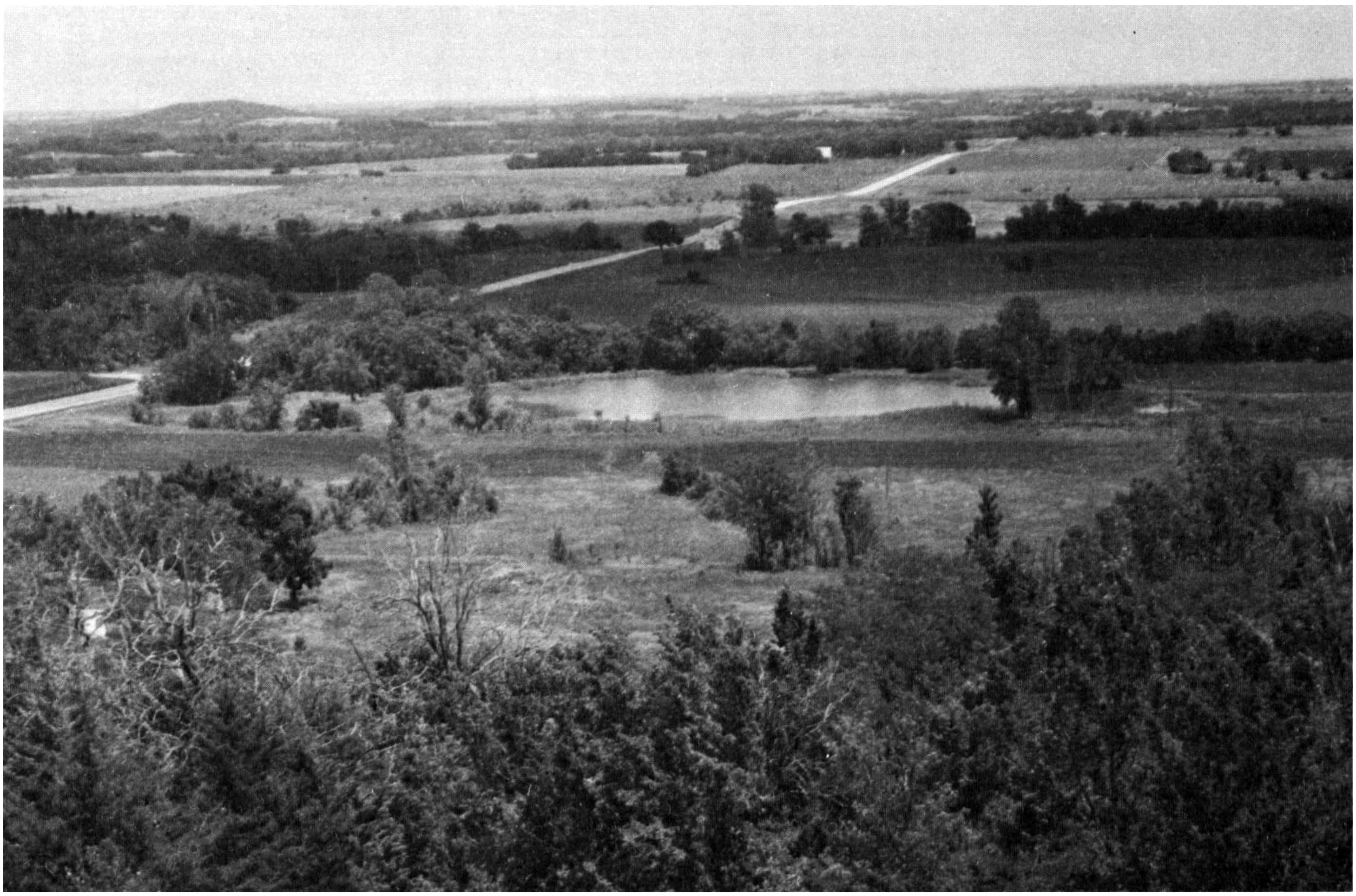
SOIL SURVEY OF

Douglas County, Kansas



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

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 who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1962–73. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. 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 Douglas County Conservation District.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

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

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

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

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

Ranchers and others can find, under "Management of Soils Used for Grassland," groupings of the soils according to their suitability for range and pasture, and also the names of many of the plants that grow on each range site and in pasture.

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the sections "Engineering Uses of the Soils" and "Use of Soils for Recreational Development."

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

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

Newcomers in Douglas County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

Cover: Vinland and Sogn soils are in the immediate foreground of this landscape south and east of Lawrence; Martin and Woodson soils are dominant in the background.

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Summary of Tables

SOIL SURVEY OF DOUGLAS COUNTY, KANSAS

BY HAROLD P. DICKEY, JEROME L. ZIMMERMAN, ROBERT O. PLINSKY, AND RICHARD D. DAVIS,
SOIL CONSERVATION SERVICE

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

DOUGLAS COUNTY is in the northeastern part of Kansas (fig. 1). It has a total area of about 474 square miles, or 303,360 acres. The population of Douglas County was 59,375 in 1973. Seventy-eight percent of the people live in Lawrence, the county seat, which is in the north-central part of the county on the Kansas River.

Farming is one of the most important parts of the economy in Douglas County, and about 47 percent of the acreage is cultivated. Corn, grain sorghum, soybeans, wheat, and alfalfa are the principal crops. Livestock production and dairy operations are also important.

Various industries, the University of Kansas, Haskell Indian Junior College, and Baker University, are also important to the economy of Douglas County.

How This Survey Was Made

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

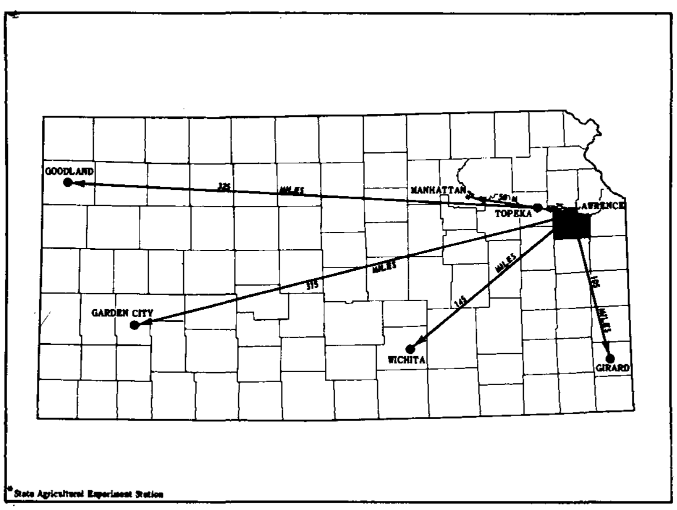

***Figure 1.*—Location of Douglas County in Kansas.**

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

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

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

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

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

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit, the soil complex, is shown on the soil map of Douglas County.

A soil complex consists of areas of two or more soils, so intricately mixed or so small that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Eudora-Kimo complex is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Stony steep land is a land type in this survey.

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

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or to its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

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

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

Soil association names and delineations on the general soil map do not fully agree with those of the general soil map in adjacent counties published at different dates Differences in the maps are the result of improvement in the classification or refinements in soil series concepts.

The five soil associations in Douglas County are discussed in the following paragraphs.

1. Martin-Sogn-Vinland Association

Deep, moderately well drained, gently sloping to strongly sloping soils and shallow, sloping to moderately, steep, somewhat excessively drained soils; on uplands

This association (fig. 2) is on uplands in areas that have narrow to moderately wide, convex ridgetops; sloping to moderately steep side slopes; and many drainageways. The soils formed in residuum derived from interbedded limestone and medium textured and moderately fine textured shale.

This association makes up about 48 percent of the county. Martin soils make up about 35 percent of this association; Sogn soils, 18 percent; and Vinland soils, 14 percent. The remaining 33 percent is minor soils of the Oska, Woodson, Kennebec, Gymer, Pawnee, Sibleyville, and Morrill series.

Martin soils are deep, gently sloping to strongly sloping, moderately well drained soils. They are mainly on foot slopes and the lower parts of side slopes, but are on ridgetops and the upper parts of side slopes in places. The surface layer is very dark brown silty clay loam, and the subsoil is very dark grayish brown to grayish brown silty clay.

Sogn soils are shallow, sloping to moderately steep, somewhat excessively drained soils on side slopes above Vinland soils. The surface layer is very dark gray to dark brown silty clay loam. Limestone is at a depth of about 12 inches.

Vinland soils are shallow, sloping to moderately steep, somewhat excessively drained soils on side slopes above Martin soils and below Sogn soils. They formed in material weathered from shale. The surface layer is very dark gray silty clay loam. Medium textured and moderately fine textured shale is at a depth of 10 to 20 inches.

Woodson, Pawnee, and Morrill soils are on ridgetops above Sogn soils. Oska soils are immediately above Sogn soils on side slopes, and Gymer and Sibleyville soils are

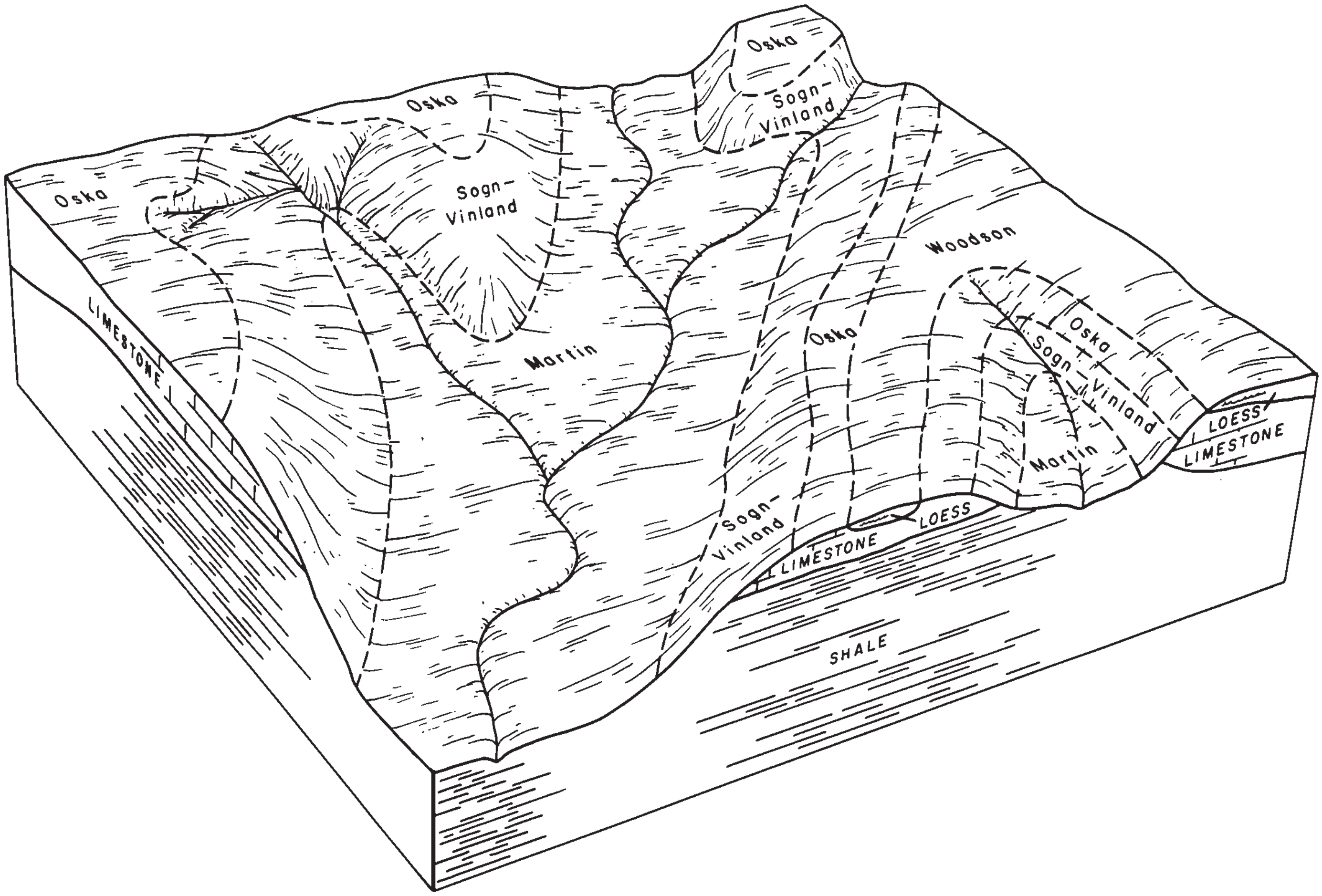

Figure 2.—**Pattern of soils in Martin-Sogn-Vinland association.**

on side slopes below Sogn soils. Kennebec soils, channeled, are in small valleys of meandering streams.

About 55 percent of the acreage of this association is used for pasture, 35 percent for cultivated crops, and 10 percent for urban purposes and recreation. Most of the limestone quarries in the county are in this association. The soils in this association are being developed more and more for urban and recreation uses. Livestock farming and general cash-grain farming are the main enterprises.

The main concerns of management are maintaining and improving grass production, controlling water erosion, and maintaining and improving fertility and tilth of the cultivated soils.

Wheat, soybeans, grain sorghum, and corn are the main crops. The main limitations for urban development are slow percolation, high shrink-swell potential, shallow depth to bedrock of Sogn and Vinland soils, and, in some areas, steep slopes.

2. Wabash-Kennebec-Reading Association

Deep, nearly level, well drained to very poorly drained soils; on bottom lands

This association is on flood plains and terraces of the larger streams. It makes up about 12 percent of the county. Wabash soils make up about 43 percent of this association; Kennebec soils, 26 percent; and Reading soils, 19 percent. The remaining 12 percent is minor soils of the Leanna and Judson series (fig. 3) and the Wakarusa River.

Wabash soils are nearly level, poorly drained to very poorly drained soils in backwater areas on high bottoms and low terraces adjacent to the uplands. The surface layer typically is black silty clay, and the subsoil is black and very dark gray silty clay.

Kennebec soils are nearly level, well drained to moderately well drained soils on first bottoms adjacent to streams. Flooding is common on these soils. The surface layer is very dark brown and black silt loam and silty clay loam. Below this is very dark grayish brown silty clay loam.

Reading soils are nearly level, well drained soils on high bottoms and terraces. They are either in the same landscape position as Wabash soils or are between Kennebec and Wabash soils. The surface layer is very dark brown silt loam, and the subsoil is very dark brown to dark grayish brown silty clay loam.

Leanna soils are on high bottoms and terraces in the southern part of the county and are occasionally flooded.

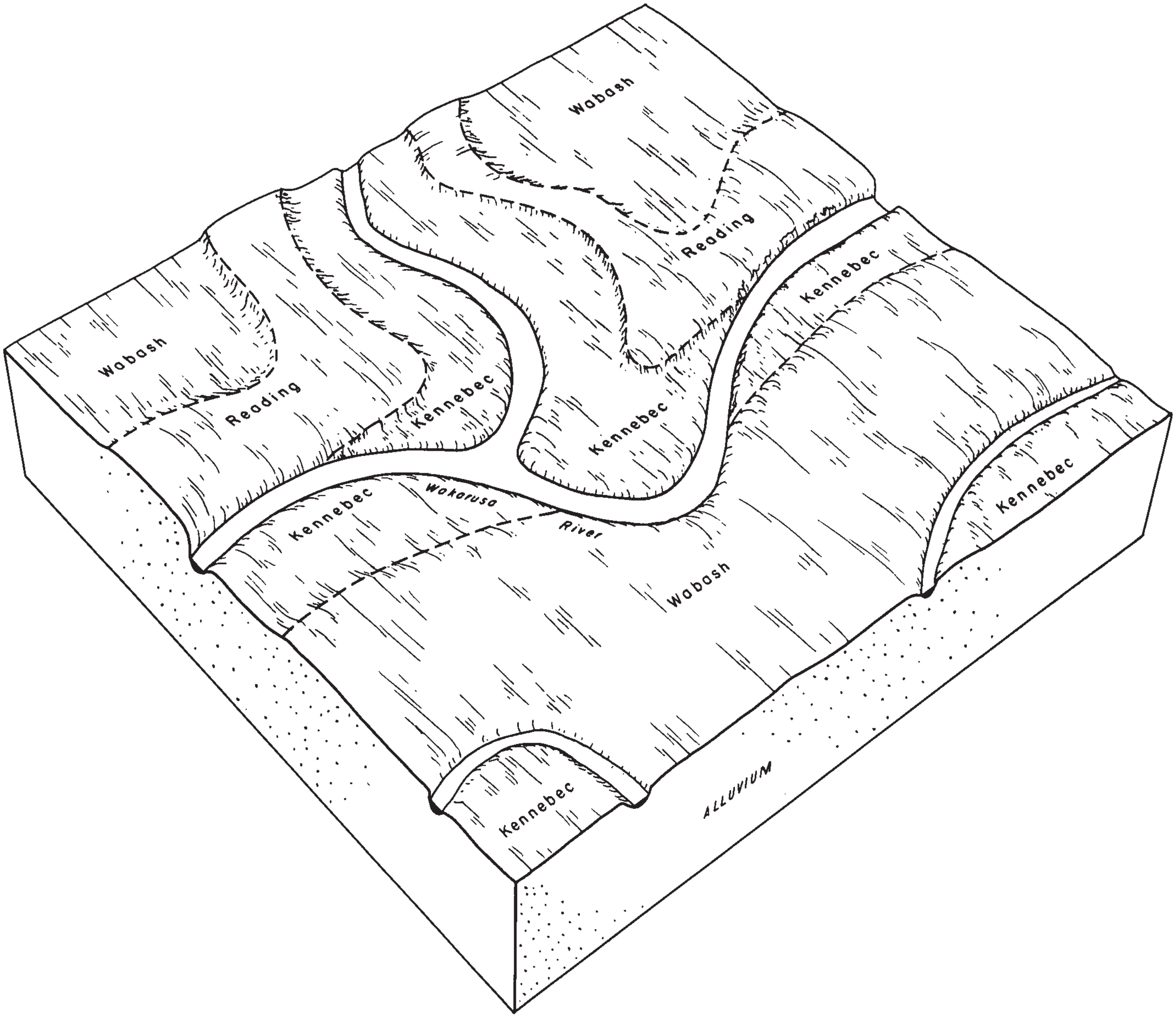

Figure 3.—**Pattern of soils in Wabash-Kennebec-Reading association.**

Judson soils are on a nearly level terrace of the Kansas River.

Most areas of this association are used for cultivated crops. A few small areas are used for woodland or wildlife habitat. General cash-grain farming is the main enterprise.

The main concerns of management are improving drainage, preventing flooding, and maintaining and improving fertility and tilth.

Corn, soybeans, wheat, and grain sorghum are the main crops. Kennebec, Reading, and Judson soils are suited to trees. The main limitation for urban development is the possibility of flooding.

3. Pawnee-Woodson-Morrill Association

Deep, nearly level to strongly sloping, well drained to somewhat poorly drained soils; on uplands

This association is in areas that have broad and moderately wide ridgetops and long, sloping side slopes. The soils formed in glacial till, glaciofluvial deposits, and old alluvial clayey sediment.

This association makes up about 9 percent of the county. Pawnee soils make up about 36 percent of this association; Woodson soils, 28 percent; and Morrill soils, 15 percent. The remaining 21 percent is minor soils of the Martin, Silbeyville, Sogn, Vinland, Kennebec, Sharpsburg, Gymer, Thurman, and Oska series.

Pawnee soils are gently sloping to sloping, moderately well drained soils on side slopes below Woodson soils. In some places where Woodson soils are not in the landscape, Pawnee soils are on both ridgetops and side slopes. The surface layer is very dark gray clay loam, and the subsoil is dark grayish brown to yellowish brown clay.

Woodson soils are nearly level to gently sloping, somewhat poorly drained soils on broad ridgetops. The surface layer is very dark gray silt loam and silty clay loam, and the subsoil is very dark gray to dark brown silty clay.

Morrill soils are sloping to strongly sloping, well drained soils generally on side slopes below Woodson or Pawnee soils. In some places, they are on narrow ridgetops. The surface layer is very dark gray clay loam, and the subsoil is dark brown to reddish brown clay loam.

Martin, Sibleyville, Sogn, and Vinland soils are on the lower side slopes. Kennebec soils, channeled, are in small drainageways. Sharpsburg, Gymer, and Thurman soils are on the bluffs along the Kansas River Valley.

Most areas of this association are used for cultivated crops. Some areas are used for pasture and urban uses. General cash-grain farming and livestock farming are the main enterprises.

The main concerns of management are controlling water erosion and maintaining and improving fertility and tilth. Maintenance and improvement of grass production are needed in areas used for grazing.

Wheat, corn, soybeans, and grain sorghum are the main crops. The main limitations for urban development are slow percolation and high shrink-swell potential.

4. Sibleyville-Martin-Woodson Association

Moderately deep, well drained, sloping to strongly sloping soils and deep, moderately well drained and somewhat poorly drained, nearly level to strongly sloping soils; on uplands

This association is in areas that have broad ridgetops, long, sloping side slopes, and numerous drainageways. The soils formed in material weathered from shale and sandstone, and in loess and old alluvium.

This association makes up about 24 percent of the county. Sibleyville soils make up about 48 percent of this association; Martin soils, 19 percent; and Woodson soils, 15 percent. The remaining 18 percent consists of minor soils of the Kennebec, Basehor, Vinland, Pawnee, Morrill, and Sogn series.

Sibleyville soils are moderately deep, sloping to strongly sloping, well drained soils generally on side slopes. The surface layer is very dark grayish brown loam, and the subsoil is dark brown loam. Depth to sandstone or loamy shale ranges from 24 to 40 inches.

Martin soils are deep, gently sloping to strongly sloping, moderatey well drained soils on the lower parts of the side slopes. The surface layer is very dark brown silty clay loam, and the subsoil is very dark grayish brown to grayish brown silty clay.

Woodson soils are deep, nearly level and gently sloping, somewhat poorly drained soils on broad ridgetops. The surface layer is very dark gray silt loam and silty clay loam, and the subsoil is very dark gray to dark brown silty clay.

Pawnee and Morrill soils are on ridgetops and the upper parts of side slopes. Basehor, Vinland, and Sogn soils are on sloping and strongly sloping side slopes. Kennebec soils, channeled, are in small drainageways.

About 70 percent of the acreage of this association is used for cultivated crops, and the rest is used for pasture. A few small areas are used for recreation and wildlife habitat. General cash-grain farming and livestock farming are the main enterprises.

The main concerns of management are controlling water erosion and maintaining and improving fertility and tilth. Maintenance and improvement of grass production are needed in areas used for grazing.

Wheat, soybeans, grain sorghum, and corn are the main crops. The main limitations for urban development are slow percolation, high shrink-swell potential, and moderate depth to bedrock.

5. Eudora-Kimo Association

Deep, nearly level to gently undulating, well drained and somewhat poorly drained soils; on bottom lands

This association is on the flood plain of the Kansas River (fig. 4). It makes up about 7 percent of the county. Eudora soils make up 50 percent of this association and Kimo soils, 26 percent. About 11 percent of the association is Riverwash and Sarpy and Judson soils, and about 13 percent is the Kansas River.

Eudora soils are nearly level to gently undulating, well drained soils in the higher areas of the gently undulating flood plains. The surface layer is very dark grayish brown silt loam, and the underlying material is dark grayish brown to grayish brown silt loam.

Kimo soils are nearly level, somewhat poorly drained soils in low areas of the gently undulating flood plains. The surface layer is very dark gray to black silty clay loam and silty clay. The next layer is dark gray silty clay loam. The underlying material is grayish brown silt loam.

Riverwash consists of an unstable mixture of sandy and loamy sediment in the lowest level along the Kansas River. Sarpy soils are on flood plains adjacent to the river, and Judson soils are on terraces along the river.

With the exception of industrial and urban areas, nearly all areas of this association are used for cultivated crops. A narrow area adjacent to the river is wooded. Sand is mined from the river and a few sand pits are along the river. The soils in this association are being developed more and more for industrial and urban uses. General cash-grain farming is the main enterprise.

The main concerns of management are controlling soil blowing and maintaining fertility and tilth. Water ponds on Kimo soils following periods of excessive precipitation and this affects row crops grown on these soils. Flooding is rare but damaging.

