay loam about 47 inches thick. The upper part is friable; the lower part is firm and very firm. In places the subsoil is redder. Also, in some places where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is silty clay loam.

Included with this soil in mapping are small areas of well drained Milan soils. These soils occupy narrow ridge crests and are adjacent to some drainageways. They make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is medium. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the surface layer and subsoil. Natural fertility is medium, but organic-matter content is moderately low because of the loss of surface soil through erosion. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains, especially in areas where the plow layer contains subsoil material.

Most areas of this soil are farmed. The soil has good potential for crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to small grain, sorghum, and trees and to grasses and legumes for hay or pasture. To a lesser extent, it is suited to soybeans and corn. If the soil is used for cultivated crops, there is a hazard of further erosion damage. Minimum tillage and winter cover crops help prevent excessive soil loss. Most areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of the soil as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes compaction of the surface, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Trees planted on the contour grow better than those planted in straight rows. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed.

This soil is suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIIe-5; Loamy Upland range site.

**Ve—Vernon sandy loam, 1 to 3 percent slopes.** This gently sloping, well drained soil is on convex ridgetops, knolls, and short, uneven side slopes. Individual areas of this unit are irregular in shape and range from 20 to 100 acres in size.

Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsoil is about 16 inches thick. The upper part is reddish brown, firm sandy clay loam; the lower part is reddish brown, very firm silty clay. The substratum to a depth of 28 inches is reddish brown clay. Below this is red clayey shale. In areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown sandy clay loam.

Included with this soil in mapping are small areas of well drained Milan, Owens, Renfrow, and Shellabarger soils. The Milan and Shellabarger soils contain more sand in the subsoil and substratum and are deeper than this Vernon soil. They occur as small, isolated areas that are remnants of former landscapes. The Owens and Renfrow soils are less sandy than this Vernon soil. They are in areas where the boundary between the shale and the clay substratum varies greatly within a short horizontal distance.

Water and air move through this soil at a very slow rate, and runoff from cultivated fields is rapid. Available water capacity is low to moderate. Reaction ranges from slightly acid to mildly alkaline in the surface layer and from neutral to moderately alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to erode if it lacks some type of protective cover. The root zone extends to the clayey shale.

About half of the acreage of this soil remains in native grass and is used for grazing. The rest is used for small grain and sorghum. The soil has fair to good potential for cultivated crops, range, and trees and shrubs. It has poor potential for most engineering uses.

This soil is suited to small grain and sorghum and to grasses and legumes for hay and pasture. Corn and soybeans are not well suited because of the limited amount of available water in this soil. If the soil is used for cultivated crops, minimum tillage, winter cover crops, terraces, and contour farming are needed to help control erosion and increase water infiltration. Returning crop residue to the soil or regularly adding other organic material improves fertility.

The use of the soil as pastureland or range is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed.

If buildings are constructed on this soil, foundations should be designed to reduce the risk of structure damage caused by shrinking and swelling. The underlying shale beds are somewhat soft. Artificial drainage should be provided around the buildings to keep the soil and shale from becoming saturated. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Suitable sites for lagoons generally can be located in some of the areas of deeper soil. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIIe-7; Red Clay Prairie range site.

**Vf—Vernon sandy loam, 3 to 6 percent slopes.** This sloping, well drained soil is on short, uneven side slopes. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 20 to 40 acres in size.

Typically, the surface layer is dark brown sandy loam about 7 inches thick. The subsoil is about 16 inches thick. The upper part is reddish brown, firm sandy clay loam; the lower part is reddish brown, very firm silty clay. The substratum to a depth of 28 inches is reddish brown clay. Below this is red clayey shale. In some areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown sandy clay loam.

Included with this soil in mapping are small areas of well drained Milan, Owens, Renfrow, and Shellabarger soils. The Milan and Shellabarger soils contain more sand in the subsoil and substratum than this Vernon soil. They occur as small, isolated areas that are remnants of former landscapes. The Owens and Renfrow soils are less sandy than this Vernon soil. They are in areas where the boundary between the shale and the clay substratum is wavy and depth to the substratum varies greatly within a short horizontal distance.

Water and air move through this soil at a very slow rate, and runoff from cultivated fields is rapid. Available water capacity is low. Reaction ranges from slightly acid to mildly alkaline in the surface layer and from neutral to moderately alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to erode unless some type of mulch is on the surface. The root zone extends to the clayey shale.

About half of the acreage of this soil is in native grass and is used for grazing. The rest is used for small grain and sorghum. This soil has fair potential for cultivated crops and good potential for range and trees and shrubs. It has poor potential for most engineering uses.

This soil is suited to small grain and sorghum and to grasses and legumes for hay and pasture. Corn, soybeans, and alfalfa are not well suited because of the limited amount of available water in this soil. If the soil is used for cultivated crops, minimum tillage, winter cover crops, terraces, and contour farming are needed to help control erosion and increase water infiltration. Returning crop residue to the soil or regularly adding other organic material improves fertility.

The use of the soil as pastureland or range is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. If buildings are constructed on this soil, foundations should be designed to reduce structural damage caused by shrinking and swelling. The underlying shale beds are somewhat soft and may be slip prone. Artificial drainage should be provided around the buildings to keep the soils and shales from becoming saturated. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Suitable sites for lagoons generally can be located in some of the areas of deeper soil. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IVe-4; Red Clay Prairie range site.

**Wa—Waldeck sandy loam.** This nearly level, somewhat poorly drained soil is on flood plains and low terraces. Flooding is occasional, averaging about once every 2 or 3 years. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 5 to 40 acres in size.

Typically, the surface layer is dark gray sandy loam about 14 inches thick. The next layer is about 13 inches thick. It is light brownish gray, very friable sandy loam that is mottled in the lower part. The substratum to a depth of 60 inches is pale brown coarse sand with common mottles.

Included with this soil in mapping are small areas of somewhat poorly drained Lesho soils and poorly drained Plevna soils. The Lesho soils are typically on the slightly higher parts of the landscape, and the Plevna soils are typically on the slightly lower parts. Included soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderately rapid rate, and runoff is slow. Available water capacity is moderate. The soil has a fluctuating water table that in most years seasonally rises to within about 2 feet of the surface. Reaction is mildly alkaline or moderately alkaline throughout the profile. Natural fertility is medium, and organic-matter content is moderate. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. Soil blowing is a hazard where the soil is bare of vegetation. Root growth is restricted below a depth of about 27 inches by the coarse sand substratum.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor to fair potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Minimum tillage, winter cover crops, and stubble mulch help prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility and stabilizes the surface layer.

If this soil is used as pastureland or hayland, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. The main problems to be concerned about when planting or harvesting trees are flooding and wetness.

This soil has severe to moderate limitations for building site development and recreational development. Areas used for these purposes must be artificially drained and protected against flooding. Dwellings and small buildings should be constructed without basements. All sanitary facilities should be connected to commercial sewers and treatment facilities. If this soil is used for local roads and streets, wetness and flooding are moderate limitations. This soil has moderate to severe limitations if it is used for recreational purposes. Capability unit IIIw-1; Subirrigated range site.

**Wb—Waurika silt loam.** This nearly level, somewhat poorly drained soil is on smooth upland flats and in shallow depressions. Individual areas of this unit range from 20 to 160 acres in size and are irregular in shape.

Typically, the surface layer is gray silt loam about 10 inches thick. The subsurface layer is gray silt loam with a few dark yellowish brown mottles. It is about 5 inches thick. The subsoil is very firm silty clay about 38 inches thick. The upper part is dark gray; the lower part is grayish brown. The substratum to a depth of 60 inches is light brownish gray silty clay.

Included with this soil in mapping are small areas of well drained Blanket soils and moderately well drained Tabler soils in shallow depressions and drainageways. These soils make up 2 to 10 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff is slow. Available water capacity is high. Many areas are ponded for a considerable period, and some areas are adjacent to intermittent lakes. Reaction is slightly acid or medium acid in the surface layer and ranges from neutral to moderately alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is very friable and can be easily tilled.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor to fair potential for most engineering uses.

This soil is suited to small grain, sorghum, soybeans, and corn and to grasses and legumes for hay and pasture. Unless the soil is artificially drained, crops are occasionally destroyed by ponding. Several methods of artificial drainage can be successfully used on this soil. Onsite investigation is needed to select the best method. Erosion generally is not a major problem unless the soil is disturbed and left bare for a considerable period.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well only if competing vegetation is controlled or removed. Wetness may be a problem in planting or harvesting trees.

If buildings are constructed on this soil, foundations and footings should be designed to reduce the risk of structure damage caused by shrinking and swelling. Artificial drainage should be provided around the buildings to keep the soil from becoming saturated. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sewage lagoons should be used for onsite disposal unless a commercial sewer system is available. This soil has moderate to severe limitations if it is used for recreational purposes. 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 tank disposal 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, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for 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

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited 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 the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, 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." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

More than 500,000 acres in the survey was used for crops, pasture, and range in 1967, according to the Conservation Needs Inventory (*6*). Of this total, about 72,000 acres was used for range; 4,000 acres was used for pasture, mainly bromegrass and bermudagrass; 435,000 acres was used for cropland, of which 10,000 acres was irrigated; 6,700 acres was used as forest; and 9,700 acres was used as other land. About 6,000 acres was used for fruit and vegetables.

The potential of the soils in Sedgwick County for increased production of food is only fair. Most areas that are well suited to crops are currently used for that purpose. Some small areas of range and forest could be converted to cropland. Increased food production will have to come from development of irrigation and use of the latest crop production technology on all cropland in the county. This soil survey can greatly facilitate the application of such technology.

The acreage in crops and pasture has gradually decreased as more and more land is developed for urban uses. In 1967, an estimated 89,000 acres of urban and built-up land was in the county. The number of acres under urban development has been growing at the rate of about 1,000 acres per year. The use of this soil survey to help make land-use decisions that will influence the future role of farming in the county is described in the section "General soil map for broad land-use planning."

Soil erosion is the major soil problem on about 42 percent of the cropland and pasture in Sedgwick County. If the slope is more than 2 percent, erosion is a hazard. Albion, Blanket, Clark, Farnum, Goessel, Irwin, Milan, Owens, Pratt, Renfrow, Rosehill, Shellabarger, Vanoss, and Vernon soils have slopes of more than 2 percent.

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. Loss of the surface layer is especially damaging on soils with a clayey subsoil, such as Blanket, Clark, Irwin, Renfrow, and Vernon soils, and on soils with a layer in or below the subsoil that limits the depth of the root zone. Such layers include the shaly clay in Clime, Owens, Renfrow, Rosehill, and Vernon soils. Erosion also reduces productivity on soils that tend to be droughty, such as Albion, Pratt, and Shellabarger soils. Second, soil erosion on farmland results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the 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 clay or hardpan spots because the original friable surface soil has been eroded away. Such spots are common in areas of the eroded Irwin soils.

Erosion control provides protective surface cover, reduces runoff, and increases water 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, legume and grass forage crops in the cropping system not only provide nitrogen and improve tilth for the following crop, but also reduce the risk of erosion on sloping soils.

Slopes are so short and irregular that contour tillage or terracing is not practical in most areas of the sloping Albion and Pratt soils and in some areas of Shellabarger soils. On these soils, cropping systems that provide substantial plant cover are needed to help control erosion unless minimum tillage is practiced. Minimizing tillage and leaving crop residue on the surface help to increase water infiltration and reduce the hazards of runoff and erosion. These practices can be adapted to most soils in the survey area, but they are less successful on the eroded soils and on soils that have a clayey surface layer, such as Clime, Goessel, and Rosehill soils. No-tillage for corn, which is not common, is effective in reducing erosion on sloping soils and can be adapted to most soils in the survey area. It is less successful, however, on the soils with a clayey surface layer.

Terraces and diversions reduce the length of slopes and the risks of runoff and erosion. They are most practical on deep, well drained soils that have regular slopes. Blanket, Farnum, Irwin, Milan, Renfrow, and Vanoss soils are suitable for terraces. The other soils are less suitable for terraces and diversions because of irregular slopes; excessive wetness in the terrace channels; a clayey subsoil, which would be exposed in terrace channels; or bedrock at a depth of less than 40 inches.

Contouring and terracing are widespread erosion-control practices in the survey area. They are best suited to soils with smooth, uniform slopes, including most areas of the sloping Blanket, Farnum, Irwin, Milan, Renfrow, Vanoss, and Vernon soils.

Soil blowing is a hazard on the sandy Albion, Pratt, and Shellabarger soils. It can damage these soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. A protective plant cover, surface mulch, wind stripcropping, and rough surfaces resulting from proper tillage minimize the hazard of soil blowing on these soils. Windbreaks of suitable shrubs, such as Tatarian honeysuckle or autumn-olive, are effective in reducing the hazard of soil blowing on these soils.

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

Soil drainage is the major management need on about 9 percent of the acreage used for crops and pasture. Some soils are naturally so wet that the production of crops common to the area is generally not possible. These are the poorly drained Plevna soils.

Unless artificially drained, somewhat poorly drained soils are so wet that crops are damaged during most years. Examples are Carwile, Drummond, Lesho, Waldeck, and Waurika soils, which make up about 43,000 acres of the survey area.

Goessel and Tabler soils have adequate drainage most of the year, but they are ponded and dry out slowly after rains. Artificial drainage is needed in some of these wetter areas.

The design of surface and subsurface drainage systems varies with the kind of soil. Drains should be more closely spaced in soils that are slowly or very slowly permeable than in the more permeable soils. Tile drainage is not commonly used in Sedgwick County, but it is feasible in some areas of Lesho and Waldeck soils if outlets are available.

Generally, surface drains adequately drain Carwile, Goessel, Tabler, and Waurika soils and prevent crop damage. The greatest difficulty is locating a proper outlet.

Soil fertility is naturally low in most sandy soils and medium in most silty and clayey soils of the uplands. All soils in the county but Clark, Clime, Drummond, Lesho, Lincoln, Plevna, and Waldeck soils are naturally acid. The soils on flood plains, such as Elandco and Lesho soils, are naturally higher in plant nutrients than most upland soils.

Many upland soils are naturally acid, and if they never have been limed they require application of ground limestone to raise the pH level sufficiently for good growth of alfalfa and other crops that grow only on nearly neutral soils. Available nitrogen and phosphorus levels are naturally low in most of these 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, loam, or silty clay loam surface layer that has a depleted organic-matter content because of years of cultivation. Generally, the surface layer of such soils is weak, and intense rainfall causes the formation of a crust on the surface. The crust is hard when dry, and it is nearly impervious to water. Once the crust forms, it reduces water infiltration and increases runoff. Regular additions of crop residue, manure, and other organic material can improve soil structure and reduce the likelihood of crust formation.

In the dark colored Clime, Goessel, and Rosehill soils, which are clayey, poor tilth is a problem because the soils often stay wet until late in spring. If they are plowed when wet, they tend to be very cloddy when dry and good seedbeds are difficult to prepare. Fall plowing generally results in good tilth in spring because of frequent freezing and thawing. If plowed in the fall, however, the soils are subject to soil blowing and water erosion in spring.

Field crops suited to the soils and climate of the survey area include some that are not commonly grown. Grain sorghum, corn, and, to an increasing extent, soybeans are the chief row crops. Irish potatoes, sunflowers, sweet potatoes, cabbage, broccoli, snap beans, sweet corn, watermelon and muskmelon, and similar crops can be grown if economic conditions are favorable. Wheat and barley are the common close-growing crops. Rye and oats could be grown, and grass seed could be produced from bromegrass and fescue.

Special crops grown commercially in the survey area are vegetables, small fruits, tree fruits, and nursery plants. A small acreage that parallels the Arkansas and Ninnescah Rivers is used for melons, strawberries, tomatoes, sweet corn, peppers, and other vegetables and small fruits. Apples and peaches are the most important tree fruits grown in the county.

Canadian, Farnum, Milan, Naron, Pratt, and Shellabarger soils, which are deep, have good natural drainage, and warm up early in spring, are especially well suited to many vegetables and small fruits. They total about 163,000 acres. If irrigation water is available, productivity is greatly increased. Crops can generally be planted and harvested earlier on these soils than on the other soils in the survey area.

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, however, generally are poorly suited to vegetables that are planted early and to small fruits and orchards.

The latest information about growing special 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 suited to the climate 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.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown; that good quality irrigation water is uniformly applied in proper amounts as needed; and that tillage is kept to a minimum.

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 classes and subclasses

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 (*5*). 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. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

Class VIII soils and 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 some parts of the United States, but not in Sedgwick County, 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.

The capability unit is identified in the description of each soil map unit in the section "Soil maps for detailed planning." 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, IIe-1 or IIIe-5.

## Rangeland

About 11 percent of Sedgwick County is rangeland. Production of livestock is the second largest farm enterprise in the county. The number of cattle, including calves, is about 64,000. The number of sheep and lambs is about 18,000.

Native grasslands total about 72,000 acres. Much of the range is adjacent to the Arkansas and Ninnescah Rivers and in the Cheney area, but smaller areas are throughout the county. The soils are sandy. Some areas are hummocky and are subject to severe soil blowing if overgrazed. Many of the soils are subject to flooding and have a high water table. Under poor rangeland management, a heavy growth of brush, weeds, and trees invades in a short period.

The native vegetation in many parts of the survey area has been greatly depleted by continued excessive use. Much of the acreage that was once open grassland is now covered with brush, weeds, and trees, especially in the valleys of the Arkansas and Ninnescah Rivers. The amount of forage produced may be less than half of that originally produced. Productivity of the range can be increased by management that is effective for specific kinds of soil and range sites. 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 names of major plant species; 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.

*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. 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 evaluation 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 major 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. Controlling brush and minimizing soil blowing are also important. Such management, which is based on soil survey information and rangeland inventories, 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 wind 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.

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 soil 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

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 information 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 generally 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 that one or more soil properties or site features are 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 made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemetery plots. Such digging or trenching is influenced by soil wetness caused by a seasonal high 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 given, 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 of the structure 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 hazard.

*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 a 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. 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. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

*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 can 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 can be installed or the size of the absorption field can be increased so that performance is satisfactory.

*Sewage lagoons* 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 content of 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 (fig. 11). Shear strength and permeability of compacted soil material affect the performance of embankments.

*Sanitary landfill* is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. 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 can 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.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

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 periods. 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.

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. Because soil survey interpretations are oriented to local roads and streets rather than highways, the 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 upper part of the roadfill is considered the subgrade, or foundation, for the road. 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 table 14.

*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.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

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.

### Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 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.

Irrigation with water from drilled wells did not become widespread in Sedgwick County until the 1950's. Nearly all the irrigation wells are drilled into Pleistocene alluvium in the valley of the Arkansas River between Mount Hope and Mulvane. Water is pumped from wells that range from 60 to 200 feet in depth. The pumps are powered by natural gas, electricity, liquid gas, or diesel fuels.

Both sprinkler and surface systems are used. Water is transported to the fields by pipes or ditches. Underground pipes or grated surface pipes eliminate the need for maintenance of ditches and control of weeds and do not take up space that could be used for crops.

Irrigation of large fields is limited to the areas where enormous supplies of ground water are available. Sufficient ground water for irrigation in Sedgwick County occurs mainly in the area of the Arkansas River between Mount Hope and Mulvane. Most irrigation is supplemental, and the use of ground water for this purpose fluctuates from year to year.

Successful irrigation requires soils that have high available water capacity, adequate subsurface drainage, and favorable permeability. An abundant supply of good quality water is required. More information about irrigation can be obtained from a local representative of the Soil Conservation Service or the Extension Service.

*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

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

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, is inadequate, or is 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. 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. Examples of grain and seed crops are corn, wheat, oats, and barley.

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

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

*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. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, cedar, and juniper.

*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. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are sand plum, buttonbush, gooseberry, and golden currant.

*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. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, and cordgrass and rushes, sedges, and reeds.

*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 structures in marshes or streams. 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. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

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

*Openland 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, striped skunk, and red fox.

*Wetland 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 habitat* consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include white-tailed deer, mule deer, meadowlark, lark bunting, prairie horned lark, jackrabbit, prairie dog, badger, and greater prairie chickens.

## 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 classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features and engineering test data.

### Engineering properties

Table 14 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

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*).

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 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.

## 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.

*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 soil 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.

*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 insure 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.

## Engineering test data

The results of analyses of engineering properties of several typical soils of the survey area are given in table 17.

The data presented are for soil samples that were collected from carefully selected sites. The soil profiles sampled are typical of the series discussed in the section "Soil series and morphology." The soil samples were analyzed by the Kansas Department of Transportation.

The methods used in obtaining the data are listed by code in the next paragraph. Most of the codes, in parentheses, refer to the methods assigned by the American Association of State Highway and Transportation Officials. The code for Unified classification is that assigned by the American Society for Testing and Materials.

The methods and codes are AASHTO classification (M-145-66); Unified classification (D-2487-69); mechanical analysis (T88-72); liquid limit (T89-68); plasticity index (T90-70); and moisture-density, method A (T99-74).

# 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 that is 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 (*4*). 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 map units, of each soil series are described in the section "Soil maps for detailed planning."

## Albion series

The Albion series consists of well drained and somewhat excessively drained, moderately rapidly permeable soils on uplands. These soils are moderately deep over sand. They formed in old sandy and gravelly alluvium. Slopes range from 1 to 15 percent.

Albion soils are similar to Milan and Shellabarger soils and are commonly adjacent to those soils on the landscape. Milan soils have fine loamy argillic horizons and are less sandy in the substratum than Albion soils. Shellabarger soils have a more clayey subsoil than Albion soils and are deeper over a sandy substratum.

Typical pedon of Albion sandy loam, in an area of Albion-Shellabarger sandy loams, 1 to 4 percent slopes, 2,620 feet east and 250 feet south of the northwest corner of section 22, T. 27 S., R. 4 W.

A1—0 to 9 inches; brown (7.5YR 4/2) sandy loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; slightly hard, friable; few coarse sand grains and fine pebbles throughout horizon; many roots; medium acid; gradual smooth boundary.
B2t—9 to 19 inches; reddish brown (5YR 4/3) heavy sandy loam, dark reddish brown (5YR 3/3) moist; moderate medium granular structure; slightly hard, friable; several coarse sand grains and fine pebbles throughout horizon; many roots; slightly acid; clear smooth boundary.
B3—19 to 26 inches; reddish brown (5YR 4/4) coarse sandy loam, dark reddish brown (5YR 3/4) moist; weak medium granular structure; slightly hard, friable; common roots; slightly acid; diffuse boundary.
IIC—26 to 60 inches; yellowish red (5YR 5/6) sand, yellowish red (5YR 4/6) moist; loose; single grained; few roots; slightly acid.

The thickness of the solum and the depth to sand or gravel range from 20 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

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, fine sandy loam, or light loam. Rounded pebbles ranging from 1/2 inch to 2 inches in diameter are in some pedons.

The B2t horizon has hue of 10YR to 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. It is sandy loam, light loam, or heavy sandy loam averaging between 12 and 18 percent clay and between 45 and 75 percent medium and coarse sand. Rounded pebbles larger than 2 millimeters are common but do not exceed 35 percent by volume. The B3 horizon has the same range in color as the B2t horizon and is coarse sandy loam or loamy sand.

The IIC horizon has hue of 10YR, 7.5YR or 5YR; value of 4 to 6 (4 or 5 moist), and chroma of 3 to 8. It is sand, coarse sand, gravelly sand, loamy sand, and gravelly sandy loam.

## Blanket series

The Blanket series consists of deep, well drained, moderately slowly permeable soils on terraces and uplands. These soils formed in old alluvium, loess, or both. Slopes range from 0 to 3 percent.

Blanket soils are similar to Irwin, Tabler, and Vanoss soils and are commonly adjacent to Clark, Farnum, Ost, Tabler, Vanoss, and Waurika soils on the landscape. Irwin and Tabler soils have a thinner A horizon than Blanket soils and are less gradational between the A and B horizons. Vanoss soils have a fine silty control section. Waurika soils have albic horizons. Clark, Farnum, and Ost soils have a fine loamy control section and are typically more undulating than Blanket soils.

Typical pedon of Blanket silt loam, 0 to 1 percent slopes, 510 feet north and 75 feet west of the southeast corner of section 13, T. 26 S., R. 3 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; few roots; slightly acid; clear smooth boundary.
A12—9 to 14 inches; dark grayish brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, friable; few roots; slightly acid; gradual smooth boundary.
B21t—14 to 21 inches; dark grayish brown (10YR 4/2) light silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, firm; few roots; neutral; gradual smooth boundary.
B22t—21 to 34 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; very hard, very firm; moderately alkaline; gradual smooth boundary.
B3ca—34 to 46 inches; brown (10YR 5/3) light silty clay, dark brown (10YR 4/3) moist; weak medium and fine blocky structure; very hard, very firm; few hard carbonate concretions; moderately alkaline; gradual smooth boundary.
C—46 to 60 inches; light brown (7.5YR 6/4) heavy silty clay loam, dark brown (7.5YR 4/3) moist; common fine faint yellowish brown (10YR 5/4) mottles; weak medium blocky structure; hard, firm; few calcium carbonate threads and soft masses; mildly calcareous; moderately alkaline.

The thickness of the solum ranges from 40 to 60 inches or more. Secondary carbonates in the form of films, threads, or soft masses are at a depth of 28 inches or more.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 3 or 2. It is dominantly silt loam, but in some areas it is silty clay loam. Reaction is slightly acid to mildly alkaline.

The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 to 4 moist), and chroma of 2 or 3. It is silty clay, silty clay loam, or clay. Clay content is 35 to 50 percent. Reaction is slightly acid to moderately alkaline. The B3ca horizon has hue of 10YR or 7.5YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is silty clay loam or silty clay.

The C horizon has hue of 10YR or 7.5YR, value of 3 to 6, and chroma of 3 to 6. It is mildly alkaline or moderately alkaline. It is silty clay loam, clay loam, or light silty clay.

## Canadian series

The Canadian series consists of deep, well drained, moderately rapidly permeable soils on alluvial terraces. These soils formed in loamy alluvial sediments. Slopes range from 0 to 3 percent.

Canadian soils are similar to Naron soils and are commonly adjacent to Elandco, Farnum, Lesho, Lincoln, Naron, and Waldeck soils. Naron soils have a fine loamy control section and are on undulating uplands. Lesho, Lincoln, and Waldeck soils are affected by a water table and typically are on the lower flood plains. Elandco, Farnum, and Naron soils are more clayey than Canadian soils and typically are on slightly higher parts of the landscape.

Typical pedon of Canadian fine sandy loam 2,600 feet east and 100 feet south of the northwest corner of section 33, T. 27 S., R. 4 W.

Ap—0 to 8 inches; brown (10YR 5/3) light fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; winnowed; soft, very friable; slightly acid; abrupt smooth boundary.
A12—8 to 20 inches; brown (7.5YR 4/2) fine sandy loam, dark brown (7.5YR 3/2) moist; moderate fine and medium granular structure; soft, very friable; slightly acid; gradual smooth boundary.
B2—20 to 35 inches; brown (7.5YR 4/4) light sandy loam, dark brown (7.5YR 4/4) moist; weak fine and medium granular structure; soft, very friable; neutral; gradual smooth boundary.
C—35 to 60 inches; light brown (7.5YR 6/4) sandy loam, brown (7.5YR 4/3) moist; very weak fine granular structure; soft, very friable; neutral.

The thickness of the solum ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

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 fine sandy loam, sandy loam, or loam and is slightly acid or neutral.

The B2 horizon has hue of 10YR or 7.5YR; value of 4, 5, or 6 (3 or 4 moist); and chroma of 2 to 6. It is fine sandy loam, sandy loam, or loam and ranges from slightly acid to moderately alkaline.

The C horizon has hue of 10YR or 7.5YR, value of 5 to 7 (4 to 6 moist), and chroma of 3 to 6. It is fine sandy loam or sandy loam and ranges from slightly acid to moderately alkaline. Loamy fine sand is below a depth of 40 inches in some pedons.

## Carwile series

The Carwile series consists of deep, somewhat poorly drained, slowly permeable soils on uplands and terraces. Slopes are 0 to 1 percent.

Carwile soils are similar to Drummond and Tabler soils and are commonly adjacent to Drummond, Tabler, and Farnum soils. Drummond soils have natric horizons. Tabler soils lack the mottling in the upper part of the argillic horizon that is characteristic of Carwile soils. Tabler, Drummond, and Carwile soils occupy similar positions on the landscape. Farnum soils are typically slightly elevated, are better drained than Carwile soils, and have a fine-loamy control section.

Typical pedon of Carwile fine sandy loam 2,400 feet south and 175 feet east of the northwest corner of section 6, T. 25 S., R. 1 W.

A1—0 to 18 inches; dark brown (7.5YR 3/2) fine sandy loam, brown (7.5YR 5/2) dry; few fine distinct dark reddish brown (5YR 3/4) mottles; weak medium granular structure; hard, friable; few open pores; slightly acid; gradual smooth boundary.

B1—18 to 24 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; many medium distinct strong brown (7.5YR 5/6) mottles; weak medium blocky structure; very hard, firm; distinct and patchy clay films; neutral; smooth gradual boundary.

B2t—24 to 47 inches; dark grayish brown (2.5Y 4/2) heavy clay loam, grayish brown (2.5Y 5/2) dry; common medium distinct strong brown (7.5YR 5/6) mottles; weak medium blocky structure; very hard, very firm; distinct and continuous clay films; few iron and manganese concretions; mildly alkaline; smooth gradual boundary.

B3—47 to 60 inches; dark grayish brown (10YR 4/2) heavy clay loam, grayish brown (10YR 5/2) dry; common medium distinct strong brown (7.5YR 5/6 mottles; weak medium blocky structure; very hard, firm; many soft lime concretions; few iron and manganese concretions about 3 millimeters in diameter; thick and patchy clay films; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 moist and 4 or 5 dry, and chroma of 1 or 2. It is dominantly fine sandy loam, but it also can be loam and clay loam. This horizon is neutral to medium acid.

The B2t horizon has hue of 7.5YR, 10YR, and 2.5Y; value of 3 to 6 moist and 5 to 7 dry; and chroma of 1 or 2. It is clay loam, clay, or sandy clay. Clay content is 35 to 60 percent and sand content more than 30 percent in the upper 20 inches of the control section. The B2 and C horizons have mottles in shades of brown, red, or gray. These mottles are few to many, fine to coarse, and distinct or prominent. The B2 horizon is slightly acid to moderately alkaline. Some pedons are calcareous in the lower part of the B2t horizon and contain a few fine or medium soft or weakly cemented calcium carbonate concretions.

The C horizon, if it occurs, has hue of 5YR, 7.5YR, 10YR, and 2.5Y; value of 3 to 6; and chroma of 1 to 6. It is fine sandy loam, loam, sandy clay loam, clay loam, sandy clay, or clay. This horizon is calcareous and moderately alkaline.

## Clark series

The Clark series consists of deep, well drained, moderately permeable soils that formed in highly calcareous old alluvium. Slopes range from 1 to 4 percent.

Clark soils are similar to Farnum and Ost soils and are commonly adjacent to Blanket, Farnum, Ost, and Tabler soils on the landscape. Blanket, Farnum, and Tabler soils lack the concentrated accumulation of lime in the argillic horizons. Ost soils lack free carbonates at the surface. Blanket, Clark, and Farnum soils are in similar positions on the landscape, whereas Tabler soils are in nearly level areas.