Corn, alfalfa, soybeans, and wheat are the main crops. These soils are well suited to vegetable crops, orchards, and trees. They are suited to irrigation, and

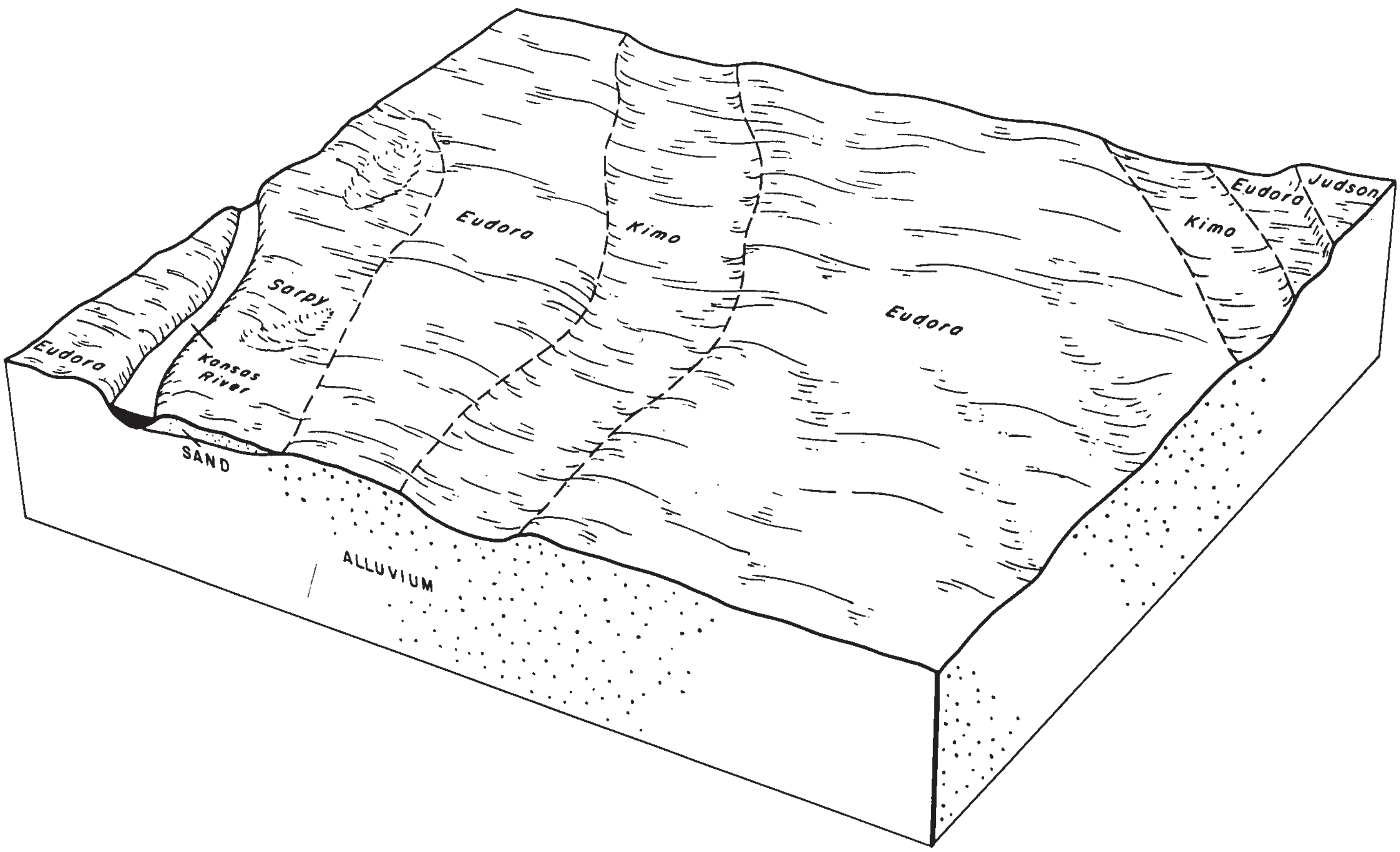

Figure 4.—**Pattern of soils in Eudora-Kimo association.**

water is available from wells or from the river. Limitations for urban development are possible flooding and contamination of ground water by sewage effluent.

Descriptions of the Soils

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

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

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

Preceeding the name of each mapping unit is the symbol that identifies the mapping unit on the detailed soil map. Listed at the end of the description of each mapping unit are the capability unit, range site, pasture suitability group, and woodland group in which the mapping unit has been placed. The page for the description of each capability unit, range site, and pasture suitability group can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*19*).[1]

[1] Italic numbers in parentheses refer to Literature Cited, p. 71

TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil name	Acres	Percent
Be	Basehor complex, 7 to 15 percent slopes	3,310	1.1
Et	Eudora silt loam	1,530	.5
Ev	Eudora-Kimo complex	6,785	2.3
Ew	Eudora-Kimo fine sandy loams, overwash	4,355	1.4
Ge	Gravelly land	375	.1
Gm	Gymer silt loam, 1 to 3 percent slopes	3,545	1.2
Gy	Gymer silt loam, 3 to 8 percent slopes	2,730	.9
Ju	Judson silt loam	1,210	.4
Kb	Kennebec silt loam	7,815	2.6
Kc	Kennebec soils, channeled	10,575	3.5
Km	Kimo silty clay loam	1,090	.4
Le	Leanna silt loam	1,695	.6
Mb	Martin silty clay loam, 1 to 3 percent slopes	4,440	1.5
Mc	Martin silty clay loam, 3 to 7 percent slopes	50,210	16.7
Mh	Martin soils, 3 to 7 percent slopes, eroded	7,640	2.5
Mo	Martin-Oska silty clay loams, 3 to 6 percent slopes	14,250	4.7
Mr	Morrill clay loam, 3 to 7 percent slopes	3,765	1.2
Ms	Morrill clay loam, 7 to 12 percent slopes	475	.2
Oe	Oska silty clay loam, 3 to 6 percent slopes	15,360	5.1
Pb	Pawnee clay loam, 1 to 3 percent slopes	2,170	.7
Pc	Pawnee clay loam, 3 to 7 percent slopes	10,825	3.6
Ph	Pawnee clay loam, 3 to 7 percent slopes, eroded	595	.2
Re	Reading silt loam	6,640	2.2
Ro	Riverwash	955	.3
Sb	Sarpy-Eudora complex, overwash	2,135	.7
Sc	Sharpsburg silt loam, 1 to 4 percent slopes	525	.2
Sd	Sharpsburg silt loam, 4 to 10 percent slopes	1,390	.5
Sh	Sibleyville loam, 3 to 7 percent slopes	16,905	5.6
So	Sibleyville loam, 3 to 7 percent slopes, eroded	1,560	.5
Ss	Sibleyville complex, 3 to 7 percent slopes	10,790	3.0
St	Sibleyville complex, 3 to 7 percent slopes, eroded	975	.3
Sv	Sibleyville complex, 7 to 15 percent slopes	3,885	1.3
Sw	Sogn-Vinland complex, 5 to 20 percent slopes	14,480	4.8
Sx	Stony steep land	11,110	3.7
Tc	Thurman complex, 4 to 10 percent slopes	580	.2
Vc	Vinland complex, 3 to 7 percent slopes	4,215	1.4
Vh	Vinland complex, 3 to 7 percent slopes, eroded	910	.3
Vm	Vinland-Martin complex, 7 to 15 percent slopes	17,490	5.8
Wc	Wabash silty clay loam	6,980	2.3
Wh	Wabash silty clay	8,125	2.7
Wo	Woodson silt loam, 0 to 1 percent slopes	1,635	.5
Ws	Woodson silt loam, 1 to 3 percent slopes	31,360	10.4
Wx	Woodson silty clay loam, 1 to 3 percent slopes, eroded	630	.2
	Borrow pits	495	.2
	Quarries	415	.1
	Water areas (more than 40 acres in size)	2,048	.6
	Water areas (less than 40 acres in size)	2,382	.8
	Total	303,360	100.0

The names, descriptions, and delineations of soils in this soil survey do not always agree fully with soil maps of adjoining counties published at an earlier date. Differences result from better knowledge of soils or modification and refinements in soil series concepts. In addition, the correlation of a recognized soil is based upon the acreage of that soil and the dissimilarity to adjacent soils within the survey area. Frequently, it is more feasible to include soils that are small in extent with similar soils, where management and response are much the same, rather than set them apart as individuals. The soil descriptions reflect these combinations. Other differences are brought about by the predominance of different soils in taxonomic units made up of two or three series. Still another difference is caused by the range in slope allowed within the mapping unit for each survey. In industrial and urban areas, the delineations of soil are inferred boundaries. These areas have been disturbed by cutting and filling with earth moving equipment.

Small areas of highly contrasting soils or special features, such as rock outcrops, that affect the use of soils are shown on the soil map by spot symbols. The spot symbols used are listed on the legend sheet under "Soil Survey Data." Not all of the symbols listed are used on the map of Douglas County, but the spot symbols that have been used are discussed in the following paragraphs.

Rock outcrops are in areas of moderately deep and deep soils that do not ordinarily have outcrops of bedrock. Each symbol represents an area of about 1 to 3 acres. Rock outcrops interfere with tillage and harvesting. They are also significant in the construction of conservation measures such as terraces and waterways.

Each symbol for a severely eroded spot represents an area of about 2 acres. Crop growth is generally poor in these areas because of low fertility and poor tilth. If clayey material has been exposed by erosion, a seedbed is difficult to prepare.

The native vegetation on all of the soils in Douglas County is tall and mid grasses unless otherwise stated.

Basehor Series

The Basehor series consists of shallow, well drained, strongly sloping soils on uplands. These soils formed in material weathered from fine-grained sandstone. Native vegetation is hardwood trees with an open canopy and on understory of woody shrubs and tall prairie grasses.

In a representative profile, the surface layer is dark brown loam about 4 inches thick. The subsoil is yellowish brown, very friable fine sandy loam about 8 inches thick. Fine-grained sandstone is at a depth of 12 inches.

Permeability is moderately rapid. Available water capacity is very low, and natural fertility is low.

Representative profile of Basehor loam, in an area of Basehor complex, 7 to 15 percent slopes, in a wooded pasture, 850 feet east and 2,500 feet north of the southwest corner of sec. 25, T. 14 S., R. 20 E.:

A1—0 to 4 inches; dark brown; (10YR 4/3) loam; weak to moderate very fine and medium granular structure; very friable; many fine roots; slightly acid; clear smooth boundary.

B2—4 to 12 inches; yellowish brown (10YR 5/4) fine sandy loam; weak fine and medium granular structure; very friable; many roots; medium acid; clear smooth boundary.

R—12 inches; yellowish brown hard fine-grained sandstone.

Thickness of the solum ranges from 10 to 20 inches. Reaction ranges from slightly acid to strongly acid. The A1 horizon is dark brown to dark grayish brown loam or fine sandy loam. The B2 horizon is fine sandy loam or loam. In some pedons, a C horizon is present.

Basehor soils are near Sibleyville and Vinland soils. Basehor soils contain less clay in the B2 horizon and are less deep to sandstone than Sibleyville soils. They have a lighter colored A1 horizon than Vinland soils.

Be—Basehor complex, 7 to 15 percent slopes. This complex consists of strongly sloping, shallow, moderately deep, and deep loamy soils that formed in material weathered from sandstone.

About 50 percent of this complex is Basehor loam, about 25 percent is a loamy soil that is 20 to 40 inches deep over sandstone or sandy shale, and 20 percent is a loamy soil that is more than 40 inches deep. Basehor loam has the profile described as representative for the series. It is mostly on the steeper side slopes, but in some areas it is on ridges. The loamy soil that is 20 to 40 inches deep has colors and textures similar to those of the Basehor soil. It is on ridges and the less steep side slopes. The loamy soil that is more than 40 inches deep also has colors and textures similar to those of the Basehor soil, but it is on foot slopes along small drainageways.

Included with these soils in mapping were a few small areas of Vinland soils and sandstone outcrops.

The erosion hazard is high if a cover of plants is not maintained.

Most of the acreage of this complex is used for pasture. Native vegetation is hardwood trees, shrubs, and tall prairie grasses. A few acres have been cleared of trees and planted to tame grasses, and a few areas are cultivated. Capability unit VIe-3, Shallow Savannah range site, pasture suitability group G, woodland group 5d.

Eudora Series

The Eudora series consists of deep, well drained, nearly level to gently undulating soils on flood plains. These soils formed in loamy alluvium. Native vegetation is tall prairie grasses and deciduous trees.

In a representative profile, the surface layer is very dark grayish brown silt loam about 12 inches thick. The underlying material is dark grayish brown coarse silt loam.

Natural fertility and available water capacity are high. Permeability is moderate.

Representative profile of Eudora silt loam, in a cultivated field, 125 feet south and 50 feet west of the northeast corner of sec. 15, T. 12 S., R. 19 E.:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium granular structure; very friable; slightly acid; gradual smooth boundary.

A12—7 to 12 inches; very dark grayish brown; (10YR 3/2) silt loam; moderate medium granular structure; very friable; many worm casts; slightly acid; gradual smooth boundary.

C1—12 to 23 inches; dark grayish brown (10-YR 4/2) coarse silt loam; massive; very friable; many worm casts; mildly alkaline; gradual smooth boundary.

C2—23 to 40 inches; dark grayish brown (10YR 4/2) coarse silt loam; massive; very friable; few worm casts; a layer of silty clay loam at a depth of 33 to 34 inches; mildly alkaline; gradual smooth boundary.

C3—40 to 48 inches; dark grayish brown (10YR 4/2) silt loam; massive; very friable; mildly alkaline; clear smooth boundary.

C4—48 to 72 inches; grayish brown (10YR 5/2) coarse silt loam; massive; very friable; some thin sandy and clayey layers less than 1 inch thick; strongly effervescent; mildly alkaline.

The A horizon ranges from 10 to 20 inches in thickness. In places where sediment was deposited by the flood in 1951, it is dark grayish brown. It is silt loam, fine sandy loam, or very fine sandy loam. Reaction ranges from slightly acid to neutral. The C horizon above a depth of 36 inches is generally silt loam that has thin layers of more sandy or clayey material. Below a depth of 36 inches, it is silt loam, loam, very fine sandy loam, fine sandy loam, or loamy very fine sand that is generally calcareous.

Eudora soils are near Kimo, Sarpy, and Judson soils. Eudora soils contain less clay in the upper 40 inches than Kimo soils. They contain less sand throughout than Sarpy soils. They contain less clay throughout and are dark colored to a shallower depth than Judson soils.

Et—Eudora silt loam. This nearly level soil is on the higher parts of the flood plain of the Kansas River. Individual areas are 4 to 160 acres in size. Flooding is rare. This soil has the profile described as representative for the series. Slopes are 0 to 1 percent.

Included with this soil in mapping were small areas of Kimo soils in depressions and Sarpy soils on ridges. Sarpy soils are generally shown on the soil map by a sand spot symbol.

Most of the acreage of this soil is cultivated. One area inside the Lawrence city limits has been developed for urban use. This soil is well suited to all crops commonly grown in this county including vegetables. Capability unit I–1, Loamy Lowland range site, pasture suitability group A–1, woodland group 2o.

Ev—Eudora-Kimo complex. This complex of nearly to gently undulating soils is on the flood plain of the Kansas River. Individual areas are 10 to 2,000 acres in size. Slopes are 0 to 3 percent.

About 60 percent of this complex is Eudora silt loam, and about 30 percent is Kimo silty clay loam. Eudora silt loam is on the higher parts of the landscape, and Kimo silty clay loam is on the lower parts, which are generally concave or depressional. Eudora silt loam is lighter colored than Kimo silty clay loam.

Included with these soils in mapping were areas of a soil similar to Kimo soils but less clayey. This included soil is between Eudora and Kimo soils or is in depressions adjacent to Eudora soils. Also included were small areas of soils similar to Eudora silt loam on short steep slopes and areas of Sarpy and Wabash soils.

Soil blowing is a slight hazard on Eudora soils, and ponding is a slight hazard on Kimo soils. Flooding is rare. The main concern of management is removing or controlling excess water.

Most of the acreage of this complex is cultivated. This complex is well suited to all crops commonly grown in this county, including vegetables. A few areas have been developed for urban use. Capability unit IIw–1; Eudora soils in Loamy Lowland range site, pasture suitability group A–1 and woodland group 2o; Kimo soils in Clay Lowland range site, pasture suitability group E, and woodland group 3o.

Ew—Eudora-Kimo fine sandy loams, overwash. These nearly level to gently undulating soils are on the lower parts of the flood plain of the Kansas River. Individual areas are 50 to 1,000 acres in size. Slopes are 0 to 2 percent.

About 65 percent of this complex is Eudora soils, and about 25 percent is Kimo soils. Eudora soils are on the higher parts of the landscape, and Kimo soils are on the lower parts, which are generally concave or depressional. These soils generally have a surface layer of dark grayish brown fine sandy loam ,the result of floods that have deposited 6 to 24 inches of sandy sediment. Following the floods, several areas were plowed to a depth of 20 to 48 inches.

Included with these soils in mapping were small areas of Sarpy soils, generally shown on the soil map by a sand spot symbol.

Soil blowing is a slight hazard on Eudora soils, and ponding water is a slight hazard on Kimo soils. Flooding is rare. The main concerns of management are controlling soil blowing and removing or controlling excess water.

Most of the acreage of this complex is cultivated. This complex is well suited to all crops commonly grown in this county, including vegetables. A few areas have been developed for urban use. Capability unit IIw–1; Eudora soils in Loamy Lowland range site, pasture suitability group A–1, and woodland group 2o; Kimo soils in Clay Lowland range site, pasture suitability group E, and woodland group 3o.

Gravelly Land

Ge—Gravelly land. This land type is made up of small, scattered areas of glacial gravel intermingled with glacial soils—Morrill clay loam, 3 to 7 percent slopes; Morrill clay loam, 7 to 12 percent slopes; and Pawnee clay loam, 3 to 7 percent slopes. It is in isolated areas near Lawrence and Clinton, generally below areas of glacial soils. Individual areas are long and narrow and range from 5 to 100 acres in size.

In most places the surface layer is clay loam or gravelly clay loam and the subsoil is gravelly clay loam. There are quartzite stones in most areas of this land type.

Included with this land type in mapping were small areas of Sogn-Vinland complex, 5 to 20 percent slopes.

The main concern of management is maintaining grass stands. Nearly all areas of this unit are used for pasture, and cultivation is impractical in most areas. Native vegetation is mid and tall prairie grasses. Capability unit VIe–1, Loamy Upland range site, pasture suitability group H, not assigned to a woodland group.

Gymer Series

The Gymer series consists of deep, well drained, gently sloping to sloping soils on uplands. These soils formed in loamy sediment. The native vegetation is generally tall prairie grasses, but on some sloping areas, the native vegetation is a combination of oak-hickory forest with an understory of tall prairie grasses.

In a representative profile the surface layer is very dark grayish brown silt loam about 15 inches thick. The subsoil extends to a depth of more than 60 inches. It is dark brown, firm silty clay loam.

Available water capacity and natural fertility are high. Permeability is moderately slow.

Most of these soils are cultivated. They are well suited to all of the crops commonly grown in the county.

Representative profile of Gymer silt loam, 3 to 8 percent slopes, in a cultivated field, 600 feet south and 70 feet west of the northeast corner of SE¼ sec. 4, T. 12 S., R. 18 E.:

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) heavy silt loam; moderate fine granular structure; friable; slightly acid; gradual smooth boundary.

AB—6 to 15 inches; very dark grayish brown (10YR 3/2) heavy silt loam; moderate fine subangular blocky structure and moderate fine granular structure; friable; slightly acid; gradual smooth boundary.

B21t—15 to 20 inches; dark brown (7.5YR 3/2) silty clay loam; moderate medium and fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.

B22t—20 to 34 inches; dark brown (7.5YR 4/2) silty clay loam; moderate medium and fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.

B3—34 to 68 inches; dark brown (7.5YR 4/2) silty clay loam; moderate medium and fine subangular blocky structure; firm; slightly acid.

The A1 horizon is mostly silt loam, but it ranges to light silty clay loam in some places. Reaction is slightly acid to strongly acid. The B and C horizons range from brown to reddish brown and from silty clay loam or clay loam to light silty clay. Reaction is slightly acid to medium acid. Limestone is at a depth of more than 5 feet in places.

Gymer soils are near Martin, Oska, Sharpsburg, and Thurman soils. Gymer soils are browner and less clayey than Martin soils. They are deeper to limestone than Oska soils, which are underlain by limestone at a depth of 40 inches or less. Gymer soils have a brown to reddish brown B horizon, whereas Sharpsburg soils have a dark grayish brown B horizon. Gymer soils are not so sandy as Thurman soils.

Gm—Gymer silt loam, 1 to 3 percent slopes. This gently sloping soil is on ridgetops. Individual areas are 8 to 120 acres in size. This soil has a profile similar to the one described as representative for the series, but it is underlain by limestone at a depth of 5 to 9 feet.

Included with this soil in mapping were small areas of a similar soil that is underlain by limestone at a depth of 40 to 60 inches. Small areas of Oska, Martin, and Woodson soils were also included.

Runoff is medium. The erosion hazard is slight to moderate. The main concern of management is controlling erosion.

Most of the acreage of this soil is cultivated. This soil is well suited to all crops commonly grown in the county. Capability unit IIe-2, Loamy Upland range site, pasture suitability group A-2, not assigned to a woodland group.

Gy—Gymer silt loam, 3 to 8 percent slopes. This sloping soil is on lower side slopes and foot slopes. Individual areas are 5 to 180 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were small areas of Martin, Morrill, Thurman, and Sharpsburg soils. Also included were some similar soils that have a lighter colored surface layer and subsurface layer. A few small eroded areas are generally shown on the soil map by a severely eroded spot symbol.

Runoff is medium to rapid. The erosion hazard is moderate to high. The main concern of management is controlling erosion.

About 60 percent of the acreage of this soil is cultivated, and the rest is used for tame and native grass pasture. Some areas in native grass have a partial stand of trees. This soil is suited to all crops commonly grown in the county. Capability unit IIIe-1, Loamy Upland range site, pasture suitability group A-2, not assigned to a woodland group.

Judson Series

The Judson series consists of deep, well drained to moderately well drained, nearly level loamy soils on terraces along the major rivers. These soils formed in alluvium. Native vegetation is tall prairie grasses and deciduous trees.

In a representative profile, the surface layer is very dark grayish brown silt loam about 14 inches thick. The subsoil extends to a depth of 47 inches. It is friable, very dark grayish brown silt loam to a depth of 21 inches and very dark grayish brown and dark grayish brown silty clay loam below. The underlying material is grayish brown and light brownish gray silt loam.

Available water capacity and natural fertility are high. Permeability is moderate.

Representative profile of Judson silt loam, in a cultivated field, 1,050 feet north and 75 feet east of the southwest corner of sec. 17, T. 12 S., R. 20 E.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine granular structure; very friable; few worm casts; neutral; clear smooth boundary.

A12—9 to 14 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium granular structure and weak platy structure in places in upper part; very friable; neutral; gradual smooth boundary.

B21—14 to 21 inches; very dark grayish brown (10YR 3/2) heavy silt loam; moderate medium and coarse granular structure; friable; few worm casts; neutral; gradual smooth boundary.

B22—21 to 31 inches; very dark grayish brown (10YR 3/2) light silty clay loam; moderate medium and coarse granular structure and weak medium subangular blocky structure; friable; many worm casts; neutral; gradual smooth boundary.

B3—31 to 47 inches; dark grayish brown (10YR 4/2) light silty clay loam; moderate medium and coarse granular structure; friable; few worm casts; mildly alkaline; clear smooth boundary.

C1—47 to 58 inches; grayish brown (10YR 5/2) silt loam; massive; very friable; few worm casts; mildly alkaline; diffuse smooth boundary.

C2—58 to 80 inches; light brownish gray (10YR 6/2) silt loam; massive; very friable; mildly alkaline.

The A horizon ranges from 7 to 16 inches in thickness and from medium acid to mildly alkaline in reaction. The B horizon ranges from heavy silt loam to light silty clay loam. Reaction is slightly acid to mildly alkaline.

Judson soils are near Eudora, Kennebec, and Reading soils. Judson soils have a lower clay content in the B horizon than Reading soils and have weaker structure. They are more clayey and are dark colored to a greater depth than Eudora soils. Judson soils are lighter colored below a depth of 36 inches than Kennebec soils and have more distinct horizons.

Ju—Judson silt loam. This nearly level soil is on terraces along the Kansas River. Individual areas are 12 to 750 acres in size. Slopes are 0 to 1 percent. Flooding is rare.

Included with this soil in mapping were small areas of Reading, Eudora, and Wabash soils.

Judson silt loam is used almost entirely for crops, but there is an airport in one area of it. This soil is well suited to all crops commonly grown in this county, including vegetables. Capability unit I-1, Loamy Lowland range site, pasture suitability group A-1, woodland group 2o.

Kennebec Series

The Kennebec series consists of deep, well drained to moderately well drained, nearly level soils on flood plains. These soils formed in loamy alluvium. Native vegetation is tall prairie grasses and deciduous trees.

In a representative profile, the surface layer is very dark brown and black silt loam and silty clay loam about 22 inches thick. The next layer is very dark grayish brown, friable silty clay loam about 16 inches thick. The underlying material is very dark brown and very dark grayish brown silty clay loam.

Permeability is moderate. Available water capacity and natural fertility are high.

Representative profile of Kennebec silt loam, in a cultivated field, 1,320 feet north and 265 feet east of the southwest corner of sec. 7, T. 14 S., R. 18 E.:

Ap—0 to 10 inches; very dark brown (10YR 2/2) heavy silt loam; weak granular structure; friable; few worm casts; slightly acid; gradual smooth boundary.

A12—10 to 22 inches; black (10YR 2/1) light silty clay loam; moderate medium and fine granular structure; friable; common worm casts; slightly acid; gradual smooth boundary.

AC—22 to 38 inches; very dark grayish brown (10YR 3/2) light silty clay loam; weak very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

C1—38 to 60 inches; very dark brown (10YR 2/2) light silty clay loam; massive and weak very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C2—60 to 71 inches; very dark grayish brown (10YR 3/2) light silty clay loam; massive; friable; neutral.

The A horizon ranges from silt loam to light silty clay loam. Reaction is medium acid to neutral. In some places yellowish brown mottles are at a depth of more than 30 inches. The C horizon ranges from silt loam to light silty clay loam. Reaction is medium acid to neutral.

Kennebec soils are near Judson and Leanna soils and are in the same landscape position as Sarpy soils. Kennebec soils have less profile development than Judson soils. They are less clayey below the A horizon than Leanna soils. They contain less sand than Sarpy soils.

Kb—Kennebec silt loam. This soil is on the first bottoms along large creeks and the Wakarusa River. It has the profile described as representative for the series. Slopes are 0 to 2 percent.

Included with this soil in mapping were small areas of Reading, Leanna, and Wabash soils. Also included along Mud Creek was an area of a similar very dark brown soil that is underlain by black silty clay below a depth of 24 inches.

The main concern of management is flooding, which commonly interferes with seedbed preparation and planting. The flooding on this soil is of short duration and is generally in spring.

Most of the acreage of this soil is cultivated. A few areas are used for tame and native pasture or woodland. This soil is well suited to all crops commonly grown in this county, and to trees. Capability unit IIw–2, Loamy Lowland range site, pasture suitability group A–1, woodland group 2o.

Kc—Kennebec soils, channeled. This mapping unit consists of soils on relatively wide, upland drainageways and flood plains. The soils are generally cut up by meandering stream channels and are subject to frequent flooding. Individual areas are 150 to 400 feet in width. Most of the soils in this unit have profiles similar to the one described as representative for the series, but they are more stratified and texture ranges from loam to heavy silty clay loam. Slopes are 0 to 2 percent.

Included with this unit in mapping were small areas of Wabash, Vinland, Sogn, and Martin soils.

Most of the acreage of this unit is used for pasture. Some areas are used for woodland and wildlife habitat. About 15 percent of this unit is suited to cultivation, but only a few acres are cultivated because most areas are inaccessible. This unit is well suited to grasses and trees. Capability unit VIw–1, Loamy Lowland range site, pasture suitability group A–1, woodland group 2o.

Kimo Series

The Kimo series consists of deep, somewhat poorly drained, nearly level soils on flood plains. These soils typically are in the lower lying areas of old stream meanders. They formed in alluvium consisting of clayey sediment underlain by distinctly contrasting, lighter colored loamy sediment. Native vegetation is water-tolerant tall prairie grasses and trees.

In a representative profile, the surface layer is about 24 inches thick. It is very dark gray silty clay loam in the upper 6 inches and very dark gray and black silty clay below. The next layer is dark gray, friable silty clay loam about 4 inches thick. The underlying material is grayish brown silt loam.

Permeability is slow. Available water capacity and natural fertility are high.

Representative profile of Kimo silty clay loam, in a cultivated field, 250 feet north and 60 feet west of the southeast corner of sec. 7, T. 12 S., R. 20 E.:

Ap—0 to 6 inches; very dark gray (10YR 3/1) heavy silty clay loam; weak fine granular structure; firm; slightly effervescent; mildly alkaline; gradual smooth boundary.

A1—6 to 14 inches; black (10YR 2/1) silty clay; weak fine and medium subangular blocky structure; very firm; mildly alkaline; gradual smooth boundary.

A12—14 to 24 inches; very dark gray (10YR 3/1) silty clay; few fine strong brown mottles in lower part; weak fine subangular blocky structure; very firm; mildly alkaline; clear smooth boundary.

AC—24 to 28 inches; dark gray (10YR 4/1) light silty clay loam that has some streaks and fingers of darker color; few fine strong brown mottles; weak fine granular structure and massive; friable; strongly effervescent; mildly alkaline; gradual smooth boundary.

IIC—28 to 60 inches; grayish brown (10YR 5/2) coarse silt loam; massive; very friable; strongly effervescent; mildly alkaline.

Reaction of the A horizon ranges from neutral to mildly alkaline. The upper part of the A horizon ranges from medium silty clay loam to silty clay. Depth to the IIC horizon ranges from 20 to 38 inches. Typically the IIC horizon is coarse silt loam, but it is very fine sandy loam, fine sandy loam, or loamy very fine sand in some places.

Kimo soils are near Wabash, Eudora, and Sarpy soils. Kimo soils are silty clay to a depth of less the 40 inches, whereas Wabash soils are silty clay to a depth of more than 40 inches. Kimo soils have a finer textured solum than Eudora and Sarpy soils.

Km—Kimo silty clay loam. This soil is on slightly concave slopes in old stream meanders on the upper part of the flood plain of the Kansas River. Individual areas are 8 to 200 acres in size. Slopes are 0 to 1 percent.

Included with this soil in mapping were small areas of Wabash and Eudora soils. Also included were small areas of a similar very dark gray soil that is heavy silt loam or light silty clay loam in the upper 24 inches. Wet areas are shown on the soil map by a wet spot symbol.

This soil is subject to ponding and has a high water table during periods of excessive rainfall. Flooding is rare. The main concern of management is removing water during periods of excessive rainfall.

Most of the acreage of this soil is cultivated. This soil is well suited to all crops commonly grown in this county. Capability unit IIw–3, Clay Lowland range site, pasture suitability group E, woodland group 3o.

Leanna Series

The Leanna series consists of deep, poorly drained, nearly level soils on flood plains and low terraces. These soils formed in clayey alluvium. Native vegetation is tall prairie grasses and deciduous trees.

In a representative profile, the surface layer is black silt loam about 10 inches thick. The subsurface layer is dark gray silt loam about 12 inches thick. The subsoil is black and very dark gray, very firm silty clay about 33 inches thick. The underlying material is dark gray silty clay.

Permeability is very slow. Available water capacity and natural fertility are high.

Representative profile of Leanna silt loam, in a cultivated field, 200 feet east and 100 feet south of the northeast corner of NW¼ sec. 15, T. 14 S., R. 21 E.:

Ap—0 to 10 inches; black (10YR 2/1) heavy silt loam; moderate very fine and fine granular structure; friable; common roots; medium acid; clear smooth boundary.

A2—10 to 22 inches; dark gray (10YR 4/1) heavy silt loam; weak very fine and fine granular structure; friable; common roots; medium acid; clear smooth boundary.

B2t—22 to 40 inches; black (10YR 2/1) silty clay; few fine faint dark yellowish brown (10YR 4/4) mottles; gray coating on faces of peds; moderate medium subangular blocky structure; very firm; few roots; medium acid; gradual smooth boundary.

B3—40 to 55 inches; very dark gray to gray (10YR 3.5/1) silty clay; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium blocky structure and massive; very firm; few black manganese concretions; few roots; medium acid; diffuse smooth boundary.

C—55 to 78 inches; dark gray (10YR 4/1) light silty clay; common fine faint dark yellowish brown (10YR 4/4) mottles; massive; very firm; common iron and manganese concretions; medium acid.

The combined thickness of the Ap and A2 horizons ranges from 10 to 26 inches. Texture is silt loam or light silty clay loam. Reaction of the A horizon and the upper part of the B horizon ranges from slightly acid to strongly acid. The B and C horizons range from heavy silty clay loam to silty clay.

Leanna soils are near Kennebec, Reading, and Wabash soils. Leanna soils have an A2 horizon, and the nearby soils do not. They have less clay throughout than Wabash soils. Leanna soils have more clay in the B and C horizons than Kennebec and Reading soils.

Le—Leanna silt loam. This nearly level soil is along streams. Individual areas are 5 to several hundred acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping were small areas of Kennebec, Reading, and Wabash soils.

Runoff is very slow. The hazard of wetness is moderate. The main concern of management is removing excess water commonly received both from adjacent uplands and adjacent streams. A surface drainage system is needed in some slightly depressional areas.

Most of the acreage of this soil is cultivated. A few areas are used for pasture or woodland. This soil is well suited to crops commonly grown in this county. Capability unit IIw–3, Loamy Lowland range site, pasture suitabilility group E, woodland group 3w.

Martin Series

The Martin series consists of deep, moderately well drained, gently sloping to strongly sloping soils on uplands. These soils formed in material weathered from moderately fine textured and fine textured shale.

In a representative profile, the surface layer is very dark brown silty clay loam about 14 inches thick. The subsoil is about 34 inches thick. It is very dark grayish brown, very firm silty clay in the upper part, and dark grayish brown and grayish brown, very firm silty clay in the lower part. The underlying material is coarsely mottled gray, strong brown, yellowish brown, and olive brown silty clay.

Permeability is slow. Available water capacity and natural fertility are high.

Representative profile of Martin silty clay loam, 3 to 7 percent slopes, in a cultivated field, about 1,440 feet north and 1,025 feet west of the southeast corner of sec. 31, T. 14 S., R. 18 E.:

A1—0 to 9 inches; very dark brown (10YR 2/2) light silty clay loam; moderate medium granular structure; firm; medium acid; gradual smooth boundary.

AB—9 to 14 inches; very dark brown (10YR 2/2) silty clay loam; moderate to strong fine and medium subangular blocky structure; firm; most peds have shiny surfaces; medium acid; gradual smooth boundary.

B21t—14 to 28 inches; very dark grayish brown (10YR 3/2) silty clay; few fine faint yellowish brown mottles; moderate medium and coarse mostly subangular blocky structure and some angular blocky structure; distinct continuous shiny films on peds; very firm; common fine black concretions; many fine worm casts; many root channels filled with black material; medium acid; gradual smooth boundary.

B22t—28 to 37 inches; dark grayish brown (10YR 4/2) silty clay; few fine distinct yellowish brown and strong brown mottles; moderate medium and coarse mostly angular blocky structure and some subangular blocky structure; very firm; distinct continuous shiny films on peds; worm casts and root channels like horizon above; common fine black concretions; slightly acid; gradual smooth boundary.

B3—37 to 48 inches; grayish brown (10YR 5/2) silty clay; common distinct coarse strong brown and yellowish brown mottles; weak coarse and medium angular and subangular blocky structure; very firm; shiny films on some peds; some dark root channels; common fine black concretions, but fewer than horizon above; neutral; diffuse boundary.

C—48 to 88 inches; coarsely mottled gray, strong brown, yellowish brown, and olive brown silty clay; massive; very firm; few fine black concretions; neutral.

The A horizon ranges from very dark brown to very dark gray or black. Depth to the B2t horizon ranges from 10 to 20 inches. These soils are generally noncalcareous throughout, but in some places hard calcium carbonate concretions are in the lower part of the B horizon and in the C horizon.

Martin soils are near Woodson, Gymer, and Vinland soils. Martin soils contain more clay throughout than Gymer soils. They lack the abrupt boundary between the A and Bt horizons as is characteristic in Woodson soils. Martin soils are deeper to bedrock than Vinland soils, and they have a B2t horizon that is lacking in those soils.

Mb—Martin silty clay loam, 1 to 3 percent slopes. This gently sloping soil is on ridgetops above limestone outcrops or on foot slopes below the outcrops. Individual areas are 5 to 160 acres in size. Slopes are generally convex on ridgetops and concave on foot slopes.

Included with this soil in mapping were small areas of Pawnee and Woodson soils.

Runoff is slow to medium, and the erosion hazard is slight. The main concern of management is controlling erosion.

Most of the acreage of this soil is cultivated. A few areas are used for pasture. This soil is well suited to all crops commonly grown in this county. Capability unit IIe–1, Loamy Upland range site, pasture suitability group A–2, not assigned to a woodland group.

Mc—Martin silty clay loam, 3 to 7 percent slopes. This sloping soil generally is on side slopes below limestone outcrops, but some areas are above the outcrops. Individual areas are 10 to several hundred acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were small areas of a soil that formed in material weathered from medium textured shale and that has a dark brown subsoil. Also included were small areas of Sogn, Sibleyville, Vinland, Oska, Gymer, and Pawnee soils. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is medium to rapid, and the erosion hazard is moderate to high. The main concern of management is controlling erosion.

About 60 percent of the acreage of this soil is cultivated. The rest is used for pasture. This soil is suited to all crops commonly grown in this county. Capability unit IIIe-3, Loamy Upland range site, pasture suitability group A-2, not assigned to a woodland group.

Mh—Martin soils, 3 to 7 percent slopes, eroded. These sloping soils generally are on side slopes below limestone outcrops and commonly are along and at the upper ends of small drainageways. Individual areas are 10 to 100 acres in size. These soils have profiles similar to the one described as representative for the series, but the surface layer is very dark brown to very dark grayish brown silty clay loam or silty clay about 6 to 8 inches thick. This layer, in most places, is a mixture of the original surface layer and material from the upper part of the subsoil. There are gullies and gully scars in most areas.

Included with this unit in mapping were small areas of Vinland, Sibleyville, Sogn, and Pawnee soils.

Runoff is rapid, and the erosion hazard is high. Tilth is poor. The main concerns of management are improving tilth and controlling erosion.

About 60 percent of the acreage of this unit is used for pasture. The rest is cultivated. These soils are better suited to permanent vegetation than to cultivated crops. If these soils are cultivated, they are better suited to wheat than to corn or soybeans. Capability unit IVe-4, Clay Upland range site, pasture suitability group C, not assigned to a woodland group.

Mo—Martin-Oska silty clay loams, 3 to 6 percent slopes. This complex of sloping soils is on the upper parts of side slopes and on narrow ridges almost entirely in areas where the Lecompton Limestone Formation crops out. These outcrop areas consist of four limestone layers and three shale layers (*13*). Individual areas are 12 to 1,000 acres in size.

About 40 percent of this complex is Martin silty clay loam, about 30 percent is Oska silty clay loam, and about 25 percent is a soil similar to Martin silty clay loam but underlain by limestone at a depth of 20 to 40 inches.

Included with these soils in mapping were small areas of Sogn and Vinland soils. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is medium, and the erosion hazard is moderate to high. These soils are commonly droughty. The main concerns of management are controlling erosion and managing crops for the best use of available water. Small areas of shallow soils make cultivation difficult in some places.

About 50 percent of the acreage of this complex is cultivated. The rest is used for pasture. This complex is better suited to pasture than to cultivated crops. If this complex is cultivated, it is better suited to wheat and grain sorghum than to corn or soybeans. This complex is also suited to brome and tall fescue. Capability unit IVe-3, Loamy Upland range site, pasture suitability group A-2, not assigned to a woodland group.

Morrill Series

The Morrill series consists of deep, well drained, sloping to strongly sloping soils on uplands. These soils formed in glacial till and glaciofluvial deposits.

In a representative profile, the surface layer is very dark gray light clay loam about 10 inches thick. The subsoil is about 46 inches thick. It is dark brown, firm clay loam in the upper 6 inches and reddish brown, firm and very firm clay loam below. The underlying material is yellowish red and reddish brown clay loam.

Permeability is moderately slow. Available water capacity and natural fertility are high.

Representative profile of Morrill clay loam, 3 to 7 percent slopes, in a bluegrass pasture, 1,400 feet east and 100 feet north of the southwest corner of sec. 3, T. 13 S., R. 21 E.:

A1—0 to 10 inches; very dark gray (10YR 3/1) light clay loam; moderate medium granular structure; friable; slightly acid; gradual smooth boundary.

B1—10 to 16 inches; dark brown (7.5YR 4/2) light clay loam; very fine and fine subangular blocky structure; firm; medium acid; gradual smooth boundary.

B21t—16 to 30 inches; reddish brown (5YR 4/3) clay loam; moderate fine subangular blocky structure; firm; medium acid; gradual smooth boundary.

B22t—30 to 56 inches; coarsely mottled reddish brown (5YR 5/4) and yellowish red (5YR 5/6) clay loam; moderate fine and medium subangular blocky structure; very firm; distinct continuous clay films; slightly acid; gradual smooth boundary.

C—56 to 66 inches; coarsely mottled yellowish red (5YR 5/6) and reddish brown (5YR 5/4) clay loam; massive; firm; few fine iron and manganese concretions; neutral.

The A1 horizon ranges from very dark gray to dark brown light clay loam to loam. Depth to the B2t horizon ranges from 9 to 18 inches. In some places, the B horizon is sandy clay loam or gravelly clay loam. The C horizon ranges from loam to sandy clay loam. Small pebbles are throughout the profile in some places.

Morrill soils are near Oska, Pawnee, Sharpsburg, and Thurman soils. Morrill soils are redder and have less clay in the B horizon than Pawnee soils. They are deeper than Oska soils and contain more sand throughout than Oska and Sharpsburg soils. They contain less sand and more clay throughout and are redder than Thurman soils.

Mr—Morrill clay loam, 3 to 7 percent slopes. This sloping soil is mainly on convex side slopes. In some places, it is on narrow ridgetops. Individual areas are 3 to 370 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were small areas of Pawnee and Oska soils. Also included were small areas of a similar soil that contains a high percentage of gravel throughout. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is medium to rapid, and the erosion hazard is moderate to high. The main concern of management is controlling erosion.

About 60 percent of the acreage of this soil is cultivated. The rest is used for pasture, mostly tame grasses. A few areas have been developed for urban use. This soil is well suited to all crops commonly grown in this county. Capability unit IIIe-1, Loamy Upland range site, pasture suitability group A-2, not assigned to a woodland group.

Ms—Morrill clay loam, 7 to 12 percent slopes. This strongly sloping soil is on uplands, mostly on side slopes along drainageways. Individual areas are 10 to 60 acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer is about 2 to 4 inches thinner.

Included with this soil in mapping were areas of Pawnee, Basehor, Thurman, and Martin soils.

Runoff is rapid, and the erosion hazard is high. The main concern of management is controlling erosion.

About 50 percent of the acreage of this soil has been developed for urban use. Most of the rest is in tame grasses used for pasture. This soil is well suited to grasses. Capability unit IVe-5, Loamy Upland range site, pasture suitability group A-2, not assigned to a woodland group.

Oska Series

The Oska series consists of moderately deep, well drained, sloping soils on uplands. These soils formed in moderately fine textured material weathered from limestone and shale.

In a representative profile, the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The subsoil is dark reddish brown, very firm silty clay and silty clay loam about 22 inches thick. The underlying material is reddish brown and yellowish brown silty clay loam about 9 inches thick. Limestone is at a depth of 40 inches.

Permeability is slow. Available water capacity is moderate, and natural fertility is high.

Representative profile of Oska silty clay loam, 3 to 6 percent slopes, in a cultivated field, 850 feet north and 400 feet east of the center of sec. 11, T. 14 S., R. 19 E.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate medium granular structure; firm; slightly acid; gradual smooth boundary.

B21t—9 to 18 inches; dark reddish brown (5YR 3/4) silty clay; strong medium subangular blocky structure; very firm; medium acid; gradual smooth boundary.

B22t—18 to 31 inches; dark reddish brown (5YR 3/4) heavy silty clay loam; strong fine and medium subangular blocky structure; very firm; few iron and manganese concretions; medium acid; clear smooth boundary.

C—31 to 40 inches; coarsely mottled reddish brown (5YR 4/3) and yellowish brown (10YR 5/8) heavy silty clay loam; massive; few calcium carbonate concretions; few weathered limestone and shale fragments; slightly acid; abrupt irregular boundary.

R—40 inches; limestone.

The thickness of the solum ranges from 20 to 40 inches, and depth to limestone ranges from 24 to 40 inches. The A horizon ranges from 6 to 10 inches in thickness. The B2 horizon ranges from 14 to 36 inches in thickness and is silty clay to heavy silty clay loam. In some uncultivated areas there is a B1 horizon. The C horizon ranges from light silty clay to heavy silty clay loam. In some places there is no C horizon.

Oska soils are near Morrill, Gymer, Sogn, and Vinland soils. Oska soils have less sand throughout than Morrill soils. They are shallower to bedrock than Gymer soils. Oska soils are deeper to bedrock than Vinland or Sogn soils. Vinland and Sogn soils do not have a B2t horizon, and Oska soils do.

Oe—Oska silty clay loam, 3 to 6 percent slopes. This sloping soil is on narrow ridgetops and side slopes above limestone outcrops (fig. 5). Individual areas are 4 to several hundred acres in size.

Included with this soil in mapping were small areas of Gymer, Martin, Sogn, and Vinland soils. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is medium, and the erosion hazard is moderate. In some places this soil is droughty. The main concern of management is controlling erosion.

Most of the acreage of this soil is cultivated. A few areas are used for pasture. This soil is well suited to all crops commonly grown in this county. Capability unit IIIe-1, Loamy Upland range site, pasture suitability group A-2, not assigned to a woodland group.

Pawnee Series

The Pawnee series consists of deep, moderately well drained, gently sloping to sloping soils on uplands. These soils formed in moderately fine textured and fine textured glacial till and glaciofluvial deposits.

In a representative profile, the surface layer is very dark gray and very dark grayish brown clay loam about 14 inches thick. The subsoil is very firm and firm clay about 40 inches thick. The upper 10 inches of the subsoil is dark grayish brown, the next 10 inches is yellowish brown, and the lower 20 inches is coarsely mottled yellowish brown and reddish brown. The underlying material is coarsely mottled light yellowish brown and dark brown sandy clay loam.

Available water capacity and natural fertility are high. Permeability is slow.

Representative profile of Pawnee clay loam, 3 to 7 percent slopes, in a cultivated field, 1,200 feet south

Figure 5.—Soil in profile view higher than the limestone is typical Oska silty clay loam, 3 to 6 percent slopes; that in profile view lower than the limestone is typical of the Vinland complex, 3 to 7 percent slopes.

and 50 feet west of the northeast corner of sec. 22, T. 13 S., R. 21 E.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) light clay loam; moderate fine and medium granular structure; friable; many fine roots; slightly acid; gradual smooth boundary.

A12—7 to 14 inches; very dark grayish brown (10YR 3/2) light clay loam; moderate fine granular structure parting to moderate fine and medium subangular blocky; friable; many fine roots; slightly acid; clear smooth boundary.

B21t—14 to 24 inches; dark grayish brown (10YR 4/2) clay; common medium distinct reddish brown mottles; moderate medium subangular blocky structure; very firm; dark gray streaks; few iron and manganese stains; few fine roots; neutral; gradual smooth boundary.

B22t—24 to 34 inches; yellowish brown (10YR 5/4) light clay; few fine faint strong brown mottles; weak and moderate medium subangular blocky structure; firm; dark gray streaks; few iron and manganese stains; very few fine roots; neutral; gradual smooth boundary.

B3—34 to 54 inches; coarsely mottled yellowish brown (10YR 5/4) and reddish brown (5YR 4/4) heavy clay loam; weak medium and coarse subangular blocky structure; firm; mildly alkaline; gradual smooth boundary.

C—54 to 72 inches; coarsely mottled light yellowish brown (10YR 6/4) and dark brown to brown (7.5YR 4/4) sandy clay loam; massive; firm; mildly alkaline.

The A horizon ranges from loam to clay loam. Depth to the B2t horizon ranges from 10 to 20 inches. The B horizon ranges from very dark grayish brown to yellowish brown and reddish brown heavy clay loam to clay and contains varying amounts of glacial pebbles and sand. The C horizon ranges from clay to sandy clay loam.

Pawnee soils are near Morrill soils and are in the same landscape position as Woodson soils. Pawnee soils contain more clay in the B horizon than Morrill soils. They have more sand throughout than Woodson soils.

Pb—Pawnee clay loam, 1 to 3 percent slopes. This gently sloping soil is on ridgetops. Individual areas are 4 to 160 acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer is slightly thicker.

Included with this soil in mapping were small areas of Woodson and Martin soils.

Runoff is slow to medium, and the erosion hazard is slight. The main concern of management is controlling erosion.

Most of the acreage of this soil is cultivated. A few areas are used for pasture. This soil is well suited to all crops commonly grown in the county. Capability unit IIe–1, Loamy Upland range site, pasture suitability group A–2, not assigned to a woodland group.

Pc—Pawnee clay loam, 3 to 7 percent slopes. This soil is on side slopes on uplands. Individual areas are 5 to 600 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were small areas of Morrill, Martin, and Oska soils and a similar soil that has a reddish brown subsoil. Eroded areas are shown on the soil map by a severely eroded spot symbol. These included eroded areas generally are on the steeper slopes or near the upper ends of small drainageways.

Runoff is medium to rapid, and the erosion hazard is moderate to high. The main concern of management is controlling erosion.