Typical pedon of Clark clay loam, in an area of Clark-Ost clay loams, 1 to 4 percent slopes, 300 feet west and 75 feet south of the northeast corner of section 16, T. 27 S., R. 3 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; weak fine granular structure; hard, firm; few very fine and fine soft masses of calcium carbonate; slight effervescence; mildly alkaline; clear wavy boundary.

A12—7 to 11 inches; very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; moderate fine and medium granular structure; hard, firm; many roots; few fine and medium soft masses of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

AC1—11 to 17 inches; brown (10YR 5/3) clay loam, very dark grayish brown (10YR 3/2) moist; strong medium and fine subangular blocky structure; very hard, very firm; many roots; common fine and medium soft masses of calcium carbonate; violent effervescence; moderately alkaline; gradual smooth boundary.

AC2—17 to 24 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate medium blocky structure; very hard, very firm; few roots; soft masses and concretions of calcium carbonate make up about 20 percent of mass by volume; violent effervescence; moderately alkaline; gradual smooth boundary.

C—24 to 60 inches; light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; moderate medium and fine blocky structure; very hard, very firm; soft masses and lime concretions make up about 30 percent of the mass by volume; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 10 to 24 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches. The soil is typically calcareous throughout, but in some pedons the upper 6 inches is noncalcareous. Reaction in all horizons is mildly alkaline or moderately alkaline.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. The calcareous horizons between the A horizon and a depth of 30 inches have a calcium carbonate content of more than 20 percent throughout a zone 6 inches or more thick. Horizons below the mollic epipedon have hue of 10YR or 7.5YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 6.

## Clime series

The Clime series consists of moderately deep, well drained, slowly permeable soils on erosional uplands. These soils formed in residuum weathered from calcareous clayey shale. Slopes range from 3 to 6 percent.

Clime soils are similar to Rosehill soils and are commonly adjacent to Goessel, Irwin, and Rosehill soils on the landscape. Goessel soils are more than 60 inches deep over shale. Irwin soils have argillic horizons and are more than 60 inches deep over shale or limestone. Rosehill soils lack free carbonates within a depth of 28 inches. Goessel soils typically are nearly level. Irwin soils are gently sloping and are in areas where the soil mantle is more than 60 inches thick. Rosehill soils typically are less sloping than Clime soils.

Typical pedon of Clime silty clay, 3 to 6 percent slopes, 1,320 feet east and 200 feet south of the northwest corner of section 20, T. 25 S., R. 2 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; moderate fine and medium granular structure; very hard, firm; few small calcium carbonate concretions; slight effervescence; few roots; moderately alkaline; clear smooth boundary.

B2—8 to 26 inches; light olive brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; moderate fine blocky structure; many vertical streaks of very dark grayish brown cover some ped faces to a depth of 15 inches; very hard, very firm; common open pores; few small lime concretions; strong effervescence; few roots; moderately alkaline; gradual wavy boundary.

Cr—26 to 34 inches; clayey calcareous platy shale; no roots.

The thickness of the solum ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 7 to 20 inches. These soils are mostly moderately alkaline throughout, but some pedons lack free carbonates in the upper few inches and are mildly alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 dry and 2 or 3 moist, and chroma of 1 or 2. It is silty clay or silty clay loam.

The B2 horizon has hue of 10YR or 2.5Y, value of 4 or 5 dry and 3 or 4 moist, and chroma of 2 to 4. It is silty clay, clay, or heavy silty clay loam averaging between 27 and 50 percent clay.

The C horizon, if it occurs, has hue of 10YR, 2.5Y, or 5Y; value of 5 to 7 dry and 4 to 6 moist, and chroma of 2 to 4. This horizon typically contains fragments of calcareous shale, but it is not more than 35 percent, by volume, coarse fragments.

## Drummond series

The Drummond series consists of deep, somewhat poorly drained, very slowly permeable soils on terraces. These soils formed in calcareous alluvium. Slopes range from 0 to 3 percent.

Drummond soils are similar to Carwile, Farnum, and Tabler soils and are commonly adjacent to those soils on the landscape. Carwile, Farnum, and Tabler soils have mollic epipedons and lack natric horizons. Carwile and Tabler soils occur on the microknolls in some areas, and Farnum soils occur on small convex ridges.

Typical pedon of Drummond clay loam, in an area of Tabler-Drummond complex, 1,650 feet west and 75 feet south of the northeast corner of section 23, T. 25 S., R. 2 W.

A1—0 to 8 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; very hard, friable; many roots; peds in lower part coated with gray silt; slightly calcareous; moderately alkaline; clear wavy boundary.

B2t—8 to 32 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to moderate medium blocky; extremely hard, very firm; few roots; few open pores; few nests and threads of lime in upper part and many nests and threads of lime in lower part; thick and continuous clay films; strongly alkaline; gradual smooth boundary.

B3—32 to 48 inches; grayish brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) moist; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium blocky structure; extremely hard, firm; few roots; few open pores; few mica flakes; thick and continuous clay films; many nests and threads of lime; strong effervescence; strongly alkaline; gradual smooth boundary.

C—48 to 60 inches; very pale brown (10YR 7/3) heavy loam, brown (10YR 5/3) moist; many medium and coarse distinct brownish yellow (10YR 6/6) mottles; massive; very hard, friable; no roots; few open pores; many clusters and nests of lime; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 60 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 or 3. It is clay loam, silt loam, or loam. Reaction ranges from slightly acid to moderately alkaline.

The B2t horizon has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 5. It ranges from clay loam to clay. Reaction ranges from neutral to strongly alkaline. Exchangeable sodium percentage ranges from 15 to 25. The B3 horizon has hue of 7.5YR or 10YR, value of 4 to 7 (3 to 6 moist), and chroma of 2 to 6. It ranges from clay to clay loam. Mottles of brown, gray, or red are in some pedons. Reaction ranges from mildly alkaline to strongly alkaline.

The C horizon is similar in color and reaction to the B3 horizon. It varies in texture and has thin layers of coarser or finer textures.

## Elandco series

The Elandco series consists of deep, well drained, moderately permeable soils on flood plains and low terraces. These soils formed in silty alluvial sediments. Slopes range from 0 to 3 percent.

Elandco soils are similar to Vanoss soils and are commonly adjacent to Canadian, Lincoln, Naron, and Tabler soils. Vanoss soils have argillic horizons. Canadian soils have a coarse loamy control section, Naron soils have a fine loamy control section, and Tabler soils have a fine control section. Canadian, Naron, Tabler, and Vanoss soils typically are somewhat higher on the landscape than Elandco soils, and Lincoln soils are lower on the landscape, but many of these landscapes have been modified and are not distinct. Also, Lincoln soils have a sandy control section.

Typical pedon of Elandco silt loam 2,400 feet north and 75 feet west of the southeast corner of section 35, T. 25 S., R. 1 W.

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

A12—8 to 22 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium and coarse granular structure; slightly hard, very friable; few open pores; many roots; slightly acid; gradual smooth boundary.

A13—22 to 40 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, very friable; few pores; few roots; neutral; clear wavy boundary.

A1b—40 to 48 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium granular structure; slightly hard, very friable; few open pores; few roots; neutral; gradual smooth boundary.

A12b—48 to 60 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very firm; few open pores; few roots; slightly alkaline.

The thickness of solum ranges from 30 to more than 50 inches. The thickness of the mollic epipedon ranges from 20 to more than 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 2. Texture is silt loam, silty clay loam, or clay loam. Reaction is slightly acid to mildly alkaline in the A11 and A12 horizons. Some pedons have coarser textures in the upper 10 inches. The A13 horizon is slightly acid to moderately alkaline. The A1b and A12b horizons have the same range of characteristics as their upper counterparts. Some pedons contain strata that are coarser or finer textured than the control section.

## Farnum series

The Farnum series consists of deep, well drained, moderately slowly permeable soils on terraces and uplands. These soils formed in somewhat stratified, old loamy alluvium that may have been modified by winnowing in the upper part of the solum. Slopes range from 0 to 3 percent.

Farnum soils are similar to Clark, Drummond, Milan, and Naron soils and are commonly adjacent to Blanket, Carwile, Clark, Drummond, Milan, Naron, Ost, Shellabarger, and Vanoss soils on the landscape. Clark, Drummond, Milan, and Naron soils lack mollic epipedons more than 20 inches thick. If Farnum soils are in association with Blanket, Carwile, Clark, Drummond, Ost, and Naron soils, they are on convex ridges. Milan and Shellabarger soils are typically more sloping than Farnum soils, Vanoss soils are in similar positions on the landscape.

Typical pedon of Farnum loam, 1 to 3 percent slopes, 2,000 feet west and 75 feet south of the northeast corner of section 17, T. 28 S., R. 2 W.

Ap—0 to 8 inches; brown (7.5YR 4/2) heavy loam, dark brown (7.5YR 3/2) moist; weak medium granular structure; slightly hard, friable; medium acid; clear smooth boundary.

A12—8 to 14 inches; brown (7.5YR 4/2) heavy loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

B1—14 to 18 inches; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate fine and very fine subangular blocky structure; hard, firm; slightly acid; clear smooth boundary.

B21t—18 to 30 inches; brown (7.5YR 5/3) clay loam, dark brown (7.5YR 3/3) moist; moderate medium blocky structure; very hard, very firm; distinct and continuous clay films; few organic stains on ped faces; few coarse sand grains; mildly alkaline; gradual smooth boundary.

B22t—30 to 40 inches; brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/4) moist; moderate medium blocky structure; very hard, very firm; distinct and continuous clay films; few small lime concretions; moderately alkaline; clear smooth boundary.

B3—40 to 46 inches; brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/4) moist; weak medium blocky structure; very hard, very firm; thin and patchy clay films; few hard calcium carbonate concretions about 5 millimeters in diameter; few threads and nests of lime; moderately alkaline; gradual smooth boundary.

C—46 to 60 inches; brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/4) moist; very weak medium blocky structure; very hard, very firm; few nests and threads of lime; moderately alkaline.

The mollic epipedon is more than 20 inches thick. The thickness of the solum and the depth to free carbonates range from 30 to more than 60 inches.

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 dominantly loam, but it can also be fine sandy loam and sandy loam. Reaction is medium acid to neutral.

The B2t horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 4 to 6 (3 to 5 moist); and chroma of 2 to 4. It is loam, sandy clay loam, or clay loam. Reaction ranges from neutral to moderately alkaline.

The C horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 to 6 (3 to 5 moist); and chroma of 3 or 4. It is loam, clay loam, sandy clay loam, fine sandy loam, loamy sand, or sand. Reaction ranges from neutral to moderately alkaline. In some pedons the B and C horizons have fine and medium mottles with chroma of more than 2.

## Goessel series

The Goessel series consists of deep, moderately well drained, very slowly permeable soils on terraces and uplands. These soils formed in old clayey alluvial sediments. Slopes range from 0 to 2 percent.

Goessel soils are similar to Rosehill and Tabler soils and are commonly adjacent to those soils and to Clime and Irwin soils on the landscape. Clime and Rosehill soils are underlain by shale at a depth of 20 to 40 inches. Irwin and Tabler soils have a silty clay loam A horizon. Clime, Irwin, and Rosehill soils typically are more sloping than Goessel soils.

Typical pedon of Goessel silty clay, 0 to 1 percent slopes, 2,660 feet north and 50 feet east of the southwest corner of section 23, T. 25 S., R. 1 W.

Ap—0 to 5 inches; very dark gray (10YR 3/1) heavy silty clay, black (10YR 2/1) moist; moderate medium granular structure; extremely hard, very firm; few open pores; few roots; slightly acid; clear smooth boundary.

AC1—5 to 35 inches; mixed very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) heavy silty clay, black (10YR 2/1) and very dark grayish brown (10YR 3/2) moist; weak medium granular and weak fine blocky structure; common medium slickensides inclined at a 45 degree angle from horizontal; extremely hard, very firm; mildly alkaline; gradual smooth boundary.

AC2—35 to 60 inches; dark gray (10YR 4/1) heavy silty clay, very dark gray (10YR 3/1) moist; few medium faint brown (10YR 5/3) mottles; weak medium blocky structure; extremely hard, very firm; few roots; many open pores; moderately alkaline.

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

The A horizon has hue of 10YR, value of 3 or 4 (2 or 3 moist), and chroma of less than 1.5 dry or moist. Typically, it is silty clay, but it is heavy silty clay loam or clay in some pedons. Reaction is slightly acid or neutral. The AC horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2 dry or moist. It is silty clay or clay. Vertical tongues of dark clayey surface soil extend to a depth of 35 inches in some pedons. They are less than 4 inches wide. Reaction is mildly alkaline or moderately alkaline.

The C horizon, if it occurs, has hue of 10YR or 2.5Y, value of 3 to 6 dry and 2 to 5 moist, and chroma of 1 to 4 dry or moist. It is silty clay, clay, or heavy clay loam. Reaction is mildly alkaline to moderately alkaline. In some pedons the AC and C horizons are mottled with yellowish brown or strong brown.

## Irwin series

The Irwin series consists of deep, well drained, very slowly permeable soils on uplands. These soils formed in old clayey alluvial sediments. Slopes range from 1 to 6 percent.

Irwin soils are similar to Blanket and Tabler soils and are commonly adjacent to Clime, Goessel, Rosehill, and Tabler soils on the landscape. Blanket soils have a thicker A horizon and are more transitional to the argillic horizon and lighter textured in the substratum than Irwin soils. Clime and Rosehill soils have shale at a depth of 20 to 40 inches. Tabler soils have lower chroma throughout the argillic horizon than Irwin soils, and Goessel soils have a more clayey surface layer. Blanket, Goessel, and Tabler soils are typically on smoother landscapes. Clime and

Rosehill soils are typically below the Irwin soils on the landscape.

Typical pedon of Irwin silty clay loam, 1 to 3 percent slopes, 600 feet north and 75 feet east of the southwest corner of section 26, T. 28 S., R. 2 E.

A1—0 to 12 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium and fine granular structure; hard, friable; slightly acid; clear smooth boundary.

B21t—12 to 28 inches; brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/3) moist; weak medium blocky structure; extremely hard, very firm; distinct and continuous clay films; slightly acid; gradual smooth boundary.

B22t—28 to 46 inches; brown (7.5YR 5/4) silty clay, dark brown (7.5YR 4/4) moist; moderate medium blocky structure; extremely hard, very firm; distinct and continuous clay films; mildly alkaline; few lime concretions; gradual smooth boundary.

B3—46 to 52 inches; brown (7.5YR 5/4) silty clay, dark brown (7.5YR 4/4) moist; common medium faint mottles of strong brown (7.5YR 5/6); weak medium blocky structure; extremely hard, very firm; few lime concretions; moderately alkaline; gradual smooth boundary.

C—52 to 60 inches; brown (7.5YR 5/4) silty clay, dark brown (7.5YR 4/4) moist; common medium faint strong brown (7.5YR 5/6) mottles; massive; extremely hard, very firm; moderately alkaline.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 20 to more than 30 inches.

The A horizon has hue of 10YR, value of 4 or 5 dry and 2 or 3 moist, and chroma of 1 to 3. It is dominantly silty clay loam, but it can also be silt loam and clay loam. Reaction ranges from medium acid to neutral.

The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5 (3 moist), and chroma of 2 or 3. It is silty clay or clay. Reaction ranges from slightly acid to mildly alkaline. The C horizon has hue of 2.5Y to 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 5. Reaction ranges from neutral to moderately alkaline. Unconforming strata are common below the Bt horizon. They are less than 40 percent clay below a depth of 40 inches. Some pedons contain carbonate concretions below a depth of 24 inches.

## Lesho series

The Lesho series consists of somewhat poorly drained, moderately slowly permeable soils that are moderately deep over sand. These soils are on flood plains and low terraces. Slopes are 0 to 1 percent.

Lesho soils in Sedgwick County are taxadjuncts to the Lesho series because the mollic epipedon is thicker than is defined as the range for the series. This difference however, does not alter the use or behavior of the soils.

Lesho soils are similar to Plevna and Waldeck soils and are commonly adjacent to Canadian, Farnum, Lincoln, Plevna, and Waldeck soils. Farnum soils are on uplands and terraces, have argillic horizons, and are better drained than Lesho soils. Plevna soils are coarser textured in the control section than Lesho soils and are poorly drained. Waldeck soils are coarser textured throughout the solum than Lesho soils, and Canadian soils are typically on higher parts of the landscape and are well drained. Lincoln soils are adjacent to major streams and are somewhat excesively drained.

Typical pedon of Lesho loam 1,800 feet west and 75 feet south of the northeast corner of section 33, T. 26 S., R. 1 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak medium granular structure; hard, friable; many open pores; moderately alkaline; calcareous; clear smooth boundary.

A12—10 to 27 inches; dark grayish brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) moist; common fine distinct mottles of dark brown (7.5YR 4/4) and few fine faint grayish brown (10YR 5/2) mottles below a depth of 15 inches; moderate medium granular structure; hard, friable; many open pores; moderately alkaline; calcareous; gradual smooth boundary.

IIC—27 to 60 inches; grayish brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; common medium faint yellowish brown (10YR 5/6) mottles; single grained but slightly coherent; moderately alkaline; slightly calcareous.

The thickness of the solum and the mollic epipedon ranges from 10 to 30 inches. Depth to free carbonates ranges from 0 to 12 inches, and depth to the IIC horizon ranges from 20 to 40 inches. Reaction ranges from mildly alkaline to strongly alkaline throughout the solum.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. It is typically heavy loam or clay loam. In places faint mottles are in the lower part of the A horizon, and depth to distinct mottles ranges from 14 to 30 inches. The IIC horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 5 to 7 (4 to 6 moist); and chroma of 2 to 6. It ranges from loamy fine sand to coarse sand.

## Lincoln series

The Lincoln series consists of somewhat excessively drained, rapidly permeable soils that are shallow over sand. These soils are on flood plains. Slopes range from 0 to 3 percent.

Lincoln soils are similar to Plevna and Tivoli soils and are commonly adjacent to those soils and to Canadian, Elandco, Lesho, Pratt, and Waldeck soils on the landscape. Plevna and Lesho soils are poorly drained and somewhat poorly drained and have a fluctuating water table. Tivoli soils are not stratified with textures finer than loamy fine sand in the control section. Canadian, Elandco, Pratt, and Tivoli soils typically are higher on the landscape than Lincoln soils. Lesho, Plevna, and Waldeck soils are intermingled with Lincoln soils in places.

Typical pedon of Lincoln loam, in an area of Lincoln soils, 1,000 feet west and 100 feet north of the southeast corner of section 17, T. 27 S., R. 4 W.

A1—0 to 8 inches; dark brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; very weak fine granular structure; soft, very friable; moderately alkaline; clear smooth boundary.

C—8 to 60 inches; brown (7.5YR 4/4) fine and medium sand, dark brown (7.5YR 4/2) moist; single grained; loose, very friable; few strata of dark brown clay loam; calcareous; moderately alkaline.

The thickness of the solum ranges from 6 to 15 inches. These soils are mostly moderately alkaline and calcareous throughout. In some pedons the upper 10 inches lacks lime and is mildly alkaline.

The A1 horizon has hue of 2.5Y, 7.5YR, and 10YR; value of 4 to 7 (3 to 6 moist), and chroma of 2 to 6. Where moist values and chromas are less than 3.5, thickness is less than 10 inches. The upper 10 inches of the A horizon ranges from fine sand to clay loam. The C horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 6 to 8 (4 to 6 moist); and chroma of 2 to 6. It is loamy fine sand or fine sand and contains strata that range from fine sandy loam to clay loam. These strata are less than 1 inch thick and are darker colored and contain more organic carbon than the rest of the soil.

## Milan series

The Milan series consists of deep, well drained, moderately slowly permeable soils on erosional uplands. These soils formed in loamy sediments. Slopes range from 1 to 6 percent.

Milan soils are similar to Albion, Farnum, Naron, and Shellabarger soils and are commonly adjacent to Albion, Farnum, Naron, Renfrow, Shellabarger, and Vernon soils on the landscape. Albion soils have sandy clay loam argillic horizons and a sandy substratum. Farnum soils are less red and have a mollic epipedon thicker than 20 inches. Naron soils are less red than Milan soils and have sandy clay loam argillic horizons. Shellabarger soils have sandy clay loam argillic horizons. Renfrow and Vernon soils have clayey shale within a depth of 60 inches and are on slope breaks and the upper sides of some drainageways.

Typical pedon of Milan loam, 1 to 3 percent slopes, 1,830 feet north and 100 feet east of the southwest corner of section 23, T. 29 S., R. 4 W.

Ap—0 to 11 inches; brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; soft, friable; slightly acid; gradual smooth boundary.

B1—11 to 16 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; moderate fine subangular blocky structure; hard, firm; slightly acid; gradual smooth boundary.

B2t—16 to 31 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; weak fine and medium blocky structure; very hard, firm; neutral; gradual smooth boundary.

B3—31 to 44 inches; dark red (2.5YR 3/6) clay loam, dark red (2.5YR 3/6) moist; weak fine blocky structure with a subangular component; hard, friable; neutral; gradual smooth boundary.

C—44 to 60 inches; yellowish red (5YR 5/6) light clay loam, yellowish red (5YR 4/6) moist; weak fine and medium subangular blocky structure; soft, friable; neutral.

The thickness of the solum ranges from 36 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 5YR to 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. Texture ranges from loam to fine sandy loam. Reaction is medium acid or slightly acid. The Bt horizon has hue of 5YR and 2.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 4 to 6. It is clay loam or sandy clay loam. It ranges from about 28 to 35 percent clay. Reaction ranges from medium acid to neutral. The C horizon has the same color range as the Bt horizon. It has less clay and more medium and coarse sand than the Bt horizon. Reaction ranges from medium acid to neutral.

## Naron series

The Naron series consists of deep, well drained, moderately permeable or moderately rapidly permeable soils on uplands. These soils formed in moderately sandy eolian deposits several feet thick. Slopes range from 0 to 2 percent.

Naron soils are similar to Canadian, Farnum, Milan, and Shellabarger soils and are commonly adjacent to those soils and to Elandco soils on the landscape. Canadian soils have a coarse loamy control section and lack an argillic horizon. Farnum soils have a mollic epipedon that is more than 20 inches thick. Milan soils are redder than Naron soils and are more than 27 percent clay in the control section. Shellabarger soils have a hue redder than 7.5YR in the argillic horizon. Canadian and Elandco soils typically occur below Naron soils on the landscape. Farnum, Milan, and Shellabarger soils typically occur on about the same level as Naron soils.

Typical pedon of Naron fine sandy loam 2,500 feet south and 100 feet west of the northeast corner of section 7, T. 25 S., R. 2 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; medium acid; clear smooth boundary.

B1—8 to 13 inches; dark grayish brown (10YR 4/2) heavy fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

B2t—13 to 23 inches; dark brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure that breaks to moderate medium and fine granular; slightly hard, friable; slightly acid; gradual smooth boundary.

B31—23 to 29 inches; brown (10YR 5/3) light sandy clay loam, dark brown (10YR 4/3) moist; moderate medium granular structure; soft, very friable; slightly acid; gradual smooth boundary.

B32—29 to 50 inches; yellowish brown (10YR 5/4) heavy sandy loam, dark yellowish brown (10YR 4/4) moist; moderate medium granular structure; soft, very friable; slightly acid; diffuse smooth boundary.

C—50 to 60 inches; light yellowish brown (10YR 6/4) medium and fine sand, yellowish brown (10YR 5/4) moist; single grained; soft, very friable; slightly acid.

The solum ranges from 36 to 60 inches in thickness. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR, value of 4 or 5 dry and 2 or 3 moist, and chroma of 2 or 3. Texture ranges from fine sandy loam to loam, and reaction ranges from medium acid to neutral. The B2t horizon has hue of 7.5YR to 10YR, value of 4 to 6 dry and 3 or 4 moist, and chroma of 2 to 4. Texture is heavy fine sandy loam, loam, or sandy clay loam. Reaction ranges from medium acid to neutral. Below a depth of 40 inches, the soil is generally noncalcareous fine sandy loam or loamy fine sand, but some pedons have strata that contain more sand, more silt, or more clay.

## Ost series

The Ost series consists of deep, well drained, moderately slowly permeable soils on erosional uplands. These soils formed in calcareous loamy old alluvial sediments. Slopes range from 1 to 4 percent.

Ost soils are similar to Clark soils and are commonly adjacent to Blanket, Clark, Farnum, and Tabler soils on the landscape. Clark soils are typically calcareous throughout and lack an argillic horizon. Blanket, Farnum, and Tabler soils lack the concentrated accumulation of lime in the argillic horizon characteristic of Ost soils. Blanket, Clark, Farnum, and Ost soils are in similar positions on the landscape, whereas Tabler soils are in nearly level areas.

Typical pedon of Ost clay loam, in an area of Clark-Ost clay loams, 1 to 4 percent slopes, 2,640 feet west and 200 feet south of the northeast corner of section 22, T. 27 S., R. 3 W.

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

B21t—7 to 15 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, very firm; mildly alkaline; few roots; gradual wavy boundary.

B22tca—15 to 19 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; very hard, firm; common soft masses and fine concretions of calcium carbonate; strong effervescence; moderately alkaline; few roots; gradual wavy boundary.

Cca—19 to 60 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; massive; hard, firm; about 35 percent, by volume, soft masses of calcium carbonate; few fine roots; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 18 to 36 inches. Depth to free carbonates ranges from 12 to 24 inches. The mollic epipedon ranges from 8 to 18 inches in thickness and commonly includes the upper part of 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 typically clay loam and less commonly is loam. Reaction is slightly acid or neutral. The B2t horizon has hue of 10YR or 7.5YR, value 4 or 5 (3 or 4 moist), and chroma of 2 to 4. It is clay loam averaging between 28 and 35 percent clay. It ranges from neutral to moderately alkaline and contains free carbonates in the lower part. The Cca horizon has hue of 10YR or 7.5YR, value 5 to 7 (4 to 6 moist), and chroma of 3 or 4. It is, by volume, 20 to 40 percent soft masses of calcium carbonate.

## Owens series

The Owens series consists of shallow, well drained, very slowly permeable soils on erosional uplands. These soils formed in clayey material that apparently weathered from Permian shale. Slopes range from 1 to 10 percent.

Owens soils are similar to Renfrow and Vernon soils and are commonly adjacent to those soils on the landscape. Renfrow and Vernon soils have a solum thicker than 20 inches and commonly occupy foot slopes below Owens soils.

Typical pedon of Owens clay loam, 1 to 3 percent slopes, 450 feet north and 75 feet west of the southeast corner of section 17, T. 28 S., R. 4 W.

A1—0 to 7 inches; reddish brown (2.5YR 4/4) heavy clay loam, dark reddish brown (2.5YR 3/4) moist; weak medium granular structure; hard, firm; moderately alkaline; clear smooth boundary.

B2ca—7 to 15 inches; reddish brown (2.5YR 4/4) silty clay, dark reddish brown (2.5YR 3/4) moist; moderate fine and very fine subangular blocky structure; extremely hard, very firm; weakly calcareous; moderately alkaline; clear smooth boundary.

Cr—15 to 20 inches; platy calcareous clayey shale.

The thickness of the solum ranges from 10 to 20 inches. Depth to free carbonates ranges from 0 to 10 inches. The soil is dominantly moderately alkaline, but some pedons are neutral and noncalcareous in the A horizon.

The A horizon has hue of 7.5YR to 2.5YR, value 4 to 6 dry and 3 or 4 moist, and chroma of 2 to 4. Texture is clay loam or clay. The B2ca horizon has hue of 7.5YR to 2.5YR, value of 4 to 6 dry and 3 or 4 moist, and chroma of 3 or 4. The C horizon is weakly consolidated clayey shale. In some pedons scattered fine shale flakes are throughout the solum.

## Plevna series

The Plevna series consists of poorly drained, moderately rapidly permeable soils that are moderately deep over sand. These soils are on flood plains. They formed in moderately coarse textured alluvial sediments. Slopes are less than 1 percent.

Plevna soils are similar to Lesho, Lincoln, and Waldeck soils and are commonly adjacent to those soils and to Pratt and Tivoli soils on the landscape. Lesho soils have a clay loam control section. Lincoln soils are shallow over sand, and Waldeck soils are better drained than Plevna soils. Pratt and Tivoli soils are on uplands next to Plevna soils.

Typical pedon of Plevna fine sandy loam 660 feet north and 25 feet west of the southeast corner of section 20, T. 26 S., R. 1 W.

A11—0 to 9 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; few medium faint mottles of brown (10YR 5/3) in lower part; weak medium granular structure; hard, friable; many fine roots; many open pores; moderately alkaline; gradual smooth boundary.

A12—9 to 20 inches; dark gray (10YR 4/1) sandy loam, very dark gray (10YR 3/1) moist; common medium distinct mottles of strong brown (7.5YR 5/6); weak medium granular structure; slightly hard, very friable; few roots; few open pores; moderately alkaline; gradual smooth boundary.

B2g—20 to 35 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; many medium and coarse distinct mottles of strong brown (7.5YR 5/6); structureless; slightly hard, very friable; few roots; few open pores; moderately alkaline; gradual smooth boundary.

IIC—35 to 60 inches; grayish brown (10YR 5/2) fine sand, grayish brown (2.5Y 5/2) moist; structureless; slightly hard, very friable; very few roots; moderately alkaline; many nests and seams of soft calcium carbonate; gravel ranges from 5 to 10 millimeters in diameter.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches. Reaction throughout the profile ranges from neutral to moderately alkaline.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is typically fine sandy loam or sandy loam and less commonly is loamy fine sand. Most pedons have mottles in the lower part of the A horizon. The B2g horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 or less. Mottles are distinct or prominent in the upper part of the B2g horizon. This horizon is fine sandy loam or sandy loam. The IIC horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. It is fine sand, sand, or loamy sand and is stratified in most areas.

## Pratt series

The Pratt series consists of deep, well drained, rapidly permeable soils on eolian uplands. These soils formed in sandy deposits generally many feet thick. Slopes range from 1 to 5 percent.

Pratt soils are similar to Tivoli soils and are commonly adjacent to Lincoln, Plevna, and Tivoli soils on the landscape. Tivoli soils lack an argillic horizon and typically are more sloping than Pratt soils. Lincoln and Plevna soils are on flood plains along streams.

Typical pedon of Pratt loamy fine sand, undulating, 660 feet south and 150 feet east of the northwest corner of section 9, T. 29 S., R. 3 W.

A1—0 to 18 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak medium granular structure; soft, very friable; few open pores; few roots; slightly acid; gradual smooth boundary.

B2t—18 to 36 inches; brown (7.5YR 5/3) heavy loamy fine sand, dark brown (7.5YR 4/3) moist; weak medium granular structure; slightly hard, very friable; few roots; few open pores; slightly acid; diffuse boundary.

C—36 to 60 inches; light brown (7.5YR 6/4) fine sand, dark brown (7.5YR 4/3) moist; single grained; loose; very few roots; slightly acid.