About 70 percent of the acreage of this soil is cultivated. The rest is used for pasture. This soil is suited to all crops commonly grown in this county. Capability unit IIIe–3, Loamy Upland range site, pasture suitability group A–2, not assigned to a woodland group.

Ph—Pawnee clay loam, 3 to 7 percent slopes, eroded. This sloping soil is on side slopes on uplands in areas along and at the upper ends of small drainageways. It has a profile similar to the one described as representative for the series, but most of the original surface layer has been removed by erosion. The surface layer is commonly heavy clay loam that is a mixture of the original surface layer and material from the upper part of the subsoil. There are shallow gullies or gully scars in most areas.

Included with this soil in mapping were small areas of Martin and Morrill soils and areas of severely eroded soils that have a surface layer of yellowish brown clay.

Runoff is rapid, and the erosion hazard is high. Tilth is poor. The main concerns of management are improving tilth and controlling erosion.

About 70 percent of the acreage of this soil is used for pasture. The rest is cultivated. A few areas are left idle. This soil is better suited to grasses than to cultivated crops. If it is cultivated, this soil is better suited to wheat than to corn or soybeans. Capability unit IVe–4, Clay Upland range site, pasture suitability group C, not assigned to a woodland group.

Reading Series

The Reading series consists of deep, well drained, nearly level soils on second bottoms along the larger streams. These soils formed in loamy alluvium. Native vegetation is tall prairie grasses and deciduous trees.

In a representative profile, the surface layer is very dark brown silt loam about 9 inches thick. The subsoil extends to a depth of more than 60 inches. It is very dark brown and dark grayish brown, firm silty clay loam.

Permeability is moderately slow. Available water capacity and natural fertility are high.

Representative profile of Reading silt loam, in a cultivated field, 2,200 feet south and 100 feet east of the northwest corner of sec. 8, T. 14 S., R. 18 E.:

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam; weak fine granular structure and weak very fine thin platy structure in lower 2 inches; friable; many fine roots; common worm casts; slightly acid; clear smooth boundary.

B1—9 to 19 inches; very dark brown (10YR 2/2) silty clay loam; moderate fine and medium subangular blocky structure; firm; many fine roots; common worm casts; slightly acid; gradual smooth boundary.

B21t—19 to 33 inches; very dark brown (10YR 2/2) silty clay loam; moderate fine and medium subangular blocky structure; firm; few fine roots; few worm casts; slightly acid; gradual smooth boundary.

B22t—33 to 46 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine faint yellowish brown (10YR 5/6) mottles in lower part of horizon; moderate fine subangular blocky structure; firm; few fine roots; few worm casts; neutral; gradual smooth boundary.

Bb—46 to 64 inches; very dark brown (10YR 2/2) silty clay loam; few fine faint yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; firm; few fine roots; few worm casts; few charcoal fragments; neutral.

The A horizon ranges from silt loam to light silty clay loam. Depth to the B2t horizon ranges from 14 to 20 inches. The B horizon ranges from brown to very dark brown. There is no Bb horizon in many places.

Reading soils are near Judson, Leanna, and Wabash soils. Reading soils have stronger structure and are more clayey in the B horizon than Judson soils. They are less clayey in the B horizon than Leanna soils. Reading soils are browner than Leanna and Wabash soils and are less clayey throughout than Wabash soils.

Re—Reading silt loam. This nearly level soil is on second bottoms and terraces. Individual areas are 5 to 100 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping were small areas of Wabash, Judson, Kennebec, and Leanna soils. Also included were a few small areas of a similar soil that has light colored subsurface layer and that is in the Lecompton area and along Captain Creek.

This soil is subject to rare flooding. The flooding is generally of short duration and causes little crop damage.

Most of the acreage of this soil is cultivated. A few areas are used for pasture or woodland. This soil is well suited to all crops commonly grown in this county. Capability unit I–1, Loamy Lowland range site, pasture suitability group A–1, woodland group 2o.

Riverwash

Ro—Riverwash. This land type consists of an unstable mixture of sandy and loamy sediment on the lowest level along the Kansas River. This mixture is constantly changed, deposited, or removed, depending on the water level and the location of the river channel. Each time the river floods, the Riverwash deposits change in depth, size, and other characteristics. Some areas of Riverwash eventually receive so much sediment that they can be used for crops.

Riverwash is generally unsuited to cultivated crops or pasture. It is better suited to wildlife habitat. Native vegetation is cottonwood and willow. Some trees grow to a large size, but most have little commercial value. Capability unit VIIIs–1, not assigned to a range site, pasture suitability group, or woodland group.

Sarpy Series

The Sarpy series consists of deep, somewhat excessively drained to excessively drained, nearly level soils on flood plains. These soils formed in sandy alluvium. Native vegetation is deciduous trees.

In a representative profile, the surface layer is dark grayish brown loamy fine sand about 9 inches thick. The underlying material to a depth of 48 inches is grayish brown fine sand. Below this it is grayish brown silt loam.

Natural fertility is high, and available water capacity is low. Permeability is very rapid. Organic-matter content is generally low.

Representative profile of Sarpy loamy fine sand, in an area of Sarpy-Eudora complex, overwash, in a cultivated field, 750 feet north and 75 feet west of the southeast corner of sec. 11, T. 12 S., R. 19 E.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loamy fine sand; single grained; very friable; slightly effervescent; mildly alkaline; clear smooth boundary.

C—9 to 48 inches; grayish-brown (10YR 5/2) fine sand; single grained; loose; strongly effervescent; mildly alkaline; clear smooth boundary.

IIC—48 to 60 inches; grayish brown (10YR 5/2) silt loam; massive; very friable; mildly alkaline.

The A horizon is loamy fine sand, fine sand, or fine sandy loam. The combined thickness of the A and C horizons ranges from 30 to 60 inches. The C horizon is fine sand or loamy fine sand that has some thin strata of silt loam. Most profiles have a IIC horizon, and it is silt loam, loam, or fine sandy loam.

Sarpy soils are near Eudora and Kimo soils and are in the same landscape position as Kennebec soils. Sarpy soils have more sand throughout than Eudora, Kimo, and Kennebec soils. They are lighter colored in the upper 28 inches than Kimo soils and are lighter colored throughout than Kennebec soils.

Sb—Sarpy-Eudora complex, overwash. This complex of nearly level to gently undulating soils is on the flood plain of the Kansas River, generally in areas nearest to the river. Individual areas are 12 to 260 acres in size. Slopes are 0 to 2 percent.

About 55 percent of this complex is Sarpy soils, and about 45 percent is Eudora soils. Sarpy soils have profiles similar to the one described as representative for the series, but the surface layer is loamy fine sand, fine sand, or fine sandy loam. Eudora soils have profiles similar to the one described as representative for the series, but the surface layer is lighter colored silt loam or fine sandy loam. Several areas in this unit have been plowed to a depth of 20 to 48 inches.

Included with these soils in mapping were small areas of Kimo soils and a soil similar to the Eudora soil but is heavy silt loam or light silty clay loam in the upper 30 inches.

These soils are subject to rare but damaging floods. Soil blowing is a moderate hazard. The main concern of management is obtaining a good stand of crops.

About 75 percent of the acreage of this complex is cultivated. The rest is used for woodland or is developed for urban use. These soils are well suited to crops commonly grown in this county, including vegetables. Trees are also well suited. Capability unit IIIw–2; Sarpy soils in Sandy Lowland range site, pasture suitability group B, and woodland group 5s; Eudora soils in Loamy Lowland range site, pasture suitability group A–1, and woodland group 2o.

Sharpsburg Series

The Sharpsburg series consists of deep, well drained or moderately well drained, gently sloping to sloping soils on uplands. These soils formed in loess.

In a representative profile, the surface layer is very dark gray silt loam about 12 inches thick. The subsoil extends to a depth of 60 inches or more. The upper 24 inches is firm, dark grayish brown silty clay loam. Below this, it is friable, grayish brown silty clay loam.

Natural fertility and available water capacity are high. Permeability is moderately slow.

Representative profile of Sharpsburg silt loam, 1 to 4 percent slopes, in a cultivated field, about 2,000 feet east and 1,650 feet north of the southwest corner of sec. 7, T. 13 S., R, 16 E.:

Ap—0 to 6 inches; very dark gray (10YR 3/1) silt loam;

weak fine and medium granular structure; friable; mildly alkaline (limed); gradual smooth boundary.

A1—6 to 12 inches; very dark gray (10YR 3/1) silt loam; moderate medium granular structure and weak fine subangular blocky structure; friable; many worm casts; slightly acid; gradual smooth boundary.

B21t—12 to 27 inches; dark grayish brown (10YR 4/2) heavy silty clay loam; strong to moderate medium and fine subangular blocky structure; firm; few clay films on vertical peds; some worm casts; few iron-manganese concretions; medium acid; gradual smooth boundary.

B22t—27 to 36 inches; dark grayish brown (10YR 4/2) heavy silty clay loam; few fine faint light gray mottles; moderate medium and fine subangular blocky structure; firm; few iron-manganese concretions and black stains; many cavities; medium acid; gradual smooth boundary.

B3—36 to 60 inches; grayish brown (10YR 5/2) light silty clay loam; few fine faint yellowish brown mottles; weak coarse prismatic structure; friable; few thin clay films on some vertical ped faces; few dark iron-manganese concretions and dark colored stains; many cavities; slightly acid.

Thickness of the solum ranges from 42 to 60 inches. The A horizon ranges from very dark gray to very dark brown and from silt loam to light silty clay loam.

Sharpsburg soils are near Gymer, Woodson, and Morrill soils. Sharpsburg soils are not so red in the B horizon as Gymer and Morrill soils. They contain less clay in the B horizon than Woodson soils and less sand throughout than Morrill soils.

Sc—Sharpsburg silt loam, 1 to 4 percent slopes. This gently sloping soil is on ridgetops on uplands adjacent to the Kansas River. Individual areas are 15 to 95 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were small areas of Gymer, Pawnee, Woodson, and Morrill soils. Also included were similar soils that have a higher clay content and mottling in the subsoil.

Runoff is medium, and the erosion hazard is slight to moderate. The main concern of management is controlling erosion.

Most of the acreage of this soil is cultivated. A few areas have been developed for urban use. This soil is well suited to all crops commonly grown in this county. Capability unit IIe–2, Loamy Upland range site, pasture suitability group A–2, woodland group 4o.

Sd—Sharpsburg silt loam, 4 to 10 percent slopes. This sloping soil is on convex side slopes on uplands adjacent to the Kansas River. Individual areas are 10 to 200 acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer is about 4 inches thinner.

Included with this soil in mapping were small areas of Gymer, Pawnee, and Morrill soils. Also included were areas of soils that are mottled in the upper part of the subsoil. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is medium to rapid, and the erosion hazard is moderate to high. The main concern of management is controlling erosion.

Much of the acreage of this soil is cultivated. About 20 percent has been developed for urban use. This soil is suited to all crops commonly grown in this county. Capability unit IIIe–1, Loamy Upland range site, pasture suitability group A–2, woodland group 4o.

Sibleyville Series

The Sibleyville series consists of moderately deep, well drained, sloping to strongly sloping soils on uplands. These soils formed in material weathered from loamy shale and sandstone. Native vegetation is tall prairie grasses and, in some places, a combination of oak-hickory forest with an understory of tall prairie grasses.

In a representative profile, the surface layer is very dark grayish brown loam about 7 inches thick. The subsoil is dark brown, very friable loam about 8 inches thick. The underlying material is yellowish brown channery loam. Partly weathered sandstone is at a depth of 27 inches.

Available water capacity and natural fertility are moderate. Permeability is moderate.

Representative profile of Sibleyville loam, in an area of Sibleyville complex, 3 to 7 percent slopes, in grassland, about 800 feet west and 60 feet north of the southeast corner of sec. 33, T. 14 S., R. 21 E.:

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) loam; moderate fine and medium granular structure; very friable; few small limestone fragments; slightly acid; gradual smooth boundary.

B2t—7 to 15 inches; dark brown (10YR 3/3) loam; moderate fine and medium granular structure; very friable; thin clay films on some peds; few small sandstone fragments; medium acid; clear wavy boundary.

C1—15 to 27 inches; yellowish brown (10YR 5/4) channery loam; massive; friable; medium acid; abrupt irregular boundary.

C2—27 to 32 inches; partly weathered yellowish brown fine-grained sandstone.

Depth to sandstone or loamy shale ranges from 24 to 40 inches. The A horizon ranges from 6 to 12 inches in thickness. In some places, it is fine sandy loam. The B horizon is loam, sandy clay loam, or clay loam and ranges from 8 to 20 inches in thickness.

Sibleyville soils are near Basehor and Vinland soils. Sibleyville soils contain more sand throughout than Vinland soils. They have a darker colored A1 horizon and are deeper to sandstone than Basehor soils.

Sh—Sibleyville loam, 3 to 7 percent slopes. This sloping soil is mainly on side slopes and narrow ridges. In some places, it is on foot slopes. Individual areas are 3 to 900 acres in size. This soil has a profile similar to the one described as representative for the series, but the subsoil is thicker and contains more clay.

Included with this soil in mapping were small areas of a similar soil that is more than 40 inches deep to sandstone or loamy shale. Also included were small areas of Woodson and Martin soils. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is medium, and the erosion hazard is moderate to high. The main concerns of management are controlling erosion and increasing fertility.

About 75 percent of the acreage of this soil is cultivated. The rest is used for pasture. This soil is suited to all crops commonly grown in the county. Capability unit IIIe–1, Loamy Upland range site, pasture suitability group A–2, not assigned to a woodland group.

So—Sibleyville loam, 3 to 7 percent slopes, eroded. This sloping soil is on side slopes, generally along and at the upper ends of small drainageways. Individual areas are 3 to 140 acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer is thinner and the subsoil is thicker and contains more clay. The surface layer reflects the mixing by cultivation of the original surface layer and material from the upper part of the subsoil. In some places, the surface layer contains a few sandstone fragments. There are gullies or gully scars in most areas.

Included with this soil in mapping were small areas of Martin and Woodson soils.

Runoff is medium, and the erosion hazard is high. The main concerns of management are controlling erosion and increasing fertility.

About 50 percent of the acreage of this soil is cultivated. The rest is used for tame grass pasture. This soil is better suited to grasses than to cultivated crops. If this soil is cultivated, it is better suited to wheat and other small grains than to corn or soybeans. Capability unit IVe–6, Loamy Upland range site, pasture suitability group A–2, not assigned to a woodland group.

Ss—Sibleyville complex, 3 to 7 percent slopes. This complex of sloping soils is on convex side slopes and narrow ridges. Individual areas are 4 to 350 acres in size.

About 60 percent of this complex is Sibleyville soils, about 25 percent is soils similar to Sibleyville soils but less than 20 inches deep to sandstone or loamy shale, and about 15 percent is soils similar to Sibleyville soils but more than 40 inches deep to sandstone or loamy shale and with a thicker subsoil that contains more clay. Sibleyville soils have the profile described as representative for the series.

Included with these soils in mapping were small areas of Martin, Vinland, Basehor, and Woodson soils. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is medium, and the erosion hazard is high. The main concerns of management are controlling erosion and increasing fertility.

About 60 percent of the acreage of this unit is cultivated. The rest is used for pasture. The pastured areas are in tame or native grasses. In some places, the areas in native grasses have a partial stand of trees. These soils are better suited to grasses than to cultivated crops. If this complex is cultivated, it is better suited to wheat, oats, and grain sorghum than to corn or soybeans. Capability unit IVe–2, Loamy Upland range site, pasture suitability group G, not assigned to a woodland group.

St—Sibleyville complex, 3 to 7 percent slopes, eroded. This complex of sloping soils is on convex side slopes. Individual areas are 4 to 50 acres in size.

About 50 percent of this complex is Sibleyville soils, about 40 percent is soils similar to Sibleyville soils but less than 20 inches deep to sandstone or loamy shale, and about 10 percent is soils similar to Sibleyville soils but more than 40 inches deep to sandstone or loamy shale and with a thicker subsoil that contains more clay. Sibleyville soils have a profile similar to the one described as representative for the series, but the surface layer is lighter colored and contains many sandstone fragments. There are gullies or gully scars in most areas.

Included with these soils in mapping were small areas of Vinland and Martin soils.

Runoff is medium, and the erosion hazard is high. The main concerns of management are maintaining and improving stands of grass, increasing fertility, and controlling erosion.

Most of the acreage of this complex is used for tame grass pasture. This complex is better suited to grasses than to crops. Capability unit VIe–1, Loamy Upland range site, pasture suitability group G, not assigned to a woodland group.

Sv—Sibleyville complex, 7 to 15 percent slopes. This complex of strongly sloping soils is mostly on convex side slopes. Some areas are on side slopes below limestone outcrops. Individual areas are 10 to 300 acres in size.

About 50 percent of this complex is Sibleyville soils, about 25 percent is soils similar to Sibleyville soils but less than 20 inches deep to sandstone or silty shale, and about 15 percent is soils similar to Sibleyville soils but more than 40 inches deep to loamy shale or limestone and with a thicker subsoil that contains more clay. In most areas of this unit, the shallow soils and the Sibleyville soils are steeper and on the higher slopes, and the deep soils are less steep and on the lower slopes.

Included with these soils in mapping were some small areas of Vinland, Martin, and Gymer soils. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is rapid. The erosion hazard is high where these soils are cultivated or where pasture is overgrazed. The main concern of management is maintaining and improving stands of grass.

Most of the acreage of this complex is used for pasture. These soils are better suited to grasses than to cultivated crops, and only a few small areas are cultivated. Capability unit VIe–1, Loamy Upland range site, pasture suitability group G, not assigned to a woodland group.

Sogn Series

The Sogn series consists of shallow, somewhat excessively drained, sloping to moderately steep soils on uplands. These soils formed in material weathered from limestone. Native vegetation is mid and tall prairie grasses.

In a representative profile, the surface layer is silty clay loam about 12 inches thick. The upper 8 inches is very dark gray, and the lower 4 inches is dark brown. Limestone is at a depth of 12 inches.

Available water capacity is very low, and natural fertility is high. Permeability is moderate.

Representative profile of Sogn silty clay loam, in an area of Sogn-Vinland complex, 5 to 20 percent slopes, in pasture, 1,000 feet south and 2,550 feet east of the northwest corner of sec. 18, T. 12 S., R. 19 E.:

A11—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam; moderate medium granular structure; friable; neutral; gradual smooth boundary.

A12—8 to 12 inches; dark brown (10YR 3/3) silty clay loam; moderate fine subangular blocky structure; friable; less than 10 percent limestone fragments; neutral; abrupt irregular boundary.

R—12 inches; limestone that has numerous vertical cracks and solution channels that are filled with dark colored soil.

The A horizon ranges from very dark gray to dark brown.

The limestone ranges from thick, massive layers to thin, broken layers that are interbedded with shale.

Sogn soils are near Vinland and Oska soils. Sogn soils are shallow over limestone, whereas Vinland soils are shallow over shale. Sogn soils are not so deep as Oska soils.

Sw—Sogn-Vinland complex, 5 to 20 percent slopes. This complex consists of sloping to moderately steep, somewhat excessively drained soils that formed in material weathered from interbedded shale and limestone. Individual areas are narrow bands that range from 100 to 800 feet in width and from 500 feet to several miles in length. Limestone outcrops are common.

About 55 percent of this complex is Sogn soils, about 30 percent is Vinland soils, and the rest is Martin, Oska, and Sibleyville soils.

Runoff is medium to rapid. The main concern of management is maintaining and improving native vegetation.

Most areas of this complex are used for pasture. Vegetation is about 60 percent mid and tall native grasses, and the rest is less desirable species and woody plants. These soils are not suited to cultivated crops. Capability unit VIe–2, pasture suitability group H, not assigned to a woodland group; Sogn soils in Shallow Limy range site; Vinland soils in Loamy Upland range site.

Stony Steep Land

Sx—Stony steep land. This land type consists of limestone outcrops intermingled with shallow, moderately deep, and deep soils. The limestone outcrops make up 60 percent of this land type, and Vinland, Sogn, Oska, and Martin soils make up 40 percent. This land type is excessively drained. It is on uplands in steep areas along the large streams and rivers. Individual areas are 11 to 275 acres in size. Slopes are 20 to 40 percent.

Runoff is very rapid, and available water capacity is dominantly low or very low.

Most areas of Stony steep land are used for pasture or left idle. Vegetation is mostly woody plants and some mid and tall native grasses. Capability unit VIIe–1, Breaks range site, pasture suitability group H, not assigned to a woodland group.

Thurman Series

The Thurman series consists of deep, somewhat excessively drained, sloping soils. These soils formed in sandy sediment. Native vegetation is tall prairie grasses and a few deciduous trees.

In a representative profile, the surface layer is very dark grayish brown loamy fine sand about 13 inches thick. The next layer is dark brown loamy fine sand about 9 inches thick. The underlying material is dark brown and dark yellowish brown fine sand.

Natural fertility is moderate, and available water capacity is low. Permeability is rapid.

Representative profile of Thurman loamy fine sand, in an area of Thurman complex, 4 to 10 percent slopes, in bromegrass, 1,500 feet north and 175 feet west of the southeast corner of sec. 8, T. 12 S., R. 20 E.:

A1—0 to 13 inches; very dark grayish brown (10YR 3/2) loamy fine sand; single grained and weak fine granular structure; very friable; some roots; slightly acid; gradual smooth boundary.

AC—13 to 22 inches; dark brown (10YR 3/3) loamy fine sand; single grained and weak fine granular structure; loose; some roots; neutral; gradual smooth boundary.

C1—22 to 38 inches; dark brown (10YR 4/3) fine sand; single grained; loose; few roots; neutral; diffuse smooth boundary.

C2—38 to 60 inches; dark yellowish brown (10YR 4/4) fine sand; single grained; loose; neutral.

The A horizon ranges from 8 to 16 inches in thickness. It is loamy fine sand or loamy sand. The C horizon is mostly loamy fine sand or fine sand, but in places below a depth of 40 inches, it is fine sandy loam, sandy clay loam, or clay loam.

Thurman soils are near Gymer and Morrill soils. Thurman soils contain more sand than Gymer soils. They are not so red as and contain more sand and less clay than Morrill soils.

Thurman soils typically are dry for shorter periods than defined in the range for the series, but this does not alter their usefulness or behavior.

Tc—Thurman complex, 4 to 10 percent slopes. This complex of sloping soils is on convex slopes on a high old alluvial terrace on the northern side of the Kansas River. It is highly dissected by streams. Individual areas are 55 to 200 acres in size.

About 35 percent of this complex is Thurman loamy fine sand; about 30 percent is a soil that has a surface layer of very dark grayish brown sandy loam and a subsoil of dark grayish brown sandy loam; and about 25 percent is a soil that has a surface layer of very dark grayish brown sandy loam, a subsoil of reddish brown sandy clay loam or light clay loam, and in places, a leached, lighter colored subsurface layer. The Thurman soil is on upper slopes, the soil that has a dark grayish brown subsoil is on lower slopes or foot slopes, and the soil that has a reddish brown subsoil is on mid slopes between the other two soils.

Included with these soils in mapping were small areas of Gymer, Morrill, and Sharpsburg soils.

Runoff is slow to medium, and the erosion hazard is high. The main concern of management is controlling erosion.

About 80 percent of the acreage of this complex is used for pasture, and the rest is cultivated. About 40 percent of the pasture is tame grasses, and the rest is native grasses or an oak-hickory woody vegetation association with an understory of tall prairie grasses. These soils are better suited to grasses than to cultivated crops. If the soils are cultivated, they are better suited to wheat and other small grains than to corn or soybeans. Capability unit IVe–7, Savannah range site, pasture suitability group B, woodland group 5s.

Vinland Series

The Vinland series consists of shallow, somewhat excessively drained, sloping to moderately steep soils on uplands. These soils formed in material weathered from loamy shale. Native vegetation is tall prairie grasses.

In a representative profile, the surface layer is very dark gray silty clay loam about 7 inches thick. The subsoil is dark gray and dark brown, firm silty clay loam about 3 inches thick. The underlying material is grayish brown silty clay loam. Olive brown to yellowish brown weathered shale is at a depth of 17 inches.

Available water capacity is low, and natural fertility is moderate. Permeability is moderate.

Representative profile of Vinland silty clay loam, in an area of Sogn-Vinland complex, 5 to 20 percent slopes, in bromegrass, 2,200 feet south and 100 feet east of the northwest corner of sec. 3, T. 15 S., R. 18 E.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam; moderate fine and medium granular structure; firm; neutral; gradual smooth boundary.

B2—7 to 10 inches; dark gray and dark brown (10YR 4/1 and 4/3) silty clay loam; moderate very fine and fine subangular blocky structure; firm; neutral; gradual smooth boundary.

C1—10 to 17 inches; grayish brown (2.5YR 5/2) silty clay loam; massive; firm; neutral; abrupt smooth boundary.

C2—17 inches; olive brown to yellowish brown shale; somewhat weathered; bedded and dense.

Reaction of the solum ranges from medium acid to neutral. The A horizon ranges from very dark gray to very dark brown. The C horizon is dark grayish brown, olive brown, or yellowish brown. Depth to underlying shale ranges from 10 to 20 inches.

Vinland soils are near Martin, Sibleyville, Oska, Sogn, and Basehor soils. Vinland soils are not so deep as Martin, Oska, and Sibleyville soils, and unlike those soils, they lack a B2t horizon. Vinland soils are shallow to shale, whereas Basehor soils are shallow to sandstone and Sogn soils are shallow to limestone.

Vc—Vinland complex, 3 to 7 percent slopes. This complex of sloping soils is on side slopes, generally below limestone or sandstone formations. Individual areas are 4 to 100 acres in size.

About 45 percent of this complex is Vinland soils, about 30 percent is a soil similar to Vinland soils but 20 to 40 inches deep to shale and with 35 to 45 percent clay in the subsoil, and about 15 percent is Martin soils.

Included with these soils in mapping were small areas of Sibleyville, Sogn, and Oska soils. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is medium, and the erosion hazard is high. The main concerns of management are controlling erosion and increasing fertility.

About 60 percent of the acreage of this complex is used for pasture, and the rest is cultivated. This complex is better suited to grasses than to cultivated crops. If these soils are cultivated, they are better suited to wheat and other small grains than to corn or soybeans. Capability unit IVe–3, Loamy Upland range site, pasture suitability group G, not assigned to a woodland group.

Vh—Vinland complex, 3 to 7 percent slopes, eroded. This complex of sloping soils is on side slopes, generally below limestone or sandstone formations. Individual areas are 4 to 100 acres in size.

About 60 percent of this complex is Vinland soils, and about 30 percent is a soil similar to Vinland soils but 20 to 40 inches deep to shale and with 35 to 45 percent clay in the subsoil. Vinland soils have a profile similar to the one described as representative for the series, but the surface layer is lighter colored and thinner. The surface layer is commonly dark grayish brown to dark brown silty clay loam that has some shale fragments. There are gullies or gully scars in most areas.

Included with these soils in mapping were small areas of Martin, Sibleyville, and Sogn soils.

Runoff is medium, and the erosion hazard is high. The main concerns of management are maintaining and improving stands of grass, increasing fertility, and controlling erosion.

Nearly all of the acreage of this complex is used for tame grass pasture. A few small areas are cultivated. These soils are better suited to grasses than to cultivated crops. Capability unit VIe–1, Loamy Upland range site, pasture suitability group G, not assigned to a woodland group.

Vm—Vinland-Martin complex, 7 to 15 percent slopes. This complex of strongly sloping soils is on side slopes below limestone and sandstone formations. Individual areas are mainly bands that range from 200 to 1,000 feet in width and from 1,300 feet to 4 miles in length. They are from 10 to 1,500 acres in size.

About 40 percent of this complex is Vinland soils, about 25 percent is Martin soils, and about 20 percent is a soil similar to Vinland soils but 20 to 40 inches deep to shale and with 35 to 45 percent clay in the subsoil.

Included with these soils in mapping were small areas of Sibleyville and Sogn soils. Small eroded areas are shown on the soil map by a severely eroded spot symbol.

Runoff is rapid. The erosion hazard is high where these soils are cultivated or where pasture is overgrazed. The main concern of management is maintaining and improving the stands of grass.

Most of the acreage of this complex is used for tame or native grass pasture. In some places, the native grass areas have a large amount of woody vegetation as part of the plant cover. A few areas of this complex are cultivated. This complex is better suited to grasses than to cultivated crops. Capability unit VIe–1, Loamy Upland range site, pasture suitability group G, not assigned to a woodland group.

Wabash Series

The Wabash series consists of deep, poorly drained to very poorly drained, nearly level soils on bottom lands and terraces. These soils formed in clayey alluvium. Native vegetation is water-tolerant prairie grasses and a few deciduous trees.

In a representative profile, the surface layer is black silty clay about 16 inches thick. The subsoil is black, very firm silty clay about 36 inches thick. The underlying material is very dark gray silty clay.

Available water capacity and natural fertility are high. Permeability is very slow.

Representative profile of Wabash silty clay, in a cultivated field, 1,175 feet west and 2,020 feet north of the southeast corner of sec. 18, T. 13 S., R. 20 E.:

Ap—0 to 5 inches; black (10YR 2/1) silty clay; weak fine granular structure; firm; common roots; slightly acid; clear smooth boundary.

A11—5 to 10 inches; black (10YR 2/1) silty clay; strong fine and medium blocky structure; very firm; many roots; slightly acid; clear smooth boundary.

A12—10 to 16 inches; black (10YR 2/1) silty clay; weak medium and coarse prismatic structure parting to moderate fine and medium subangular blocky; very firm; many roots; few fine black concretions; slightly acid; gradual smooth boundary.

B1g—16 to 28 inches; black (10YR 2/1) silty clay; few fine faint very dark grayish brown (10YR 3/2) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; very firm; few fine roots; few fine black concretions; neutral; diffuse wavy boundary.

B2g—28 to 52 inches; black (10YR 2/1) silty clay; few fine faint very dark grayish brown (10YR 3/2) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; very firm; few fine roots; few fine black concretions; neutral; diffuse wavy boundary.

Cg—52 to 70 inches; very dark gray (10YR 3/1) silty clay; common fine faint dark yellowish brown (10YR 3/4) mottles; massive; very firm; few fine black concretions; slightly acid.

The A horizon ranges from silty clay to silty clay loam. The B horizon is silty clay or clay. The A horizon and upper part of the B horizon range from medium acid to neutral. The lower part of the B horizon and the C horizon range from slightly acid to mildly alkaline and contain a few calcium carbonate concretions in some places.

Wabash soils are near Reading and Kimo soils and are in the same landscape position as Leanna soils. Wabash soils are more clayey in the B horizon than Reading soils. They lack the gray A2 horizon that is characteristic of Leanna soils. Wabash soils are more clayey below a depth of 24 inches than Kimo soils.

Wc—Wabash silty clay loam. This nearly level soil is on flood plains and terraces along streams. Individual areas are 5 to 100 acres in size. This soil has a profile similar to the one described as representative for the series, but the surface layer is silty clay loam about 12 to 20 inches thick. Slopes are 0 to 1 percent.

Included with this soil in mapping were small areas of Wabash silty clay and Leanna, Reading, and Kennebec soils.

Runoff is very slow. Flooding is rare or occasional. The main concern of management is removing excess water that drained from adjacent uplands and overflowed from adjacent streams. A surface drainage system is needed in some slightly depressional areas.

Most of the acreage of this soil is cultivated. A few areas are used for pasture. This soil is well suited to all crops commonly grown in the county. Capability unit IIw–3, Clay Lowland range site, pasture suitability group E, woodland group 4w.

Wh—Wabash silty clay. This nearly level soil is on second bottoms and terraces of the larger streams. Individual areas are 10 to 1,000 acres in size. This soil has the profile described as representative for the series. Slopes are 0 to 1 percent.

Included with this soil in mapping were small areas of Wabash silty clay loam and Reading soils.

Runoff is very slow to ponded. Flooding is rare or occasional. The hazard of wetness is high. The main concern of management is removing excess water. This soil is difficult to cultivate because the surface layer is sticky and plastic when wet and hard when dry.

About 85 percent of the acreage of this soil is cultivated. The rest is used for pasture or left idle. This soil is better suited to soybeans, grain sorghum, and wheat than to corn or alfalfa. Capability unit IIIw–1, Clay Lowland range site, pasture suitability group E, woodland group 4w.

Woodson Series

The Woodson series consists of deep, somewhat poorly drained, nearly level to gently sloping soils on uplands. These soils formed in moderately fine textured and fine textured sediment.

In a representative profile, the surface layer is very dark gray silt loam and silty clay loam about 11 inches thick. The subsoil is about 34 inches thick. It is very dark gray, very firm silty clay in the upper 22 inches and coarsely mottled dark brown and grayish brown, very firm silty clay in the lower 12 inches. The underlying material is mostly coarsely mottled grayish brown and dark brown clay loam.

Available water capacity is high, and natural fertility is moderate. Permeability is very slow.

Representative profile of Woodson silt loam, 1 to 3 percent slopes, in a cultivated field, 750 feet west and 820 feet south of the northeast corner of sec. 7, T. 15 S., R. 21 E.:

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam; weak to moderate fine granular structure; friable; common fine roots; strongly acid; clear smooth boundary.

A1—8 to 11 inches; very dark gray (10YR 3/1) light silty clay loam; weak to moderate fine platy structure in upper part and moderate fine subangular blocky structure in lower part; friable; few fine black concretions; common fine roots; medium acid; abrupt smooth boundary.

B21t—11 to 20 inches; very dark gray (10YR 3/1) silty clay; few fine faint dark brown (10YR 3/3) mottles; moderate medium and coarse prismatic structure parting to moderate fine and medium blocky; very firm; gray silt coatings on ped faces; few fine black concretion; common fine roots; medium acid; gradual smooth boundary.

B22t—20 to 33 inches; very dark gray (10YR 3/1) silty clay; few fine distinct dark yellowish brown (10YR 3/4) and very dark grayish brown (10YR 3/2) mottles; moderate coarse prismatic structure parting to moderate fine blocky; very firm; gray silt coatings on ped faces; few fine black concretions; common fine roots; slightly acid; gradual smooth boundary.

B3—33 to 45 inches; coarsely mottled dark brown (10YR 4/3) and grayish brown (10YR 5/2) light silty clay; about 30 percent vertical fillings of black (10YR 2/1) silty clay about 1.5 inches wide; moderate coarse prismatic structure parting to weak fine and medium blocky; very firm; common fine black concretions; few fine roots; neutral; gradual smooth boundary.

C1—45 to 58 inches; grayish brown (10YR 5/2) clay loam; about 30 percent vertical fillings of very dark gray (10YR 3/1) light silty clay about 1.5 inches wide; many fine and medium faint dark yellowish brown (10YR 4/4) mottles; massive; friable; few fine black concretions; few fine roots; neutral; gradual smooth boundary.

C2—58 to 78 inches; coarsely mottled dark brown (10YR 4/3) and grayish brown (10YR 5/2) clay loam; few vertical fillings; massive; friable; few fine black concretions; many yellowish red stains; few fine roots; neutral.

The A horizon ranges from strongly acid to slightly acid. It is heavy silt loam or light silty clay loam and ranges in depth from 6 to 14 inches. The C horizon is silty clay, silty clay loam, or clay loam.

Woodson soils are near Martin, Pawnee, and Sharpsburg soils. Woodson soils have an abrupt boundary between the A and B horizons, and Martin soils do not. They have less sand throughout than Pawnee soils. They have more clay in the B horizon than Sharpsburg soils.

Wo—Woodson silt loam, 0 to 1 percent slopes. This nearly level soil generally is on broad, flat ridgetops and old stream terraces. Individual areas are irregular in shape and are 50 to 300 acres in size.

Included with this soil in mapping were small areas of Martin and Pawnee soils. Also included in the northeastern part of the county was an area of a similar soil that has less clay in the underlying material, coarser sand particles, and a few pebbles.

Runoff is slow, and the erosion hazard is slight. The main concern of management is controlling runoff. This soil is wet for a few days after excessive amounts of rain because runoff is slow and permeability is very slow. However, it is somewhat droughty if it does not receive a moderate amount of rain each week during the growing season.

Most of the acreage of this soil is cultivated. This soil is suited to all crops commonly grown in the county. It is generally better suited to wheat, grain sorghum, and soybeans than to corn. Capability unit IIs–1, Clay Upland range site, pasture suitability group C, not assigned to a woodland group.

Ws—Woodson silt loam, 1 to 3 percent slopes. This gently sloping soil is on ridges and old stream terraces. Individual areas are irregular in shape and are 5 to several hundred acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping were small areas of Martin and Pawnee soils. Also included in the northeastern part of the county was an area of a similar soil that has less clay in the substratum, coarser sand particles, and a few pebbles. Small eroded areas were included near the upper ends and along the sides of small drainageways, and these areas are shown on the soil map by a severely eroded spot symbol. Also included, along drainageways, were a few small areas of a Woodson silt loam that have slopes of more than 3 percent. Small areas of a soil that has a puddled surface layer, generally caused by excessive amounts of soluble salts, are shown on the soil map by gumbo or scabby spot symbols. These scabby areas are difficult to cultivate because tilth is poor and water generally ponds temporarily during periods of excessive rain.

Runoff is slow to medium, and the erosion hazard is moderate. The main concern of management is controlling erosion. Because it is very slowly permeable and has a subsoil of dense silty clay, this soil is somewhat droughty if it does not receive a moderate amount of rain each week during the growing season.

Most of the acreage of this soil is cultivated. A few areas are used for pasture. This soil is suited to all crops commonly grown in the county. It is generally better suited to wheat, grain sorghum, and soybeans than to corn. Capability unit IIIe–2, Clay Upland range site, pasture suitability group C, not assigned to a woodland group.

Wx—Woodson silty clay loam, 1 to 3 percent slopes, eroded. This gently sloping soil is on the sides of ridges near small drainageways. It has a profile similar to the one described as representative for the series, but erosion has thinned the original surface layer. Cultivation has mixed the remaining surface layer with material from the upper part of the subsoil, producing the present surface layer of silty clay loam.

Included with this soil in mapping were small areas of Sibleyville and Martin soils.

Runoff is medium, and the erosion hazard is high. The main concerns of management are controlling erosion and improving tilth.

About half of the acreage of this soil is cultivated. The rest is used for pasture. This soil is better suited to grasses than to cultivated crops. If this soil is cultivated, it is suited to wheat and other small grain. Capability unit IVe–1, Clay Upland range site, pasture suitability group C, not assigned to a woodland group.

Use and Management of the Soils

The soil survey is a detailed analysis and evaluation of the most basic resource of the survey area--the soil. It may be used to fit the use of the land, including urbanization, to the limitations and potentials of the natural resources and to the environment and to help avoid soil-related failures in uses of the land.

During a soil survey, soil scientists, conservationists, engineers, and others keep extensive notes not only about the nature of the soils but also about unique aspects of behavior of these soils in the field and at construction sites. These notes include observations of erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors relating the kinds of soil to their productivity, potentials, and limitations under various uses and levels of management. In this way field experience, incorporated with measured data on soil properties and performance, is used as a basis for predicting soil behavior.

Information in this section will be useful in applying basic facts about the soils to plans and decisions for use and management of soils for crops and pasture, range, woodland, and many nonfarm uses including building sites, highways and other transportation systems, sanitary facilities, parks and other recreational developments, and wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures, related to unfavorable soil properties, in homes and other structures can be avoided. A site can be selected where the soil properties are favorable, or practices can be planned that will overcome the soil limitations.

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. Both of these factors are closely related to the nature of the soil. Plans can be made to maintain or create a land use pattern in harmony with the natural soil.

Contractors can find the information in this section useful in locating sources of sand and gravel, road fill, and topsoil, and in determining the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

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

Management of Soils Used for Cultivated Crops [2]

About 47 percent of Douglas County is used to grow cultivated crops (*11*). Soybeans, grain and forage sorghum, corn for grain and forage, and small grain are the commonly cultivated crops. Alfalfa, sweetclover, vetch, sudangrass, lespedeza, and redclover are grown for forage or cover.

The loamy soils in the Kansas River Valley are well suited to most vegetables. They are also well suited to irrigation. Water is available, but only a few acres are irrigated. Most of the alfalfa used to make dehydrated products is grown in the Kansas River Valley.

A system of soil management consists of a combination of practices used to produce crops. A good system should maintain and improve the productivity of the soil. The main considerations in managing cultivated soils in the county are maintaining fertility, controlling erosion, and making the most efficient use of available water.

Maintaining fertility can be accomplished by controlling erosion, using barnyard manure and crop residues, and adding commercial fertilizers. The kind and amount of fertilizer for each crop is determined by field trials, experience of farmers, and soil tests.

Controlling erosion can be accomplished by the use of terracing, contour farming, crop residues, timely tillage, and minimum tillage. Terracing and contour farming can be used to reduce water erosion and help conserve rainfall on all of the sloping soils in the county. These practices, alone or in combination, also can be beneficial on some nearly level soils that have long slopes. Each row planted on the contour acts as a miniature terrace by holding back water and letting it soak into the soil. The water that is saved by terracing and contour farming increases crop growth, which in turn adds to the amount of residue available to protect the soil.

Proper management of crop residues is necessary on all of the soils in Douglas County. It helps to maintain good soil structure, increase infiltration of water, and control water erosion and soil blowing. A cover of residue on the surface helps to hold the soil in place and reduce the puddling effect of beating raindrops.

Minimum or reduced tillage is done only when it is necessary to break up a surface crust, to control weeds, or to prepare a seedbed. The use of minimum tillage prevents the breakdown of soil aggregates and maintains more residue on the surface.

Stripcropping is another measure that can be used to control soil blowing. It is generally used in combination with a good crop residue management program, minimum tillage, and a good fertility program. Stripcropping is especially suited to some of the nearly level soils that have a surface layer of fine sandy loam or coarse silt loam.

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

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so 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 requiring special management.

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

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

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, 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, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, 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 largely to pasture, range, woodland or wildlife habitat. (None in Douglas County.)
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.
- Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.
- Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or to esthetic purposes.

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 interfers with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage) ; *s* shows that the soil is limited mainly because it is shallow droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold to too dry.

[2] EARL BONDY, conservation agronomist, Soil Conservation Service, helped prepare this section.

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

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–2 or IIIe–3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following paragraphs the capability units in Douglas County are described, and suggestions for the use and management of the soils are given.

For a complete explanation of capability classification, see Agriculture Handbook No. 210, Land Capability Classification (*20*).

Management by capability units

The use and management of soils by capability units are described in the following pages. The names of the soil series represented are given in the description of each unit, but this does not mean that all of the soils of a given series are in the unit. The capability unit designation for each soil in the county is given in the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I–1

This unit consists of deep, nearly level soils of the Eudora, Judson, and Reading series. These soils are well drained or moderately well drained, loamy soils in stream valleys that are not subject to damaging overflow.

Permeability is moderate or moderately slow. Available water capacity and natural fertility are high. Erosion is not a concern. Flooding is rare and causes little damage.

The soils of the unit are well suited to all crops commonly grown in the county. These include field and vegetable crops, grasses, and trees.

Management practices such as minimum tillage, proper management of crop residues, and adequate use of commercial fertilizers maintain organic-matter content, fertility, and tilth. A well-planned cropping system helps to control weeds and insects. These soils are easily tilled.

CAPABILITY UNIT IIe–1

This unit consists of deep, gently sloping soils of the Martin and Pawnee series. These soils are moderately well drained upland soils that have a surface layer of silty clay loam or clay loam and a subsoil of silty clay or clay.

Available water capacity and natural fertility are high. Permeability is slow. The erosion hazard is slight.

The soils of this unit are suited to all cultivated crops commonly grown in the county. They are also suited to tame and native grasses.

Management practices such as minimum tillage, terracing and contour farming, proper management of crop residues, and adequate use of commercial fertilizers maintain organic-matter content, fertility, and tilth and control erosion.

CAPABILITY UNIT IIe–2

This unit consists of deep, gently sloping soils of the Gymer and Sharpsburg series. These soils are well drained or moderately well drained upland soils that have a surface layer of silt loam and a subsoil of silty clay loam.

Natural fertility and available water capacity are high. Permeability is moderately slow. The erosion hazard is slight.

The soils of this unit are well suited to all cultivated crops commonly grown in the county. They are also suited to tame and native grasses.

Management practices such as minimum tillage, proper management of crop residues, and adequate use of commercial fertilizers maintain organic-matter content, fertility, and tilth. Terracing and contour tilling are needed on some fields to control erosion. These soils are easily tilled.

CAPABILITY UNIT IIs–1

Woodson silt loam, 0 to 1 percent slopes, is the only soil in this unit. This upland soil is deep and somewhat poorly drained. It has a thin surface layer of silt loam and a dense subsoil of silty clay.

Natural fertility is moderate, and available water capacity is high. Permeability is very slow, and runoff is slow. The erosion hazard is slight.

This soil is suited to all cultivated crops commonly grown in the county. It is also suited to tame and native grasses.

Management practices such as minimum tillage, proper management of crop residues, and adequate and properly timed applications of commercial fertilizers maintain organic-matter content, fertility, and tilth. A cropping system is also helpful. In some years fall tillage is needed to prepare a desirable seedbed for early planting of crops. During periods of excessive rainfall, this soil is difficult to till and harvest because it is very slowly permeable and runoff is slow.

CAPABILITY UNIT IIw–1

This unit consists of deep, nearly level and undulating soils of Eudora-Kimo complex and Eudora-Kimo fine sandy loams, overwash. These soils are somewhat poorly drained to well drained soils in the Kansas River Valley.

Available water capacity and natural fertility are high. Low lying areas are wet or ponded following excessive rainfall. Soil blowing is a concern in some areas of Eudora-Kimo fine sandy loams, overwash.

The soils of this unit are well suited to all crops commonly grown in the county. These include field and vegetable crops, grasses, and trees.

Management practices such as minimum tillage, proper management of crop residues, and adequate use of commercial fertilizers maintain organic-matter content, fertility, and tilth. Stripcropping is helpful in areas where soil blowing is a concern. A cropping system helps to control weeds and insects. Surface drainage systems and land leveling control wetness in most areas. These soils are easy to till.

CAPABILITY UNIT IIw-2

Kennebec silt loam is the only soil in this unit. This bottom land soil is deep and well drained or moderately well drained.

Natural fertility and available water capacity are high. Permeability is moderate. The major hazard is damage to crops by floods.

This soil is suited to all cultivated crops commonly grown in the county. It is also suited to tame and native grasses and to trees.

Management practices such as minimum tillage, proper management of crop residues, and adequate use of commercial fertilizers maintain organic-matter content, fertility, and tilth. Providing protection from flooding generally is not feasible. This soil is easy to till.

CAPABILITY UNIT IIw-3

This unit consists of deep, nearly level soils of the Wabash, Leanna, and Kimo series. These soils are somewhat poorly drained to very poorly drained soils on the high flood plains of streams. They have a surface layer of silt loam or silty clay loam and a subsoil of silty clay.

Natural fertility and available water capacity are high. Permeability is slow to very slow. Wetness caused by runoff from surrounding higher areas and by flooding of large streams is the main management concern. Kimo silty clay loam is adjacent to the Kansas River, and a high water table can cause this soil to be wet.

The soils of this unit are suited to all cultivated crops commonly grown in the county. They are also suited to tame and native grasses and to trees.

Management practices such as minimum tillage, crop rotation, proper management of crop residues, and adequate use of commercial fertilizers maintain organic-matter content, fertility, and tilth. Diversion terraces and terraces constructed in adjacent upland areas help to keep water from running onto these soils. Also, drainage ditches and land leveling are needed in some areas.

CAPABILITY UNIT IIIe-1

This unit consists of deep and moderately deep, sloping soils of the Oska, Sibleyville, Morrill, Gymer, and Sharpsburg series. These soils are well drained or moderately well drained upland soils that have a surface layer of loam, silt loam, clay loam, or silty clay loam and a subsoil of clay loam, silty clay loam, or light silty clay.

Natural fertility and available water capacity are moderate to high. Permeability ranges from slow to moderate. The erosion hazard is moderate to high if these soils are cultivated or overgrazed. Well managed grassland has a slight erosion hazard.

The soils of this unit are suited to all cultivated crops commonly grown in the county. They are well suited to tame and native grasses. Some areas of Gymer silt loam, 3 to 8 percent slopes, are suited to trees.

Management practices such as minimum tillage, crop rotation, proper management of crop residues, and adequate use of commercial fertilizers maintain organic-matter content, fertility, and tilth. Terracing and contour farming are needed to help control erosion. These soils are easily tilled.

CAPABILITY UNIT IIIe-2

Woodson silt loam, 1 to 3 percent slopes, is the only soil in this unit. This upland soil is deep and somewhat poorly drained. It has a thin surface layer of silt loam and a dense subsoil of silty clay.

Natural fertility is moderate, and available water capacity is high. Permeability is very slow. The erosion hazard is moderate if this soil is cultivated. Well managed grassland has a slight erosion hazard.

This soil is suited to all cultivated crops commonly grown in the county. It is also suited to tame and native grasses.

Management practices such as minimum tillage, crop rotation, proper management of crop residues, and adequate and properly timed applications of commercial fertilizers maintain organic-matter content, fertility, and tilth. Terracing and contour farming help to control erosion.

CAPABILITY UNIT IIIe-3

This unit consists of deep, sloping soils of the Martin and Pawnee series. These soils are moderately well drained upland soils that have a surface layer of silty clay loam or clay loam and a subsoil of silty clay or clay.

Available water capacity and natural fertility are high. Permeability is slow. The erosion hazard is high if these soils are cultivated or overgrazed. Well managed grassland has a slight erosion hazard.

The soils of this unit are suited to all cultivated crops commonly grown in the county. They are also suited to tame and native grasses.