The thickness of the solum ranges from 24 to 50 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 1 to 3. It is loamy fine sand or sand. Reaction ranges from medium acid to neutral. The Bt horizon has hue of 10YR to 5YR, value of 4 to 6 dry and 4 or 5 moist, and chroma of 2 to 6. It is loamy sand or loamy fine sand that is 3 to 9 percent more clay than the A horizon. The Bt horizon ranges from medium acid to neutral. The C horizon ranges from light yellowish brown (10YR 6/4) to pale brown (10YR 6/3) and light brown (7.5YR 6/4). It is loamy fine sand or fine sand. It is slightly acid or neutral.

## Renfrow series

The Renfrow series consists of deep, well drained, very slowly permeable soils on erosional uplands. These soils formed in material weathered from clay or shale. Slopes range from 1 to 6 percent.

The Renfrow soils in Sedgwick County are taxadjuncts to the Renfrow series because the depth to clayey shale is less than 60 inches in most pedons. This difference, however, does not affect use and management of the soils.

Renfrow soils are similar to Owens and Vernon soils and are commonly adjacent to Milan, Owens, and Vernon soils on the landscape. Milan soils are deep and have a clay loam control section. Owens soils are less than 20 inches deep over shale. Vernon soils lack an argillic horizon. Milan soils typically occur on ridgetops; Owens and Vernon soils are on short, uneven side slopes; and Renfrow soils are on foot slopes and upland divides.

Typical pedon of Renfrow silty clay loam, 1 to 3 percent slopes, 2,300 feet east and 75 feet north of the southwest corner of section 34, T. 28 S., R. 4 W.

A1—0 to 9 inches; brown (7.5YR 4/2) silty clay loam, very dark brown (7.5YR 3/2) moist; moderate medium granular structure; slightly hard, friable; few open pores; many roots; slightly acid; gradual smooth boundary.

B1—9 to 13 inches; dark reddish brown (5YR 3/3) heavy silty clay loam, dark reddish brown (5YR 3/3) moist; moderate fine subangular blocky structure; very hard, very firm; many roots; few open pores; thin and patchy clay films; neutral; clear smooth boundary.

B21t—13 to 28 inches; dusky red (2.5YR 3/2) silty clay, dusky red (2.5YR 3/2) moist; weak medium blocky structure that breaks to weak very fine subangular blocky; extremely hard, extremely firm; few roots; few open pores; thin and patchy clay films; mildly alkaline; gradual smooth boundary.

B22—28 to 45 inches; dark reddish brown (2.5YR 3/4) silty clay, dusky red (2.5YR 3/2) moist; weak fine blocky structure that breaks to weak fine subangular blocky; extremely hard, extremely firm; platy shale fragments make up about 20 percent of the volume; clay films cover ped faces and shale partings; few roots; few open pores; moderately alkaline; clear smooth boundary.

B3—45 to 50 inches; reddish brown (2.5Y 4/4) silty clay, dark reddish brown (2.5YR 3/4) moist; moderate very fine subangular blocky structure; extremely hard, very firm; 70 percent of the mass consists of platy, much fractured silty shale and clay films cover the shale partings; very few roots; few hard lime concretions about 5 millimeters in diameter; moderately alkaline; clear smooth boundary.

C4—50 to 60 inches; silty and clayey shale.

The solum is 50 or more inches thick. The thickness of mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5 (3 or 4 moist); and chroma of 2 or 3. It is typically silty clay loam, but it can also be clay loam and silt loam. Reaction is slightly acid or neutral. The B2t horizon has hue of 2.5YR or 5YR, value of 3 to 5, and chroma of 2 to 4. It is clay or silty clay. Reaction is slightly acid to moderately alkaline. The lower part of the B2t horizon has various amounts of shale fragments, but these fragments do not exceed 35 percent of the volume. Some pedons have lime concretions at a depth of 28 inches. Also, some pedons have an R layer of consolidated shale at a depth of 40 inches.

## Rosehill series

The Rosehill series consists of moderately deep, well drained, very slowly permeable soils on erosional uplands. These soils formed in clayey residuum weathered from shale. Slopes range from 1 to 3 percent.

Rosehill soils are similar to Clime and Goessel soils and are commonly adjacent to Clime, Goessel, Irwin, and Tabler soils on the landscape. Clime soils contain carbonates within a depth of 10 inches. Goessel soils are more than 60 inches deep over shale and are on broader, smoother parts of the landscape. Irwin soils are deeper than Rosehill soils and have an argillic horizon. Tabler soils have an argillic horizon and are nearly level.

Typical pedon of Rosehill silty clay, 1 to 3 percent slopes, 1,520 feet west and 50 feet north of the southeast corner of section 25, T. 25 S., R. 1 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; weak medium granular and fine blocky structure; extremely hard, very firm; very few roots; few sand grains; neutral; clear smooth boundary.

AC1—8 to 20 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak fine blocky structure; extremely hard, very firm; few open pores; few fine sand grains; mildly alkaline; gradual smooth boundary.

AC2—20 to 30 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; interior of some peds is olive brown (2.5Y 4/4); common very dark grayish brown (10YR 3/2) vertical tongues and pockets; weak fine blocky structure; extremely hard, very firm; few fine hard calcium carbonate concretions; no roots; few open pores; few fine grains of sand; moderately alkaline; clear smooth boundary.

Cr—30 to 37 inches; dark gray and light yellowish brown shaly clay.

The thickness of the solum ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay, but it can also be heavy silty clay loam. Reaction is neutral or slightly acid. The AC horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 to 7 (3 to 6 moist), and chroma of 2 to 4 moist. It is silty clay or clay. Reaction ranges from neutral to moderately alkaline. The C horizon, if it occurs, has hue of 10YR or 2.5Y, value of 4 to 7 dry or moist, and chroma of 2 to 4. It is clay or shaly clay. Reaction is mildly alkaline or moderately alkaline. Free carbonates in the form of films, threads, or soft masses are within a depth of 28 inches in some pedons.

## Shellabarger series

The Shellabarger series consists of deep, well drained, moderately permeable soils that formed in old alluvium on terraces and uplands. Slopes range from 1 to 12 percent.

Shellabarger soils are similar to Albion, Milan, and Naron soils and are commonly adjacent to those soils and to Farnum and Vernon soils. Albion soils have a sand substratum at a depth of 20 to 40 inches and are typically more sloping than Shellabarger soils. Farnum and Milan soils have a clay loam argillic horizon and are less sloping than Shellabarger soils. Naron soils are less red than Shellabarger soils and typically are less sloping. Vernon soils are underlain by shale at a depth of 20 to 40 inches.

Typical pedon of Shellabarger sandy loam, 1 to 3 percent slopes (fig. 12), 300 feet south and 1,800 feet east of the northwest corner of section 2, T. 28 S., R. 2 W.

A1—0 to 10 inches; dark brown (7.5YR 3/2) sandy loam, very dark brown (7.5YR 2/2) moist; weak fine granular structure; soft, very friable; many roots; slightly acid; gradual smooth boundary.

B1—10 to 15 inches; dark reddish brown (5YR 3/2) heavy sandy loam, dark reddish brown (5YR 2/2) moist; moderate medium granular structure; slightly hard, friable; many roots; slightly acid; clear smooth boundary.

B2t—15 to 40 inches; yellowish red (5YR 4/6) sandy clay loam, yellowish red (5YR 3/6) moist; moderate coarse prismatic structure that breaks to moderate fine subangular blocky; hard, firm; clay bridges between sand particles; common roots; slightly acid; gradual smooth boundary.

C—40 to 60 inches; yellowish red (5YR 5/6) heavy sandy loam, yellowish red (5YR 4/6) moist; very weak medium blocky structure; slightly hard, very friable; few roots; slightly acid.

The thickness of the solum ranges from 36 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 5YR, 7.5YR, 10YR; value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3 dry or moist. It is typically sandy loam and less commonly is loamy fine sand. Reaction is medium 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 6 dry or moist. It is sandy clay loam or heavy sandy loam. It averages between 18 and 27 percent clay and more than 20 percent sand coarser than fine sand. Some pedons have a few mottles of yellow or brown in the lower part of the B horizon. Reaction ranges from slightly acid to mildly alkaline.

The C horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 4 to 6 (3.5 to 6 moist); and chroma of 4 to 6 dry or moist. It is sandy loam, fine sandy loam, or loamy sand. Reaction ranges from slightly acid to moderately alkaline. Some pedons contain gravel as much as 1 inch in diameter in the upper part of the solum, but no horizon is more than 10 percent by volume.

## Tabler series

The Tabler series consists of deep, moderately well drained, very slowly permeable soils on terraces and uplands. These soils formed in old clayey sediments. Slopes are 0 to 1 percent.

Tabler soils are similar to Blanket, Carwile, Drummond, Goessel, Irwin, and Waurika soils and are commonly adjacent to Blanket, Carwile, Drummond, Elandco, Goessel, Irwin, Rosehill, and Waurika soils. Blanket soils have a thicker A horizon than Tabler soils and are more gradational to the B2t horizon. Carwile soils have a coarser textured A horizon than Tabler soils and have distinct mottles within 15 inches of the surface. Drummond soils have a natric horizon. Goessel soils have a silty clay A horizon and lack an argillic horizon. Irwin soils have higher chroma in the upper part of the argillic horizon than Tabler soils and are more sloping. Rosehill soils are moderately deep over shale, and Waurika soils have an albic horizon. Blanket, Irwin, and Rosehill soils are typically more undulating than Tabler soils. Elandco soils are on flood plains.

Typical pedon of Tabler silty clay loam 1,100 feet south and 900 feet west of the northeast corner of section 16, T. 25 S., R. 2 E.

Ap—0 to 9 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate fine granular structure; hard, friable; few roots; few open pores; medium acid; clear smooth boundary.

B21t—9 to 27 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; weak fine blocky structure; very hard, firm; few roots; few open pores; slightly acid; gradual smooth boundary.

B22t—27 to 32 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak medium blocky structure; extremely hard, very firm; few open pores; thick continuous clay films; moderately alkaline; gradual smooth boundary.

B3—32 to 44 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; weak medium blocky structure; extremely hard, very firm; few small lime concretions; moderately alkaline; gradual smooth boundary.

C—44 to 60 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; few faint medium mottles of brown (10YR 5/3); massive; very hard, very firm; few small lime concretions; moderately alkaline.

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

The A horizon has hue of 10YR, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. It is silty clay loam, clay loam, or silt loam. Reaction ranges from medium acid to moderately alkaline. The Bt horizon has hue of 10YR, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. It is silty clay or clay. Reaction ranges from slightly acid to moderately alkaline. The C horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 1 to 3. It is silty clay loam, silty clay, clay loam, or clay. Reaction is mildly alkaline or moderately alkaline. This horizon is mottled in shades of gray, brown, or red. It is calcareous or noncalcareous.

## Tivoli series

The Tivoli series consists of deep, excessively drained, rapidly permeable soils on eolian uplands. These soils formed in eolian sandy sediments. Slopes range from 5 to 30 percent.

Tivoli soils are similar to Lincoln and Pratt soils and are commonly adjacent to Plevna, Pratt, and Lincoln soils on the landscape. Pratt soils are on smoother parts of the landscape and have an argillic horizon. Plevna soils are on flood plains, have a fine sandy loam solum, and are poorly drained. Lincoln soils are on flood plains and contain strata finer than loamy fine sand in the control section.

Typical pedon of Tivoli loamy fine sand, in an area of Pratt-Tivoli complex, rolling, 400 feet north and 1,000 feet west of the southeast corner of section 6, T. 29 S., R. 3 W.

A1—0 to 10 inches; brown (7.5YR 5/2) loamy fine sand, dark brown (7.5YR 4/2) moist; very weak fine granular structure; loose, very friable; neutral; gradual smooth boundary.

C—10 to 60 inches; light brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) moist, single grained; loose; neutral.

The thickness of the solum ranges from 4 to 10 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 2 to 6. It is loamy fine sand or fine sand. It is slightly acid to mildly alkaline. The C horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 3 to 6. It is slightly acid to mildly alkaline in the upper part and neutral to moderately alkaline in the lower part. The C horizon is fine sand or sand.

## Vanoss series

The Vanoss series consists of deep, well drained, moderately permeable soils on loess-covered uplands. These soils formed in loamy or silty sediments. Slopes range from 0 to 6 percent.

Vanoss soils are similar to Blanket and Elandco soils and are commonly adjacent to Blanket, Farnum, and Waurika soils on the landscape. Blanket, Elandco, and Farnum soils have a mollic epipedon thicker than 20 inches. Also, Elandco soils also lack an argillic horizon. Blanket and Farnum soils typically are less sloping than Vanoss soils and are above those soils on the landscape. Elandco soils are on flood plains. Waurika soils have an albic horizon and are in depressional areas.

Typical pedon of Vanoss silt loam, 1 to 3 percent slopes, 2,600 feet north and 100 feet east of the southwest corner of section 25, T. 26 S., R. 3 W.

Ap—0 to 6 inches; brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A12—6 to 13 inches; brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

B1—13 to 16 inches; brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; strong fine and very fine subangular blocky structure; hard, friable; medium acid; gradual smooth boundary.

B21t—16 to 40 inches; brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 3/4) moist; moderate fine and medium blocky structure; hard, firm; medium acid; gradual smooth boundary.

B22t—40 to 60 inches; brown (7.5YR 5/3) silty clay loam, dark brown (7.5YR 4/3) moist; weak medium blocky structure; very hard, very firm; slightly acid.

The thickness of the solum ranges from 40 to more than 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

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

The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5 dry and 3 or 4 moist, and chroma of 3 or 4. It is silty clay loam or clay loam that is about 27 to 35 percent clay. Reaction ranges from slightly acid to strongly acid.

The C horizon, if it occurs, has hue of 7.5YR or 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 3 to 5. It is clay loam, silt loam, or silty clay loam. Reaction is medium acid to neutral.

## Vernon series

The Vernon series consists of well drained, very slowly permeable soils that are moderately deep over clayey shale. These soils are on uplands. They formed in clayey material apparently weathered from shale. Slopes range from 1 to 6 percent.

The Vernon soils in Sedgwick County are taxadjuncts to the Vernon series because the A and B1 horizons contain more sand than is defined as the range for the series and because the soils lack free carbonates. These differences, however, do not alter the use or behavior of the soils.

Vernon soils are similar to Owens and Renfrow soils and are commonly adjacent to those soils and to Milan and Shellabarger soils on the landscape. Owens soils have a solum that is less than 20 inches thick. Renfrow soils have a solum that is more than 40 inches thick. Shellabarger and Milan soils have fine loamy control sections and are on narrow, convex ridgetops.

Typical pedon of Vernon sandy loam, 1 to 3 percent slopes (fig. 13), 800 feet north and 100 feet west of the southeast corner of section 31, T. 27 S., R. 4 W.

Ap—0 to 8 inches; dark brown (7.5YR 4/2) sandy loam, dark brown (7.5YR 3/2) moist; weak medium granular structure; slightly hard, friable; neutral; gradual smooth boundary.

B1—8 to 13 inches; reddish brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; hard, firm; many open pores; few roots; neutral; gradual smooth boundary.

IIB2—13 to 24 inches; reddish brown (5YR 4/3) silty clay, dark reddish brown (5YR 3/3) moist; moderate fine blocky structure; thick and continuous clay films; extremely hard, very firm; many open pores; few roots; neutral; gradual smooth boundary.

C1—24 to 28 inches; reddish brown (5YR 4/3) clay, dark reddish gray (5YR 4/2) moist; very weak fine blocky structure; few shale fragments; extremely hard, very firm; few black concretions; slightly alkaline; clear smooth boundary.

Cr—28 inches; red clayey shale.

The thickness of solum ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 moist and 3 to 5 dry, chroma of 2 or 3. It is loam, sandy loam, or clay loam. Reaction ranges from slightly acid to mildly alkaline. The B2t horizon has hue of 2.5YR or 5YR, value of 3 or 4, and chroma of 3 or 4. It is neutral to moderately alkaline. It is sandy clay, silty clay, or clay. The C horizon is red, yellowish red, pale red, or reddish brown in hues 2.5YR and 5YR. It ranges from massive clay to silty or clayey shale.

## Waldeck series

The Waldeck series consists of somewhat poorly drained, moderately rapidly permeable, nearly level soils on flood plains and low terraces. These soils are moderately deep over sand. They formed in moderately coarse textured alluvium that grades to coarse textured alluvium at a depth of 2 to 4 feet. Slopes are 0 to 1 percent.

Waldeck soils are similar to Lesho and Plevna soils and are commonly adjacent to Canadian, Lesho, Plevna, and Lincoln soils on the landscape. Lesho soils have a thicker mollic epipedon than Waldeck soils and have a fine loamy control section. Plevna soils are poorly drained. Canadian soils are deeper than Waldeck soils and are less mottled, better drained, and in slightly higher areas. Lesho, Plevna, and Waldeck soils are on similar parts of the landscape. Lincoln soils are somewhat excessively drained and occur adjacent to streams.

Typical pedon of Waldeck sandy loam 1,000 feet east and 50 feet north of the southwest corner of section 34, T. 26 S., R. 1 W.

Ap—0 to 14 inches; dark gray (10YR 4/1) sandy loam, very dark gray (10YR 3/1) moist; weak fine granular structure; soft, very friable; slight effervescence; mildly alkaline; gradual smooth boundary.

AC—14 to 27 inches; light brownish gray (10YR 6/2) sandy loam, grayish brown (10YR 5/2) moist; common medium distinct yellowish brown (10YR 5/6) mottles in the lower part; weak medium granular structure; soft, very friable; slight effervescence, mildly alkaline; gradual smooth boundary.

C—27 to 60 inches; pale brown (10YR 6/3) coarse sand, brown (10YR 5/3) moist; common medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose, soft; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 18 to 30 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches. Reaction throughout the profile is mildly alkaline or moderately alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is sandy loam, fine sandy loam, or loam. The AC horizon has hue of 7.5YR or 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. It is sandy loam or fine sandy loam. The C horizon has hue of 7.5YR or 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is fine sand or sand. Strata of finer or coarser textured material are typically throughout the C horizon.

## Waurika series

The Waurika series consists of deep, somewhat poorly drained, very slowly permeable soils on nearly level or slightly concave uplands. These soils formed in clayey sediments. Slopes are 0 to 1 percent.

Waurika soils are similar to Tabler soils and are commonly adjacent to Blanket, Tabler, and Vanoss soils on the landscape. Tabler soils lack an albic horizon. Blanket and Vanoss soils are well drained.

Typical pedon of Waurika silt loam 2,500 feet south and 1,850 feet east of the northwest corner of section 10, T. 26 S., R. 2 W.

Ap—0 to 10 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; few medium faint mottles of dark yellowish brown (10YR 4/4) in the lower part; weak fine granular structure; soft, very friable; many open pores; slightly acid; clear smooth boundary.

A2—10 to 15 inches; gray (10YR 5/1) silt loam, dark gray (10YR 4/1) moist; few medium faint mottles of dark yellowish brown (10YR 4/4); massive; porous; soft, very friable; many open pores; slightly acid; abrupt smooth boundary.

B2t—15 to 40 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; weak medium blocky structure; extremely hard, very firm; few open pores; neutral; gradual smooth boundary.

B3—40 to 53 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; few medium faint mottles of dark yellowish brown (10YR 4/4); weak fine blocky structure; extremely hard, very firm; few open pores; few fine black concretions; mildly alkaline; gradual smooth boundary.

C—53 to 60 inches; light brownish gray (10YR 6/2) light silty clay, dark grayish brown (10YR 4/2) moist; common medium faint mottles of pale brown (10YR 6/3); massive; extremely hard, very firm; very few fine open pores; mildly alkaline.

The thickness of the solum ranges from 40 to more than 60 inches. The mollic epipedon is 10 to 15 inches thick.

The Ap or A1 horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. Texture is silt loam. Reaction is slightly acid or medium acid. The A2 horizon has hue of 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 1 or 2. Texture is silt loam. The B2t horizon has hue of 10YR, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. Texture is silty clay or clay. Reaction is neutral to moderately alkaline. The B3 and C horizons have hue of 10YR, value of 5 or 6 (3 to 5 moist), and chroma of 1 to 3. Texture is silty clay, heavy silty clay loam, or heavy clay loam. Reaction is mildly alkaline or moderately alkaline.

Dark yellowish brown mottles are concentrated in the lower part of the A1 horizon in most pedons. In some pedons they extend through the A2 horizon and the upper part of the B2t horizon.

# Classification of the soils

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 "Soil taxonomy" (*7*).

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 Ustoll (*Ust*, meaning Ustic moisture regime, 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 Argiustolls (*Argi*, meaning argillic horizons, plus *ustoll*, the suborder of Mollisols that have a ustic 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 preceding the name of the great group. The adjective *Pachic* identifies the subgroup that has a thick dark surface layer. An example is Pachic Argiustolls.

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 Pachic Argiustolls.

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

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

The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material formed and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or topography of the land, and (5) the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly bring about the development of 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 changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Typically, 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 effect of any one factor unless conditions are specified for the other four. Many processes of soil formation are unknown.

## Parent material

Parent material, the unconsolidated material from which a soil forms, is a result of the weathering of rocks through the processes of freezing and thawing and soil blowing and erosion and the grinding away of rocks by rivers and glaciers. It forms as a result of chemical processes.

The oldest geologic formation furnishing parent material in Sedgwick County is the Wellington Formation of the Permian System (*8*), which crops out in the eastern part of the county. It is soft, calcareous, gray and bluish gray shale that contains several thin beds of limestone and gypsum. Rosehill and Clime soils probably formed in material weathered from this shale. In the western part of the county are outcrops of Ninnescah shale, which is also part of the Permian System. Renfrow, Vernon, and Owens soils probably formed in material weathered from this shale.

During the Pleistocene epoch, streams deposited sediments ranging from sand to clay. Some of these outwash sediments were reworked by wind before vegetation became established. Other areas were covered by windblown material. The thickness of this material varies. Blanket, Carwile, Farnum, Milan, Vanoss, and Irwin soils formed in this material.

Eolian sand is the parent material of some of the soils in the county. The sand is probably derived from sediments in the Arkansas Valley and from older Pleistocene stream deposits southwest of this area (*8*). Pratt and Tivoli soils formed in these sandy deposits. Naron, Farnum, Milan, and Shellabarger soils formed partly in eolian deposits.

Alluvium of late Quaternary age is in stream valleys (*6*). Lesho, Lincoln, and Elandco soils formed in these sediments.

## Climate

Climate has played an improtant role in the formation of soils in Sedgwick County. Precipitation, temperature, and wind affect the type of soil profile that forms.

Moisture from rainfall and other sources enters the soil, dissolves soluble materials, and transports them downward. It permits plants to grow and contributes organic matter to the soil. As moisture moves downward, it carries clay particles and minerals with it and deposits them in the subsoil, or B horizon. Moisture also allows soil organisms to increase in number and activity. These organisms help to darken the soil by changing plant material to organic matter.

Alternate wetting and drying of soils that are high in content of clay results in shrinking and swelling of soil particles. This shrinking and swelling in turn causes a churning action, and the soil becomes unstable. This churning action throws fences out of alignment, pops staples, and cracks foundations. It takes place, for example, in Goessel soils.

Variations in temperature affect soils in several ways. Alternate freezing and thawing break up soil aggregates and change soil structure. As temperature increases, more evaporation takes place and less moisture is available for plant growth. The growth of organisms generally increases as temperature increases. Another factor that increases with a rise in temperature is the rate at which chemicals react and affect the weathering of minerals and the decomposition of organic material.

Wind also affects soil formation. Most of the precipitation in Sedgwick County falls in summer. The hot summer wind, however, evaporates moisture rapidly. It blows the fine particles from the plow layer and thus decreases soil fertility and, in time, changes soil texture. This winnowing is evident in Naron, Canadian, Pratt, and Shellabarger soils.

### Plant and animal life

Animal life and vegetation are indispensable in soil formation. Burrowing animals, fungi, and other micro-organisms help to weather rock and decompose organic material. Plant and animal life also influences the chemical and biological processes that take place in the soil.

Plants are the main source or organic matter. The soils in Sedgwick County formed under tall and mid grasses, which supply enormous amounts of roots that decay and add organic matter. Organic matter from decayed roots accounts for the dark colored surface layer of the soils in Sedgwick County.

### Relief

Relief, or lay of the land, influences formation of soils through its effect on drainage, erosion, temperature, and plant cover. Runoff is excessive where slopes are moderate and steep because the soil is unable to absorb all the rainfall. A steep soil that is not protected by plant cover is eroded by excessive runoff more readily than a less sloping one. Owens soils are an example. Soils in low-lying areas where surface drainage is poor are likely to have a dark gray or mottled subsoil. Examples are Tabler, Goessel, and Carwile soils.

### Time

Time is needed for soils to form from parent material. Some soils form rapidly, and others form slowly. The length of time required for a particular soil to form depends on the other factors of soil formation. As water moves downward through the soil, soluble material and fine particles are leached from the surface layer and deposited in the subsoil. How long this process takes depends chiefly on how long the soil material has been in place and how much water penetrates the surface.

Some soils, such as Tivoli soils, lack horizon development because they formed in material that is highly resistant to weathering. Others, such as Elandco or Lesho soils, show little horizon development because they are young and time has been insufficient for genetic horizons to develop. Blanket, Irwin, and Tabler soils have been exposed to soil-forming processes for thousands of years and have well defined horizons.

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## Glossary

**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.

**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 |

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

**Blowout.** A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

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

**Cation.** An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

**Cation-exchange capacity.** The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

**Chiseling.** Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

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

**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.

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

**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.

**Coarse textured (light textured) soil.** Sand or loamy sand.

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

**Complex slope.** Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

**Complex, soil.** A map 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.

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

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

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

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

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

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

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

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

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

*Cemented.*—Hard; little affected by moistening.

**Control section.** The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

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

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

**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.

**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."

**Drainage, surface.** Runoff, or surface flow of water, from an area.

**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.

**Fertility, soil.** The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

**Fine textured (heavy textured) soil.** Sandy clay, silty clay, and clay.

**First bottom.** The normal flood plain of a stream, subject to frequent or occasional flooding.

**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.

**Foot slope.** The inclined surface at the base of a hill.

**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.

**Frost action.** Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

**Genesis, soil.** The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

**Gilgai.** Typically, the microrelief of Vertisols—clayey soils having a high coefficient of expansion and contraction with changes in moisture content. Commonly a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope.

**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.

**Ground water** (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

**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.

**Hummocky.** Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

**Humus.** The well decomposed, more or less stable part of the organic matter in mineral soils.

**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.

**Infiltration rate.** The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

**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.

**Lacustrine deposit** (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

**Light textured soil.** Sand and loamy sand.

**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.

**Medium textured soil.** Very fine sandy loam, loam, silt loam, or silt.

**Mineral soil.** Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

**Minimum tillage.** Only the tillage essential to crop production and prevention of soil damage.

**Miscellaneous areas.** Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

**Moderately coarse textured (moderately light textured) soil.** Sandy loam and fine sandy loam.

**Moderately fine textured (moderately heavy textured) soil.** Clay loam, sandy clay loam, and silty clay loam.

**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.

**Neutral soil.** A soil having a pH value between 6.6 and 7.3.

**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.

**Pan.** A compact, dense layer in a soil. A pan impedes the movement of water and the growth of roots. The word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan*, *fragipan*, *claypan*, *plowpan*, and *traffic pan*.

**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 basis 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.

**Plowpan.** A compacted layer formed in the soil directly below the plowed layer.

**Poorly graded.** Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

**Poor outlets.** Surface or subsurface drainage outlets difficult or expensive to install.

**Productivity** (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

**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 |

**Regolith.** The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Residuum (residual soil material).** Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

**Rill.** A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

**Rock fragments.** Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

**Rooting depth.** Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

**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-alkali soil.** A soil that contains a harmful concentration of salts and exchangeable sodium; contains harmful salts and is strongly alkaline; or contains harmful salts and exchangeable sodium and is very strongly alkaline. The salts, exchangeable sodium, and alkaline reaction are in the soil in such location that growth of most crop plants is less than normal.

**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.

**Sedimentary rock.** Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

**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.

**Shale.** Sedimentary rock formed by the hardening of a clay deposit.

**Sheet erosion.** The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

**Shrink-swell.** The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

**Silt.** As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

**Site index.** A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

**Slickensides.** Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

**Slick spot.** Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

**Slope.** The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

**Slow intake.** The slow movement of water into the soil.

**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 characteristic 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.

**Stripcropping.** Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

**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).

**Stubble mulch.** Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Subsoiling.** Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

**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."

**Taxadjuncts.** Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

**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.

**Trace elements.** The chemical elements in soils, in only extremely small amounts, essential to plant growth. Examples are zinc, cobalt, manganese, copper, and iron.

**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.

**Well graded.** Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

# Illustrations

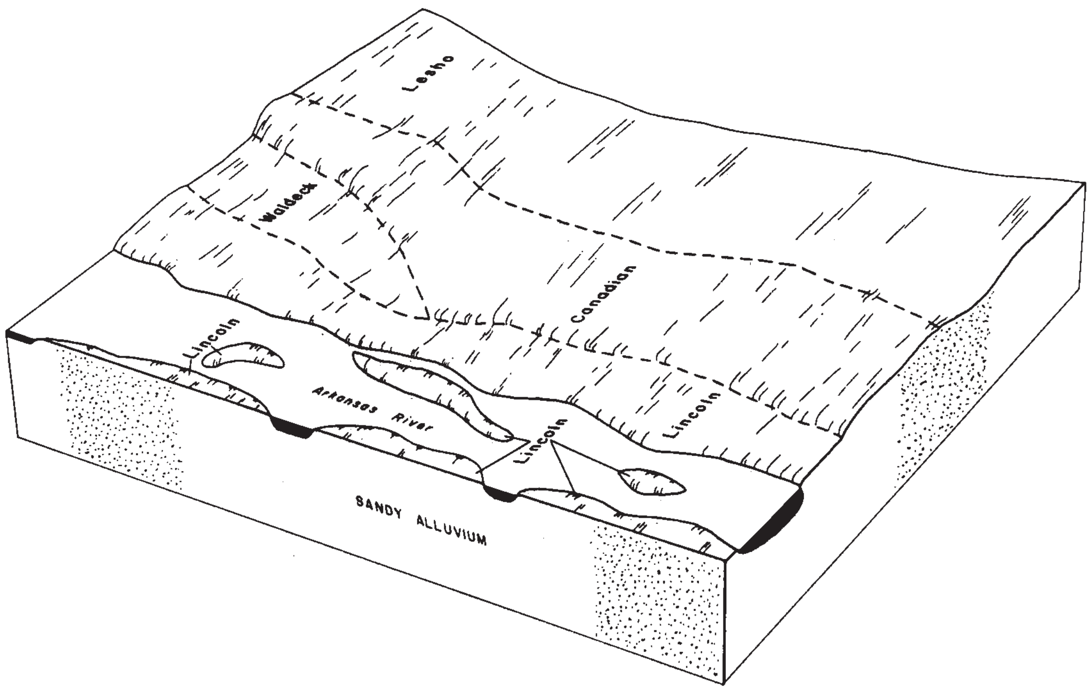


*Figure 1.*—Typical pattern of soils and underlying material in the Lesho-Lincoln-Canadian map unit.

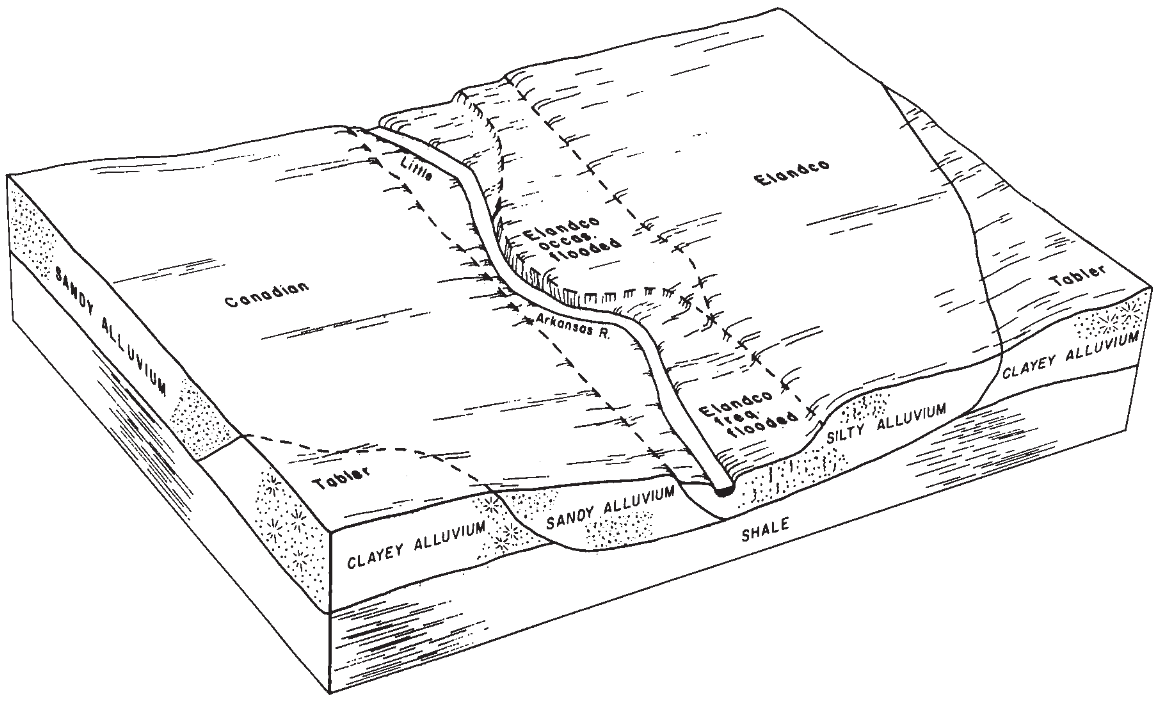


*Figure 2.*—Typical pattern of soils and underlying material in the Elandco-Canadian map unit.

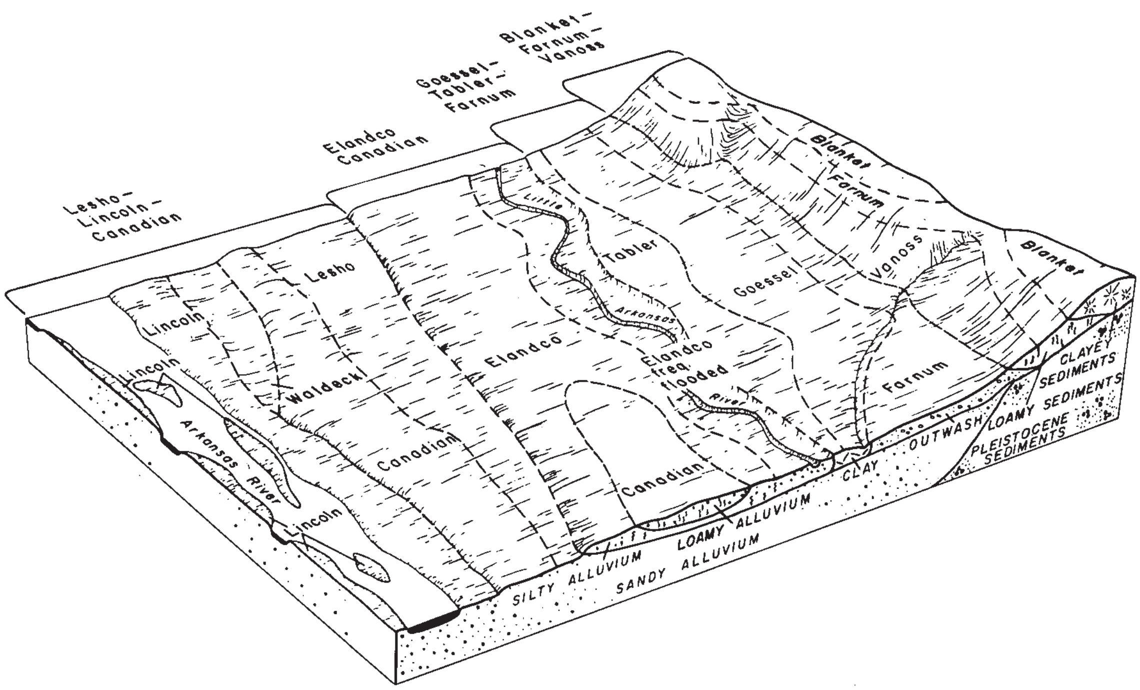


*Figure 3.*—Typical pattern of soils and underlying material in the valley of the Arkansas River and adjacent uplands.

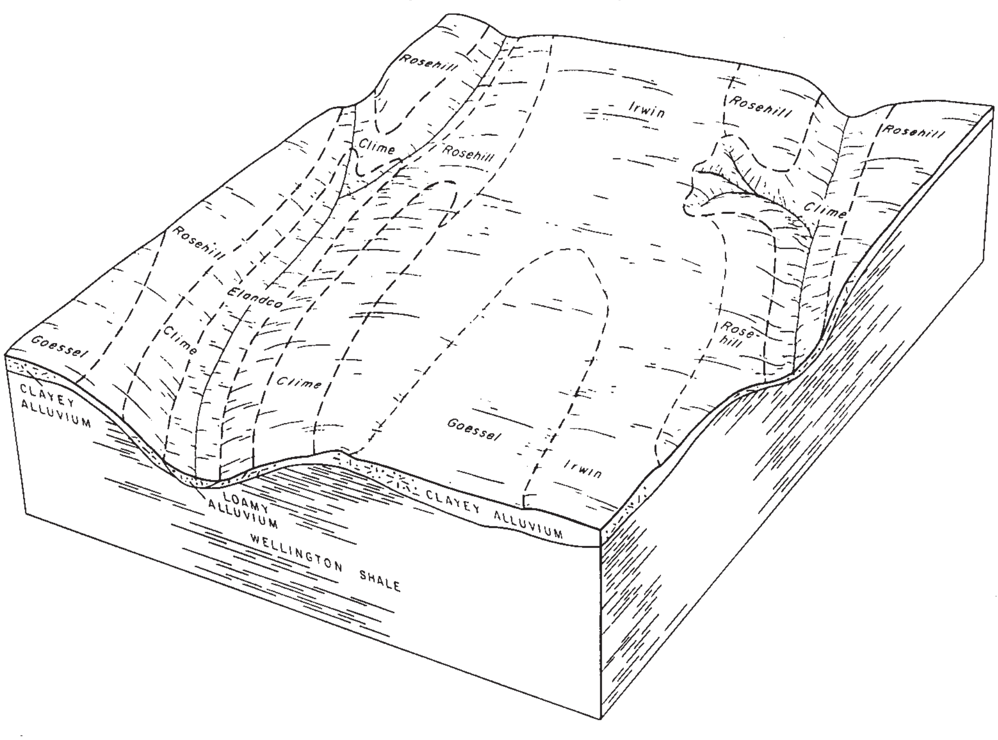


*Figure 4.*—Typical pattern of soils and underlying material in the Irwin-Goessel-Rosehill map unit.

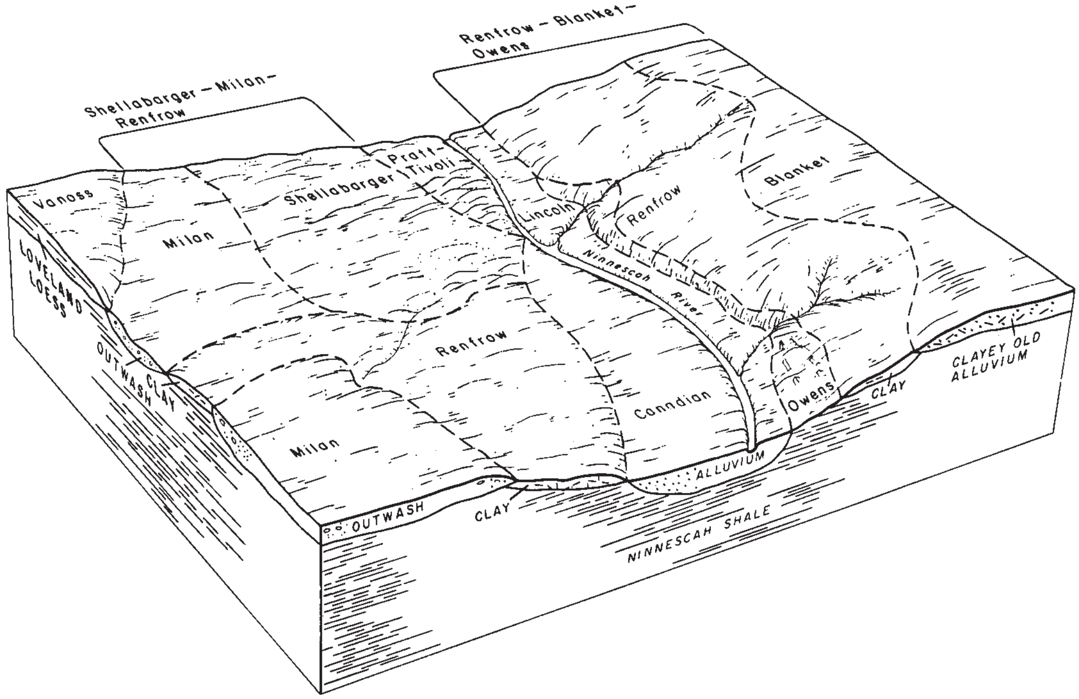


*Figure 5.*—Typical pattern of soils and underlying material in the Shellabarger-Milan-Renfrow and the Renfrow-Blanket-Owens map units.

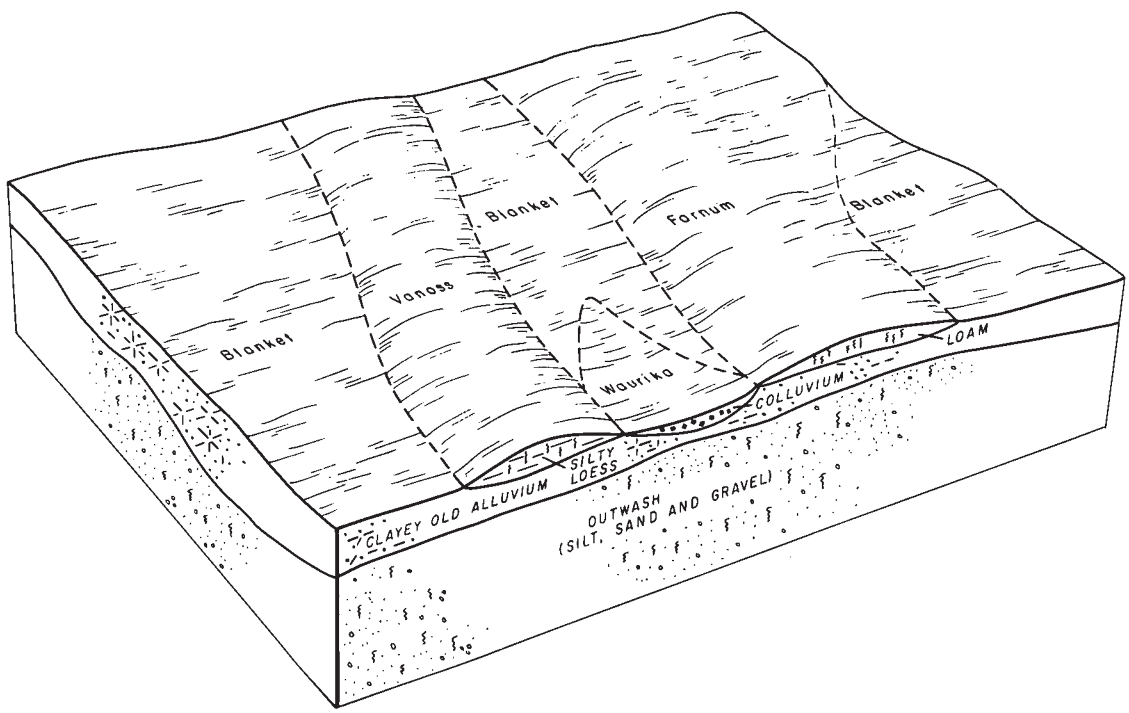


*Figure 6.*—Typical pattern of soils and underlying material in the Blanket-Farnum-Vanoss map unit.

*Figure 7.*—Range on Elandco silt loam, frequently flooded.

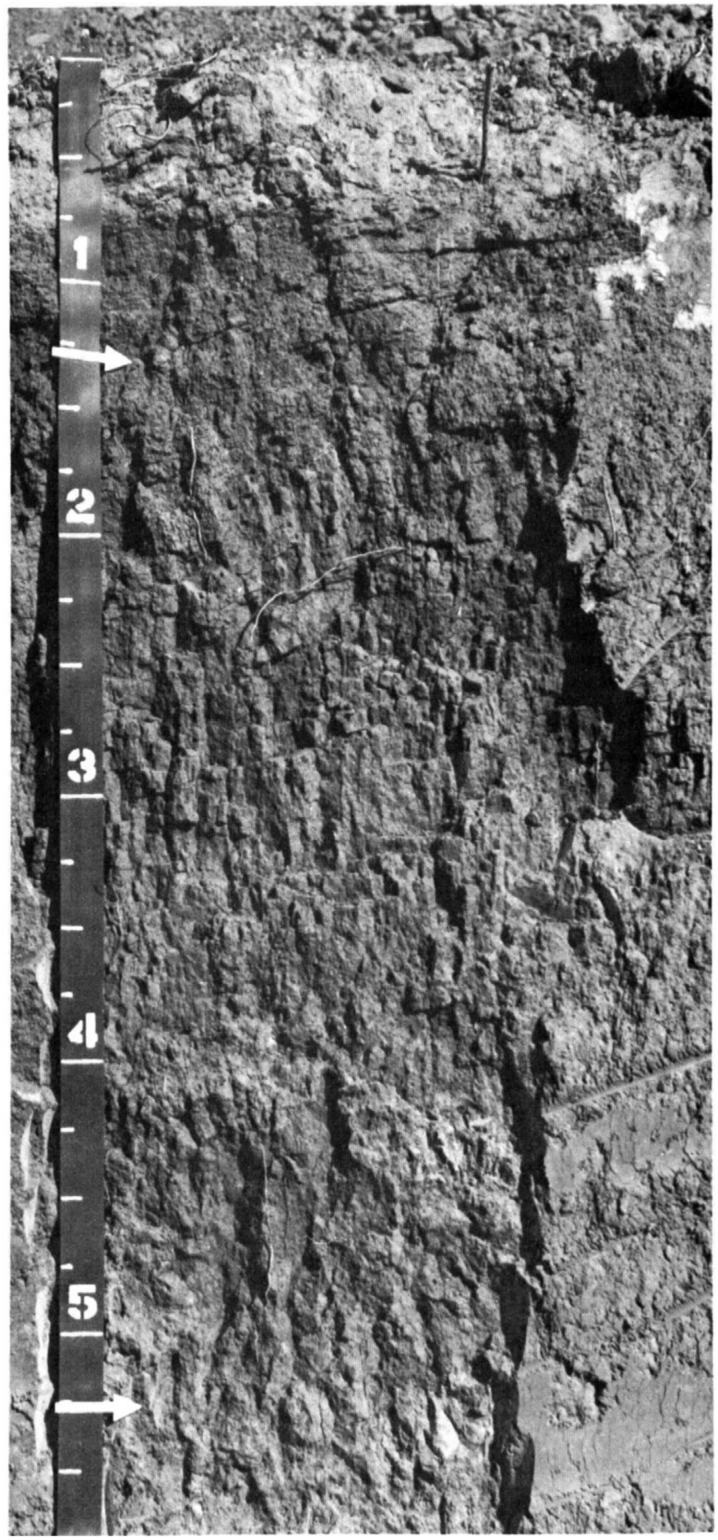


*Figure 8.*—Typical profile of Farnum loam, 0 to 1 percent slopes.

*Figure 9.*—Abundant prairie cordgrass on Plevna fine sandy loam.

*Figure 10.*—Housing development on Tabler-Drummond complex. The white, crusty surface is practically void of vegetation.

*Figure 11.*—Pollution abatement facility on Elandco silt loam, occasionally flooded.

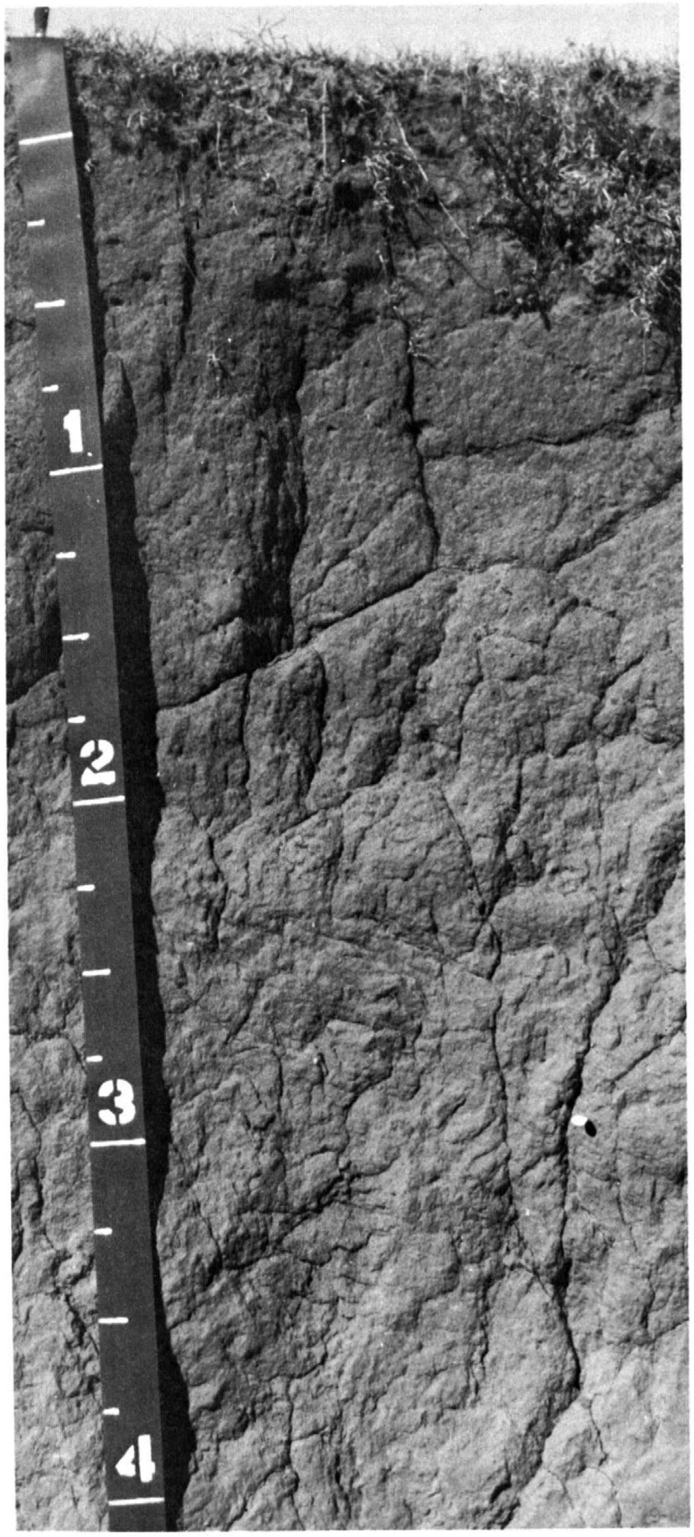

*Figure 12.*—Typical profile of Shellabarger sandy loam, 1 to 3 percent slopes.

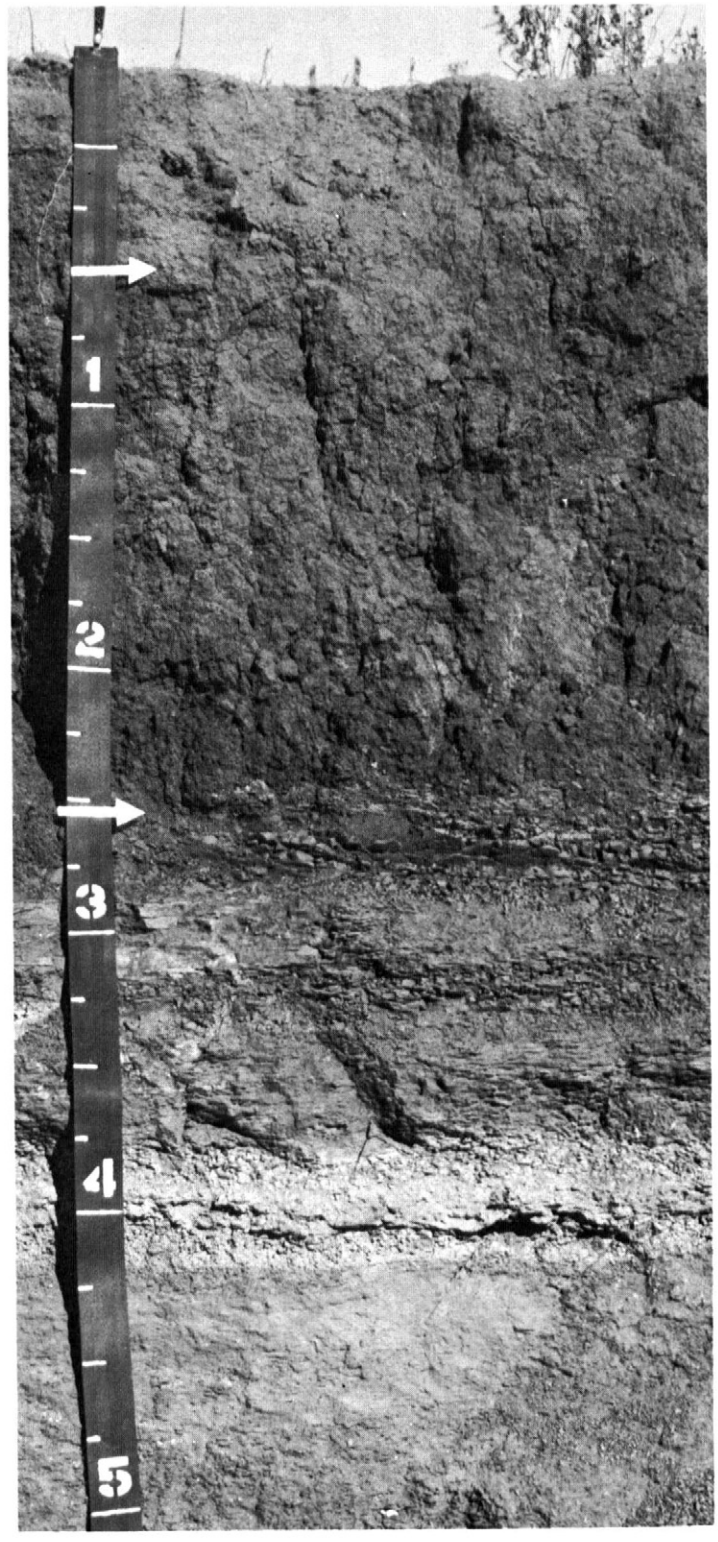

*Figure 13.*—Typical profile of Vernon sandy loam, 1 to 3 percent slopes. Red clayey shale is at a depth of about 28 inches.

# Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

| Month | Temperature[1]: Average daily maximum | Average daily minimum | Average daily | 2 years in 10 will have--: Maximum temperature higher than-- | Minimum temperature lower than-- | Precipitation[1]: Average | 2 years in 10 will have--: Less than-- | More than-- | Average number of days with 0.10 inch or more | Average snowfall |
|---|---|---|---|---|---|---|---|---|---|---|
| | °F | °F | °F | °F | °F | In | In | In | | In |
| January----- | 40.6 | 20.2 | 30.4 | 69 | -5 | 0.53 | 0.17 | 0.91 | 2 | 3.9 |
| February---- | 46.5 | 24.7 | 35.6 | 77 | 2 | 0.79 | 0.21 | 1.42 | 2 | 3.2 |
| March------- | 54.9 | 31.5 | 43.2 | 86 | 4 | 1.55 | 0.53 | 2.64 | 3 | 3.7 |
| April------- | 69.0 | 45.2 | 57.1 | 92 | 26 | 2.06 | 1.15 | 3.11 | 4 | 0.1 |
| May--------- | 78.0 | 55.6 | 66.8 | 98 | 35 | 3.80 | 1.41 | 5.96 | 6 | 0 |
| June-------- | 86.4 | 64.6 | 75.5 | 102 | 47 | 4.38 | 2.37 | 6.76 | 7 | 0 |
| July-------- | 92.6 | 70.2 | 81.4 | 106 | 55 | 3.30 | 1.59 | 6.81 | 6 | 0 |
| August------ | 91.1 | 68.1 | 79.6 | 107 | 52 | 3.05 | 1.02 | 5.39 | 4 | 0 |
| September--- | 81.4 | 59.5 | 70.5 | 101 | 42 | 4.04 | 1.79 | 5.99 | 6 | 0 |
| October----- | 70.9 | 47.7 | 59.3 | 92 | 29 | 2.77 | 0.98 | 4.93 | 4 | 0 |
| November---- | 55.9 | 33.7 | 44.8 | 77 | 11 | 1.15 | 0.04 | 2.42 | 2 | 0.5 |
| December---- | 44.7 | 24.4 | 34.6 | 68 | -2 | 0.89 | 0.37 | 1.49 | 2 | 3.2 |
| Year------ | 67.7 | 45.4 | 56.6 | 107 | -5 | 28.93 | 19.88 | 36.93 | 47 | 15.4 |

[1]Recorded in the period 1954-70 at Wichita, Kansas.

TABLE 2.--FREEZE DATES IN SPRING AND FALL

| Probability | Minimum 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 8 | April 19 | April 30 |
| 2 years in 10 later than-- | April 3 | April 14 | April 25 |
| 5 years in 10 later than-- | March 25 | April 4 | April 15 |
| First freezing temperature in fall: | | | |
| 1 year in 10 earlier than-- | November 2 | October 22 | October 10 |
| 2 years in 10 earlier than-- | November 6 | October 27 | October 14 |
| 5 years in 10 earlier than-- | November 16 | November 5 | October 24 |

[1]Recorded in the period 1931-60 at Wichita.

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 | 222 | 204 | 191 |
| 8 years in 10 | 231 | 211 | 197 |
| 5 years in 10 | 248 | 223 | 210 |
| 2 years in 10 | 265 | 235 | 222 |
| 1 year in 10 | 273 | 241 | 229 |

[1]Recorded in the period 1931-60 at Wichita.

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

| Map symbol | Soil name | Acres | Percent |
|---|---|---|---|
| Aa | Albion-Shellabarger sandy loams, 1 to 4 percent slopes | 2,346 | 0.4 |
| Ab | Albion and Shellabarger sandy loams, 7 to 15 percent slopes | 783 | 0.1 |
| Ba | Blanket silt loam, 0 to 1 percent slopes | 52,961 | 8.3 |
| Bb | Blanket silt loam, 1 to 3 percent slopes | 49,997 | 7.9 |
| Ca | Canadian fine sandy loam | 17,779 | 2.8 |
| Cb | Canadian-Waldeck fine sandy loams | 4,352 | 0.7 |
| Cc | Carwile fine sandy loam | 13,696 | 2.1 |
| Cd | Clark-Ost clay loams, 1 to 4 percent slopes | 2,887 | 0.4 |
| Ce | Clime silty clay, 3 to 6 percent slopes | 9,775 | 1.5 |
| Ea | Elandco silt loam | 21,049 | 3.3 |
| Eb | Elandco silt loam, occasionally flooded | 8,658 | 1.3 |
| Ec | Elandco silt loam, frequently flooded | 9,867 | 1.5 |
| Fa | Farnum loam, 0 to 1 percent slopes | 12,693 | 2.0 |
| Fb | Farnum loam, 1 to 3 percent slopes | 54,537 | 8.6 |
| Fc | Farnum loam, sandy substratum, 0 to 1 percent slopes | 13,199 | 2.0 |
| Ga | Goessel silty clay, 0 to 1 percent slopes | 3,161 | 0.5 |
| Gb | Goessel silty clay, 1 to 2 percent slope | 9,994 | 1.5 |
| Ia | Irwin silty clay loam, 1 to 3 percent slopes | 40,456 | 6.3 |
| Ib | Irwin silty clay loam, 3 to 6 percent slopes | 1,231 | 0.2 |
| Ic | Irwin silty clay loam, 2 to 6 percent slopes, eroded | 1,700 | 0.3 |
| La | Lesho loam | 8,845 | 1.4 |
| Lb | Lincoln soils | 5,910 | 0.9 |
| Ma | Milan loam, 1 to 3 percent slopes | 24,169 | 3.7 |
| Mb | Milan loam, 3 to 6 percent slopes | 5,870 | 0.9 |
| Mc | Milan clay loam, 2 to 6 percent slopes, eroded | 2,554 | 0.4 |
| Na | Naron fine sandy loam | 21,558 | 3.3 |
| Oc | Owens clay loam, 1 to 3 percent slopes | 1,408 | 0.2 |
| Od | Owens-Rock outcrop complex, 3 to 10 percent slopes | 1,128 | 0.2 |
| Pa | Pits | 1,188 | 0.2 |
| Pb | Plevna fine sandy loam | 4,808 | 0.7 |
| Pc | Pratt loamy fine sand, undulating | 6,710 | 1.0 |
| Pd | Pratt-Tivoli complex, rolling | 2,302 | 0.4 |
| Ra | Renfrow silty clay loam, 1 to 3 percent slopes | 15,749 | 2.4 |
| Rb | Renfrow silty clay loam, 3 to 6 percent slopes | 1,462 | 0.2 |
| Rc | Renfrow-Owens clay loams, 1 to 4 percent slopes | 1,152 | 0.2 |
| Rd | Rosehill silty clay, 1 to 3 percent slopes | 29,584 | 4.6 |
| Sa | Shellabarger sandy loam, 1 to 3 percent slopes | 19,596 | 3.0 |
| Sb | Shellabarger sandy loam, 3 to 6 percent slopes | 2,746 | 0.4 |
| Sc | Shellabarger sandy loam, 3 to 6 percent slopes, eroded | 747 | 0.1 |
| Ta | Tabler silty clay loam | 41,964 | 6.5 |
| Tb | Tabler-Drummond complex | 10,654 | 1.7 |
| Ua | Urban land-Canadian complex | 11,152 | 1.7 |
| Ub | Urban land-Elandco complex | 7,252 | 1.1 |
| Uc | Urban land-Farnum complex, 0 to 3 percent slopes | 5,877 | 0.9 |
| Ud | Urban land-Irwin complex, 1 to 3 percent slopes | 5,902 | 0.9 |
| Ue | Urban land-Tabler complex | 4,807 | 0.7 |
| Va | Vanoss silt loam, 0 to 1 percent slopes | 17,116 | 2.7 |
| Vb | Vanoss silt loam, 1 to 3 percent slopes | 28,843 | 4.5 |
| Vc | Vanoss silt loam, 3 to 6 percent slopes | 4,124 | 0.6 |
| Vd | Vanoss silt loam, 3 to 6 percent slopes, eroded | 2,207 | 0.3 |
| Ve | Vernon sandy loam, 1 to 3 percent slopes | 3,527 | 0.5 |
| Vf | Vernon sandy loam, 3 to 6 percent slopes | 1,391 | 0.2 |
| Wa | Waldeck sandy loam | 8,908 | 1.4 |
| Wb | Waurika silt loam | 2,149 | 0.3 |
| | Water | 640 | 0.1 |
| | Total | 645,120 | 100.0 |

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

[Yields in columns N are for nonirrigated soils; those in columns I are for irrigated soils. All yields were estimated for a high level of management in 1975. Absence of a yield figure indicates the crop is seldom grown or is not suited. Only arable soils are listed]

| Soil name and map symbol | Wheat, winter | | Grain sorghum | | Alfalfa hay | |
|---|---|---|---|---|---|---|
| | N | I | N | I | N | I |
| | Bu | Bu | Bu | Bu | Ton | Ton |
| Albion: | | | | | | |
| [1]Aa | 22 | --- | 35 | --- | 2.1 | --- |
| Blanket: | | | | | | |
| Ba | 38 | --- | 65 | --- | 3.5 | --- |
| Bb | 35 | --- | 60 | --- | 3.2 | --- |
| Canadian: | | | | | | |
| Ca | 30 | --- | 52 | --- | 3.5 | --- |
| [1]Cb | 26 | --- | 48 | --- | 3.5 | --- |
| Carwile: | | | | | | |
| Cc | 23 | --- | 35 | --- | 2.8 | --- |
| Clark: | | | | | | |
| [1]Cd | 26 | --- | 44 | --- | 3.0 | --- |
| Clime: | | | | | | |
| Ce | 28 | --- | 42 | --- | 1.6 | --- |
| Elandco: | | | | | | |
| Ea | 35 | --- | 60 | --- | 5.0 | --- |
| Eb | 35 | --- | 60 | --- | 5.0 | --- |
| Farnum: | | | | | | |
| Fa | 38 | --- | 54 | 120 | 2.8 | 7.0 |
| Fb | 32 | --- | 52 | --- | 2.6 | --- |
| Fc | 32 | --- | 52 | 120 | --- | 7.0 |
| Goessel: | | | | | | |
| Ga | 36 | --- | 56 | --- | 3.0 | --- |
| Gb | 34 | --- | 52 | --- | 2.6 | --- |
| Irwin: | | | | | | |
| Ia | 37 | --- | 57 | --- | 3.0 | --- |
| Ib | 33 | --- | 52 | --- | 2.6 | --- |
| Ic | 27 | --- | 42 | --- | 2.2 | --- |
| Lesho: | | | | | | |
| La | 25 | --- | 42 | --- | 3.0 | --- |
| Milan: | | | | | | |
| Ma | 32 | --- | 52 | 110 | 2.6 | 6.5 |
| Mb | 30 | --- | 48 | --- | 2.4 | --- |
| Mc | 27 | --- | 44 | --- | 2.0 | --- |
| Naron: | | | | | | |
| Na | 35 | --- | 59 | 110 | 2.6 | 6.5 |
| Owens: | | | | | | |
| Oc | 13 | --- | --- | --- | --- | --- |

See footnote at end of table.