Management practices such as minimum tillage, crop rotation, proper management of crop residues, and adequate use of commercial fertilizers maintain organic-matter content, fertility, and tilth. Terracing and contour farming are needed to help control erosion.

CAPABILITY UNIT IIIw-1

Wabash silty clay is the only soil in this unit. This soil is deep, nearly level, and very poorly drained. It is on large, high flood plains of the major streams.

Natural fertility and available water capacity are high. This soil shrinks during dry periods, causing many deep cracks, especially where alfalfa is grown. The high clay content restricts permeability, causing ponding. This soil is occasionally flooded because it is near large streams and receives runoff from surrounding higher areas. Surface drainage is slow, and in places crops are drowned during some growing seasons. Removal of excess water is the main management concern.

This soil is better suited to soybeans, wheat, and grain sorghum than to corn. It is well suited to water-tolerant grasses and can be developed for wetland wildlife habitat.

A bedding system helps to remove some excess water. Diversion terraces and terraces constructed in adjacent upland areas control runoff that spreads across this soil. Proper use of crop residues and crop rotation improve tilth. Adequate and properly timed applications of commercial fertilizers maintain fertility. Tilling in the fall generally provides a more desirable seedbed. This soil is difficult to cultivate because of the high clay content.

CAPABILITY UNIT IIIw-2

This unit consists only of Sarpy-Eudora complex, overwash. These soils are deep and well drained to excessively drained and are on the gently undulating flood plain of the Kansas River. They are sandy or loamy throughout.

Available water capacity is low to high and natural fertility is high. The soil blowing hazard is moderate. Flooding is rare but damaging.

The soils of this unit are well suited to all crops commonly grown in the county. These include field and vegetable crops, grasses, and trees.

Management practices such as minimum tillage, proper management of crop residues and green manure crops, and adequate use of commercial fertilizers maintain organic-matter content and fertility. Stripcropping and winter cover crops are needed to control soil blowing. These soils are easy to till.

CAPABILITY UNIT IVe-1

The only soil in this unit is Woodson silty clay loam, 1 to 3 percent slopes, eroded. This deep, somewhat poorly drained upland soil has a surface layer of heavy silty clay loam and a dense subsoil of silty clay.

Organic-matter content is low, and natural fertility is moderate. Permeability is very slow. The erosion hazard is high.

This soil is better suited to tame and native grasses than to cultivated crops. If cultivated, it is suited to wheat or other small grain.

Management practices such as minimum tillage, proper management of crop residues and green manure crops, and adequate use of commercial fertilizers are needed if this soil is cultivated. Terracing and contour farming help to control erosion. This soil is difficult to till.

CAPABILITY UNIT IVe-2

This unit consists only of Sibleyville complex, 3 to 7 percent slopes. These soils are well drained, shallow and moderately deep, and loamy throughout.

Permeability is moderate. Available water capacity is low to moderate, and natural fertility is moderate. The erosion hazard is high.

The soils of this unit are better suited to tame and native grasses than to cultivated crops. If cultivated, they are suited to wheat and other small grain.

Management practices such as minimum tillage, crop rotation, proper management of crop residues, and adequate use of commercial fertilizers are needed if these soils are cultivated. Terracing and contour farming are needed to control erosion.

CAPABILITY UNIT IVe-3

This unit consists of Martin-Oska silty clay loams, 3 to 6 percent slopes, and Vinland complex, 3 to 7 percent slopes. These soils are shallow, moderately deep and deep, and moderately well drained to excessively drained. They have a surface layer of silty clay loam and a subsoil of silty clay loam or silty clay.

Natural fertility is high to moderate, and available water capacity is low to high. Permeability is slow to moderate. The erosion hazard is high.

The soils of this unit are better suited to tame and native grasses than to cultivated crops. If cultivated, they are suited to wheat, other small grain, and grain sorghum.

Management practices such as minimum tillage, crop rotation, proper management of crop residues, and adequate use of commercial fertilizers maintain organic-matter content, fertility, and tilth. Terracing and contour farming are needed in cultivated areas. These soils are difficult to cultivate because of the regular pattern of shallow areas.

CAPABILITY UNIT IVe-4

This unit consists of deep, sloping, eroded soils of the Martin and Pawnee series. These soils are moderately well drained upland soils that are clayey throughout.

Organic-matter content is low. Natural fertility and available water capacity are high. Permeability is slow. The erosion hazard is high.

The soils of this unit are better suited to tame and native grasses than to cultivated crops. If cultivated, they are suited to wheat or other small grain.

Management practices such as minimum tillage, proper management of crop residues and green manure crops, and adequate use of commercial fertilizers are needed if these soils are cultivated. Terracing and contour farming help to control erosion. These soils are difficult to till.

CAPABILITY UNIT IVe-5

Morrill clay loam, 7 to 12 percent slopes, is the only soil in this unit. This upland soil is deep and well drained. It has a surface layer and subsoil of clay loam.

Natural fertility and available water capacity are high. Permeability is moderately slow. The erosion hazard is high.

This soil is well suited to tame and native grasses. It is also suited to wheat or other small grain.

Management practices such as minimum tillage, crop rotation, proper management of crop residues, and adequate use of commercial fertilizers are needed if this soil is cultivated. Terracing and contour farming are needed to control erosion.

CAPABILITY UNIT IVe-6

Sibleyville loam, 3 to 7 percent slopes, eroded, is the only soil in this unit. This soil is deep and well drained. It has a surface layer of heavy loam and a subsoil of clay loam. The surface layer contains some sandstone fragments. There are some gullies and gully scars.

Natural fertility and available water capacity are moderate. Organic-matter content is low. The erosion hazard is high.

This soil is better suited to tame and native grasses than to cultivated crops. If cultivated, it is suited to wheat or other small grain.

Management practices such as minimum tillage, crop rotation, proper management of crop residues and green manure crops, and adequate use of commercial fertilizers are needed if this soil is cultivated. Terracing and contour farming are needed to control erosion.

CAPABILITY UNIT IVe–7

This unit consists only of Thurman complex, 4 to 10 percent slopes. These soils are deep and are sandy and loamy throughout.

Permeability is moderate to rapid. Natural fertility is moderate, and available water capacity is low to high. The erosion hazard is high.

The soils of this unit are better suited to grasses and trees than to cultivated crops. If cultivated, they are suited to wheat, oats, and grain sorghum. They are also suited to corn and soybeans in some areas.

Management practices such as minimum tillage, crop rotation, proper management of crop residues, and adequate use of commercial fertilizers are needed if these soils are cultivated. Terracing and contour farming are needed to control erosion.

CAPABILITY UNIT VIe–1

This unit consists of strongly sloping soils and eroded sloping soils of the Martin, Sibleyville, and Vinland series and the land type Gravelly land. These upland soils are shallow, moderately deep and deep, and moderately well drained to somewhat excessively drained. They generally have a surface layer of loam to silty clay loam and a subsoil of loam to silty clay, but some areas are gravelly throughout. The eroded soils in this unit have many shale and sandstone fragments in the surface layer in some places.

The erosion hazard is high.

The soils of this unit are well suited to tame and native grasses. They are not suited to cultivated crops. Areas that have a gravelly surface layer are better suited to native grasses than to tame grasses.

Management practices needed are those that maintain and improve grasses. Renovating the grasses is practical in some areas, but this depends upon the amount of woody vegetation.

CAPABILITY UNIT VIe–2

This unit consists only of Sogn-Vinland complex, 5 to 20 percent slopes. These soils are shallow and somewhat excessively drained. They are silty clay loam throughout.

Available water capacity is very low and low, and natural fertility is moderate to high.

The soils of this unit are better suited to native grasses than to tame grasses. Establishing tame grasses is possible but generally expensive. These soils are not suited to cultivated crops.

Management practices needed are those that maintain and improve the grasses.

CAPABILITY UNIT VIe–3

This unit consists of Basehor complex, 7 to 15 percent slopes. These soils are well drained and shallow, moderately deep, and deep. They are loamy throughout.

Natural fertility is low, and available water capacity is very low to moderate. The erosion hazard is high.

The soils of this unit are suited to trees and grasses. Most of the trees currently have little commercial value. These soils are not suited to cultivated crops.

Management practices needed are those that maintain or improve the vegetative cover. Revegetation of some areas to tame or native grasses is practical.

CAPABILITY UNIT VIw–1

Kennebec soils, channeled, are the only soils in this unit. These soils are deep, moderately well drained to well drained loamy soils on narrow flood plains that have a meandering stream channel.

Available water capacity and natural fertility are high. Flooding is frequent.

The soils of this unit are well suited to trees and grasses. Because of flooding and inaccessibility, they are not suited to cultivated crops.

Management practices needed are those that maintain and improve the grasses and the value and amount of wood crops.

CAPABILITY UNIT VIIe–1

Only Stony steep land is in this unit. It consists of limestone outcrops intermingled with shallow, moderately deep, and deep soils. This land is excessively drained.

Most areas of this unit are used for grazing or wildlife habitat. Vegetation is native prairie grasses and trees. This unit is not well suited to trees. The main wood product is firewood.

Careful management of grazing is needed to protect and increase the native prairie grasses. Pasture renovation is impractical.

CAPABILITY UNIT VIIIs–1

Only Riverwash is in this unit. It consists of deep sandy and loamy soil material in the lowest areas along the Kansas River. Floodwaters shift this soil material so frequently that it has almost no value for farming. Some areas support stands of cottonwood and willow and are useful as wildlife habitat.

Yields per acre

The average yields per acre that can be expected under a high level of management are shown in table 2 for the principal crops grown in the county. In any given year, yields may be higher or lower than those indicated in table 2 because of seasonal variations in rainfall and other climatic factors. Absence of a yield estimate indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated on the soil.

The predicted yields are 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 latest soil and crop management practices used by most farmers in the county are assumed in predict-

TABLE 2.—*Yields per acre of crops and pasture*

[All yields were estimated for a high level of management in 1974. Only arable soils are listed]

Soil name and map symbol	Corn	Grain sorghum	Soybeans	Wheat	Alfalfa hay	Smooth bromegrass
	Bu	*Bu*	*Bu*	*Bu*	*Ton*	*AUM* [1]
Eudora:						
Et	110	112	45	50	5.6	6.5
Ev[2]	100	100	40	43	5.0	6.2
Ew[2]	105	106	42	47	5.5	6.3
Gymer:						
Gm	90	94	38	42	4.3	5.5
Gy	83	90	35	40	4.0	6.1
Judson: Ju	109	111	44	52	5.6	7.0
Kennebec: Kb	103	98	40	42	5.5	6.5
Kimo: Km	85	90	38	40	4.5	5.5
Leanna: Le	80	85	32	36	4.0	7.0
Martin:						
Mb	80	85	35	40	3.9	5.5
Mc	75	80	31	38	3.6	5.5
Mh[2]	50	59	24	26	2.9	4.5
Mo[2]	68	78	30	37	3.4	5.0
Morrill:						
Mr	80	85	32	40	4.0	6.5
Ms	68	75	28	37	3.5	6.0
Oska: Oe	67	79	32	38	3.4	5.4
Pawnee:						
Pb	73	80	34	38	3.8	6.0
Pc	68	75	30	35	3.6	5.5
Ph	44	55	23	26	2.7	4.5
Reading: Re	103	106	44	50	5.6	6.5
Sarpy: Sb[2]	70	80	30	35	5.0	3.9
Sharpsburg:						
Sc	95	95	38	42	4.7	6.8
Sd	90	90	36	41	4.5	6.5
Sibleyville:						
Sh	62	73	25	34	3.6	6.0
So	52	57	21	28	3.0	5.0
Ss[2]	54	60	22	29	3.2	4.5
St[2], Sv[2]	----	----	----	----	----	5.2
Thurman: Tc	60	60	22	32	3.0	5.0
Vinland: Vc[2]	48	55	23	27	2.2	4.0
Wabash:						
Wc	82	88	37	38	4.0	6.0
Wh	65	65	31	32	3.0	5.5
Woodson:						
Wo	65	75	28	34	3.5	5.0
Ws	65	75	24	32	3.5	5.0
Wx	50	55	20	25	2.3	4.5

[1] Animal-unit-month (AUM) is a term used to express the carrying capacity of pasture. It is the amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

[2] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

ing the yields. Hay and pasture yields are predicted for varieties of grasses and legumes suited to the soil. A few farmers may be using more advanced practices and obtaining average yields higher than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends upon the kind of soil and the crop. Such management includes drainage, erosion control, and protection from flooding; proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including timely tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

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

Crops other than those shown in table 2 are grown in the survey area, but because their acreage is small, predicted yields for these crops are not included. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the productivity and management concerns of the soils for these crops.

Management of Soils Used for Grassland

About 44 percent of the acreage of the county is in grassland (*11*). This includes native range and tame grass pasture.

The main concerns in managing these areas of grass are to maintain or improve the quality and quantity of forage, provide soil protection, and reduce water loss. Leaf development, root growth, flower-stalk formation, seed production, forage regrowth, and food storage in roots are processes in the development and growth of grass. Use of these areas of grass must be controlled to allow these natural processes to take place if maximum yields of forage are to be maintained.

Use of soils for pasture [3]

About 47,000 acres throughout Douglas County are in cool-season tame grasses, such as smooth brome (fig. 6), tall fescue, reed canarygrass, and orchard grass (*11*). Some livestock farmers use only tame grasses, and others use both tame and native grasses. Some management practices needed to maintain a good stand of tame grasses are:

1. Proper stocking rate: Adjust the livestock numbers to the expected yield. Make provision for forage and feed for livestock for the entire season. As a guide, allow 40 pounds of forage per mature cow per day for continuous seasonal grazing or 35 pounds per mature cow per day for rotation grazing.
2. Grazing management: Delay grazing in spring until the soil is dry and firm to prevent trampling and compaction damage. Give grasses a rest from grazing during their semi-dormant season. When rotation grazing is practiced, provide an adequate number of pastures with sufficient acreage in ratio to the number of livestock to allow the grasses to make a satisfactory recovery between each grazing.
3. Water and salt: Provide adequate water and salt at locations that will promote distribution of livestock and result in more uniform grazing.
4. Fertilizing: The kind and amount of fertilizers to be applied should be determined by soil test, field observation, and experience of farmers.
5. Mowing and controlling unwanted vegetation: Mow pasture if it is grazed unevenly or if there is too much forage. Mow and spray with herbicides to control invading trees, brush, low-quality grass, and broad-leaved weeds.

[3] EARL BONDY, conservation agronomist, Soil Conservation Service, helped prepare this section.

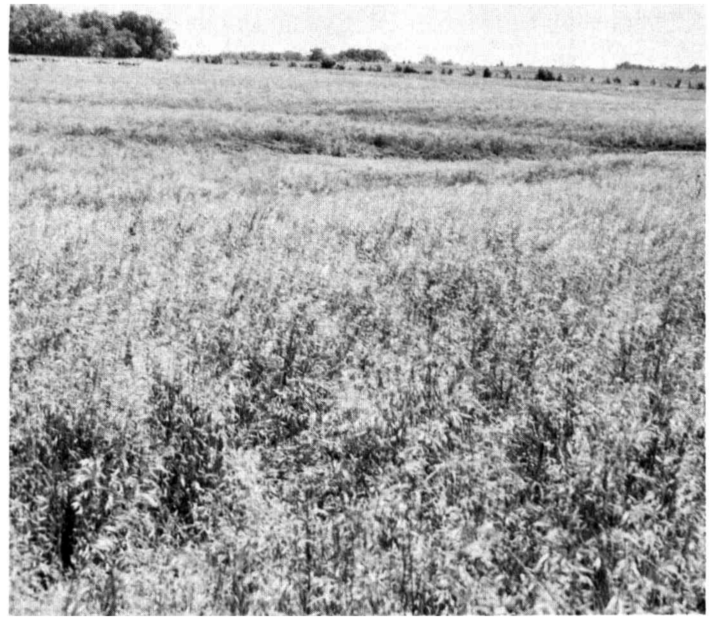

Figure 6.—**Excellent stand of bromegrass on clayey soils.**

Pasture suitability groups

Described in the following paragraphs are groups of soils that have a similar potential for producing tame grasses. The predicted yield of total air-dry forage is given for each group when it is well managed, adequately fertilized, and receives an average amount of rainfall. To determine the soils that make up each suitability group, refer to the "Guide to Mapping Units" at the back of this soil survey.

PASTURE SUITABILITY GROUP A-1

This group consists of nearly level, well drained to moderately well drained soils of the Eudora, Kennebec, Judson, and Reading series. These soils are on bottom lands. They have a loamy surface layer and subsoil.

Available water capacity and natural fertility are high.

The soils of this group are well suited to smooth brome, tall fescue, and orchardgrass.

When the soils of this group are well managed and rainfall is average, the expected annual yield of air-dry forage is about 7,500 to 9,000 pounds per acre.

PASTURE SUITABILITY GROUP A-2

This group consists of gently sloping to strongly sloping, well drained to moderately well drained upland soils of the Gymer, Martin, Morrill, Oska, Pawnee, Sharpsburg, and Sibleyville series. These soils have a loamy surface layer and a loamy and clayey subsoil.

Natural fertility and available water capacity are moderate to high.

The soils of this group are suited to smooth brome, tall fescue, and orchardgrass. Reed canarygrass also grows well on some of these soils (fig. 7).

When the soils of this group are well managed and rainfall is average, the expected annual yield of air-dry forage is about 7,000 to 8,500 pounds per acre.

PASTURE SUITABILITY GROUP B

This group consists of nearly level to sloping, somewhat excessively drained to excessively drained sandy soils of the Sarpy and Thurman series.

Available water capacity is low, and natural fertility is moderate to high.

The soils of this group are suited to smooth brome, tall fescue, and orchard grass.

When the soils of this group are well managed and rainfall is average, the expected annual yield of air-dry forage is about 5,500 to 7,000 pounds per acre.

PASTURE SUITABILITY GROUP C

This group consists of nearly level to sloping, somewhat poorly drained to moderately well drained upland soils of the Woodson, Martin, and Pawnee series. These soils have a loamy and clayey surface layer and a clayey subsoil. The Martin and Pawnee soils and some of the Woodson soils in this group are eroded.

Available water capacity is high, and natural fertility is moderate to high.

The soils of this group are suited to tall fescue, smooth brome, and reed canarygrass.

When the soils of this group are well managed and rainfall is average, the expected annual yield of air-dry forage is about 4,500 to 6,000 pounds per acre.

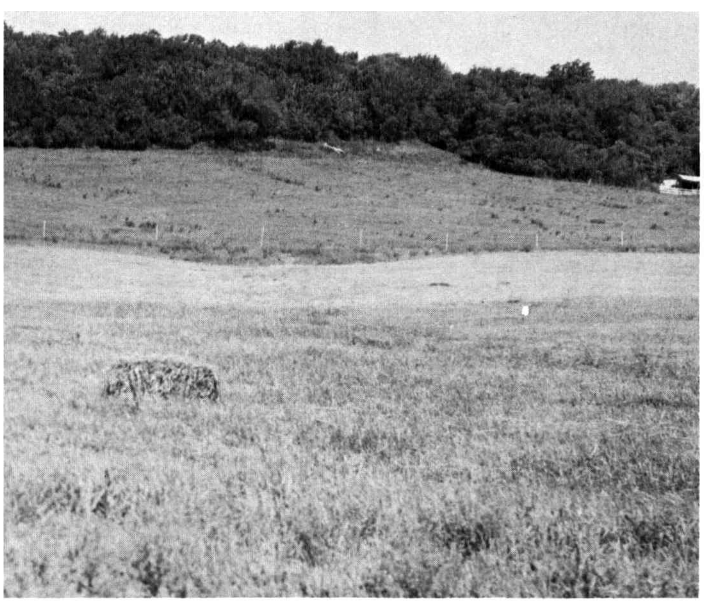

Figure 7.—Pasture renovation in an area of soils in pasture suitability group A-2 (foreground).

PASTURE SUITABILITY GROUP E

This group consists of nearly level, somewhat poorly drained to very poorly drained soils of the Kimo, Leanna, and Wabash series. These soils are on bottom lands. They have a loamy and clayey surface layer and a clayey subsoil.

Natural fertility and available water capacity are high. Additional moisture is received from runoff from nearby uplands and from flooding.

The soils of this group are suited to reed canarygrass, tall fescue, smooth brome, and redtop.

When the soils of this group are well managed and rainfall is average, the expected annual yield of air-dry forage is about 5,500 to 7,500 pounds per acre.

PASTURE SUITABILITY GROUP G

This group consists of shallow to deep, sloping to strongly sloping, well drained to moderately well drained upland soils of the Basehor, Martin, Sibleyville, and Vinland series. These soils have a loamy surface layer and a loamy to clayey subsoil.

Natural fertility and available water capacity are low to moderate.

The soils of this group are suited to such tame grasses as smooth brome, tall fescue, and orchard grass. In some areas of Basehor complex, 7 to 15 percent slopes, and Vinland-Martin complex, 7 to 15 percent slopes, it is not feasible to clear the trees and seed to tame grasses.

When the soils of this group are well managed and rainfall is average, the expected annual yield of air-dry forage is about 4,500 to 6,000 pounds per acre.

PASTURE SUITABILITY GROUP H

This group consists of sloping to steep upland soils of the Sogn-Vinland complex, 5 to 20 percent slopes, and of Gravelly land and Stony steep land. These soils are shallow to limestone or shale, or they are gravelly and have a few large stones.

It is not generally feasible to seed these soils to tame grasses because of the difficulty in establishing and maintaining a good stand. Areas that are feasible to seed to tame grasses are suited to smooth brome, tall fescue, or orchardgrass.

Use of soils for range [4]

In Douglas County about 85,000 acres are in range (*11*). About 4,000 acres are mowed annually for native hay production. About 15 percent of the range is producing near its potential. The rest is supporting less desirable grasses, trees, shrubs, and broadleaf weeds and is producing much below the potential for livestock forage.

Large areas that once supported a plant community consisting primarily of tall warm-season grasses, including big bluestem, indiangrass, little bluestem, and switchgrass, now support an abundance of less desirable cool-season grasses such as Kentucky bluegrass, Scribner panicum, and sedges. These pastures are

[4] By HARLAND E. DIETZ, range conservationist, Soil Conservation Service.

locally referred to as "bluegrass pastures." This change resulted from annual overgrazing in summer when warm-season plants are making their growth. Gradually these plants were weakened and replaced by cool-season plants which make most of their growth early in spring or late in fall. Trees and brush have invaded the grasslands in some parts of the county because of overgrazing and the absence of fire.

Improvement of these areas requires grazing management techniques. Control of brush is necessary where woody species are seriously competing with grasses for sunlight and moisture.

Range sites and condition classes

Management of rangeland requires knowledge of the capabilities of the various soils, the combinations of plants that can be produced, and the effects of grazing on the different kinds of plants. A system for classifying and evaluating rangeland resources is discussed in the following paragraphs.

The kinds of soils and the climate of Douglas County vary widely. For this reason, several different kinds of rangeland are recognized. They are called range sites.

Through the centuries, a mixture of plants best adapted to each range site has developed. This group of plants is called the potential, or climax, plant community for the site. The climax plant community varies slightly from year to year, but the kinds and amounts of plants remain about the same if the site is properly managed.

The original mixture of plants fitted the soil and climate of the range site so perfectly that other kinds of plants could not invade unless an area was disturbed. The relationship between plants, climate, and soils is so consistent that the climax plant community can be accurately predicted even on severely disturbed sites if the soil is identified.

Range conservationists and soil scientists, working together, have grouped into range sites those soils which naturally support the same climax plant communities.

Repeated overuse by grazing animals and excessive burning or plowing result in changes in the kinds, proportions, or amounts of climax plants in the plant community. Depending on the kind and degree of disturbance, some kinds of plants increase while others decrease. If disturbance is severe, plants which do not belong in the climax plant community can invade. Plant response to grazing depends on the kind of animal, the season of use, and the amount of grazing. If good management follows the disturbances, however, the climax plant community is gradually reestablished unless the soils have been seriously eroded.

Range condition is a comparision of the present plant community and the climax plant community for the range site. The more the present kinds and amounts of plants are like the climax plant mixture, the higher the range condition.

The present condition provides an index to the changes which have taken place in the plant community. More importantly, however, range condition is a basis for predicting the kinds and amounts of changes in the present plant community which can be expected from management and treatment measures. Thus, the range condition rating indicates the nature of the present plant community, whereas the climax cover for the range sites represents a goal toward which rangeland management can be directed.

To indicate the degree to which the vegetation on a range site has deteriorated from its potential, four classes of range condition are recognized. A soil is in excellent condition if 76 to 100 percent of the present vegetation is of the same composition as the original or climax vegetation for the range site, in good condition if 51 to 75 percent of the present vegetation is of the same composition as the original vegetation, in fair condition if 26 to 50 percent of the present vegetation is of the same composition as the original vegetation, and in poor condition if less that 25 percent of the present vegetation is of the same composition as the original vegetation.