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

| Soil name and map symbol | Wheat, winter | | Grain sorghum | | Alfalfa hay | |
|---|---|---|---|---|---|---|
| | N | I | N | I | N | I |
| | Bu | Bu | Bu | Bu | Ton | Ton |
| Pratt: | | | | | | |
| Pc | 26 | --- | 46 | 90 | 2.5 | 5.5 |
| Renfrow: | | | | | | |
| Ra | 25 | --- | 32 | --- | 2.5 | --- |
| Rb | 20 | --- | 25 | --- | 2.5 | --- |
| [1]Rc | 23 | --- | 29 | --- | 2.5 | --- |
| Rosehill: | | | | | | |
| Rd | 28 | --- | 40 | --- | 1.8 | --- |
| Shellabarger: | | | | | | |
| Sa | 26 | --- | 45 | --- | 2.2 | --- |
| Sb | 22 | --- | 40 | --- | --- | --- |
| [1]Sc | 18 | --- | 35 | --- | --- | --- |
| Tabler: | | | | | | |
| Ta | 30 | --- | 40 | --- | 3.0 | --- |
| [1]Tb | 22 | --- | 35 | --- | 2.5 | --- |
| Vanoss: | | | | | | |
| Va | 35 | --- | 55 | --- | 3.5 | --- |
| Vb | 32 | --- | 50 | --- | 3.0 | --- |
| Vc, Vd | 27 | --- | 45 | --- | 2.5 | --- |
| Vernon: | | | | | | |
| Ve | 22 | --- | 35 | --- | --- | --- |
| Vf | 20 | --- | 30 | --- | --- | --- |
| Waldeck: | | | | | | |
| Wa | 22 | --- | 44 | --- | 3.5 | --- |
| Waurika: | | | | | | |
| Wb | 25 | --- | 40 | --- | 2.5 | --- |

[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 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 |
| Albion: | | | | | |
| [1]Aa: | | | | | |
| Albion part | Sandy | Favorable | 4,000 | Sand bluestem | 35 |
| | | Normal | 3,000 | Little bluestem | 20 |
| | | Unfavorable | 2,000 | Indiangrass | 10 |
| | | | | Switchgrass | 10 |
| | | | | Sand lovegrass | 5 |
| Shellabarger part | Sandy | Favorable | 4,500 | Sand bluestem | 35 |
| | | Normal | 3,200 | Little bluestem | 25 |
| | | Unfavorable | 2,500 | Indiangrass | 15 |
| | | | | Switchgrass | 10 |
| [1]Ab: | | | | | |
| Albion part | Sandy | Favorable | 4,000 | Sand bluestem | 35 |
| | | Normal | 3,000 | Little bluestem | 20 |
| | | Unfavorable | 2,000 | Indiangrass | 10 |
| | | | | Switchgrass | 10 |
| | | | | Sand lovegrass | 5 |
| Shellabarger part | Sandy | Favorable | 4,500 | Sand bluestem | 35 |
| | | Normal | 3,200 | Little bluestem | 25 |
| | | Unfavorable | 2,500 | Indiangrass | 15 |
| | | | | Switchgrass | 10 |
| Blanket: | | | | | |
| Ba, Bb | Loamy Upland | Favorable | 6,500 | Little bluestem | 20 |
| | | Normal | 5,000 | Indiangrass | 15 |
| | | Unfavorable | 3,000 | Big bluestem | 10 |
| | | | | Side-oats grama | 10 |
| | | | | Silver bluestem | 5 |
| | | | | Tall dropseed | 5 |
| | | | | Texas needlegrass | 5 |
| | | | | Canada wildrye | 5 |
| Canadian: | | | | | |
| Ca | Sandy | 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 |
| | | | | Sedge | 5 |
| [1]Cb: | | | | | |
| Canadian part | Sandy | 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 |
| | | | | Sedge | 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 |
| Canadian: | | | | | |
| Waldeck part | Subirrigated | Favorable | 9,000 | Big bluestem | 20 |
| | | Normal | 8,000 | Indiangrass | 15 |
| | | Unfavorable | 7,000 | Switchgrass | 10 |
| | | | | Eastern gamagrass | 10 |
| | | | | Prairie cordgrass | 10 |
| | | | | Little bluestem | 5 |
| | | | | Maximilian sunflower | 5 |
| | | | | Alkali sacaton | 5 |
| | | | | Meadow dropseed | 5 |
| | | | | Western wheatgrass | 5 |
| | | | | Sedge | 5 |
| | | | | Wholeleaf rosinweed | 5 |
| 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 |
| Clark: | | | | | |
| [1]Cd: | | | | | |
| Clark part | Limy Upland | Favorable | 5,000 | Sand bluestem | 30 |
| | | Normal | 4,000 | Big bluestem | 20 |
| | | Unfavorable | 3,000 | Side-oats grama | 10 |
| | | | | Indiangrass | 5 |
| | | | | Switchgrass | 5 |
| | | | | Leadplant | 5 |
| | | | | Tall dropseed | 5 |
| | | | | Western wheatgrass | 5 |
| Ost part | Loamy Upland | Favorable | 6,000 | Big bluestem | 30 |
| | | Normal | 4,000 | Little bluestem | 25 |
| | | Unfavorable | 2,000 | Switchgrass | 10 |
| | | | | Indiangrass | 10 |
| | | | | Side-oats grama | 5 |
| Clime: | | | | | |
| Ce | Limy Upland | Favorable | 5,000 | Little bluestem | 30 |
| | | Normal | 3,500 | Big bluestem | 20 |
| | | Unfavorable | 2,500 | Side-oats grama | 15 |
| | | | | Indiangrass | 5 |
| | | | | Switchgrass | 5 |
| | | | | Blue grama | 5 |
| | | | | Jersey-tea | 5 |
| | | | | Leadplant | 5 |
| Elandco: | | | | | |
| Ea, Eb, Ec | Loamy Lowland | Favorable | 8,500 | Indiangrass | 15 |
| | | Normal | 6,000 | Switchgrass | 15 |
| | | Unfavorable | 4,500 | Little bluestem | 10 |
| | | | | Big bluestem | 25 |
| | | | | Eastern gamagrass | 5 |
| | | | | Prairie cordgrass | 5 |
| | | | | Compassplant | 5 |
| | | | | Tall dropseed | 5 |
| Farnum: | | | | | |
| Fa, Fb, Fc | Loamy Upland | Favorable | 6,000 | Big bluestem | 30 |
| | | Normal | 5,000 | Little bluestem | 25 |
| | | Unfavorable | 4,000 | Indiangrass | 10 |
| | | | | Switchgrass | 10 |
| | | | | Side-oats grama | 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 |
| Goessel: | | | | | |
| Ga, Gb | Clay Upland | Favorable | 5,500 | Big bluestem | 30 |
| | | Normal | 44,500 | Little bluestem | 15 |
| | | Unfavorable | 3,000 | Switchgrass | 10 |
| | | | | Indiangrass | 5 |
| | | | | Side-oats grama | 5 |
| | | | | Tall dropseed | 5 |
| | | | | Western wheatgrass | 5 |
| | | | | Canada wildrye | 5 |
| | | | | Leadplant | 5 |
| | | | | Blue grama | 5 |
| Irwin: | | | | | |
| Ia, Ib, Ic | Clay Upland | Favorable | 6,000 | Big bluestem | 25 |
| | | Normal | 4,200 | Little bluestem | 20 |
| | | Unfavorable | 2,000 | Indiangrass | 15 |
| | | | | Switchgrass | 15 |
| | | | | Tall dropseed | 5 |
| | | | | Side-oats grama | 5 |
| Lesho: | | | | | |
| La | 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 |
| | | | | Sedge | 5 |
| | | | | Texas bluegrass | 5 |
| | | | | Maximilian sunflower | 5 |
| Lincoln: | | | | | |
| Lb | Sandy Lowland | Favorable | 4,000 | Switchgrass | 30 |
| | | Normal | 3,000 | Sand bluestem | 15 |
| | | Unfavorable | 2,000 | Indiangrass | 15 |
| | | | | Little bluestem | 5 |
| | | | | Purpletop | 5 |
| | | | | Maximilian sunflower | 5 |
| | | | | Goldenrod | 5 |
| Milan: | | | | | |
| Ma, Mb, Mc | 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 |
| Naron: | | | | | |
| Na | Sandy | Favorable | 4,000 | Sand bluestem | 35 |
| | | Normal | 3,000 | Big bluestem | 20 |
| | | Unfavorable | 2,000 | Indiangrass | 10 |
| | | | | Switchgrass | 10 |
| | | | | Leadplant | 5 |
| | | | | Sand lovegrass | 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: | | | | | |
| Oc | Red Clay Prairie | Favorable | 3,000 | Big bluestem | 15 |
| | | Normal | 2,500 | Switchgrass | 20 |
| | | Unfavorable | 1,500 | Little bluestem | 20 |
| | | | | Compassplant | 15 |
| | | | | Indiangrass | 5 |
| | | | | Side-oats grama | 5 |
| | | | | Maximilian sunflower | 5 |
| | | | | Leadplant | 5 |
| [1]Od: | | | | | |
| Owens part | Red Clay Prairie | Favorable | 3,000 | Big bluestem | 15 |
| | | Normal | 2,500 | Switchgrass | 20 |
| | | Unfavorable | 1,500 | Little bluestem | 15 |
| | | | | Compassplant | 15 |
| | | | | Indiangrass | 5 |
| | | | | Side-oats grama | 5 |
| | | | | Maximilian sunflower | 5 |
| | | | | Leadplant | 5 |
| Rock outcrop part | Not assigned to a range site. | | | | |
| Plevna: | | | | | |
| Pb | Subirrigated | Favorable | 9,000 | Big bluestem | 20 |
| | | Normal | 8,000 | Indiangrass | 15 |
| | | Unfavorable | 7,000 | Prairie cordgrass | 10 |
| | | | | Switchgrass | 10 |
| | | | | Eastern gamagrass | 10 |
| | | | | Western wheatgrass | 5 |
| | | | | Little bluestem | 5 |
| | | | | Alkali sacaton | 5 |
| | | | | Meadow dropseed | 5 |
| | | | | Sedge | 5 |
| | | | | Maximilian sunflower | 5 |
| | | | | Wholeleaf rosinweed | 5 |
| Pratt: | | | | | |
| Pc | 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 |
| [1]Pd: | | | | | |
| Pratt part | 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 |
| Tivoli part | Sands | Favorable | 4,000 | Little bluestem | 25 |
| | | Normal | 3,000 | Sand bluestem | 20 |
| | | Unfavorable | 2,000 | Big sandreed | 10 |
| | | | | Switchgrass | 10 |
| | | | | Sand lovegrass | 5 |
| | | | | Scribner panicum | 5 |
| | | | | Sand dropseed | 5 |
| | | | | Lespedeza | 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: | | | | | |
| Ra, Rb | Red Clay Prairie | 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 |
| | | | | Indiancurrant coralberry | 5 |
| [1]Rc: | | | | | |
| Renfrow part | Red Clay Prairie | 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 |
| | | | | Indiancurrant coralberry | 5 |
| Owens part | Red Clay Prairie | Favorable | 3,000 | Big bluestem | 15 |
| | | Normal | 2,500 | Switchgrass | 20 |
| | | Unfavorable | 1,500 | Little bluestem | 20 |
| | | | | Compassplant | 15 |
| | | | | Indiangrass | 5 |
| | | | | Side-oats grama | 5 |
| | | | | Maximilian sunflower | 5 |
| | | | | Leadplant | 5 |
| Rosehill: | | | | | |
| Rd | Clay Upland | Favorable | 5,000 | Big bluestem | 30 |
| | | Normal | 3,500 | 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 |
| Shellabarger: | | | | | |
| Sa, Sb, Sc | Sandy | Favorable | 5,000 | Sand bluestem | 35 |
| | | Normal | 3,200 | Little bluestem | 25 |
| | | Unfavorable | 2,500 | Indiangrass | 15 |
| | | | | Switchgrass | 10 |
| Tabler: | | | | | |
| Ta | 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 | 10 |
| [1]Tb: | | | | | |
| Tabler 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 | 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 |
| Tabler: | | | | | |
| Drummond part | Saline Lowland | Favorable | 7,000 | Prairie cordgrass | 30 |
| | | Normal | 5,800 | Switchgrass | 10 |
| | | Unfavorable | 5,000 | Indiangrass | 10 |
| | | | | Inland saltgrass | 10 |
| | | | | Little bluestem | 5 |
| | | | | Vine-mesquite | 5 |
| | | | | Western wheatgrass | 5 |
| | | | | Alkali sacaton | 5 |
| | | | | Sunflower | 5 |
| | | | | Illinois bundleflower | 5 |
| | | | | Sedge | 5 |
| Vanoss: | | | | | |
| Va, Vb, Vc, Vd | 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 |
| Vernon: | | | | | |
| Ve, Vf | Red Clay Prairie | Favorable | 1,750 | Side-oats grama | 5 |
| | | Normal | 1,350 | Indiangrasss | 15 |
| | | Unfavorable | 900 | Big bluestem | 10 |
| | | | | Switchgrass | 15 |
| | | | | Little bluestem | 25 |
| | | | | Leadplant | 5 |
| | | | | Sand bluestem | 15 |
| | | | | Blue grama | 5 |
| Waldeck: | | | | | |
| Wa | Subirrigated | Favorable | 9,000 | Big bluestem | 20 |
| | | Normal | 8,000 | Indiangrass | 15 |
| | | Unfavorable | 7,000 | Switchgrass | 10 |
| | | | | Eastern gamagrass | 10 |
| | | | | Prairie cordgrass | 10 |
| | | | | Little bluestem | 5 |
| | | | | Maximilian sunflower | 5 |
| | | | | Alkali sacaton | 5 |
| | | | | Meadow dropseed | 5 |
| | | | | Western wheatgrass | 5 |
| | | | | Sedge | 5 |
| | | | | Wholeleaf rosinweed | |
| Waurika: | | | | | |
| Wb | Clay Upland | Favorable | 3,500 | Little bluestem | 25 |
| | | Normal | 2,300 | Big bluestem | 20 |
| | | Unfavorable | 1,500 | Switchgrass | 15 |
| | | | | Indiangrass | 10 |
| | | | | Side-oats grama | 5 |
| | | | | Blue grama | 5 |
| | | | | Buffalograss | 5 |
| | | | | Leadplant | 5 |
| | | | | Goldenrod | 5 |
| | | | | Indiancurrant coralberry | 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

[Only soils suited to windbreaks are listed. Absence of an entry means the species does not grow well in the soil]

| Soil name and map symbol | Expected heights of specified trees at 20 years of age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Eastern cottonwood | Eastern redcedar | Hackberry | Honey-locust | Ponderosa pine | Russian-olive | Siberian elm | Osage-orange |
| | Ft | Ft | Ft | Ft | Ft | Ft | Ft | Ft |
| Albion: | | | | | | | | |
| [1]Aa: | | | | | | | | |
| Albion part------- | --- | 18 | --- | --- | 20 | --- | 22 | 20 |
| Shellabarger part | --- | 18 | 27 | 26 | 24 | 18 | 25 | 24 |
| [1]Ab: | | | | | | | | |
| Albion part------- | --- | 18 | --- | --- | 20 | --- | 22 | 20 |
| Shellabarger part | --- | 18 | 27 | 26 | 24 | 18 | 25 | 24 |
| Blanket: | | | | | | | | |
| Ba, Bb-------------- | --- | 25 | 22 | 22 | 19 | --- | 44 | 19 |
| Canadian: | | | | | | | | |
| Ca------------------ | 65 | 30 | 27 | 35 | 25 | 18 | 44 | 22 |
| [1]Cb: | | | | | | | | |
| Canadian part----- | 65 | 30 | 27 | 35 | 25 | 18 | 44 | 22 |
| Waldeck part------ | 50 | 30 | 35 | 40 | 30 | 25 | 50 | 25 |
| Carwile: | | | | | | | | |
| Cc------------------ | 50 | 25 | 25 | 22 | 25 | --- | 46 | 22 |
| Clark: | | | | | | | | |
| [1]Cd: | | | | | | | | |
| Clark part-------- | --- | 24 | 27 | 30 | 25 | 22 | 40 | 22 |
| Ost part---------- | --- | 25 | 28 | 36 | 26 | --- | 45 | 23 |
| Clime: | | | | | | | | |
| Ce------------------ | --- | 18 | 22 | 22 | 16 | 16 | 23 | 16 |
| Elandco: | | | | | | | | |
| Ea, Eb, Ec---------- | 50 | 30 | 35 | 40 | 30 | 25 | 50 | 25 |
| Farnum: | | | | | | | | |
| Fa, Fb, Fc---------- | --- | 25 | 25 | 24 | 20 | --- | --- | 19 |
| Goessel: | | | | | | | | |
| Ga, Gb-------------- | --- | 22 | --- | --- | 17 | --- | 25 | 17 |
| Irwin: | | | | | | | | |
| Ia, Ib, Ic---------- | --- | 18 | --- | --- | 17 | --- | 25 | 17 |
| Lesho: | | | | | | | | |
| La------------------ | 45 | 25 | --- | 35 | 25 | 22 | --- | --- |
| Lincoln: | | | | | | | | |
| Lb------------------ | --- | --- | --- | --- | --- | --- | 15 | --- |
| Milan: | | | | | | | | |
| Ma, Mb, Mc---------- | --- | 25 | 25 | 24 | 20 | --- | 44 | 19 |
| Naron: | | | | | | | | |
| Na------------------ | --- | 24 | 27 | 35 | 25 | --- | 44 | 22 |
| Plevna: | | | | | | | | |
| Pb------------------ | --- | --- | --- | --- | --- | 15 | --- | --- |
| Pratt: | | | | | | | | |
| Pc------------------ | 45 | 16 | 18 | 28 | 20 | 15 | 36 | 10 |

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

| Soil name and map symbol | Expected heights of specified trees at 20 years of age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Eastern cottonwood | Eastern redcedar | Hackberry | Honey-locust | Ponderosa pine | Russian-olive | Siberian elm | Osage-orange |
| | Ft | Ft | Ft | Ft | Ft | Ft | Ft | Ft |
| Pratt: | | | | | | | | |
| [1]Pd: | | | | | | | | |
| Pratt part | 45 | 16 | 18 | 28 | 20 | 15 | 36 | 10 |
| Tivoli part | --- | 18 | --- | --- | 20 | --- | --- | --- |
| Renfrow: | | | | | | | | |
| Ra, Rb | --- | 20 | 26 | 24 | 16 | --- | 23 | 16 |
| [1]Rc: | | | | | | | | |
| Renfrow part | --- | 20 | 26 | 24 | 16 | --- | 23 | 16 |
| Owens part. | | | | | | | | |
| Rosehill: | | | | | | | | |
| Rd | --- | 17 | 25 | --- | 16 | --- | 23 | 15 |
| Shellabarger: | | | | | | | | |
| Sa, Sb, Sc | 40 | 18 | 27 | 26 | 24 | --- | 25 | 24 |
| Tabler: | | | | | | | | |
| Ta | --- | 20 | --- | --- | 17 | --- | 25 | 17 |
| [1]Tb: | | | | | | | | |
| Tabler part | --- | 20 | --- | --- | 17 | --- | 25 | 17 |
| Drummond part | --- | --- | --- | --- | --- | 15 | --- | --- |
| Urban land: | | | | | | | | |
| [1]Ua: | | | | | | | | |
| Urban land part. | | | | | | | | |
| Canadian part | 65 | 30 | 27 | 35 | 25 | 18 | 44 | 22 |
| [1]Ub: | | | | | | | | |
| Urban land part. | | | | | | | | |
| Elandco part | 50 | 30 | 35 | 40 | 30 | 25 | 50 | 25 |
| [1]Uc: | | | | | | | | |
| Urban land part. | | | | | | | | |
| Farnum part | --- | 25 | 25 | 24 | 20 | --- | --- | 19 |
| [1]Ud: | | | | | | | | |
| Urban land part. | | | | | | | | |
| Irwin part | --- | 18 | --- | --- | 17 | --- | 25 | 17 |
| [1]Ue: | | | | | | | | |
| Urban land part. | | | | | | | | |
| Tabler part | --- | 20 | --- | --- | 17 | --- | 25 | 17 |
| Vanoss: | | | | | | | | |
| Va, Vb, Vc, Vd | --- | 20 | 22 | 22 | 19 | --- | --- | --- |
| Waldeck: | | | | | | | | |
| Wa | 50 | 30 | 35 | 40 | 30 | 25 | 50 | 25 |
| Waurika: | | | | | | | | |
| Wb | --- | 20 | --- | --- | --- | --- | --- | --- |

[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

["Depth to rock" 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." Absence of an entry means soil was not rated]

| Soil name and map symbol | Shallow excavations | Dwellings without basements | Dwellings with basements | Small commercial buildings | Local roads and streets |
|---|---|---|---|---|---|
| Albion: | | | | | |
| [1]Aa: | | | | | |
| Albion part | Severe: cutbanks cave. | Slight | Slight | Slight | Slight. |
| Shellabarger part | Slight | Slight | Slight | Slight | Moderate: low strength. |
| [1]Ab: | | | | | |
| Albion part | Severe: cutbanks cave. | Moderate: slope. | Moderate: slope. | Severe: slope. | Moderate: slope. |
| Shellabarger part | Moderate: slope. | Moderate: slope. | Moderate: slope. | Severe: slope. | Moderate: low strength. |
| Blanket: | | | | | |
| Ba, Bb | Moderate: too clayey. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Severe: low strength. |
| Canadian: | | | | | |
| Ca | Moderate: floods. | Severe: floods. | Severe: floods. | Severe: floods. | Moderate: floods, low strength. |
| [1]Cb: | | | | | |
| Canadian part | Moderate: floods. | Severe: floods. | Severe: floods. | Severe: floods. | Moderate: floods, low strength. |
| Waldeck part | Severe: floods, wetness, cutbanks cave. | Severe: floods. | Severe: floods, wetness. | Severe: floods. | Severe: floods. |
| 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. |
| Clark: | | | | | |
| [1]Cd: | | | | | |
| Clark part | Slight | Moderate: low strength, shrink-swell. | Moderate: low strength, shrink-swell. | Moderate: low strength, shrink-swell. | Severe: low strength. |
| Ost part | Moderate: too clayey. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Severe: low strength. |
| Clime: | | | | | |
| Ce | Severe: too clayey. | Moderate: shrink-swell, low strength. | Moderate: depth to rock, shrink-swell, low strength. | Moderate: shrink-swell, slope, low strength. | Severe: low strength. |
| Elandco: | | | | | |
| Ea | Moderate: floods. | Severe: floods. | Severe: floods. | Severe: floods. | 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 |
|---|---|---|---|---|---|
| Elandco: | | | | | |
| Eb | Severe: floods. | Severe: floods. | Severe: floods. | Severe: floods. | Severe: low strength. |
| Ec | Severe: floods. | Severe: floods. | Severe: floods. | Severe: floods. | Severe: floods, low strength. |
| Farnum: | | | | | |
| Fa, Fb | Moderate: too clayey. | Moderate: low strength, shrink-swell. | Moderate: low strength, shrink-swell. | Moderate: low strength, shrink-swell. | Severe: low strength. |
| Fc | Severe: cutbanks cave. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Severe: low strength. |
| Goessel: | | | | | |
| Ga, Gb | Severe: too clayey. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. |
| Irwin: | | | | | |
| Ia, Ib, Ic | Severe: too clayey. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. |
| Lesho: | | | | | |
| La | Severe: floods, wetness. | Severe: floods, wetness. | Severe: floods, wetness. | Severe: floods, wetness. | Moderate: low strength, wetness, shrink-swell. |
| Lincoln: | | | | | |
| Lb | Severe: floods, cutbanks cave. | Severe: floods. | Severe: floods. | Severe: floods. | Severe: floods. |
| Milan: | | | | | |
| Ma | Moderate: too clayey. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Severe: low strength. |
| Mb, Mc | Moderate: too clayey. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength, slope. | Severe: low strength. |
| Naron: | | | | | |
| Na | Slight | Slight | Slight | Slight | Moderate: low strength. |
| Owens: | | | | | |
| Oc | Severe: too clayey. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. |
| [1]Od: | | | | | |
| Owens part | Severe: too clayey. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. |
| Rock outcrop part. | | | | | |
| Pits: | | | | | |
| Pa. | | | | | |
| Plevna: | | | | | |
| Pb | Severe: floods, wetness. | Severe: floods, wetness. | Severe: floods, wetness. | Severe: floods, wetness. | Severe: floods, wetness. |

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 |
|---|---|---|---|---|---|
| Pratt: | | | | | |
| Pc | Severe: too sandy, cutbanks cave. | Slight | Slight | Moderate: slope. | Slight. |
| [1]Pd: | | | | | |
| Pratt part | Severe: too sandy, cutbanks cave. | Moderate: slope. | Moderate: slope. | Severe: slope. | Moderate: slope. |
| Tivoli part | Severe: cutbanks cave, too sandy. | Moderate: slope. | Moderate: slope. | Severe: slope. | Moderate: slope. |
| Renfrow: | | | | | |
| Ra, Rb | Severe: too clayey. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. |
| [1]Rc: | | | | | |
| 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. |
| Owens part | Severe: too clayey. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. |
| Rosehill: | | | | | |
| Rd | 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. |
| [1]Tb: | | | | | |
| Tabler part | Severe: too clayey. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: low strength, shrink-swell. |
| Drummond part | Severe: too clayey, wetness. | Severe: floods, shrink-swell, low strength. | Severe: wetness, floods, shrink-swell. | Severe: floods, shrink-swell, low strength. | Severe: low strength, shrink-swell. |
| Urban land: | | | | | |
| [1]Ua: | | | | | |
| Urban land part. | | | | | |
| Canadian part | Moderate: floods. | Severe: floods. | Severe: floods. | Severe: floods. | Moderate: floods, low strength. |
| [1]Ub: | | | | | |
| Urban land part. | | | | | |
| Elandco part | Moderate: floods. | Severe: floods. | Severe: floods. | Severe: floods. | 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 |
|---|---|---|---|---|---|
| Urban land: | | | | | |
| [1]Uc: | | | | | |
| Urban land part. | | | | | |
| Farnum part | Severe: cutbanks cave. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Severe: low strength. |
| [1]Ud: | | | | | |
| Urban land part. | | | | | |
| Irwin 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]Ue: | | | | | |
| Urban land part. | | | | | |
| Tabler part | Severe: too clayey. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: low strength, shrink-swell. |
| Vanoss: Va, Vb, Vc, Vd | Moderate: too clayey. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: low strength, shrink-swell. |
| Vernon: Ve, Vf | Severe: too clayey. | Severe: low strength, shrink-swell. | Severe: low strength, shrink-swell. | Severe: low strength, shrink-swell. | Severe: low strength, shrink-swell. |
| Waldeck: Wa | Severe: floods, wetness, cutbanks cave. | Severe: floods. | Severe: floods, wetness. | Severe: floods. | Severe: floods. |
| Waurika: Wb | 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