Knowledge of the climax plant communities and the nature of present plant communities in relation to that potential is important in planning and applying conservation on range. Such information is the basis for selecting management objectives, designing grazing systems, managing wildlife habitats, determining potential for recreation, and rating watershed conditions.

Any management objective for range must provide for a plant cover which will adequately protect or improve the soil and water resources and meet the needs of the operator. This generally involves maintaining or increasing desirable plants and restoring a degraded plant community to near climax conditions. Sometimes, however, a plant cover somewhat below climax will better fit specific grazing needs, provide better wildlife habitat, or furnish other benefits while still protecting the soil and water resources.

On the following pages the range sites of Douglas County are described, and the climax plants are listed for each site. The plant species most likely to invade are also shown. In addition, an estimate of the potential annual production of air-dry herbage is indicated for each site. The soils in each range site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey.

BREAKS RANGE SITE

This site is on steep uplands. It consists of Stony steep land, which is made up of rock outcrops and soils that are dominantly shallow over limestone and shale.

The approximate composition of the climax plant community is:

Major species	*Percent composition, by weight*
Side-oats grama	25
Little bluestem	25
Plains muhly	10
Big bluestem	10
Switchgrass	5
Tall dropseed	5
Fall witchgrass	5
Jersey-tea	5
Prairie-clover	5
Woody plants	5

Continuous overgrazing causes changes in the climax plant community. The more preferred plants, including big bluestem, little bluestem, plains muhly, switchgrass, and Jersey-tea. are selectively grazed by livestock. When repeatedly overgrazed, these plants are weakened and gradually decrease in abundance. Less preferred plants, including side-oats grama, tall dropseed, and western ragweed, increase in amount. Where the site is overgrazed for many years, the vegetation commonly degenerates and is dominantly Kentucky bluegrass, annual bromegrass, silver bluestem, western ragweed, annual broomweed, and woody plants.

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

CLAY LOWLAND RANGE SITE

This site consists of deep, somewhat poorly drained to very poorly drained, nearly level soils on slightly depressional bottom lands. The soils are in the Kimo and Wabash series. They typically have a surface layer of silty clay loam or silty clay and a subsoil of silty clay. The subsoil is slowly to very slowly permeable, and plant root penetration is impeded. The soils have high available water capacity. Runoff from nearby uplands and flooding provide additional moisture.

The approximate composition of the climax plant community is:

Major species	*Percent composition, by weight*
Prairie cordgrass	30
Eastern gamagrass	15
Big bluestem	15
Indiangrass	10
Woody plants	10
Switchgrass	5
Canada wildrye and Virginia wildrye	5
Maximilian sunflower	5
Tall dropseed	3
Carex	2

Prolonged overgrazing causes changes in the climax plant community. The taller grasses, including prairie cordgrass, eastern gamagrass, big bluestem, indiangrass, and switchgrass, decrease in amount. Plants such as side-oats grama, carex, and tall dropseed increase in abundance. Palatable forbs, Maximilian sunflower, wholeleaf rosinweed, and Illinois bundleflower also decrease when the site is subjected to continuous overgrazing. Louisiana sagewort, baldwin ironweed, western ragweed, and tall goldenrod are in the climax plant communities only in minor amounts, but they increase rapidly when overgrazed. Where the site has been overgrazed for many years, the vegetation is dominantly bluegrass, seacoast sumpweed, tall goldenrod, and tall dropseed.

Woody plants on the site increase in abundance with overgrazing. Common woody species include oak, elm, cottonwood, ash, and hackberry.

Where this site is in excellent condition, the average annual yield of air-dry herbage is 9,000 pounds per acre in years of favorable moisture and 5,000 pounds per acre in years of unfavorable moisture.

CLAY UPLAND RANGE SITE

This site consists of nearly level to sloping soils on uplands. The soils are in the Woodson series and eroded phases of the Martin and Pawnee series. They have a thin loamy or clayey surface layer and a clayey subsoil. The soils have high available water capacity and slow or very slow permeability. When rainfall is below normal, these soils are quite droughty.

The approximate composition of the climax plant community is:

Major species	*Percent composition, by weight*
Big bluestem	25
Little bluestem	20
Indiangrass	15
Switchgrass	15
Side-oats grama	5
Tall dropseed	5
Compassplant	5
Leadplant	5
Missouri goldenrod	3
Western ragweed	2

Continuous overgrazing causes changes in the climax plant community. The more preferred plants, including big bluestem, little bluestem, indiangrass, switchgrass, compassplant, and leadplant, are selectively grazed by livestock. When repeatedly overgrazed, these plants are weakened and gradually decrease in aboundance. Less preferred plants, including side-oats grama, tall dropseed, Missouri goldenrod, and western ragweed, increase in amount. Where the site is overgrazed for many years, the vegetation commonly deteriorates and is dominantly Kentucky bluegrass, tall dropseed, annual three-awn, western ragweed, and annual broomweed.

Where this site is in excellent condition, the average annual yield of air-dry herbage is 6,000 pounds per acre in years of favorable moisture and 2,500 pounds per acre in years of unfavorable moisture.

LOAMY LOWLAND RANGE SITE

This site consists of deep alluvial soils on nearly level bottom lands and terraces along rivers and major streams throughout the county. The soils are in the Eudora, Leanna, Kennebec, Judson and Reading series. They have a loamy surface and a clayey or loamy subsoil. They are moderately to very slowly permeable and have high available water capacity. Runoff from adjacent sites, from floods, or from a high water table provide additional moisture.

The approximate composition of the climax plant community is:

Major species	*Percent composition, by weight*
Big bluestem	35
Indiangrass	15
Prairie cordgrass	10
Eastern gamagrass	10
Woody plants	10
Switchgrass	5
Little bluestem	5
Maximilian sunflower	5
Tall dropseed	3
Carex	2

Prolonged overgrazing causes changes in the climax plant community. The taller grasses, including big bluestem, indiangrass, eastern gamagrass, and prairie cordgrass, decrease in amount. Plants such as tall dropseed, purpletop, sedges and woody plants increase in abundance. Palatable forbs, Maximilian sunflower, compassplant, and wholeleaf rosinweed also decrease when the site is subjected to continuous overgrazing. Heath aster, Baldwin ironweed, and tall goldenrod are in the climax plant communities only in minor amounts, but they increase when overgrazed. Where the site has been overgrazed for many years, the vegetation commonly deteriorates and is dominantly tall dropseed, Kentucky bluegrass, purpletop, buckbrush, and ironweed.

Woody plants are common on the site, especially along stream channels and in areas that are frequently flooded. They increase in abundance with overgrazing. Common woody species include cottonwood, elm, oak, sycamore, and buckbrush.

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

LOAMY UPLAND RANGE SITE

This site consists of deep to shallow, gently sloping, sloping, strongly sloping, and moderately steep soils on uplands. The soils are in the Gymer, Martin, Morrill, Oska, Pawnee, Sharpsburg, Vinland, and Sibleyville series. Areas of Gravelly land are also in this site. The soils have a loamy surface layer and a loamy or clayey subsoil. They are moderately to slowly permeable. They have low to high available water capacity and a root zone with ample depth.

The approximate composition of the climax plant community is:

Major species	*Percent composition, by weight*
Big bluestem	30
Little bluestem	20
Indiangrass	15
Switchgrass	10
Side-oats grama	5
Tall dropseed	5
Compassplant	5
Leadplant	5
Louisiana sagewort	3
Sedges	2

Continuous overgrazing causes changes in the climax plant community. The more preferred plants, including big bluestem, indiangrass, little bluestem, and switchgrass, are selectively grazed by livestock. When repeatedly overgrazed these plants are weakened and gradually decrease in abundance. Plants that increase include side-oats, grama, tall dropseed, purpletop, Scribner panicum, western ragweed, and Louisiana sagewort. Where the site is overgrazed for many years the vegetation commonly degenerates and is dominantly Kentucky bluegrass, tall dropseed, sedges, goldenrod, osageorange, and buckbrush.

Where this site is in excellent condition, the average annual yield of air-dry herbage is 7,000 pounds per acre in years of favorable moisture and 4,000 pounds per acre in years of unfavorable moisture.

SANDY LOWLAND RANGE SITE

This site consists of a deep, nearly level Sarpy soil on the flood plain of the Kansas River. This soil has a surface layer of loamy fine sand and a substratum of fine sand. The soil has very rapid permeability. It has low available water capacity, but the water table provides some additional moisture.

The approximate composition of the climax plant community is:

Major species	*Percent composition, by weight*
Big bluestem	20
Woody plants	20
Switchgrass	10
Indiangrass	10
Little bluestem	10
Canada wildrye	5
Scribner panicum	5
Purpletop	5
Illinois bundleflower	5
Tall goldenrod	5
Louisiana sagewort	5

Prolonged overgrazing causes changes in the climax plant community. The taller grasses, including big bluestem, indiangrass, switchgrass, and little bluestem decrease in amount. Plants such as purpletop, sand paspalum, purple lovegrass, blue grama, and sand dropseed increase in abundance. Louisiana sagewort, western ragweed, and goldenrod are in the climax plant communities only in minor amounts, but they increase when overgrazed.

Woody plants, including willow, elm, and cottonwood, eventually dominate the vegetation when the site is mismanaged for many years.

Where this site is in excellent condition, the average annual yield of air-dry herbage is 7,000 pounds per acre in years of favorable moisture and 5,000 pounds per acre in years of unfavorable moisture.

SAVANNAH RANGE SITE

This site consists only of the deep, somewhat excessively drained Thurman complex, 4 to 10 percent slopes, on uplands. These sloping soils typically have a surface layer of loamy fine sand and a subsoil of loamy sand. They have rapid permeability and low available water capacity.

The approximate composition of the climax plant community is:

Major species	*Percent composition, by weight*
Big bluestem	25
Little bluestem	25
Woody plants	20
Indiangrass	10
Switchgrass	5
Purpletop	5
Tickclovers	3
Wildryes	3
Rosette panicum	2
Sedges	2

The climax vegetation is savannah, consisting of an open or scattered stand of blackjack oak, red oak, and hickory and an understory of tall grasses and forbs.

Prolonged overgrazing causes changes in the climax plant community. The taller grasses, including big bluestem, little bluestem, switchgrass, and indiangrass, decrease in amount. Plants such as purpletop, sedges, rosette panicum, and woody species increase in abundance. Continuous overgrazing for many years generally results in a plant community consisting of a dense stand of woody plants with a sparse understory of Kentucky bluegrass, sedges, broomsedge bluestem, and purpletop.

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

SHALLOW LIMY RANGE SITE

This site consists of the somewhat excessively drained, sloping to moderately steep Sogn soil on uplands. This soil is shallow to limestone. The surface layer is loam and ranges from 4 to 20 inches thick over limestone. Plant root penetration is limited in most places.

The approximate composition of the climax plant community is:

Major species	*Percent composition, by weight*
Side-oats grama	25
Little bluestem	25
Plains muhly	10
Big bluestem	10
Switchgrass	5
Tall dropseed	5
Fall witchgrass	5
Jersey-tea	5
Prairie-clover	5
Woody plants	5

Continuous overgrazing causes changes in the climax plant community. The more preferred plants, including big bluestem, little bluestem, plains muhly, switchgrass, and Jersey-tea, are selectively grazed by livestock. When repeatedly overgrazed, these plants are weakened and gradually decrease in abundance. Less preferred plants, including side-oats grama, tall dropseed, and western ragweed, increase in amount. Where the site is overgrazed for many years, the vegetation commonly degenerates and is dominantly Kentucky bluegrass, annual bromegrass, silver bluestem, western ragweed, and annual broomweed.

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

SHALLOW SAVANNAH RANGE SITE

This site consists only of the Basehor complex, 7 to 15 percent slopes, on uplands. These strongly sloping soils are shallow to sandstone. They are loamy throughout. They have low available water capacity and moderately rapid permeability.

The approximate composition of the climax plant community is:

Major species	*Percent composition, by weight*
Little bluestem	30
Woody plants	23
Big bluestem	15
Indiangrass	5
Switchgrass	5
Purpletop	5
Rosette panicum	5
Sedges	5
Louisiana sagewort	5
Tickclovers	2

Prolonged overgrazing causes changes in the climax plant community. The taller grasses, including big bluestem, indiangrass, switchgrass, and little bluestem, decrease in amount. Plants such as purpletop, sedges, rosette panicum, sand paspalum, and woody species increase in abundance. Continuous overgrazing for many years can result in a plant community consisting primarily of a dense canopy of oak, hickory, elm, and osageorange with an understory of Kentucky bluegrass, purpletop, rosette panicum, and sedges.

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

Use of Soils for Woodland

About 33,800 acres of woodland are in Douglas County. They represent about 11 percent of the total acreage. An estimated 95 percent of the woodland is used for grazing.

About 70 percent of the woodland is on uplands, mostly in the northern and eastern parts of the county. The rest is on bottom lands scattered along streams.

The woodland on uplands is an oak-hickory association with an understory of grasses (*17*). It is commonly referred to as a savannah-type plant association. The woody vegetation consists of hickory, oak, elm, ash, osageorange, and other trees and sumac, buckbrush, and other small woody plants. Little and big bluestem make up 75 percent of the annual grass yields, and the rest is indiangrass, sedges, switchgrass, Virginia wildrye, rosette panicums, and a variety of lesser species. Total herbage yields, by type of vegetation, vary according to the percent of tree canopy cover. When the canopy cover is 0 to 25 percent, trees produce 10 to 25 percent of the total herbage yield. Trees produce 90 to 100 percent of the total herbage yield when the canopy cover is 76 to 100 percent.

The woodland on bottom lands is a lowland plains hardwood association (*17*). Ash, cottonwood, elm, willow, sycamore, bur oak, soft maple, black walnut, hackberry, hickory, boxelder, and other smaller woody plants make up the woody vegetation. Cottonwood and willow are the major trees in the Kansas River Valley and elm, ash, and cottonwood are the major trees in the Wakarusa River Valley. Elm, ash, black walnut, and hackberry are the major trees along the tributaries of these rivers.

Woodland management and productivity [5]

Table 3 contains information useful to woodland owners or forest managers in planning the use of soils for wood crops. Mapping unit symbols for those soils suitable for wood crops are listed alphabetically by soil name, and the symbol for the woodland group of each soil is given. All soils in the same woodland group require the same general kinds of woodland management and have about the same potential productivity.

The first part of the symbol, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that there are no significant limitations or restrictions.

In table 3 the soils are also rated for a number of factors to be considered in management. Ratings of

[5] RICHARD W. FENWICK, soil scientist, Soil Conservation Service, helped prepare this section.

TABLE 3.—*Woodland management and productivity*

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Soil name and map symbol	Woodland group	Management concerns					Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Important trees	Site index	
Basehor: [1] Be	5d	Slight	Moderate	Moderate	Moderate	Slight	White oak Northern red oak Hackberry Green ash	45 50 55 55	Hackberry, green ash.
Eudora: Et	2o	Slight	Slight	Slight	Slight	Moderate	Eastern cottonwood American sycamore Hackberry Black walnut Green ash	105 105 ------- ------- -------	Eastern cottonwood, American sycamore.
[1] Ev: Eudora part	2o	Slight	Slight	Slight	Slight	Moderate	Eastern cottonwood American sycamore Hackberry Black walnut Green ash	105 105 ------- ------- -------	Eastern cottonwood, American sycamore.
Kimo part	3o	Slight	Moderate	Moderate	Slight	Slight	Eastern cottonwood White oak Northern red oak Hackberry Green ash	90 62 ------- ------- -------	Eastern cottonwood, green ash, American sycamore, pecan.
[1] Ew: Eudora part	2o	Slight	Slight	Slight	Slight	Moderate	Eastern cottonwood American sycamore Hackberry Black walnut Green ash	105 105 ------- ------- -------	Eastern cottonwood, American sycamore.
Kimo part	3o	Slight	Moderate	Moderate	Slight	Slight	Eastern cottonwood White oak Northern red oak Hackberry Green ash	90 62 ------- ------- -------	Eastern cottonwood, green ash, American sycamore, pecan.
Judson: Ju	2o	Slight	Slight	Slight	Slight	Moderate	Black walnut White oak Northern red oak	73 ------- -------	Black walnut, eastern cottonwood, green ash.
Kennebec: Kb, [1] Kc	2o	Slight	Slight	Slight	Slight	Moderate	Black walnut Bur oak Hackberry Green ash Eastern cottonwood	79 63 ------- ------- -------	Black walnut, bur oak, hackberry, green ash, eastern cottonwood, American sycamore.
Kimo: Km	3o	Slight	Moderate	Moderate	Slight	Slight	Eastern cottonwood White oak Northern red oak Hackberry Green ash	90 62 ------- ------- -------	Eastern cottonwood, green ash, American sycamore, pecan.
Leanna: Le	3w	Slight	Severe	Moderate	Moderate	Severe	Pin oak Eastern cottonwood Pecan Hackberry Green ash	80 85 ------- ------- 75	Pecan, green ash, American sycamore, eastern cottonwood.

Footnote is at end of table.

TABLE 3.—*Woodland management and productivity*—Continued

Soil name and map symbol	Woodland group	Management concerns					Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Important trees	Site index	
Reading: Re	2o	Slight	Slight	Slight	Slight	Moderate	Black walnut Hackberry Bur oak Shagbark hickory Southern red oak	73 69 60 62 -------	Black walnut, green ash, hackberry, American sycamore, eastern cottonwood.
Sarpy: [1] Sb: Sarpy part	5s	Slight	Slight	Severe	Slight	Slight	Eastern cottonwood	60	Eastern cottonwood, black willow.
Eudora part	2o	Slight	Slight	Slight	Slight	Moderate	Eastern cottonwood American sycamore Hackberry Black walnut Green ash	105 105 ------- ------- -------	Eastern cottonwood, American sycamore.
Sharpsburg: Sc, Sd	4o	Slight	Slight	Slight	Slight	Slight	Black oak Black walnut White oak Hackberry Green ash	60 60 ------- ------- -------	Black walnut, hackberry, green ash.
Thurman: [1] Tc	5s	Slight	Slight	Severe	Slight	Slight	White oak Red oak Shagbark hickory Hackberry Black walnut	50 55 ------- ------- -------	White oak, green ash, hackberry.
Wabash: Wc, Wh	4w	Slight	Moderate	Severe	Slight	Severe	Pin oak	75	Pin oak, pecan, eastern cottonwood.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

slight, moderate, and *severe* are used to indicate the degree of major soil limitations.

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

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

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

Considered in the ratings of the windthrow hazard are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate,* that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe,* that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

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

The potential productivity of merchantable trees on a soil is expressed as a site index. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands and is based on recognized site index curves for upland oaks (*15*) and cottonwoods (*6*).

The best trees to plant are those that are suitable for commercial wood production and suited to the soils (*8*).

Use of Soils for Wildlife Habitat[6]

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

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

In table 4 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—

1. Planning the use of parks, wildlife refuges, nature study areas, and other developments for wildlife.
2. Selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat.
3. Determining the intensity of management needed for each element of the habitat.
4. Determining areas that are suitable for acquisition to manage for wildlife.

The potential of the soil for wildlife habitat is rated *good, fair, poor,* or *very poor.* A rating of *good* means that the element or kind of wildlife 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 or kind of wildlife habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are 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 requires intensive effort. A rating of *very poor* means that restrictions for the element or kind of wildlife habitat are very severe and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

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

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, sorghum, wheat, oats, barley, and soybeans. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted as food and cover for wildlife. Examples are fescue, bluegrass, switchgrass, bromegrass, timothy, orchardgrass, clover, alfalfa, trefoil, and crownvetch. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds that provide food and cover for wildlife. Examples are bluestem, indiangrass, switchgrass, goldenrod, beggarweed, pokeweed, partridgepea, wheatgrass, and grama. Major soil properties that affect the growth of these plants are thickness of the soil, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruits, buds, catkins, twigs, bark, or foliage that wildlife eat. The plants generally regenerate naturally, but they can be planted. Examples of native plants are oak, hawthorn, dogwood, persimmon, hickory, black walnut, blackberry, grape, blackhaw, sycamore, cottonwood, cherry, sweetgum, apple, viburnum, gooseberry, and briers. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated good are Russian-olive, autumn-olive, and crabapple. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness.

Coniferous plants are cone-bearing trees, shrubs, or ground cover that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. They are commonly established through natural processes, but they can be planted or transplanted. Examples are pine, spruce, redcedar, and juniper. Major soil properties that affect the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Shrubs are bushy woody plants that produce fruits, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Example are buckbrush, sumac, and sassafras. Major soil properties that affect the growth of shrubs are

[6] LOYD G. WILSON, biologist, Soil Conservation Service, helped write this section.

TABLE 4.—*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 herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Basehor:												
[1] Be	Poor	Poor	Fair	Poor	Poor	--------	Very poor.	Very poor.	Poor	Poor	Very poor.	--------
Eudora:												
Et	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	--------
[1] Ev:												
Eudora part	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	--------
Kimo part	Good	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good	--------
[1] Ew:												
Eudora part	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	--------
Kimo part	Good	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good	--------
Gravelly land:												
Ge	Poor	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Gymer:												
Gm	Good	Good	Fair	Good	Good	Good	Poor	Very poor.	Good	--------	Very poor.	Fair.
Gy	Fair	Good	Fair	Good	Good	Good	Poor	Very poor.	Fair	--------	Very poor.	Fair.
Judson:												
Ju	Good	Good	Good	Good	Good	--------	Poor	Poor	Good	Good	Poor	--------
Kennebec:												
Kb	Good	Good	Good	Good	Good	--------	Poor	Poor	Good	Good	Poor	--------
[1] Kc	Poor	Poor	Good	Good	Good	--------	Poor	Poor	Poor	Good	Poor	--------
Kimo:												
Km	Good	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good	--------
Leanna:												
Le	Fair	Good	Fair	Good	Good	Good	Fair	Good	Fair	Good	Fair	--------
Martin:												
Mb	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	--------	Poor	Good.
Mc, [1] Mh	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	--------	Very poor.	Good.
[1] Mo:												
Martin part	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	--------	Poor	Good.
Oska part	Fair	Good	Good	Fair	Fair	Good	Poor	Poor	Good	--------	Poor	Good.
Morrill:												
Mr, Ms	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	--------	Very poor.	Good.
Oska:												
Oe	Fair	Good	Good	Fair	Fair	Good	Poor	Poor	Good	--------	Poor	Good.
Pawnee:												
Pb	Good	Good	Good	--------	Fair	Fair	Very poor.	Good	Good	--------	Poor	Fair.
Pc, Ph	Fair	Good	Good	--------	Fair	Fair	Very poor.	Good	Good	--------	Poor	Fair.
Reading:												
Re	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	--------
Riverwash:												
Ro	Very poor	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Fair	Good	--------

See footnote at end of table.

TABLE 4.—*Wildlife habitat potentials*—Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for—: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Sarpy:												
[1] Sb:												
Sarpy part	Poor	Poor	Fair	Poor	Poor	--------	Very poor.	Very poor.	Poor	Poor	Very poor.	--------
Eudora part	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	--------
Sharpsburg:												
Sc	Good	Good	Good	Good	Good	--------	Poor	Poor	Good	Good	Poor	--------
Sd	Fair	Good	Good	Good	Good	--------	Poor	Poor	Good	Good	Poor	--------
Sibleyville:												
Sh, So, [1] Ss, [1] St	Fair	Good	Good	Good	Good	--------	Poor	Very poor.	Good	Good	Very poor.	Good.
[1] Sv	Fair	Good	Good	Good	Good	--------	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Sogn:												
[1] Sw:												
Sogn part	Very poor.	Very poor.	Poor	--------	--------	Poor	Very poor.	Very poor.	Very poor.	--------	Very poor.	Poor.
Vinland part	Poor	Poor	Fair	Fair	Fair	--------	Very poor.	Very poor.	Poor	Fair	Very poor.	--------
Stony steep land:												
Sx	Very poor.	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	--------
Thurman:												
[1] Tc	Poor	Fair	Good	--------	Fair	Fair	Very poor.	Very poor.	Fair	--------	Very poor.	Fair.
Vinland:												
[1] Vc, [1] Vh	Poor	Poor	Fair	Fair	Fair	--------	Very poor.	Very poor.	Poor	Fair	Very poor.	--------
[1] Vm:												
Vinland part	Poor	Poor	Fair	Fair	Fair	--------	Very poor.	Very poor.	Poor	Fair	Very poor.	--------
Martin part	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	--------	Very poor.	Good.
Wabash:												
Wc	Poor	Poor	Poor	Poor	Poor	--------	Good	Good	Poor	Poor	Good	--------
Wh	Poor	Poor	Poor	Poor	Poor	--------	Poor	Good	Poor	Poor	Fair	--------
Woodson:												
Wo, Ws, Wx	Fair	Good	Poor	--------	--------	Good	Poor	Good	Fair	--------	Fair	Fair.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

depth of the root zone, available water capacity, salinity and moisture.