["Depth to rock" 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. Absence of an entry means soil was not rated]

| Soil name and map symbol | Septic tank absorption fields | Sewage lagoon areas | Trench sanitary landfill | Area sanitary landfill | Daily cover for landfill |
|---|---|---|---|---|---|
| Albion: | | | | | |
| [1]Aa: | | | | | |
| Albion part | Slight | Severe: seepage. | Severe: seepage. | Severe: seepage. | Fair: thin layer, too sandy. |
| Shellabarger part | Slight | Moderate: seepage, slope. | Slight | Slight | Good. |
| [1]Ab: | | | | | |
| Albion part | Moderate: slope. | Severe: seepage, slope. | Severe: seepage. | Severe: seepage. | Fair: thin layer, slope, too sandy. |
| Shellabarger part | Moderate: slope. | Severe: slope. | Slight | Moderate: slope. | Fair: slope. |
| Blanket: | | | | | |
| Ba | Severe: percs slowly. | Slight | Moderate: too clayey. | Slight | Fair: too clayey. |
| Bb | Severe: percs slowly. | Moderate: slope. | Moderate: too clayey. | Slight | Fair: too clayey. |
| Canadian: | | | | | |
| Ca | Moderate: floods. | Severe: seepage, floods. | Severe: seepage. | Severe: seepage. | Good. |
| [1]Cb: | | | | | |
| Canadian part | Moderate: floods. | Severe: seepage, floods. | Severe: seepage. | Severe: seepage. | Good. |
| Waldeck part | Severe: floods, wetness. | Severe: floods, seepage, wetness. | Severe: floods, seepage, wetness. | Severe: floods, seepage, wetness. | Good. |
| Carwile: | | | | | |
| Cc | Severe: percs slowly, wetness, floods. | Severe: wetness, floods. | Severe: floods, too clayey. | Severe: wetness, floods. | Poor: thin layer. |
| Clark: | | | | | |
| [1]Cd: | | | | | |
| Clark part | Moderate: percs slowly. | Moderate: seepage, slope. | Slight | Slight | Good. |
| Ost part | Severe: percs slowly. | Moderate: slope. | Moderate: too clayey. | Slight | Fair: too clayey. |
| Clime: | | | | | |
| Ce | Severe: percs slowly, depth to rock. | Severe: depth to rock. | Severe: too clayey, depth to rock. | Slight | Poor: too clayey. |
| Elandco: | | | | | |
| Ea | Moderate: percs slowly. | Moderate: seepage. | Moderate: floods. | Moderate: floods. | Fair: 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 |
|---|---|---|---|---|---|
| Elandco: | | | | | |
| Eb | Severe: floods. | Severe: floods. | Severe: floods. | Severe: 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 | Severe: percs slowly. | Moderate: slope. | Moderate: too clayey. | Slight | Fair: too clayey. |
| Fc | Severe: percs slowly. | Severe: seepage. | Severe: wetness, seepage. | Slight | Fair: thin layer. |
| Goessel: | | | | | |
| Ga, Gb | Severe: percs slowly. | Slight | Severe: too clayey. | Slight | Poor: too clayey. |
| Irwin: | | | | | |
| Ia, Ib, Ic | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey. |
| Lesho: | | | | | |
| La | Severe: floods, wetness. | Severe: floods, wetness. | Severe: floods, wetness. | Severe: floods, wetness. | Fair: thin layer, area reclaim. |
| Lincoln: | | | | | |
| Lb | Severe: floods. | Severe: seepage, floods. | Severe: floods, seepage. | Severe: floods, seepage. | Fair: too sandy. |
| Milan: | | | | | |
| Ma, Mb, Mc | Severe: percs slowly. | Moderate: slope. | Moderate: too clayey. | Slight | Fair: too clayey. |
| Naron: | | | | | |
| Na | Slight | Moderate: seepage. | Moderate: seepage. | Moderate: seepage. | Good. |
| Owens: | | | | | |
| Oc | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey, area reclaim. |
| [1]Od: | | | | | |
| Owens part | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey, area reclaim. |
| Rock outcrop part. | | | | | |
| Pits: | | | | | |
| Pa. | | | | | |
| Plevna: | | | | | |
| Pb | Severe: floods, wetness. | Severe: floods, wetness. | Severe: floods, wetness. | Severe: floods, wetness. | Poor: wetness. |
| Pratt: | | | | | |
| Pc | Slight | Severe: seepage. | Severe: seepage. | Severe: seepage. | Fair: too sandy. |

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 |
|---|---|---|---|---|---|
| Pratt: | | | | | |
| [1]Pd: | | | | | |
| Pratt part | Moderate: slope. | Severe: seepage, slope. | Severe: seepage. | Severe: seepage. | Fair: too sandy, slope. |
| Tivoli part | Moderate: slope. | Severe: seepage, slope. | Severe: seepage, too sandy. | Severe: seepage. | Poor: thin layer, too sandy. |
| Renfrow: | | | | | |
| Ra, Rb | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: thin layer. |
| [1]Rc: | | | | | |
| Renfrow part | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: thin layer. |
| Owens part | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey, area reclaim. |
| Rosehill: | | | | | |
| Rd | Severe: percs slowly, depth to rock. | Severe: depth to rock. | Severe: too clayey. | Slight | Poor: too clayey. |
| Shellabarger: | | | | | |
| Sa, Sb, Sc | Slight | Moderate: seepage, slope. | Slight | Slight | Good. |
| Tabler: | | | | | |
| Ta | Severe: percs slowly, wetness. | Slight | Severe: wetness, too clayey. | Severe: wetness. | Poor: hard to pack, too clayey. |
| [1]Tb: | | | | | |
| Tabler part | Severe: percs slowly, wetness. | Slight | Severe: wetness, too clayey. | Severe: wetness. | Poor: hard to pack, too clayey. |
| Drummond part | Severe: percs slowly, wetness. | Severe: wetness. | Severe: too clayey. | Severe: wetness. | Poor: too clayey, hard to pack. |
| Urban land: | | | | | |
| [1]Ua: | | | | | |
| Urban land part. | | | | | |
| Canadian part | Moderate: floods. | Severe: seepage, floods. | Severe: seepage. | Severe: seepage. | Good. |
| [1]Ub: | | | | | |
| Urban land part. | | | | | |
| Elandco part | Moderate: percs slowly. | Moderate: seepage. | Moderate: floods. | Moderate: floods. | Fair: too clayey. |
| [1]Uc: | | | | | |
| Urban land part. | | | | | |
| Farnum part | Severe: percs slowly. | Severe: seepage. | Severe: wetness, seepage. | Slight | Fair: thin layer. |

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 |
|---|---|---|---|---|---|
| Urban land: | | | | | |
| [1]Ud: | | | | | |
| Urban land part. | | | | | |
| Irwin part | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey. |
| [1]Ue: | | | | | |
| Urban land part. | | | | | |
| Tabler part | Severe: percs slowly, wetness. | Slight | Severe: wetness, too clayey. | Severe: wetness. | Poor: hard to pack, too clayey. |
| Vanoss: Va, Vb, Vc, Vd | Slight | Moderate: seepage. | Moderate: too clayey. | Slight | Fair: too clayey. |
| Vernon: Ve, Vf | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey. |
| Waldeck: Wa | Severe: floods, wetness. | Severe: floods, seepage, wetness. | Severe: floods, seepage, wetness. | Severe: floods, seepage, wetness. | Good. |
| Waurika: Wb | 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." Absence of an entry means soil was not rated]

| Soil name and map symbol | Roadfill | Sand | Gravel | Topsoil |
|---|---|---|---|---|
| Albion: | | | | |
| [1]Aa: | | | | |
| Albion part | Good | Fair: excess fines. | Fair: excess fines. | Good. |
| Shellabarger part | Fair: low strength. | Poor: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| [1]Ab: | | | | |
| Albion part | Good | Fair: excess fines. | Fair: excess fines. | Fair: slope. |
| Shellabarger part | Fair: low strength. | Poor: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| Blanket: | | | | |
| Ba, Bb | Poor: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| Canadian: | | | | |
| Ca | Fair: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Good. |
| [1]Cb: | | | | |
| Canadian part | Fair: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Good. |
| Waldeck part | Fair: wetness. | Fair: excess fines. | Unsuited: excess fines. | Good. |
| Carwile: | | | | |
| Cc | Poor: low strength, shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Poor: thin layer. |
| Clark: | | | | |
| [1]Cd: | | | | |
| Clark part | Poor: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: too clayey. |
| Ost part | Poor: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: too clayey. |
| Clime: | | | | |
| Ce | Poor: low strength, area reclaim. | Unsuited: excess fines. | Unsuited: excess fines. | Poor: too clayey. |
| Elandco: | | | | |
| Ea, Eb, Ec | Poor: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: too clayey. |
| Farnum: | | | | |
| Fa, Fb | Poor: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Good. |
| Fc | Poor: low strength. | Fair: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| Goessel: | | | | |
| Ga, Gb | Poor: shrink-swell, low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Poor: too clayey. |

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

| Soil name and map symbol | Roadfill | Sand | Gravel | Topsoil |
|---|---|---|---|---|
| Irwin: | | | | |
| Ia, Ib, Ic | Poor: shrink-swell, low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: thin layer, too clayey. |
| Lesho: | | | | |
| La | Fair: low strength, wetness, shrink-swell. | Fair: excess fines. | Unsuited: excess fines. | Good. |
| Lincoln: | | | | |
| Lb | Good | Fair: excess fines. | Unsuited: excess fines. | Poor: too sandy. |
| Milan: | | | | |
| Ma, Mb, Mc | Poor: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| Naron: | | | | |
| Na | Fair: low strength. | Poor: excess fines. | Unsuited: excess fines. | Good. |
| Owens: | | | | |
| Oc | Poor: shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Poor: too clayey. |
| [1]Od: | | | | |
| Owens part | Poor: shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Poor: too clayey. |
| Rock outcrop part. | | | | |
| Pits: | | | | |
| Pa. | | | | |
| Plevna: | | | | |
| Pb | Poor: wetness. | Fair: excess fines. | Unsuited: excess fines. | Poor: wetness. |
| Pratt: | | | | |
| Pc | Good | Fair: excess fines. | Unsuited: excess fines. | Fair: too sandy. |
| [1]Pd: | | | | |
| Pratt part | Good | Fair: excess fines. | Unsuited: excess fines. | Fair: too sandy, slope. |
| Tivoli part | Good | Fair: excess fines. | Unsuited: excess fines. | Poor: too sandy. |
| Renfrow: | | | | |
| Ra, Rb | Poor: low strength, shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: too clayey, thin layer. |
| [1]Rc: | | | | |
| Renfrow part | Poor: low strength, shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: too clayey, thin layer. |
| Owens part | Poor: shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Poor: too clayey. |
| Rosehill: | | | | |
| Rd | Poor: low strength, shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Poor: too clayey. |

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

| Soil name and map symbol | Roadfill | Sand | Gravel | Topsoil |
|---|---|---|---|---|
| Shellabarger: | | | | |
| Sa, Sb, Sc | Fair: low strength. | Poor: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| Tabler: | | | | |
| Ta | Poor: low strength, shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| [1]Tb: | | | | |
| Tabler part | Poor: low strength, shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| Drummond part | Poor: low strength, shrink-swell, area reclaim. | Unsuited: excess fines. | Unsuited: excess fines. | Poor: area reclaim. |
| Urban land: | | | | |
| [1]Ua: | | | | |
| Urban land part. | | | | |
| Canadian part | Fair: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Good. |
| [1]Ub: | | | | |
| Urban land part. | | | | |
| Elandco part | Poor: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: clayey. |
| [1]Uc: | | | | |
| Urban land part. | | | | |
| Farnum part | Poor: low strength. | Fair: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| [1]Ud: | | | | |
| Urban land part. | | | | |
| Irwin part | Poor: shrink-swell, low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: thin layer, too clayey. |
| [1]Ue: | | | | |
| Urban land part. | | | | |
| Tabler part | Poor: low strength, shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| Vanoss: | | | | |
| Va, Vb, Vc, Vd | Poor: low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| Vernon: | | | | |
| Ve | Poor: shrink-swell, low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: thin layer. |
| Vf | Poor: shrink-swell, low strength. | Unsuited: excess fines. | Unsuited: excess fines. | Fair: too clayey. |
| Waldeck: | | | | |
| Wa | Fair: wetness. | Fair: excess fines. | Unsuited: excess fines. | Good. |

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

| Soil name and map symbol | Roadfill | Sand | Gravel | Topsoil |
|---|---|---|---|---|
| Waurika: Wb | Poor: low strength, shrink-swell. | Unsuited: excess fines. | Unsuited: excess fines. | 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. Absence of an entry means soil was not evaluated]

| Soil name and map symbol | Pond reservoir areas | Embankments, dikes, and levees | Drainage | Irrigation | Terraces and diversions | Grassed waterways |
|---|---|---|---|---|---|---|
| Albion: | | | | | | |
| [1]Aa: | | | | | | |
| Albion part----- | Seepage--------- | Seepage--------- | Not needed------ | Soil blowing---- | Too sandy, soil blowing. | Droughty, rooting depth. |
| Shellabarger part----------- | Seepage--------- | Low strength, piping. | Not needed------ | Soil blowing---- | Too sandy, soil blowing. | Favorable. |
| [1]Ab: | | | | | | |
| Albion part----- | Seepage--------- | Seepage--------- | Not needed------ | Soil blowing, slope. | Too sandy, soil blowing. | Droughty, rooting depth. |
| Shellabarger part----------- | Seepage--------- | Low strength, piping. | Not needed------ | Soil blowing, slope. | Too sandy, soil blowing. | Favorable. |
| Blanket: | | | | | | |
| Ba, Bb------------ | Seepage--------- | Piping---------- | Not needed------ | Favorable------- | Favorable------- | Favorable. |
| Canadian: | | | | | | |
| Ca---------------- | Seepage--------- | Favorable------- | Not needed------ | Soil blowing---- | Not needed------ | Erodes easily. |
| [1]Cb: | | | | | | |
| Canadian part--- | Seepage--------- | Favorable------- | Not needed------ | Soil blowing---- | Not needed------ | Erodes easily. |
| Waldeck part---- | Seepage--------- | Seepage--------- | Floods---------- | Floods, wetness, soil blowing. | Not needed------ | Favorable. |
| Carwile: | | | | | | |
| Cc---------------- | Favorable------- | Favorable------- | Percs slowly, floods, poor outlets. | Slow intake, wetness, soil blowing. | Not needed------ | Percs slowly, wetness. |
| Clark: | | | | | | |
| [1]Cd: | | | | | | |
| Clark part------ | Seepage--------- | Favorable------- | Not needed------ | Favorable------- | Erodes easily | Erodes easily. |
| Ost part-------- | Favorable------- | Favorable------- | Not needed------ | Favorable------- | Favorable------- | Percs slowly, erodes easily. |
| Clime: | | | | | | |
| Ce---------------- | Depth to rock | Thin layer------ | Not needed------ | Droughty, rooting depth. | Depth to rock, erodes easily. | Depth to rock, erodes easily. |
| Elandco: | | | | | | |
| Ea---------------- | Seepage--------- | Piping---------- | Not needed------ | Erodes easily--- | Not needed------ | Favorable. |
| Eb---------------- | Seepage--------- | Piping---------- | Not needed------ | Floods, erodes easily. | Not needed------ | Favorable. |
| Ec---------------- | Seepage--------- | Piping---------- | Not needed------ | Floods, erodes easily. | Not needed------ | Favorable. |
| Farnum: | | | | | | |
| Fa---------------- | Favorable------- | Favorable------- | Not needed------ | Favorable------- | Favorable------- | Favorable. |

[1] 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 |
|---|---|---|---|---|---|---|
| Farnum: | | | | | | |
| Fb | Favorable | Favorable | Not needed | Favorable | Favorable | Favorable. |
| Fc | Seepage | Favorable | Not needed | Favorable | Not needed | Favorable. |
| Goessel: | | | | | | |
| Ga, Gb | Favorable | Hard to pack | Percs slowly | Slow intake | Not needed | Percs slowly. |
| Irwin: | | | | | | |
| Ia, Ib, Ic | Depth to rock | Hark to pack | Favorable | Slow intake erodes easily. | Percs slowly | Favorable. |
| Lesho: | | | | | | |
| La | Favorable | Seepage | Floods | Floods | Not needed | Favorable. |
| Lincoln: | | | | | | |
| Lb | Seepage | Seepage | Floods | Seepage, fast intake. | Not needed | Favorable. |
| Milan: | | | | | | |
| Ma, Mb, Mc | Favorable | Favorable | Not needed | Slow intake, slope. | Favorable | Favorable. |
| Naron: | | | | | | |
| Na | Seepage | Piping | Not needed | Soil blowing | Not needed | Erodes easily. |
| Owens: | | | | | | |
| Oc | Favorable | Hark to pack | Not needed | Droughty, percs slowly. | Rooting depth, percs slowly. | Droughty, erodes easily. |
| [1]Od: | | | | | | |
| Owens part | Favorable | Hard to pack | Not needed | Droughty, percs slowly. | Percs slowly, rooting depth. | Droughty, erodes easily. |
| Rock outcrop part. | | | | | | |
| Pits: | | | | | | |
| Pa. | | | | | | |
| Plevna: | | | | | | |
| Pb | Seepage | Seepage | Floods | Floods, wetness, soil blowing. | Not needed | Wetness. |
| Pratt: | | | | | | |
| Pc | Seepage | Piping, seepage. | Not needed | Fast intake, soil blowing. | Too sandy, soil blowing. | Droughty. |
| [1]Pd: | | | | | | |
| Pratt part | Seepage | Piping, seepage. | Not needed | Fast intake, soil blowing. | Too sandy, soil blowing. | Droughty. |
| Tivoli part | Seepage | Seepage | Not needed | Fast intake, droughty, soil blowing. | Too sandy, soil blowing. | Droughty. |
| Renfrow: | | | | | | |
| Ra, Rb | Favorable | Hard to pack | Not needed | Erodes easily, percs slowly. | Erodes easily, percs slowly. | Erodes easily, percs slowly. |
| [1]Rc: | | | | | | |
| Renfrow part | Favorable | Hard to pack | Not needed | Erodes easily, percs slowly. | Erodes easily, percs slowly. | Erodes easily, percs slowly. |
| Owens part | Favorable | Hard to pack | Not needed | Droughty, percs slowly. | Rooting depth, percs slowly. | Droughty, erodes easily. |

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 |
|---|---|---|---|---|---|---|
| Rosehill: | | | | | | |
| Rd | Depth to rock | Thin layer, hard to pack. | Not needed | Slow intake, rooting depth. | Depth to rock | Rooting depth. |
| Shellabarger: | | | | | | |
| Sa, Sb, Sc | Seepage | Piping | Not needed | Soil blowing | Soil blowing | Favorable. |
| Tabler: | | | | | | |
| Ta | Favorable | Hard to pack | Percs slowly | Slow intake, percs slowly. | Not needed | Percs slowly. |
| [1]Tb: | | | | | | |
| Tabler part | Favorable | Hard to pack | Percs slowly | Slow intake, percs slowly. | Not needed | Percs slowly. |
| Drummond part | Favorable | Piping, hard to pack. | Percs slowly, floods. | Slow intake, excess sodium. | Not needed | Droughty, erodes easily, excess salt. |
| Urban land: | | | | | | |
| [1]Ua: | | | | | | |
| Urban land part. | | | | | | |
| Canadian part | Seepage | Favorable | Not needed | Fast intake, soil blowing. | Not needed | Favorable. |
| [1]Ub: | | | | | | |
| Urban land part. | | | | | | |
| Elandco part | Seepage | Piping | Not needed | Favorable | Not needed | Favorable. |
| [1]Uc: | | | | | | |
| Urban land part. | | | | | | |
| Farnum part | Seepage | Favorable | Not needed | Slow intake | Favorable | Favorable. |
| [1]Ud: | | | | | | |
| Urban land part. | | | | | | |
| Irwin part | Depth to rock | Hard to pack | Favorable | Slow intake, erodes easily. | Percs slowly | Favorable. |
| [1]Ue: | | | | | | |
| Urban land part. | | | | | | |
| Tabler part | Favorable | Hard to pack | Percs slowly | Slow intake, percs slowly. | Not needed | Percs slowly. |
| Vanoss: | | | | | | |
| Va, Vb, Vc, Vd | Seepage | Piping | Not needed | Favorable | Favorable | Favorable. |
| Vernon: | | | | | | |
| Ve, Vf | Favorable | Hard to pack | Not needed | Droughty, percs slowly. | Percs slowly | Droughty, percs slowly. |
| Waldeck: | | | | | | |
| Wa | Seepage | Seepage | Floods | Floods, wetness. | Not needed | Favorable. |
| Waurika: | | | | | | |
| Wb | Favorable | Hard to pack, wetness. | Percs slowly | Wetness, slow intake, percs slowly. | Not needed | Wetness, percs slowly. |

[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." Absence of an entry means soil was not rated]

| Soil name and map symbol | Camp areas | Picnic areas | Playgrounds | Paths and trails |
|---|---|---|---|---|
| Albion: | | | | |
| [1]Aa: | | | | |
| Albion part | Slight | Slight | Moderate: slope. | Slight. |
| Shellabarger part | Slight | Slight | Moderate: slope. | Slight. |
| [1]Ab: | | | | |
| Albion part | Moderate: slope. | Moderate: slope. | Severe: slope. | Slight. |
| Shellabarger part | Moderate: slope. | Moderate: slope. | Severe: slope. | Slight. |
| Blanket: | | | | |
| Ba | Moderate: percs slowly. | Slight | Moderate: percs slowly. | Slight. |
| Bb | Moderate: percs slowly. | Slight | Moderate: slope, percs slowly. | Slight. |
| Canadian: | | | | |
| Ca | Severe: floods. | Moderate: floods. | Moderate: floods. | Slight. |
| [1]Cb: | | | | |
| Canadian part | Severe: floods. | Moderate: floods. | Moderate: floods. | Slight. |
| Waldeck part | Severe: floods. | Moderate: wetness. | Moderate: floods, wetness. | Slight. |
| Carwile: | | | | |
| Cc | Severe: wetness, floods. | Severe: wetness. | Severe: wetness. | Severe: wetness. |
| Clark: | | | | |
| [1]Cd: | | | | |
| Clark part | Moderate: too clayey. | Moderate: too clayey. | Moderate: slope. | Moderate: too clayey. |
| Ost part | Moderate: too clayey, percs slowly. | Moderate: too clayey. | Moderate: too clayey, percs slowly, slope. | Moderate: too clayey. |
| Clime: | | | | |
| Ce | Severe: too clayey. | Severe: too clayey. | Severe: too clayey. | Severe: too clayey. |
| Elandco: | | | | |
| Ea | Moderate: floods. | Moderate: dusty. | Moderate: dusty, too clayey. | Slight. |
| Eb | Severe: floods. | Moderate: floods. | Moderate: floods. | Slight. |
| Ec | Severe: floods. | Moderate: floods. | Severe: floods. | Slight. |

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

| Soil name and map symbol | Camp areas | Picnic areas | Playgrounds | Paths and trails |
|---|---|---|---|---|
| Farnum: | | | | |
| Fa | Moderate: percs slowly. | Slight | Moderate: percs slowly. | Slight. |
| Fb | Moderate: percs slowly. | Slight | Moderate: percs slowly, slope. | Slight. |
| Fc | Moderate: percs slowly. | Slight | Moderate: percs slowly. | Slight. |
| Goessel: | | | | |
| Ga, Gb | Severe: percs slowly. | Severe: too clayey. | Severe: percs slowly. | Severe: too clayey. |
| Irwin: | | | | |
| Ia, Ib, Ic | Severe: percs slowly. | Moderate: too clayey. | Severe: percs slowly. | Moderate: too clayey. |
| Lesho: | | | | |
| La | Severe: floods, wetness. | Moderate: floods, wetness. | Moderate: floods, wetness, percs slowly. | Moderate: wetness. |
| Lincoln: | | | | |
| Lb | Severe: floods. | Severe: floods. | Severe: floods. | Severe: floods. |
| Milan: | | | | |
| Ma, Mb, Mc | Moderate: percs slowly. | Slight | Moderate: percs slowly, slope. | Slight. |
| Naron: | | | | |
| Na | Slight | Slight | Slight | Slight. |
| Owens: | | | | |
| Oc | Severe: too clayey, percs slowly. | Severe: too clayey. | Severe: too clayey, percs slowly. | Severe: too clayey. |
| [1]Od: | | | | |
| Owens part | Severe: too clayey, percs slowly. | Severe: too clayey. | Severe: slope, too clayey. | Severe: too clayey. |
| Rock outcrop part. | | | | |
| Pits: | | | | |
| Pa. | | | | |
| Plevna: | | | | |
| Pb | Severe: floods, wetness. | Severe: wetness. | Severe: floods, wetness. | Severe: wetness. |
| Pratt: | | | | |
| Pc | Moderate: too sandy. | Moderate: too sandy. | Moderate: too sandy, slope. | Moderate: too sandy. |
| [1]Pd: | | | | |
| Pratt part | Moderate: too sandy, slope. | Moderate: too sandy, slope. | Severe: slope. | Moderate: too sandy. |
| Tivoli part | 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 |
|---|---|---|---|---|
| Renfrow: | | | | |
| Ra, Rb | Severe: percs slowly, too clayey. | Moderate: too clayey. | Severe: percs slowly, slope. | Moderate: too clayey. |
| [1]Rc: | | | | |
| Renfrow part | Severe: percs slowly, too clayey. | Moderate: too clayey. | Severe: percs slowly, slope. | Moderate: too clayey. |
| Owens part | Severe: too clayey, percs slowly. | Severe: too clayey. | Severe: too clayey, percs slowly. | Severe: too clayey. |
| Rosehill: | | | | |
| Rd | Severe: percs slowly, too clayey. | Severe: too clayey. | Severe: percs slowly, too clayey. | Severe: 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. |
| [1]Tb: | | | | |
| Tabler part | Severe: percs slowly. | Moderate: too clayey. | Severe: percs slowly. | Moderate: too clayey. |
| Drummond part | Severe: percs slowly. | Moderate: wetness. | Severe: percs slowly. | Moderate: wetness. |
| Urban land: | | | | |
| [1]Ua: | | | | |
| Urban land part. | | | | |
| Canadian part | Severe: floods. | Moderate: floods. | Moderate: floods. | Slight. |
| [1]Ub: | | | | |
| Urban land part. | | | | |
| Elandco part | Moderate: floods. | Moderate: dusty. | Moderate: dusty, too clayey. | Slight. |
| [1]Uc: | | | | |
| Urban land part. | | | | |
| Farnum part | Moderate: percs slowly. | Slight | Moderate: percs slowly. | Slight. |
| [1]Ud: | | | | |
| Urban land part. | | | | |
| Irwin part | Severe: percs slowly. | Moderate: too clayey. | Severe: percs slowly. | Moderate: too clayey. |
| [1]Ue: | | | | |
| Urban land part. | | | | |
| Tabler part | Severe: percs slowly. | Moderate: too clayey. | Severe: percs slowly. | Moderate: too clayey. |
| Vanoss: | | | | |
| Va | Slight | Slight | Slight | Slight. |

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

| Soil name and map symbol | Camp areas | Picnic areas | Playgrounds | Paths and trails |
|---|---|---|---|---|
| Vanoss: | | | | |
| Vb, Vc, Vd | Slight | Slight | Moderate: slope. | Slight. |
| Vernon: | | | | |
| Ve | Severe: percs slowly. | Slight | Severe: percs slowly, too clayey. | Slight. |
| Vf | Severe: percs slowly. | Moderate: too clayey. | Severe: percs slowly, too clayey. | Moderate: too clayey. |
| Waldeck: | | | | |
| Wa | Severe: floods. | Moderate: wetness. | Moderate: floods, wetness. | Slight. |
| Waurika: | | | | |
| Wb | 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." Absence of an entry indicates the soil was not rated]

| Soil name and map symbol | Potential for habitat elements | | | | | | | Potential as habitat for-- | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herba-ceous plants | Conif-erous plants | Shrubs | Wetland plants | Shallow water areas | Openland wildlife | Wetland wildlife | Rangeland wildlife |
| Albion: | | | | | | | | | | |
| [1]Aa: | | | | | | | | | | |
| Albion part | Fair | Good | Fair | --- | Fair | Very poor. | Very poor. | Fair | Very poor. | Fair. |
| Shellabarger part | Good | Good | Good | --- | Fair | Poor | Very poor. | Good | Very poor. | Fair. |
| [1]Ab: | | | | | | | | | | |
| Albion part | Poor | Fair | Fair | --- | Fair | Very poor. | Very poor. | Fair | Very poor. | Fair. |
| Shellabarger part | Poor | Fair | Good | --- | Fair | Very poor. | Very poor. | Fair | Very poor. | Fair. |
| Blanket: | | | | | | | | | | |
| Ba, Bb | Good | Good | Fair | Good | Good | Poor | Very poor. | Good | Very poor. | Fair. |
| Canadian: | | | | | | | | | | |
| Ca | Good | Good | Good | --- | Good | Poor | Very poor. | Good | Very poor. | Good. |
| [1]Cb: | | | | | | | | | | |
| Canadian part | Good | Good | Good | --- | Good | Poor | Very poor. | Good | Very poor. | Good. |
| Waldeck part | Fair | Good | Good | --- | Good | Fair | Fair | Good | Fair | Good. |
| Carwile: | | | | | | | | | | |
| Cc | Fair | Good | Good | --- | Good | Good | Fair | Good | Fair | Good. |
| Clark: | | | | | | | | | | |
| [1]Cd: | | | | | | | | | | |
| Clark part | Fair | Good | Fair | --- | Poor | Poor | Very poor. | Fair | Very poor. | Poor. |
| Ost part | Good | Good | Fair | --- | Fair | Poor | Poor | Good | Poor | Fair. |
| Clime: | | | | | | | | | | |
| Ce | Fair | Fair | Fair | --- | Fair | Very poor. | Very poor. | Fair | Very poor. | Fair. |
| Elandco: | | | | | | | | | | |
| Ea | Good | Good | Fair | --- | Good | Poor | Very poor. | Good | Very poor. | Fair. |
| Eb | Good | Good | Fair | --- | Good | Poor | Very poor. | Good | Very poor. | Fair. |
| Ec | Very poor | Poor | Fair | --- | Good | Poor | Very poor. | Poor | Very poor. | Fair. |
| Farnum: | | | | | | | | | | |
| Fa, Fb, Fc | Good | Good | Good | --- | Fair | Fair | Poor | Good | Poor | Fair. |
| Goessel: | | | | | | | | | | |
| Ga, Gb | Fair | Fair | Fair | --- | Fair | Poor | Fair | Fair | Poor | Fair. |
| Irwin: | | | | | | | | | | |
| Ia, Ib, Ic | Good | Good | Good | --- | Fair | Poor | Poor | Good | Poor | Fair. |
| Lesho: | | | | | | | | | | |
| La | Fair | Fair | Fair | --- | Fair | Fair | Fair | Fair | Fair | 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 | Coniferous plants | Shrubs | Wetland plants | Shallow water areas | Openland wildlife | Wetland wildlife | Rangeland wildlife |
| Lincoln: | | | | | | | | | | |
| Lb | Poor | Fair | Fair | --- | Fair | Very poor. | Very poor. | Fair | Very poor. | Fair. |
| Milan: | | | | | | | | | | |
| Ma | Good | Good | Good | --- | Fair | Fair | Poor | Good | Poor | Fair. |
| Mb, Mc | Fair | Good | Good | --- | Fair | Poor | Very poor. | Good | Very poor. | Fair. |
| Naron: | | | | | | | | | | |
| Na | Good | Good | Good | --- | Fair | Poor | Very poor. | Good | Very poor. | Fair. |
| Owens: | | | | | | | | | | |
| Oc | Fair | Fair | Fair | --- | Poor | Very poor. | Very poor. | Fair | Very poor. | Poor. |
| [1]Od: | | | | | | | | | | |
| Owens part | Poor | Fair | Fair | --- | Poor | Very poor. | Very poor. | Fair | Very poor. | Poor. |
| Rock outcrop part | | | | | | | | | | |
| Pits: | | | | | | | | | | |
| Pa. | | | | | | | | | | |
| Plevna: | | | | | | | | | | |
| Pb | Poor | Fair | Fair | --- | Fair | Good | Good | Fair | Good | Fair. |
| Pratt: | | | | | | | | | | |
| Pc | Fair | Good | Fair | --- | Fair | Very poor. | Very poor. | Fair | Very poor. | Fair. |
| [1]Pd: | | | | | | | | | | |
| Pratt part | Fair | Good | Fair | --- | Fair | Very poor. | Very poor. | Fair | Very poor. | Fair. |
| Tivoli part | Poor | Poor | Fair | --- | Poor | Very poor. | Very poor. | Poor | Very poor. | Poor. |
| Renfrow: | | | | | | | | | | |
| Ra, Rb | Good | Good | Fair | --- | Fair | Poor | Very poor. | Good | Very poor. | Fair. |
| [1]Rc: | | | | | | | | | | |
| Renfrow part | Good | Good | Fair | --- | Fair | Poor | Very poor. | Good | Very poor. | Fair. |
| Owens part | Fair | Fair | Fair | --- | Poor | Very poor. | Very poor. | Fair | Very poor. | Poor. |
| Rosehill: | | | | | | | | | | |
| Rd | Fair | Good | Fair | --- | Fair | Poor | Very poor. | Fair | Very poor. | Fair. |
| Shellabarger: | | | | | | | | | | |
| Sa | Good | Good | Good | --- | Fair | Poor | Very poor. | Good | Very poor. | Fair. |
| Sb, Sc | Fair | Good | Good | --- | Fair | Poor | Very poor. | Good | Very poor. | Fair. |
| Tabler: | | | | | | | | | | |
| Ta | Good | Good | Fair | --- | Fair | Poor | Poor | Good | Poor | Fair. |
| [1]Tb: | | | | | | | | | | |
| Tabler part | Good | Good | Fair | --- | Fair | Poor | Poor | Good | Poor | Fair. |
| Drummond part | Poor | Fair | Fair | Poor | Poor | Fair | Fair | Fair | Fair | Poor. |

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 | Coniferous plants | Shrubs | Wetland plants | Shallow water areas | Openland wildlife | Wetland wildlife | Rangeland wildlife |
| Urban land: | | | | | | | | | | |
| [1]Ua: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Canadian part | Good | Good | Good | --- | Good | Poor | Very poor. | Good | Very poor. | Good. |
| [1]Ub: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Elandco part | Good | Good | Fair | --- | Good | Poor | Very poor. | Good | Very poor. | Fair. |
| [1]Uc: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Farnum part. | | | | | | | | | | |
| [1]Ud: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Irwin part | Good | Good | Good | --- | Fair | Poor | Poor | Good | Poor | Fair. |
| [1]Ue: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Tabler part | Good | Good | Fair | --- | Fair | Poor | Poor | Good | Poor | Fair. |
| Vanoss: Va, Vb, Vc, Vd | Good | Good | Good | --- | Good | Poor | Very poor. | Good | Very poor. | Good. |
| Vernon: | | | | | | | | | | |
| Ve. | | | | | | | | | | |
| Vf | Fair | Fair | Fair | --- | Fair | Poor | Very poor. | Fair | Very poor. | Fair. |
| Waldeck: Wa | Fair | Good | Good | --- | Good | Fair | Fair | Good | Fair | Good. |
| Waurika: Wb | Fair | Good | 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 map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

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

| 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 | |
| Albion: | | | | | | | | | | | |
| [1]Aa: | | | | | | | | | | | |
| Albion part | 0-9 | Sandy loam | SM, ML | A-2, A-4 | 0 | 100 | 70-100 | 60-90 | 25-55 | <30 | [2]NP-5 |
| | 9-19 | Sandy loam, loam | SM, ML, GM, GC | A-2, A-4 | 0 | 50-100 | 45-100 | 45-90 | 30-55 | 20-35 | NP-10 |
| | 19-26 | Coarse sandy loam, loamy sand. | SM, GM | A-2, A-1 | 0 | 50-100 | 45-90 | 40-70 | 15-30 | <30 | NP-5 |
| | 26-60 | Loamy sand, gravelly sandy loam, gravelly sand. | SP-SM, GP-GM, SM, GM | A-2, A-1, A-3 | 0-5 | 40-100 | 40-90 | 30-70 | 5-30 | <30 | NP-5 |
| Shellabarger part | 0-15 | Sandy loam | SM, ML | A-4, A-2 | 0 | 95-100 | 95-100 | 75-100 | 30-55 | <30 | NP-5 |
| | 15-40 | Sandy clay loam, sandy loam, fine sandy loam. | SC, CL | A-4, A-6 | 0 | 95-100 | 95-100 | 70-90 | 36-55 | 25-40 | 8-20 |
| | 40-60 | Coarse sandy loam, fine sandy loam, sand. | SC, SM | A-2, A-4 | 0 | 70-100 | 70-100 | 50-80 | 10-40 | <30 | NP-10 |
| [1]Ab: | | | | | | | | | | | |
| Albion part | 0-9 | Sandy loam | SM, ML | A-2, A-4 | 0 | 100 | 70-100 | 60-90 | 25-55 | <30 | NP-5 |
| | 9-19 | Sandy loam, loam | SM, ML, GM, GC | A-2, A-4 | 0 | 50-100 | 45-100 | 45-90 | 30-55 | 20-35 | NP-10 |
| | 19-26 | Coarse sandy loam, loamy sand. | SM, GM | A-2, A-1 | 0 | 50-100 | 45-90 | 40-70 | 15-30 | <30 | NP-5 |
| | 26-60 | Loamy sand, gravelly sandy loam, gravelly sand. | SP-SM, GP-GM, SM, GM | A-2, A-1, A-3 | 0-5 | 40-100 | 40-90 | 30-70 | 5-30 | <30 | NP-5 |
| Shellabarger part | 0-15 | Sandy loam | SM, ML | A-4, A-2 | 0 | 95-100 | 95-100 | 75-100 | 30-55 | <30 | NP-5 |
| | 15-40 | Sandy clay loam, sandy loam, fine sandy loam. | SC, CL | A-4, A-6 | 0 | 95-100 | 95-100 | 70-90 | 35-55 | 25-40 | 8-20 |
| | 40-60 | Coarse sandy loam, fine sandy loam, sand. | SC, SM | A-2, A-4 | 0 | 70-100 | 70-100 | 50-80 | 10-40 | <30 | NP-10 |
| Blanket: | | | | | | | | | | | |
| Ba, Bb | 0-14 | Silt loam | CL | A-6 | 0 | 95-100 | 95-100 | 90-100 | 60-80 | 28-40 | 12-24 |
| | 14-34 | Clay loam, clay, silty clay. | CL, CH | A-7 | 0 | 95-100 | 95-100 | 85-100 | 70-90 | 41-55 | 20-35 |
| | 34-60 | Clay loam, clay, silty clay loam. | CL | A-6, A-7 | 0 | 85-100 | 80-100 | 70-90 | 51-85 | 30-45 | 15-30 |
| Canadian: | | | | | | | | | | | |
| Ca | 0-20 | Fine sandy loam | SM, ML, SC, CL | A-4 | 0 | 100 | 98-100 | 94-100 | 36-85 | <31 | NP-10 |
| | 20-60 | Fine sandy loam, loam, sandy loam. | SM, ML, SC, CL | A-4, A-2 | 0 | 100 | 98-100 | 90-100 | 15-85 | <31 | NP-10 |
| [1]Cb: | | | | | | | | | | | |
| Canadian part | 0-20 | Fine sandy loam | SM, ML, SC, CL | A-4 | 0 | 100 | 98-100 | 94-100 | 36-85 | <31 | NP-10 |
| | 20-60 | Fine sandy loam, loam, sandy loam. | SM, ML, SC, CL | A-4, A-2 | 0 | 100 | 98-100 | 90-100 | 15-85 | <31 | NP-10 |

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 | |
| Canadian: | | | | | | | | | | | |
| Waldeck part----- | 0-14 | Fine sandy loam | SM, SM-SC, ML, CL-ML | A-2, A-4 | 0 | 100 | 95-100 | 75-100 | 25-55 | <25 | NP-5 |
| | 14-27 | Fine sandy loam, sandy loam. | SM, SM-SC | A-2, A-4 | 0 | 100 | 95-100 | 70-100 | 30-50 | <25 | NP-5 |
| | 27-60 | Fine sand, sand | SM, SP | A-1, A-2, A-3 | 0 | 90-100 | 80-100 | 40-60 | 1-35 | --- | NP |
| Carwile: | | | | | | | | | | | |
| Cc----------------- | 0-18 | Fine sandy loam | ML, CL, CL-ML, SM | A-4 | 0 | 100 | 98-100 | 94-100 | 36-85 | <30 | NP-10 |
| | 18-24 | Clay loam, sandy clay loam. | CL, SC | A-6, A-7 | 0 | 100 | 100 | 90-100 | 36-90 | 35-50 | 14-26 |
| | 24-47 | Clay loam, clay, sandy clay. | CL, CH, SC | A-6, A-7 | 0 | 100 | 100 | 90-100 | 40-95 | 35-70 | 14-38 |
| | 47-60 | Clay loam, sandy clay loam, clay. | CL, CH, SC | A-4, A-6, A-7 | 0 | 100 | 100 | 90-100 | 36-95 | 25-70 | 7-38 |
| Clark: | | | | | | | | | | | |
| [1]Cd: | | | | | | | | | | | |
| Clark part------- | 0-11 | Clay loam-------- | CL-ML, CL | A-4, A-6 | 0 | 100 | 95-100 | 90-100 | 50-90 | 20-40 | 5-20 |
| | 11-60 | Loam, clay loam | CL | A-6, A-7 | 0 | 100 | 95-100 | 90-100 | 55-90 | 25-45 | 10-25 |
| Ost part--------- | 0-7 | Clay loam-------- | CL | A-6, A-4 | 0 | 100 | 100 | 90-100 | 75-90 | 25-40 | 8-15 |
| | 7-60 | Clay loam-------- | CL | A-6, A-7-6 | 0 | 100 | 100 | 90-100 | 75-90 | 33-50 | 15-30 |
| Clime: | | | | | | | | | | | |
| Ce----------------- | 0-8 | Silty clay------- | CL, CH | A-7, A-6 | 0-20 | 90-100 | 90-100 | 85-100 | 80-95 | 38-60 | 18-30 |
| | 8-26 | Silty clay, clay, silty clay loam. | CH, CL | A-7, A-6 | 0 | 100 | 100 | 95-100 | 85-95 | 38-60 | 18-35 |
| | 26 | Unweathered bedrock. | | | | | | | | | |
| Elandco: | | | | | | | | | | | |
| Ea, Eb, Ec--------- | 0-40 | Silt loam-------- | CL, ML, CL-ML | A-4, A-6, A-7-6 | 0 | 100 | 100 | 95-100 | 85-95 | 25-45 | 4-20 |
| | 40-60 | Silty clay loam, clay loam, silt loam. | CL, ML, CL-ML | A-4, A-6, A-7-6 | 0 | 100 | 100 | 95-100 | 75-90 | 20-45 | 4-16 |
| Farnum: | | | | | | | | | | | |
| Fa, Fb------------- | 0-14 | Loam------------- | CL-ML, CL | A-4, A-6 | 0 | 100 | 100 | 95-100 | 65-85 | <30 | 5-15 |
| | 14-60 | Clay loam, sandy clay loam, loam. | SC, CL, CH | A-6, A-7-6 | 0 | 100 | 100 | 65-100 | 45-80 | 35-55 | 15-30 |
| Fc----------------- | 0-14 | Loam------------- | CL-ML, CL | A-4, A-6 | 0 | 100 | 100 | 90-100 | 60-85 | <30 | 5-15 |
| | 14-28 | Clay loam, sandy clay loam, loam. | SC, CL | A-6, A-7 | 0 | 100 | 100 | 65-100 | 45-80 | 35-50 | 15-25 |
| | 28-40 | Sandy loam, loam, clay loam. | SM, ML, CL, SC | A-4, A-6 | 0 | 100 | 100 | 85-100 | 40-80 | 20-35 | 2-15 |
| | 40-60 | Fine sand, loamy sand, coarse sand. | SM, SP-SM | A-3 | 0 | 100 | 95-100 | 50-95 | 5-30 | --- | NP |
| Goessel: | | | | | | | | | | | |
| Ga, Gb------------- | 0-5 | Silty clay------- | CH, CL | A-7-6 | 0 | 100 | 100 | 95-100 | 95-100 | 41-60 | 20-35 |
| | 5-60 | Silty clay, clay | CH | A-7-6 | 0 | 100 | 100 | 95-100 | 95-100 | 51-65 | 30-40 |

See footnotes at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

| Soil name and map symbol | Depth | USDA texture | Classification | | Fragments > 3 inches | Percentage passing sieve number-- | | | | Liquid limit | Plasticity index |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unified | AASHTO | | 4 | 10 | 40 | 200 | | |
| | In | | | | Pct | | | | | Pct | |
| Irwin: | | | | | | | | | | | |
| Ia, Ib, Ic---------- | 0-13 | Silty clay loam | CL | A-6 | 0 | 100 | 100 | 95-100 | 90-100 | 30-40 | 11-20 |
| | 13-52 | Silty clay, clay | CH | A-7-6 | 0 | 100 | 100 | 95-100 | 90-100 | 50-65 | 25-40 |
| | 52-60 | Silty clay, clay, silty clay loam. | CH, CL | A-7-6 | 0 | 100 | 100 | 95-100 | 90-100 | 40-60 | 20-40 |
| Lesho: | | | | | | | | | | | |
| La------------------ | 0-27 | Loam------------- | CL | A-6, A-4, A-7-6 | 0 | 100 | 100 | 95-100 | 65-85 | 30-45 | 8-20 |
| | 27-60 | Loamy fine sand, sand, coarse sand. | SM, SP-SM | A-2, A-3, A-4, A-1 | 0 | 100 | 100 | 30-85 | 8-35 | --- | NP |
| Lincoln: | | | | | | | | | | | |
| Lb------------------ | 0-8 | Loamy fine sand | SM, SM-SP | A-2, A-3 | 0 | 90-100 | 85-100 | 75-100 | 8-35 | --- | NP |
| | 8-60 | 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-------------- | 0-11 | Loam------------- | CL-ML, CL | A-4, A-6 | 0 | 95-100 | 95-100 | 95-100 | 65-85 | 20-30 | 5-15 |
| | 11-60 | Clay loam, sandy clay loam, loam. | SC, CL, CH | A-6, A-7-6 | 0 | 95-100 | 95-100 | 65-100 | 45-80 | 35-55 | 15-30 |
| Mc------------------ | 0-6 | Clay loam-------- | CL-ML, CL | A-4, A-6 | 0 | 95-100 | 95-100 | 95-100 | 65-85 | 20-30 | 5-15 |
| | 6-60 | Clay loam, sandy clay loam, loam. | SC, CL, CH | A-6, A-7-6 | 0 | 95-100 | 95-100 | 65-100 | 45-80 | 35-55 | 15-30 |
| Naron: | | | | | | | | | | | |
| Na------------------ | 0-8 | Fine sandy loam | SM, SM-SC, ML, CL-ML | A-2, A-4 | 0 | 100 | 95-100 | 75-100 | 25-60 | <26 | 1-7 |
| | 8-50 | Fine sandy loam, sandy clay loam, sandy loam. | SC, CL | A-4, A-6 | 0 | 100 | 95-100 | 80-100 | 36-60 | 26-40 | 8-18 |
| | 50-60 | Fine sandy loam, loamy fine sand, fine sand. | SM, SM-SC | A-2, A-4 | 0 | 100 | 95-100 | 75-100 | 20-50 | <26 | NP-7 |
| Owens: | | | | | | | | | | | |
| Oc------------------ | 0-7 | Clay loam-------- | CL, CH | A-7-6 | 0-5 | 95-100 | 95-100 | 85-100 | 75-95 | 45-60 | 22-32 |
| | 7-15 | Clay, clay loam | CL, CH | A-7-6 | 0-5 | 95-100 | 90-100 | 85-100 | 75-95 | 45-60 | 22-32 |
| | 15-20 | Shaly clay------- | CL, CH | A-6, A-7-6 | 0-5 | 90-100 | 85-100 | 80-100 | 55-95 | 40-55 | 25-35 |
| [1]Od: | | | | | | | | | | | |
| Owens part-------- | 0-7 | Clay loam-------- | CL, CH | A-7-6 | 0-5 | 95-100 | 95-100 | 85-100 | 75-95 | 45-60 | 22-32 |
| | 7-15 | Clay, clay loam | CL, CH | A-7-6 | 0-5 | 95-100 | 90-100 | 85-100 | 75-95 | 45-60 | 22-32 |
| | 15-20 | Shaly clay------- | CL, CH | A-6, A-7-6 | 0-5 | 90-100 | 85-100 | 80-100 | 55-95 | 40-55 | 25-35 |
| Rock outcrop part. | | | | | | | | | | | |
| Pits: | | | | | | | | | | | |
| Pa. | | | | | | | | | | | |
| Plevna: | | | | | | | | | | | |
| Pb------------------ | 0-9 | Fine sandy loam | SM, SM-SC | A-2, A-4 | 0 | 100 | 95-100 | 70-100 | 20-50 | <26 | NP-6 |
| | 9-35 | Fine sandy loam, sandy loam. | SM, SM-SC | A-2, A-4 | 0 | 100 | 95-100 | 70-100 | 30-50 | <26 | NP-6 |
| | 35-60 | Fine sand, sand | SM, SP | A-2, A-3 | 0 | 100 | 90-100 | 50-90 | 4-35 | --- | NP |

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 | |
| Pratt: | | | | | | | | | | | |
| Pc------------------ | 0-18 | Loamy fine sand | SM | A-2 | 0 | 100 | 95-100 | 70-100 | 15-35 | --- | NP |
| | 18-36 | Loamy fine sand, loamy sand, fine sandy loam. | SM, SM-SC | A-2, A-4 | 0 | 100 | 95-100 | 90-100 | 15-40 | <20 | NP-6 |
| | 36-60 | Loamy fine sand, fine sand. | SM, SP-SM | A-2, A-3 | 0 | 100 | 95-100 | 80-100 | 5-35 | --- | NP |
| [1]Pd: | | | | | | | | | | | |
| Pratt part------- | 0-18 | Loamy fine sand | SM | A-2 | 0 | 100 | 95-100 | 70-100 | 15-35 | --- | NP |
| | 18-36 | Loamy fine sand, loamy sand, fine sandy loam. | SM, SM-SC | A-2, A-4 | 0 | 100 | 95-100 | 90-100 | 15-40 | <20 | NP-6 |
| | 36-60 | Loamy fine sand, fine sand. | SM, SP-SM | A-2, A-3 | 0 | 100 | 95-100 | 80-100 | 5-35 | --- | NP |
| Tivoli part------ | 0-10 | Loamy fine sand | SM, SP-SM | A-2, A-3 | 0 | 100 | 98-100 | 80-100 | 5-35 | --- | NP |
| | 10-60 | Fine sand, sand | SM, SP-SM | A-2, A-3 | 0 | 100 | 98-100 | 80-98 | 5-20 | --- | NP |
| Renfrow: | | | | | | | | | | | |
| Ra, Rb------------- | 0-9 | Silty clay loam | CL | A-6, A-7 | 0 | 100 | 100 | 96-100 | 80-98 | 33-49 | 12-26 |
| | 9-13 | Clay loam, silty clay loam. | CL | A-6, A-7 | 0 | 100 | 100 | 96-100 | 80-98 | 37-49 | 15-26 |
| | 13-60 | Clay, silty clay, silty clay loam. | ML, CL, CH, MH | A-6, A-7 | 0 | 100 | 100 | 96-100 | 80-99 | 37-70 | 15-38 |
| [1]Rc: | | | | | | | | | | | |
| Renfrow part----- | 0-9 | Clay loam-------- | CL | A-6, A-7 | 0 | 100 | 100 | 96-100 | 80-98 | 33-49 | 12-26 |
| | 9-13 | Clay loam, silty clay loam. | CL | A-6, A-7 | 0 | 100 | 100 | 96-100 | 80-98 | 37-49 | 15-26 |
| | 13-60 | Clay, silty clay, silty clay loam. | ML, CL, CH, MH | A-6, A-7 | 0 | 100 | 100 | 96-100 | 80-99 | 37-70 | 15-38 |
| Owens part------- | 0-7 | Clay loam-------- | CL, CH | A-7-6 | 0-5 | 95-100 | 95-100 | 85-100 | 75-95 | 45-60 | 22-32 |
| | 7-15 | Clay, clay loam | CL, CH | A-7-6 | 0-5 | 95-100 | 90-100 | 85-100 | 75-95 | 45-60 | 22-32 |
| | 15-20 | Shaly clay------- | CL, CH | A-6, A-7-6 | 0-5 | 90-100 | 85-100 | 80-100 | 55-95 | 40-55 | 25-35 |
| Rosehill: | | | | | | | | | | | |
| Rd------------------ | 0-8 | Silty clay------- | CH, CL | A-7 | 0 | 100 | 100 | 95-100 | 90-100 | 45-70 | 30-50 |
| | 8-30 | Silty clay, clay | CH, CL | A-7 | 0 | 100 | 100 | 95-100 | 90-100 | 45-70 | 30-50 |
| | 30 | Unweathered bedrock. | | | | | | | | | |
| Shellabarger: | | | | | | | | | | | |
| Sa, Sb, Sc--------- | 0-15 | Sandy loam------- | SM, ML | A-4, A-2 | 0 | 95-100 | 95-100 | 75-100 | 30-55 | <30 | NP-5 |
| | 15-40 | Sandy clay loam, sandy loam, fine sandy loam. | SC, CL | A-4, A-6 | 0 | 95-100 | 95-100 | 70-90 | 35-55 | 25-40 | 8-20 |
| | 40-60 | Coarse sandy loam, fine sandy loam, sand. | SC, SM | A-2, A-4 | 0 | 70-100 | 70-100 | 50-80 | 10-40 | <30 | NP-10 |
| Tabler: | | | | | | | | | | | |
| Ta------------------ | 0-9 | Silty clay loam | CL, ML, CL-ML | A-4, A-6 | 0 | 100 | 100 | 96-100 | 80-98 | 20-40 | 3-18 |
| | 9-32 | Silty clay, clay | CL, CH | A-7 | 0 | 100 | 100 | 96-100 | 90-99 | 41-65 | 18-35 |
| | 32-60 | 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 |

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 | |
| Tabler: | | | | | | | | | | | |
| [1]Tb: | | | | | | | | | | | |
| Tabler part------ | 0-9 | Silt loam-------- | CL, ML, CL-ML | A-4, A-6 | 0 | 100 | 100 | 96-100 | 80-98 | 20-40 | 3-18 |
| | 9-32 | Silty clay, clay | CL, CH | A-7 | 0 | 100 | 100 | 96-100 | 90-99 | 41-65 | 18-35 |
| | 32-60 | 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 |
| Drummond part---- | 0-8 | Silt loam-------- | CL, ML, CL-ML | A-4, A-6 | 0 | 100 | 100 | 96-100 | 65-97 | 22-39 | 3-15 |
| | 8-48 | Clay loam, silty clay loam, clay. | CL, CH | A-6, A-7 | 0 | 100 | 100 | 96-100 | 80-98 | 35-60 | 15-35 |
| | 48-60 | Variable. | | | | | | | | | |
| Urban land: | | | | | | | | | | | |
| [1]Ua: | | | | | | | | | | | |
| Urban land part. | | | | | | | | | | | |
| Canadian part---- | 0-20 | Fine sandy loam | SM, ML, SC, CL | A-4 | 0 | 100 | 98-100 | 94-100 | 36-85 | <31 | NP-10 |
| | 20-60 | Fine sandy loam, loam, sandy loam. | SM, ML, SC, CL | A-4, A-2 | 0 | 100 | 98-100 | 90-100 | 15-85 | <31 | NP-10 |
| [1]Ub: | | | | | | | | | | | |
| Urban land part. | | | | | | | | | | | |
| Elandco part----- | 0-40 | Silt loam-------- | CL, ML, CL-ML | A-4, A-6, A-7-6 | 0 | 100 | 100 | 95-100 | 85-95 | 25-45 | 4-20 |
| | 40-60 | Silty clay loam, clay loam, silt loam. | CL, ML, CL-ML | A-4, A-6, A-7-6 | 0 | 100 | 100 | 95-100 | 75-90 | 20-45 | 4-16 |
| [1]Uc: | | | | | | | | | | | |
| Urban land part. | | | | | | | | | | | |
| Farnum part------ | 0-14 | Loam------------- | CL-ML, CL | A-4, A-6 | 0 | 100 | 100 | 90-100 | 60-85 | <30 | 5-15 |
| | 14-28 | Clay loam, sandy clay loam, loam. | SC, CL | A-6, A-7 | 0 | 100 | 100 | 65-100 | 45-80 | 35-50 | 15-25 |
| | 28-40 | Sandy loam, loam, clay loam. | SM, ML, CL, SC | A-4, A-6 | 0 | 100 | 100 | 85-100 | 40-80 | 20-35 | 2-15 |
| | 40-60 | Fine sand, loamy sand, coarse sand. | SM, SP-SM | A-3 | 0 | 100 | 95-100 | 50-95 | 5-30 | --- | NP |
| [1]Ud: | | | | | | | | | | | |
| Urban land part. | | | | | | | | | | | |
| Irwin part------- | 0-13 | Silty clay loam | CL | A-6 | 0 | 100 | 100 | 95-100 | 90-100 | 30-40 | 11-20 |
| | 13-52 | Silty clay, clay | CH | A-7-6 | 0 | 100 | 100 | 95-100 | 90-100 | 50-65 | 25-40 |
| | 52-60 | Silty clay, clay, silty clay loam. | CH, CL | A-7-6 | 0 | 100 | 100 | 95-100 | 90-100 | 40-60 | 20-40 |
| [1]Ue: | | | | | | | | | | | |
| Urban land part. | | | | | | | | | | | |
| Tabler part------ | 0-9 | Silty clay loam | CL, ML, CL-ML | A-4, A-6 | 0 | 100 | 100 | 96-100 | 80-98 | 20-40 | 3-18 |
| | 9-32 | Silty clay, clay | CL, CH | A-7 | 0 | 100 | 100 | 96-100 | 90-99 | 41-65 | 18-35 |
| | 32-60 | 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 |

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 | |
| Vanoss: | | | | | | | | | | | |
| Va, Vb, Vc, Vd | 0-13 | Silt loam | ML, CL | A-4, A-6 | 0 | 100 | 100 | 96-100 | 65-95 | 22-37 | 2-14 |
| | 13-16 | Loam, silt loam, clay loam. | CL, ML | A-4, A-6, A-7 | 0 | 100 | 100 | 96-100 | 65-98 | 22-43 | 2-20 |
| | 16-60 | Clay loam, silty clay loam. | CL | A-6, A-7 | 0 | 100 | 100 | 96-100 | 80-98 | 33-43 | 12-20 |
| Vernon: | | | | | | | | | | | |
| Ve | 0-13 | Sandy loam | SM, ML, SM-SC, CL-ML | A-6, A-7-6 | 0 | 100 | 95-100 | 75-100 | 25-55 | <25 | NP-5 |
| | 13-28 | Clay | CL, CH | A-6, A-7-6 | 0 | 95-100 | 90-100 | 90-100 | 80-98 | 38-60 | 20-38 |
| | 28-60 | Shaly clay | CL, CH | A-6, A-7-6 | 0-5 | 90-100 | 85-100 | 65-100 | 65-95 | 30-60 | 15-38 |
| Vf | 0-13 | Clay loam | CL | A-6, A-7-6 | 0 | 95-100 | 90-100 | 90-100 | 70-95 | 35-50 | 17-30 |
| | 13-28 | Clay | CL, CH | A-6, A-7-6 | 0 | 95-100 | 90-100 | 90-100 | 80-98 | 38-60 | 20-38 |
| | 28-60 | Shaly clay | CL, CH | A-6, A-7-6 | 0-5 | 90-100 | 85-100 | 65-100 | 65-95 | 30-60 | 15-38 |
| Waldeck: | | | | | | | | | | | |
| Wa | 0-14 | Sandy loam | SM, SM-SC, ML, CL-ML | A-2, A-4 | 0 | 100 | 95-100 | 75-100 | 25-55 | <25 | NP-5 |
| | 14-27 | Fine sandy loam, sandy loam. | SM, SM-SC | A-2, A-4 | 0 | 100 | 95-100 | 70-100 | 30-50 | <25 | NP-5 |
| | 27-60 | Fine sand, sand | SM, SP | A-1, A-2, A-3 | 0 | 90-100 | 80-100 | 40-60 | 1-35 | --- | NP |
| Waurika: | | | | | | | | | | | |
| Wb | 0-15 | Silt loam | CL, ML | A-4, A-6 | 0 | 100 | 100 | 96-100 | 80-95 | 22-37 | 3-14 |
| | 15-40 | Clay, silty clay | CL, CH, MH | A-7 | 0 | 95-100 | 95-100 | 90-100 | 80-98 | 41-66 | 20-40 |
| | 40-53 | Silty clay loam, clay loam, clay. | CL, CH, ML, MH | A-6, A-7 | 0 | 90-100 | 90-100 | 85-100 | 80-98 | 38-55 | 16-30 |
| | 53-60 | Clay loam, silty clay loam. | CL, ML | A-6, A-7 | 0 | 90-100 | 90-100 | 80-100 | 70-98 | 33-43 | 12-20 |

[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 means nonplastic.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means greater then. The erosion tolerance factor (T) is for the entire profile. Absence of an entry means data were not available or were not estimated]

| Soil name and map symbol | Depth | Permeability | Available water capacity | Soil reaction | Shrink-swell potential | Risk of corrosion | | Erosion factors | | Wind erodibility group |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Uncoated steel | Concrete | K | T | |
| | In | In/hr | In/in | pH | | | | | | |
| Albion: | | | | | | | | | | |
| [1]Aa: | | | | | | | | | | |
| Albion part | 0-9 | 2.0-6.0 | 0.13-0.20 | 5.6-6.5 | Low | Low | Low | 0.20 | 3 | 3 |
| | 9-19 | 2.0-6.0 | 0.12-0.18 | 6.1-8.4 | Low | Low | Moderate | 0.20 | | |
| | 19-26 | 2.0-6.0 | 0.09-0.12 | 6.1-8.4 | Low | Low | Low | 0.20 | | |
| | 26-60 | 6.0-20 | 0.03-0.10 | 6.1-8.4 | Low | Low | Low | 0.15 | | |
| Shellabarger part | 0-15 | 0.6-2.0 | 0.13-0.21 | 5.6-6.5 | Low | Low | Moderate | 0.20 | 5 | 3 |
| | 15-40 | 0.6-2.0 | 0.16-0.18 | 6.1-7.3 | Low | Low | Moderate | 0.28 | | |
| | 40-60 | 0.6-20 | 0.05-0.16 | 6.1-8.4 | Low | Low | Low | 0.28 | | |
| [1]Ab: | | | | | | | | | | |
| Albion part | 0-9 | 2.0-6.0 | 0.13-0.20 | 5.6-6.5 | Low | Low | Low | 0.20 | 3 | 3 |
| | 9-19 | 2.0-6.0 | 0.12-0.18 | 6.1-8.4 | Low | Low | Moderate | 0.20 | | |
| | 19-26 | 2.0-6.0 | 0.09-0.12 | 6.1-8.4 | Low | Low | Low | 0.20 | | |
| | 26-60 | 6.0-20 | 0.03-0.10 | 6.1-8.4 | Low | Low | Low | 0.15 | | |
| Shellabarger part | 0-15 | 0.6-2.0 | 0.13-0.21 | 5.6-6.5 | Low | Low | Moderate | 0.20 | 5 | 3 |
| | 15-40 | 0.6-2.0 | 0.16-0.18 | 6.1-7.3 | Low | Low | Moderate | 0.28 | | |
| | 40-60 | 0.6-20 | 0.05-0.16 | 6.1-8.4 | Low | Low | Low | 0.28 | | |
| Blanket: | | | | | | | | | | |
| Ba, Bb | 0-14 | 0.6-2.0 | 0.15-0.20 | 6.1-7.8 | Moderate | High | Low | 0.32 | 5 | 5 |
| | 14-34 | 0.2-0.6 | 0.12-0.18 | 6.1-8.4 | Moderate | High | Low | 0.37 | | |
| | 34-60 | 0.6-2.0 | 0.12-0.18 | 7.9-8.4 | Moderate | High | Low | 0.43 | | |
| Canadian: | | | | | | | | | | |
| Ca | 0-20 | 2.0-6.0 | 0.11-0.20 | 5.6-8.4 | Low | Low | Low | 0.20 | 5 | 3 |
| | 20-60 | 2.0-20 | 0.07-0.20 | 6.1-8.4 | Low | Low | Low | 0.20 | | |
| [1]Cb: | | | | | | | | | | |
| Canadian part | 0-20 | 2.0-6.0 | 0.11-0.20 | 5.6-8.4 | Low | Low | Low | 0.20 | 5 | 3 |
| | 20-60 | 2.0-20 | 0.07-0.20 | 6.1-8.4 | Low | Low | Low | 0.20 | | |
| Waldeck part | 0-14 | 2.0-6.0 | 0.14-0.18 | 7.4-8.4 | Low | Moderate | Low | 0.20 | 5 | 3 |
| | 14-27 | 2.0-6.0 | 0.12-0.17 | 7.4-8.4 | Low | Moderate | Low | 0.20 | | |
| | 27-60 | 6.0-20 | 0.05-0.07 | 7.4-8.4 | Low | Moderate | Low | 0.15 | | |
| Carwile: | | | | | | | | | | |
| Cc | 0-18 | 0.6-2.0 | 0.11-0.20 | 5.1-7.3 | Low | Moderate | Moderate | 0.43 | 5 | 3 |
| | 18-24 | 0.2-2.0 | 0.12-0.20 | 5.1-7.3 | Moderate | High | Moderate | 0.37 | | |
| | 24-47 | 0.06-0.2 | 0.12-0.20 | 6.1-8.4 | High | High | Low | 0.37 | | |
| | 47-60 | 0.2-2.0 | 0.12-0.20 | 6.6-8.4 | High | High | Low | 0.32 | | |
| Clark: | | | | | | | | | | |
| [1]Cd: | | | | | | | | | | |
| Clark part | 0-11 | 0.6-2.0 | 0.17-0.22 | 7.4-8.4 | Moderate | Moderate | Low | 0.28 | 5 | 4L |
| | 11-60 | 0.6-2.0 | 0.15-0.19 | 7.4-8.4 | Moderate | Moderate | Low | 0.28 | | |
| Ost part | 0-7 | 0.2-0.6 | 0.17-0.19 | 6.1-7.3 | Moderate | Low | Low | 0.28 | 5 | 6 |
| | 7-60 | 0.2-0.6 | 0.15-0.19 | 6.6-8.4 | Moderate | Moderate | Low | 0.37 | | |
| Clime: | | | | | | | | | | |
| Ce | 0-8 | 0.06-0.6 | 0.12-0.20 | 7.4-8.4 | Moderate | High | Low | 0.28 | 3 | 4 |
| | 8-26 | 0.06-0.6 | 0.12-0.18 | 7.9-8.4 | Moderate | High | Low | 0.28 | | |
| | 26 | --- | --- | --- | --- | --- | --- | --- | | |
| Elandco: | | | | | | | | | | |
| Ea, Eb, Ec | 0-40 | 0.6-2.0 | 0.15-0.22 | 6.6-8.4 | Moderate | Moderate | Low | 0.37 | 5 | 5 |
| | 40-60 | 0.6-2.0 | 0.15-0.22 | 7.4-8.4 | Moderate | Moderate | Low | 0.43 | | |
| Farnum: | | | | | | | | | | |
| Fa, Fb | 0-14 | 0.6-2.0 | 0.20-0.22 | 5.6-7.3 | Low | Low | Low | 0.28 | 5 | 6 |
| | 14-60 | 0.2-0.6 | 0.14-0.21 | 6.1-8.4 | Moderate | Moderate | Low | 0.28 | | |

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

| Soil name and map symbol | Depth | Permeability | Available water capacity | Soil reaction | 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 | | | | | | |
| Farnum: | | | | | | | | | | |
| Fc | 0-14 | 0.6-2.0 | 0.20-0.22 | 5.6-7.3 | Low | Low | Low | 0.28 | 5 | 6 |
| | 14-28 | 0.2-0.6 | 0.14-0.21 | 6.1-7.8 | Moderate | Moderate | Low | 0.28 | | |
| | 28-40 | 0.6-2.0 | 0.13-0.19 | 6.1-7.8 | Low | Low | Low | 0.28 | | |
| | 40-60 | 6.0-20 | 0.02-0.10 | 6.1-8.4 | Low | Low | Low | 0.15 | | |
| Goessel: | | | | | | | | | | |
| Ga, Gb | 0-5 | <0.06 | 0.12-0.20 | 6.1-7.3 | High | High | Low | 0.28 | 5 | 4 |
| | 5-60 | <0.06 | 0.10-0.15 | 7.4-8.4 | High | High | Low | 0.28 | | |
| Irwin: | | | | | | | | | | |
| Ia, Ib, Ic | 0-13 | 0.2-2.0 | 0.18-0.23 | 5.6-7.3 | Moderate | Moderate | Low | 0.37 | 4 | 7 |
| | 13-52 | <0.06 | 0.10-0.15 | 5.6-8.4 | High | High | Low | 0.37 | | |
| | 52-60 | <0.2 | 0.09-0.15 | 6.6-8.4 | High | High | Low | 0.37 | | |
| Lesho: | | | | | | | | | | |
| La | 0-27 | 0.2-0.6 | 0.17-0.22 | 7.4-9.0 | Moderate | High | Low | 0.28 | 3 | 4L |
| | 27-60 | >2.0 | 0.02-0.10 | 7.4-9.0 | Low | Low | Low | 0.28 | | |
| Lincoln: | | | | | | | | | | |
| Lb | 0-8 | 6.0-20 | 0.05-0.10 | 7.4-8.4 | Low | Low | Low | 0.17 | 5 | 2 |
| | 8-60 | 6.0-20 | 0.05-0.10 | 7.9-8.4 | Low | Low | Low | 0.17 | | |
| Milan: | | | | | | | | | | |
| Ma, Mb, Mc | 0-11 | 0.6-2.0 | 0.20-0.22 | 5.6-6.5 | Low | Low | Low | 0.28 | 5 | 6 |
| | 11-60 | 0.2-0.6 | 0.14-0.21 | 5.6-7.3 | Moderate | Moderate | Low | 0.28 | | |
| Naron: | | | | | | | | | | |
| Na | 0-8 | 0.6-6.0 | 0.14-0.20 | 5.6-7.3 | Low | Low | Low | 0.20 | 5 | 3 |
| | 8-50 | 0.6-2.0 | 0.15-0.18 | 5.6-7.8 | Low | Low | Low | 0.32 | | |
| | 50-60 | 0.6-6.0 | 0.10-0.15 | 6.1-8.4 | Low | Low | Low | 0.32 | | |
| Owens: | | | | | | | | | | |
| Oc | 0-7 | <0.06 | 0.13-0.17 | 7.9-8.4 | High | High | Low | 0.32 | 1 | 6 |
| | 7-15 | <0.06 | 0.13-0.17 | 7.9-8.4 | High | High | Low | 0.32 | | |
| | 15-20 | <0.06 | 0.03-0.08 | 7.9-8.4 | High | High | Low | 0.37 | | |
| [1]Od: | | | | | | | | | | |
| Owens part | 0-7 | <0.06 | 0.13-0.17 | 7.9-8.4 | High | High | Low | 0.32 | 1 | 6 |
| | 7-15 | <0.06 | 0.13-0.17 | 7.9-8.4 | High | High | Low | 0.32 | | |
| | 15-20 | <0.06 | 0.03-0.08 | 7.9-8.4 | High | High | Low | 0.37 | | |
| Rock outcrop part. | | | | | | | | | | |
| Pits: | | | | | | | | | | |
| Pa. | | | | | | | | | | |
| Plevna: | | | | | | | | | | |
| Pb | 0-9 | 2.0-6.0 | 0.14-0.18 | 6.6-8.4 | Low | High | Low | 0.20 | 5 | 3 |
| | 9-35 | 2.0-6.0 | 0.12-0.16 | 6.6-8.4 | Low | High | Low | 0.20 | | |
| | 35-60 | 2.0-6.0 | 0.05-0.07 | 6.6-8.4 | Low | High | Low | 0.20 | | |
| Pratt: | | | | | | | | | | |
| Pc | 0-18 | 6.0-20 | 0.10-0.13 | 5.6-7.3 | Low | Low | Moderate | 0.17 | 5 | 2 |
| | 18-36 | 6.0-20 | 0.09-0.16 | 5.6-7.3 | Low | Low | Low | 0.17 | | |
| | 36-60 | 6.0-20 | 0.08-0.12 | 6.1-7.3 | Low | Low | Low | 0.17 | | |
| [1]Pd: | | | | | | | | | | |
| Pratt part | 0-18 | 6.0-20 | 0.10-0.13 | 5.6-7.3 | Low | Low | Moderate | 0.17 | 5 | 2 |
| | 18-36 | 6.0-20 | 0.09-0.16 | 5.6-7.3 | Low | Low | Low | 0.17 | | |
| | 36-60 | 6.0-20 | 0.08-0.12 | 6.1-7.3 | Low | Low | Low | 0.17 | | |
| Tivoli part | 0-10 | 6.0-20.0 | 0.05-0.11 | 6.1-7.8 | Low | Low | Low | 0.17 | 5 | 1 |
| | 10-60 | 6.0-20.0 | 0.02-0.06 | 6.1-8.4 | Low | Low | Low | 0.17 | | |
| Renfrow: | | | | | | | | | | |
| Ra, Rb | 0-9 | 0.2-0.6 | 0.15-0.22 | 6.1-7.8 | Moderate | Moderate | Low | 0.43 | 4 | 7 |
| | 9-13 | 0.2-0.6 | 0.15-0.22 | 6.1-7.8 | Moderate | Moderate | Low | 0.43 | | |
| | 13-60 | <0.06 | 0.12-0.22 | 6.1-8.4 | High | High | Low | 0.43 | | |

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 | Shrink- swell potential | Risk of corrosion | | Erosion factors | | Wind erodi- bility group |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Uncoated steel | Concrete | K | T | |
| | In | In/hr | In/in | pH | | | | | | |
| Renfrow: | | | | | | | | | | |
| [1]Rc: | | | | | | | | | | |
| Renfrow part | 0-9 | 0.2-0.6 | 0.15-0.22 | 6.1-7.8 | Moderate | Moderate | Low | 0.43 | 4 | 7 |
| | 9-13 | 0.2-0.6 | 0.15-0.22 | 6.1-7.8 | Moderate | Moderate | Low | 0.43 | | |
| | 13-60 | <0.06 | 0.12-0.22 | 6.1-8.4 | High | High | Low | 0.43 | | |
| Owens part | 0-7 | <0.06 | 0.13-0.17 | 7.9-8.4 | High | High | Low | 0.32 | 1 | 6 |
| | 7-15 | <0.06 | 0.13-0.17 | 7.9-8.4 | High | High | Low | 0.32 | | |
| | 15-20 | <0.06 | 0.03-0.08 | 7.9-8.4 | High | High | Low | 0.37 | | |
| Rosehill: | | | | | | | | | | |
| Rd | 0-8 | <0.06 | 0.11-0.14 | 6.1-7.3 | High | High | Low | 0.28 | 3 | 4 |
| | 8-30 | <0.06 | 0.10-0.14 | 6.6-8.4 | High | High | Low | 0.28 | | |
| | 30 | --- | --- | --- | --- | --- | --- | --- | | |
| Shellabarger: | | | | | | | | | | |
| Sa, Sb, Sc | 0-15 | 0.6-2.0 | 0.13-0.21 | 5.6-6.5 | Low | Low | Moderate | 0.20 | 5 | 3 |
| | 15-40 | 0.6-2.0 | 0.16-0.18 | 6.1-7.3 | Low | Low | Moderate | 0.28 | | |
| | 40-60 | 0.6-20 | 0.05-0.16 | 6.1-8.4 | Low | Low | Low | 0.28 | | |
| Tabler: | | | | | | | | | | |
| Ta | 0-9 | 0.2-0.6 | 0.15-0.24 | 5.6-8.4 | Low | Moderate | Low | 0.49 | 5 | 7 |
| | 9-32 | <0.06 | 0.12-0.18 | 6.1-8.4 | High | High | Low | 0.37 | | |
| | 32-60 | <0.06 | 0.12-0.22 | 7.4-8.4 | High | High | Low | 0.43 | | |
| [1]Tb: | | | | | | | | | | |
| Tabler part | 0-9 | 0.2-0.6 | 0.15-0.24 | 5.6-8.4 | Low | Moderate | Low | 0.49 | 5 | 7 |
| | 9-32 | <0.06 | 0.12-0.18 | 6.1-8.4 | High | High | Low | 0.37 | | |
| | 32-60 | <0.06 | 0.12-0.22 | 7.4-8.4 | High | High | Low | 0.43 | | |
| Drummond part | 0-8 | 0.6-2.0 | 0.11-0.18 | 6.1-8.4 | Low | High | Low | 0.49 | 3 | 5 |
| | 8-48 | <0.06 | 0.09-0.17 | 7.4-9.0 | High | High | High | 0.55 | | |
| | 48-60 | --- | --- | --- | --- | --- | --- | --- | | |
| Urban land: | | | | | | | | | | |
| [1]Ua: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Canadian part | 0-20 | 2.0-6.0 | 0.11-0.20 | 5.6-8.4 | Low | Low | Low | 0.20 | 5 | 3 |
| | 20-60 | 2.0-20 | 0.07-0.20 | 6.1-8.4 | Low | Low | Low | 0.20 | | |
| [1]Ub: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Elandco part | 0-40 | 0.6-2.0 | 0.15-0.22 | 6.6-8.4 | Moderate | Moderate | Low | 0.37 | 5 | 5 |
| | 40-60 | 0.6-2.0 | 0.15-0.22 | 7.4-8.4 | Moderate | Moderate | Low | 0.43 | | |
| [1]Uc: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Farnum part | 0-14 | 0.6-2.0 | 0.20-0.22 | 5.6-7.3 | Low | Low | Low | 0.28 | 5 | 6 |
| | 14-28 | 0.2-0.6 | 0.14-0.21 | 6.1-7.8 | Moderate | Moderate | Low | 0.28 | | |
| | 28-40 | 0.6-2.0 | 0.13-0.19 | 6.1-7.8 | Low | Low | Low | 0.28 | | |
| | 40-60 | 6.0-20 | 0.02-0.10 | 6.1-8.4 | Low | Low | Low | 0.15 | | |
| [1]Ud: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Irwin part | 0-13 | 0.2-2.0 | 0.18-0.23 | 5.6-7.3 | Moderate | Moderate | Low | 0.37 | 4 | 7 |
| | 3-52 | <0.06 | 0.10-0.15 | 5.6-8.4 | High | High | Low | 0.37 | | |
| | 52-60 | <0.2 | 0.09-0.15 | 6.6-8.4 | High | High | Low | 0.37 | | |
| [1]Ue: | | | | | | | | | | |
| Urban land part. | | | | | | | | | | |
| Tabler part | 0-9 | 0.2-0.6 | 0.15-0.24 | 5.6-8.4 | Low | Moderate | Low | 0.49 | 5 | 7 |
| | 9-32 | <0.06 | 0.12-0.18 | 6.1-8.4 | High | High | Low | 0.37 | | |
| | 32-60 | <0.06 | 0.12-0.22 | 7.4-8.4 | High | High | Low | 0.43 | | |

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

| Soil name and map symbol | Depth | Permeability | Available water capacity | Soil reaction | Shrink-swell potential | Risk of corrosion | | Erosion factors | | Wind erodibility group |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Uncoated steel | Concrete | K | T | |
| | In | In/hr | In/in | pH | | | | | | |
| Vanoss: | | | | | | | | | | |
| Va, Vb, Vc, Vd---- | 0-13 | 0.6-2.0 | 0.15-0.20 | 5.1-6.5 | Low-------- | Low------- | Low------- | 0.37 | 5 | 5 |
| | 13-16 | 0.6-2.0 | 0.16-0.21 | 5.1-6.5 | Low-------- | Low------- | Low------- | 0.37 | | |
| | 16-60 | 0.6-2.0 | 0.17-0.22 | 5.1-6.5 | Moderate | Moderate | Moderate | 0.37 | | |
| Vernon: | | | | | | | | | | |
| Ve------------------ | 0-13 | 2.0-6.0 | 0.10-0.17 | 7.9-8.4 | Low-------- | Moderate | Low------- | 0.20 | 5 | 3 |
| | 13-28 | <0.06 | 0.10-0.15 | 7.9-8.4 | High------- | High------ | Low------- | 0.32 | | |
| | 28-60 | <0.06 | 0.00-0.10 | 7.9-8.4 | High------- | High------ | Low------- | --- | | |
| Vf------------------ | 0-13 | 2.0-6.0 | 0.10-0.17 | 7.9-8.4 | Low-------- | Moderate | Low------- | 0.20 | 5 | 6 |
| | 13-28 | <0.06 | 0.10-0.15 | 7.9-8.4 | High------- | High------ | Low------- | 0.32 | | |
| | 28-60 | <0.06 | 0.00-0.10 | 7.9-8.4 | High------- | High------ | Low------- | --- | | |
| Waldeck: | | | | | | | | | | |
| Wa------------------ | 0-14 | 2.0-6.0 | 0.14-0.18 | 7.4-8.4 | Low-------- | Moderate | Low------- | 0.20 | 5 | 3 |
| | 14-27 | 2.0-6.0 | 0.12-0.17 | 7.4-8.4 | Low-------- | Moderate | Low------- | | | |
| | 27-60 | 6.0-20 | 0.05-0.07 | 7.4-8.4 | Low-------- | Moderate | Low------- | 0.15 | | |
| Waurika: | | | | | | | | | | |
| Wb------------------ | 0-15 | 0.6-2.0 | 0.16-0.20 | 5.6-7.3 | Low-------- | High------ | Low------- | 0.49 | 5 | 5 |
| | 15-40 | <0.06 | 0.13-0.17 | 6.6-8.4 | High------- | High------ | Moderate | | | |
| | 40-53 | 0.06-0.2 | 0.15-0.19 | 7.4-8.4 | Moderate | High------ | Moderate | 0.37 | | |
| | 53-60 | 0.06-0.2 | 0.15-0.19 | 7.4-8.4 | Moderate | High------ | Moderate | 0.37 | | |

[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 definitions of "flooding" and "water table" in the Glossary explain such terms as "rare," "brief," and "perched." The symbol > means greater than]

| Soil name and map symbol | Hydrologic group | Flooding | | | High water table | | | Bedrock | |
|---|---|---|---|---|---|---|---|---|---|
| | | Frequency | Duration | Months | Depth | Kind | Months | Depth | Hardness |
| | | | | | Ft | | | In | |
| Albion: | | | | | | | | | |
| [1]Aa: | | | | | | | | | |
| Albion part | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Shellabarger part | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| [1]Ab: | | | | | | | | | |
| Albion part | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Shellabarger part | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Blanket: | | | | | | | | | |
| Ba, Bb | C | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Canadian: | | | | | | | | | |
| Ca | B | Rare | --- | --- | >6.0 | --- | --- | >60 | --- |
| [1]Cb: | | | | | | | | | |
| Canadian part | B | Rare | --- | --- | >6.0 | --- | --- | >60 | --- |
| Waldeck part | C | Occasional | Brief | Mar-Oct | 2.0-6.0 | Apparent | Oct-Apr | >60 | --- |
| Carwile: | | | | | | | | | |
| Cc | D | Occasional | Brief to very long. | Apr-Oct | 2.0-6.0 | Apparent | Oct-Apr | >60 | --- |
| Clark: | | | | | | | | | |
| [1]Cd: | | | | | | | | | |
| Clark part | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Ost part | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Clime: | | | | | | | | | |
| Ce | C | None | --- | --- | >6.0 | --- | --- | 20-40 | Rippable |
| Elandco: | | | | | | | | | |
| Ea, Eb, Ec | B | Rare to common. | Brief | Oct-May | >6.0 | --- | --- | >60 | --- |
| Farnum: | | | | | | | | | |
| Fa, Fb, Fc | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Goessel: | | | | | | | | | |
| Ga, Gb | D | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Irwin: | | | | | | | | | |
| Ia, Ib, Ic | D | None | --- | --- | >6.0 | --- | --- | >40 | Hard |
| Lesho: | | | | | | | | | |
| La | C | Occasional | Very brief | Mar-Jul | 2.0-6.0 | Apparent | Jan-Dec | >60 | --- |
| Lincoln: | | | | | | | | | |
| Lb | A | Common | Very brief to brief. | Apr-Oct | 5.0-8.0 | Apparent | Nov-May | >60 | --- |
| Milan: | | | | | | | | | |
| Ma, Mb, Mc | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |

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 | |
| Naron: | | | | | | | | | |
| Na | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Owens: | | | | | | | | | |
| Oc | D | None | --- | --- | >6.0 | --- | --- | 10-20 | Rippable |
| [1]Od: | | | | | | | | | |
| Owens part | D | None | --- | --- | >6.0 | --- | --- | 10-20 | Rippable |
| Rock outcrop part. | | | | | | | | | |
| Pits: | | | | | | | | | |
| Pa. | | | | | | | | | |
| Plevna: | | | | | | | | | |
| Pb | D | Frequent | Brief to long. | Mar-Oct | 0-4.0 | Apparent | Jan-Dec | >60 | --- |
| Pratt: | | | | | | | | | |
| Pc | A | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| [1]Pd: | | | | | | | | | |
| Pratt part | A | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Tivoli part | A | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Renfrow: | | | | | | | | | |
| Ra, Rb | D | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| [1]Rc: | | | | | | | | | |
| Renfrow part | D | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Owens part | D | None | --- | --- | >6.0 | --- | --- | 10-20 | Rippable |
| Rosehill: | | | | | | | | | |
| Rd | D | None | --- | --- | >6.0 | --- | --- | 20-40 | Rippable |
| Shellabarger: | | | | | | | | | |
| Sa, Sb, Sc | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Tabler: | | | | | | | | | |
| Ta | D | None | --- | --- | 2.5-3.5 | Perched | Oct-Apr | >60 | --- |
| [1]Tb: | | | | | | | | | |
| Tabler part | D | None | --- | --- | 2.5-3.5 | Perched | Oct-Apr | >60 | --- |
| Drummond part | D | Rare | --- | --- | 2.0-6.0 | Apparent | Nov-Apr | >60 | --- |
| Urban land: | | | | | | | | | |
| [1]Ua: | | | | | | | | | |
| Urban land part. | | | | | | | | | |
| Canadian part | B | Rare | --- | --- | >6.0 | --- | --- | >60 | --- |
| [1]Ub: | | | | | | | | | |
| Urban land part. | | | | | | | | | |
| Elandco part | B | Rare to common. | Brief | Oct-May | >6.0 | --- | --- | >60 | --- |
| [1]Uc: | | | | | | | | | |
| Urban land part. | | | | | | | | | |
| Farnum part | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |

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 | |
| Urban land: | | | | | | | | | |
| [1]Ud: | | | | | | | | | |
| Urban land part. | | | | | | | | | |
| Irwin part | D | None | --- | --- | >6.0 | --- | --- | >40 | Hard |
| [1]Ue: | | | | | | | | | |
| Urban land part. | | | | | | | | | |
| Tabler part | D | None | --- | --- | 2.5-3.5 | Perched | Oct-Apr | >60 | --- |
| Vanoss: Va, Vb, Vc, Vd | B | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Vernon: Ve, Vf | D | None | --- | --- | >6.0 | --- | --- | >60 | --- |
| Waldeck: Wa | C | Occasional | Brief | Mar-Oct | 2.0-6.0 | Apparent | Oct-Apr | >60 | --- |
| Waurika: Wb | 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 Kansas Department of Transportation, 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 number | Depth | Moisture density[1/] | | Percentage less than 3 inches passing sieve--[2/] | | | Percentage smaller than--[2/] | | | | Liquid limit | Plasticity index | Classification[3/] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Maximum | Optimum | No. 10 | No. 40 | No. 200 | 0.05 mm | 0.02 mm | 0.005 mm | 0.002 mm | | | AASHTO | Unified |
| | | | In | lb/cu ft | Pct | | | | | | | | Pct | | | |
| Canadian fine sandy loam: 2,600 feet east and 100 feet south of the northwest corner of sec. 33, T. 27 S., R. 4 W. (Nonmodal) | Alluvium. | S74Kans 87-4-1 | 0-28 | 118 | 10 | 99 | 91 | 28 | 21 | 12 | 7 | 7 | 18 | 3 | A-2-4 (0) | SM |
| | | 87-4-2 | 28-48 | 113 | 11 | 99 | 86 | 12 | 9 | 5 | 3 | 3 | 18 | [4/]NP | A-2-4 (0) | SP-SM |
| Lesho loam: 1,800 feet west and 75 feet south of the northeast corner of sec. 33, T. 26 S., R. 1 W. (Modal) | Alluvium. | S74Kans 87-6-1 | 0-10 | 110 | 13 | 100 | 98 | 59 | 50 | 30 | 18 | 13 | 27 | 8 | A-4(2) | CL |
| | | 87-6-2 | 10-27 | 118 | 12 | 100 | 97 | 40 | 34 | 25 | 15 | 13 | 22 | 5 | A-4(0) | SM-SC |
| Milan loam: 1,830 feet north and 100 feet east of the southwest corner of sec. 23, T. 29 S., R. 4 W. (Modal) | Old alluvium. | S74Kans 87-2-1 | 0-11 | 124 | 9 | 100 | 71 | 41 | 35 | 24 | 15 | 13 | 19 | 5 | A-4(0) | SM-SC |
| | | 87-2-2 | 11-31 | 110 | 15 | 99 | 79 | 45 | 40 | 35 | 31 | 29 | 38 | 18 | A-6(4) | SC |
| | | 87-2-3 | 31-44 | 110 | 16 | 100 | 96 | 51 | 47 | 37 | 28 | 25 | 32 | 15 | A-6(4) | CL |
| Naron fine sandy loam: 200 feet west and 75 feet north of the southeast corner of sec. 3, T. 25 S., R. 3 W. (Modal) | Eolian deposits. | S74Kans 87-3-1 | 0-20 | 115 | 12 | 100 | 91 | 62 | 53 | 32 | 18 | 14 | 23 | 5 | A-4(1) | CL-ML |
| | | 87-3-2 | 20-45 | 114 | 13 | 98 | 86 | 64 | 56 | 38 | 23 | 19 | 31 | 12 | A-6(5) | CL |

See footnotes at end of table.

TABLE 17.--ENGINEERING TEST DATA--Continued

| Soil name and location | Parent material | Report number | Depth | Moisture density 1/ | | Percentage less than 3 inches passing sieve--2/ | | | Percentage smaller than--2/ | | | | Liquid limit | Plasticity index | Classification 3/ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Maximum | Optimum | No. 10 | No. 40 | No. 200 | 0.05 mm | 0.02 mm | 0.005 mm | 0.002 mm | | | AASHTO | Unified |
| | | | In | lb/cu ft | Pct | | | | | | | | Pct | | | |
| Waldeck sandy loam: 1,000 feet east and 50 feet north of the southwest corner of sec. 34, T. 26 S., R. 1 W. (Modal) | Alluvium. | S74Kans 87-5-1 | 0-14 | 115 | 10 | 100 | 88 | 19 | 14 | 7 | 4 | 3 | 19 | 2 | A-2-4 (0) | SM |
| | | 87-5-2 | 14-27 | 108 | 14 | 100 | 96 | 19 | 13 | 5 | 2 | 2 | -- | NP | A-2-4 (0) | SM |

1/Based on AASHTO Designation T99-74, 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 the AASHTO Designation T88-72 (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 value 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. 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/AASHTO classification based on AASHTO Designation M145-49 (1); Unified, on ASTM Stand. D-2487-69 (2). The SCS and Bureau of Public Roads have agreed that all soils having plasticity indexes within two points of A-line are to be given a borderline classification. An example of a borderline classification is CL-ML.

4/Nonplastic.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics of this taxadjunct that are outside the range of the series]

| Soil name | Family or higher taxonomic class |
|---|---|
| Albion | Coarse-loamy, mixed, thermic Udic Argiustolls |
| Blanket | Fine, mixed, thermic Pachic Argiustolls |
| Canadian | Coarse-loamy, mixed, thermic Udic Haplustolls |
| Carwile | Fine, mixed, thermic Typic Argiaquolls |
| Clark | Fine-loamy, mixed, thermic Typic Calciustolls |
| Clime | Fine, mixed, mesic Udic Haplustolls |
| Drummond | Fine, mixed, thermic Mollic Natrustalfs |
| Elandco | Fine-silty, mixed, thermic Cumulic Haplustolls |
| Farnum | Fine-loamy, mixed, thermic Pachic Argiustolls |
| Goessel | Fine, montmorillonitic, mesic Udic Pellusterts |
| Irwin | Fine, mixed, mesic Pachic Argiustolls |
| *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 |
| Naron | Fine-loamy, mixed, thermic Udic Argiustolls |
| Ost | Fine-loamy, mixed, thermic Typic Argiustolls |
| Owens | Clayey, mixed, thermic, shallow Typic Ustochrepts |
| Plevna | Coarse-loamy, mixed, thermic Fluvaquentic Haplaquolls |
| Pratt | Sandy, mixed, thermic Psammentic Haplustalfs |
| *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 |
| Vanoss | Fine-silty, mixed, thermic Udic Argiustolls |
| *Vernon | Fine, mixed, thermic Typic Ustochrepts |
| Waldeck | Coarse-loamy, mixed, thermic Fluvaquentic Haplustolls |
| Waurika | Fine, montmorillonitic, thermic Typic Argialbolls |

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