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

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

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

Openland habitat consists of croplands, pastures, 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, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, and woodchuck.

Woodland habitat consists of hardwoods or conifers or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Examples of wildlife attracted to this habitat are wild turkey, hawks, owls, thrushes, vireos, woodpeckers, tree squirrels, gray fox, raccoon, deer, opossum, and badger.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Examples of wildlife attracted to this habitat are ducks, geese, herons, shore birds, rails, kingfishers, muskrat, mink, and beaver.

Rangeland habitat consists of wild herbaceous plants and shrubs on range. Examples of wildlife attracted to this habitat are deer, coyote, prairie chicken, meadowlark, and lark bunting.

The most important game birds in Douglas County are the bobwhite quail and mourning dove. Both species are abundant, and both are largely dependent upon woody and herbaceous habitat and small grain agriculture. Pheasants are very scarce in this county and are seldom seen. Prairie chickens are hunted in the southwestern part of the county, but their numbers are relatively low.

Whitetailed deer are the only big game in this area. They are in moderate populations that are increasing. Habitat for this species is available along the Kansas and Wakarusa Rivers and nearly all of the larger streams in this county. During the hunting season late in fall, hunters are allowed to harvest part of the surplus deer population.

Cottontail rabbits are in all parts of the county. The most productive areas are near streams where food and suitable cover are abundant. Thick, brushy areas support the densest rabbit populations.

Fox and gray squirrel populations are moderate in Douglas County. The highest population densities are in heavily timbered areas on alluvial soils along the major drainageways.

The main species of game fish in ponds, rivers, and streams are bass, bluegill, and channel catfish. These species are available from State fish hatcheries for stocking ponds. Bullhead, carp, crappie, and flathead catfish are also plentiful.

Habitat development requires the proper establishment of various types of plant cover on soils that support them. The Soil Conservation Service can provide technical assistance in planning wildlife developments and determining suitable vegetation for plantings. Additional information and assistance can be obtained from the Bureau of Sport Fisheries and Wildlife; the Kansas Forestry, Fish, and Game Commission; and the County Extension Service.

Use of Soils for Recreational Development

Douglas County is easily accessible by automobile for large numbers of people seeking recreation. The Kansas Turnpike connects Lawrence and Kansas City to the east and Wichita, Emporia, and Topeka, the capital of Kansas, to the west. A north-south highway, U.S. 59, connects Ottawa to Lawrence. In addition, U.S. highways 24, 40, and 10 merge in Lawrence. Several lakes, including Douglas County State Lake and Lone Star Lake, are in the vicinity of Lawrence. In addition, Perry and Pomona Reservoirs, in adjacent counties, are within 30 miles of the county.

Knowledge of soils is necessary in planning, developing, and maintaining areas for recreation. In table 5 the soils of Douglas County are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails.

In table 5 the soils are rated as having *slight, moderate*, or *severe* limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they can be easily overcome. A *moderate* limitation can be overcome or modified by planning, design, or special maintenance. A *severe* limitation means that costly soil reclamation, special design, intensive maintenance, or a combination of these, is required to overcome soil limitations.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic is confined to access roads. The best soils are firm when wet but not dusty when dry, are free from flooding during the season of use, and do not have slopes or stoniness that greatly increases the cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use must withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

TABLE 5.—*Recreational development*

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Basehor: [1] Be	Moderate: slope	Moderate: slope	Severe: depth to rock	Slight.
Eudora:				
Et	Severe: floods	Moderate: floods	Moderate: floods	Slight.
[1] Ev:				
Eudora part	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Kimo part	Severe: wetness	Moderate: wetness	Severe: wetness	Moderate: wetness.
[1] Ew:				
Eudora part	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Kimo part	Severe: wetness	Moderate: wetness	Severe: wetness	Moderate: wetness.
Gravelly land: Ge	Severe: small stones	Severe: small stones	Severe: small stones	Moderate: small stones.
Gymer: Gm, Gy	Moderate: percs slowly.	Slight	Moderate: percs slowly, slope.	Slight.
Judson: Ju	Slight	Slight	Slight	Slight.
Kennebec:				
Kb	Severe: floods	Moderate: floods	Moderate: floods	Slight.
[1] Kc	Severe: floods	Moderate: floods	Moderate: floods	Moderate: too clayey.
Kimo: Km	Severe: wetness	Moderate: wetness	Severe: wetness	Moderate: wetness.
Leanna: Le	Severe: wetness, percs slowly.	Severe: wetness	Severe: wetness, percs slowly.	Severe: wetness.
Martin:				
Mb, Mc, [1] Mh	Moderate: too clayey, percs slowly.	Moderate: too clayey	Moderate: too clayey, percs slowly.	Moderate: too clayey.
[1] Mo:				
Martin part	Moderate: too clayey, percs slowly.	Moderate: too clayey	Moderate: too clayey, percs slowly.	Moderate: too clayey.
Oska part	Moderate: percs slowly, too clayey.	Moderate: too clayey	Moderate: percs slowly, too clayey, depth to rock.	Moderate: too clayey.
Morrill:				
Mr	Moderate: percs slowly.	Moderate: too clayey	Moderate: percs slowly.	Moderate: too clayey.
Ms	Moderate: percs slowly.	Moderate: too clayey	Severe: slope	Moderate: too clayey.
Oska: Oe	Moderate: percs slowly, too clayey.	Moderate: too clayey	Moderate: percs slowly, too clayey, depth to rock.	Moderate: too clayey.
Pawnee: Pb, Pc, Ph	Moderate: percs slowly.	Moderate: too clayey	Moderate: percs slowly.	Moderate: too clayey.
Reading: Re	Slight	Slight	Slight	Slight.
Riverwash: Ro	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Sarpy:				
[1] Sb:				
Sarpy part	Severe: floods, too sandy, soil blowing.	Severe: too sandy, soil blowing.	Severe: floods, too sandy, soil blowing.	Moderate: floods, too sandy, soil blowing.
Eudora part	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Sharpsburg:				
Sc	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Sd	Moderate: percs slowly.	Slight	Severe: slope	Slight.

See footnote at end of table.

TABLE 5.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Sibleyville:				
Sh, So, [1] Ss, [1] St	Slight	Slight	Moderate: depth to rock, slope.	Slight.
[1] Sv	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Sogn:				
[1] Sw:				
Sogn part	Moderate: too clayey	Moderate: too clayey	Severe: depth to rock	Moderate: too clayey.
Vinland part	Moderate: too clayey	Moderate: too clayey	Severe: depth to rock	Moderate: too clayey.
Stony steep land: Sx	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.
Thurman: [1] Tc	Moderate: too sandy, soil blowing.	Moderate: too sandy	Severe: slope	Moderate: too sandy.
Vinland:				
[1] Vc, [1] Vh	Moderate: too clayey	Moderate: too clayey	Severe: depth to rock	Moderate: too clayey.
[1] Vm				
Vinland part	Moderate: too clayey	Moderate: too clayey	Severe: depth to rock	Moderate: too clayey.
Martin part	Moderate: too clayey, percs slowly.	Moderate: too clayey	Severe: slope	Moderate: too clayey.
Wabash: Wc, Wh	Severe: floods, wetness, percs slowly.	Severe: wetness, floods, too clayey.	Severe: wetness, floods, percs slowly.	Severe: wetness, too clayey.
Woodson: Wo, Ws, Wx	Severe: percs slowly, wetness.	Moderate: wetness	Severe: percs slowly, wetness.	Moderate: wetness.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

Engineering Uses of the Soils [7]

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

The ratings in tables in this section 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 the soil survey and used in determining the ratings in this section are grain-size distribution, liquid limit, plasticity index, soil reaction, depth to and hardness of bedrock within 5 or 6 feet of the surface, soil wetness characteristics, depth to a seasonal 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.

Based on the 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 select potential residential, commercial, industrial, and recreational areas; make preliminary estimates pertinent to construction in a particular area; evaluate alternate routes for roads, streets, highways, pipelines, and underground cables; evaluate alternate sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; plan detailed onsite investigations of soils and geology; find sources of gravel, sand, clay, and topsoil; plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; 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 predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-

[7] CLIFTON E. DEAL, civil engineer, Soil Conservation Service, helped prepare this section.

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 (*5*). First, the data are generally not presented for soil material below a depth of 5 to 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 and testing.

The information is presented mainly in tables. Table 6 shows, for each kind of soil, ratings of the degree and kind of limitations for building site development; table 7, for sanitary facilities; and table 9 for water management. Table 8 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 different meanings in soil science and in engineering. 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 6. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features 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 are not feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by the soil wetness of a 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 and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

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

Dwellings and small commercial buildings referred to in table 6 are built on undisturbed soil and have a foundation load not 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 neither cracking or subsidence from settling nor shear failure of the foundation occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and inplace density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation.

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

The load-supporting capacity and the stability of the soil as well as the quantity and workability of available fill material are important in design and construction of roads and streets. The AASHTO and Unified classifications of the soil (see the section "Engineering Properties and Classification,") and the soil texture, density, shrink-swell potential, and potential frost action indicate 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, all of which affect stability and ease of excavation, were also considered.

Sanitary facilities

Favorable soil properties and site features are needed for the 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 deal with the ease of excavation or installation of these facilities are of interest to contractors and local officials. Table 7 shows the degree and kind of limitations of each soil for these uses and for use as daily cover for landfill.

If the degree of soil limitation is indicated by the rating *slight,* soils are 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 are required.

Septic tank absorbtion fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil (*12, 21*). Only the soil horizons at a depth of 18 to 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.

TABLE 6.—*Building site development*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." 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
Basehor: [1] Be	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Eudora:					
Et	Moderate: floods	Severe: floods	Severe: floods	Severe: floods	Severe: frost action.
[1] Ev:					
Eudora part	Moderate: floods	Severe: floods	Severe: floods	Severe: floods	Severe: frost action.
Kimo part	Severe: wetness	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: shrink-swell, low strength.
[1] Ew:					
Eudora part	Moderate: floods	Severe: floods	Severe: floods	Severe: floods	Severe: frost action.
Kimo part	Severe: wetness	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: shrink-swell, low strength.
Gravelly land: Ge	Severe: small stones.	Moderate: slope	Moderate: slope	Moderate: slope	Slight.
Gymer: Gm, Gy	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Judson: Ju	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action.
Kennebec: Kb, [1] Kc	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, frost action, low strength.
Kimo: Km	Severe: wetness	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: shrink-swell, low strength.
Leanna: Le	Severe: wetness, floods, too clayey.	Severe: wetness, shrink-swell, floods.	Severe: wetness, shrink-swell, floods.	Severe: wetness, shrink-swell, floods.	Severe: wetness, shrink-swell, low strength.
Martin:					
Mb, Mc, [1] Mh	Severe: too clayey	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
[1] Mo:					
Martin part	Severe: too clayey	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Oska part	Severe: depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell.
Morrill:					
Mr	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell.
Ms	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: slope	Moderate: shrink-swell.
Oska: Oe	Severe: depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell.

Footnote is at end of table.

TABLE 6.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Pawnee: Pb, Pc, Ph	Severe: too clayey	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
Reading: Re	Moderate: floods	Severe: floods	Severe: floods	Severe: floods	Severe: low strength, frost action.
Riverwash: Ro	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Sarpy:					
[1] Sb:					
Sarpy part	Severe: floods, cutbanks cave.	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Eudora part	Moderate: floods	Severe: floods	Severe: floods	Severe: floods	Severe: frost action.
Sharpsburg: Sc, Sd	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Sibleyville:					
Sh, So, [1] Ss, [1] St	Moderate: depth to rock.	Moderate: depth to rock, low strength.	Moderate: depth to rock, low strength.	Moderate: depth to rock, low strength.	Moderate: low strength.
[1] Sv	Moderate: depth to rock.	Moderate: depth to rock, low strength.	Moderate: depth to rock, low strength.	Severe: slope	Moderate: low strength.
Sogn:					
[1] Sw:					
Sogn part	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Vinland part	Moderate: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock.	Severe: slope	Moderate: depth to rock.
Stony steep land: Sx	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.
Thurman: [1] Tc	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Vinland:					
[1] Vc, [1] Vh	Moderate: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.
[1] Vm:					
Vinland part	Moderate: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock.	Severe: slope	Moderate: depth to rock.
Martin part	Severe: too clayey	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Wabash: Wc, Wh	Severe: wetness, floods, too clayey.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.
Woodson: Wo, Ws, Wx	Severe: too clayey, wetness.	Severe: shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

Properties and features that effect the absorption of the effluent are permeability, depth to a seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the tile lines. In these soils the absorption field does

TABLE 7.—*Sanitary facilities*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "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
Basehor: [1] Be	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: seepage	Poor: thin layer.
Eudora:					
Et	Moderate: floods	Moderate: seepage.	Moderate: floods	Moderate: floods	Good.
[1] Ev:					
Eudora part	Moderate: floods	Moderate: seepage.	Moderate: floods	Moderate: floods	Good.
Kimo part	Severe: percs slowly.	Slight	Severe: wetness	Severe: wetness	Fair: too clayey.
[1] Ew:					
Eudora part	Moderate: floods	Moderate: seepage.	Moderate: floods	Moderate: floods	Good.
Kimo part	Severe: percs slowly.	Slight	Severe: wetness	Severe: wetness	Fair: too clayey.
Gravelly land: Ge	Severe: small stones.	Severe: seepage, small stones.	Severe: seepage	Severe: seepage	Poor: small stones.
Gymer: Gm, Gy	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Judson: Ju	Slight	Moderate: seepage.	Slight	Slight	Good.
Kennebec:					
Kb	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Good.
[1] Kc	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Fair: too clayey.
Kimo: Km	Severe: percs slowly.	Slight	Severe: wetness	Severe: wetness	Fair: too clayey.
Leanna: Le	Severe: percs slowly, wetness, floods.	Severe: floods	Severe: floods, wetness, too clayey.	Severe: wetness, floods.	Poor: wetness, thin layer.
Martin:					
Mb, Mc, [1] Mh	Severe: percs slowly.	Moderate: slope	Severe: too clayey	Slight	Poor: thin layer.
[1] Mo:					
Martin part	Severe: percs slowly.	Moderate: slope	Severe: too clayey	Slight	Poor: thin layer.
Oska part	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: too clayey.
Morrill:					
Mr	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Ms	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope	Fair: too clayey.
Oska: Oe	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: too clayey.
Pawnee:					
Pb	Severe: percs slowly.	Slight	Severe: too clayey	Slight	Severe: too clayey.
Pc, Ph	Severe: percs slowly.	Moderate: slope	Severe: too clayey	Slight	Severe: too clayey.

Footnote is at end of table.

TABLE 7.—*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
Reading: Re	Moderate: percs slowly.	Moderate: seepage.	Moderate: floods, too clayey.	Moderate: floods	Fair: too clayey.
Riverwash: Ro	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Poor: seepage.
Sarpy:					
[1] Sb:					
Sarpy part	Severe: floods	Severe: floods, seepage.	Severe: floods, seepage.	Severe: floods, seepage.	Poor: too sandy, seepage.
Eudora part	Moderate: floods	Moderate: seepage.	Moderate: floods	Moderate: floods	Good.
Sharpsburg:					
Sc	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Sd	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Sibleyville:					
Sh, So, [1] Ss, [1] St	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Slight	Fair: thin layer.
[1] Sv	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: slope	Fair: thin layer.
Sogn:					
[1] Sw:					
Sogn part	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: slope	Poor: thin layer, area reclaim.
Vinland part	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: slope	Poor: thin layer.
Stony steep land: Sx	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: slope	Poor: slope.
Thurman: [1] Tc	Slight	Severe: seepage	Severe: too sandy, seepage.	Severe: seepage	Fair: too sandy.
Vinland:					
[1] Vc, [1] Vh	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Slight	Poor: thin layer.
[1] Vm:					
Vinland part	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: slope	Poor: thin layer.
Martin part	Severe: percs slowly.	Severe: slope	Severe: too clayey	Moderate: slope	Poor: thin layer.
Wabash: Wc, Wh	Severe: percs slowly, floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Severe: wetness, too clayey.
Woodson:					
Wo	Severe: percs slowly.	Slight	Severe: too clayey	Moderate: wetness.	Poor: thin layer.
Ws, Wx	Severe: percs slowly.	Moderate: slope	Severe: too clayey	Moderate: wetness.	Poor: thin layer.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

not adequately filter the effluent, and as a result ground water supplies 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.

Sewage lagoon areas are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor area surrounded by cut slopes or embankments of compacted, nearly impervious soil material. Aerobic lagoons generally are designed so that depth of the sewage is 2 to 6 feet. Impervious soil at least 4 feet thick is required for the lagoon floor and sides to minimize seepage and contamination of local ground water.

TABLE 8.—*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	Road fill	Sand	Gravel	Topsoil
Basehor: [1] Be	Poor: thin layer	Unsuited	Unsuited	Fair: thin layer.
Eudora:				
Et	Poor: frost action, low strength.	Unsuited: excess fines	Unsuited: excess fines	Good.
[1] Ev:				
Eudora part	Poor: frost action, low strength.	Unsuited: excess fines	Unsuited: excess fines	Good.
Kimo part	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: too clayey.
[1] Ew:				
Eudora part	Poor: frost action, low strength.	Unsuited: excess fines	Unsuited: excess fines	Good.
Kimo part	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: thin layer.
Gravelly land: Ge	Good	Unsuited	Fair	Poor: small stones.
Gymer: Gm, Gy	Poor: low strength	Unsuited	Unsuited	Fair: too clayey.
Judson: Ju	Poor: frost action	Unsuited	Unsuited	Good.
Kennebec:				
Kb	Poor: excess humus, frost action, low strength.	Unsuited	Unsuited	Good.
[1] Kc	Poor: excess humus, frost action, low strength.	Unsuited	Unsuited	Fair: too clayey.
Kimo: Km	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: too clayey
Leanna: Le	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor: wetness.
Martin:				
Mb, Mc, [1] Mh	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: too clayey.
[1] Mo:				
Martin part	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: too clayey.
Oska part	Poor: shrink-swell, low strength, thin layer.	Unsuited	Unsuited	Fair: thin layer, too clayey.
Morrill: Mr, Ms	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines	Fair: thin layer.
Oska: Oe	Poor: shrink-swell, low strength, thin layer.	Unsuited	Unsuited	Fair: thin layer, too clayey.
Pawnee: Pb, Pc, Ph	Poor: shrink-swell	Unsuited	Unsuited	Poor: too clayey.
Reading: Re	Poor: low strength, frost action.	Unsuited	Unsuited	Fair: too clayey.
Riverwash: Ro	Poor: thin layer	Poor: excess fines	Unsuited	Poor: thin layer.
Sarpy:				
[1] Sb:				
Sarpy part	Good	Poor: excess fines	Unsuited	Poor: too sandy.
Eudora part	Poor: frost action, low strength.	Unsuited: excess fines	Unsuited: excess fines	Good.
Sharpsburg: Sc, Sd	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Good.

Footnote is at end of table.

TABLE 8.—*Construction materials*—Continued

Soil name and map symbol	Road fill	Sand	Gravel	Topsoil
Sibleyville: Sh, So, [1] Ss, [1] St, [1] Sv.	Fair: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer.
Sogn:				
[1] Sw:				
Sogn part	Poor: thin layer	Unsuited: excess fines	Unsuited: excess fines	Poor: area reclaim.
Vinland part	Poor: thin layer	Unsuited	Unsuited	Poor: area reclaim, thin layer.
Stony steep land: Sx	Poor: thin layer, slope	Unsuited	Unsuited	Poor: thin layer.
Thurman: [1] Tc	Good	Fair: excess fines	Unsuited	Poor: too sandy.
Vinland:				
[1] Vc, [1] Vh	Poor: thin layer	Unsuited	Unsuited	Poor: area reclaim, thin layer.
[1] Vm:				
Vinland part	Poor: thin layer	Unsuited	Unsuited	Poor: area reclaim, thin layer.
Martin part	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: too clayey.
Wabash: Wc, Wh	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines	Unsuited: excess fines	Poor: wetness, too clayey.
Woodson: Wo, Ws, Wx	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

Soils that have very high organic-matter content and those that have stones and boulders are undesirable. Unless the soil has very slow permeability, contamination of local ground water is a hazard in areas 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 its capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the location of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste, either in excavated trenches or on the surface of the soil. The waste is spread, compacted in layers, and covered with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for this purpose. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to bedrock and a seasonal water table, are free of large stones and boulders, and are not subject to flooding. In areas where the seasonal water table is high, water seeps into the trenches and causes problems in excavating and filling the trenches. Also, seepage into the refuse increases the risk of pollution of ground water. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability that could allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 7 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings 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, can 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 during both wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils can be sticky and difficult to spread; sandy soils are subject to soil blowing.

In addition to these features, the soils selected for final cover of landfills should be suitable for growing plants. In comparison with other 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, such as slope, erodibility, and potential for plant growth.

TABLE 9.—*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	Aquifer-fed excavated ponds	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Basehor: [1] Be	Depth to rock, seepage.	Thin layer, erodes easily.	No water	Not needed	Rooting depth, seepage.	Depth to rock, erodes easily.	Rooting depth, erodes easily.
Eudora:							
Et	Seepage	Low strength, piping.	Deep to water	Not needed	Favorable	Not needed	Not needed.
[1] Ev:							
Eudora part	Seepage	Low strength, piping.	Deep to water	Not needed	Favorable	Not needed	Not needed.
Kimo part	Favorable	Shrink-swell, low strength.	Favorable	Wetness, poor outlets.	Wetness, floods, percs slowly.	Not needed	Not needed.
[1] Ew:							
Eudora part	Seepage	Low strength, piping.	Deep to water	Not needed	Favorable	Not needed	Not needed.
Kimo part	Favorable	Shrink-swell, low strength.	Favorable	Wetness, poor outlets.	Wetness, floods, percs slowly.	Not needed	Not needed.
Gravelly land: Ge	Seepage	Seepage	No water	Not needed	Droughty, seepage.	Not needed	Not needed.
Gymer: Gm, Gy	Favorable	Shrink-swell, low strength.	No water	Not needed	Slow intake, erodes easily.	Favorable	Favorable.
Judson: Ju	Seepage	Compressible, low strength, shrink-swell.	No water	Not needed	Favorable	Favorable	Favorable.
Kennebec: Kb, [1] Kc	Seepage	Low strength, compressible, excess humus.	Deep to water	Floods, frost action.	Floods	Favorable	Favorable.
Kimo: Km	Favorable	Shrink-swell, low strength.	Favorable	Wetness, poor outlets.	Wetness, floods, percs slowly.	Not needed	Not needed.
Leanna: Le	Favorable	Shrink-swell, low strength.	Deep to water	Floods, wetness, poor outlets.	Floods, percs slowly, wetness.	Not needed	Wetness.
Martin:							
Mb, Mc, [1] Mh	Favorable	Shrink-swell, low strength.	No water	Not needed	Slow intake, slope.	Percs slowly	Favorable.
[1] Mo:							
Martin part	Favorable	Shrink-swell, low strength.	No water	Not needed	Slow intake, slope.	Percs slowly	Favorable.
Oska part	Depth to rock	Low strength, thin layer, shrink-swell.	No water	Not needed	Slow intake, erodes easily, droughty.	Depth to rock	Depth to rock, erodes easily.
Morrill: Mr, Ms	Favorable	Low strength	No water	Not needed	Slope, erodes easily.	Favorable	Favorable.
Oska: Oe	Depth to rock	Low strength, thin layer, shrink-swell.	No water	Not needed	Slow intake, erodes easily, droughty.	Depth to rock	Depth to rock, erodes easily.

Footnote is at end of table.

Pawnee: Pb, Pc, Ph	Favorable	Shrink-swell	No water	Not needed	Percs slowly, slow intake.	Percs slowly, erodes easily.	Percs slowly.
Reading: Re	Favorable	Shrink-swell, erodes easily.	Deep to water	Not needed	Slow intake	Favorable	Favorable.
Riverwash: Ro	Seepage	Piping, seepage	Favorable	Floods, wetness	Droughty, seepage.	Not needed	Not needed.
Sarpy:							
[1] Sb:							
Sarpy part	Seepage	Piping, unstable fill, seepage.	Deep to water	Not needed	Droughty, fast intake, soil blowing.	Not needed	Droughty.
Eudora part	Seepage	Low strength, piping.	Deep to water	Not needed	Favorable	Not needed	Not needed.
Sharpsburg: Sc, Sd	Favorable	Compressible, low strength, shrink-swell.	No water	Not needed	Erodes easily	Favorable	Favorable.
Sibleyville: Sh, So, [1] Ss, [1] St, [1] Sv.	Depth to rock, slope.	Thin layer, erodes easily.	No water	Not needed	Erodes easily, slope, rooting depth.	Depth to rock, erodes easily.	Erodes easily, slope.
Sogn:							
[1] Sw:							
Sogn part	Depth to rock	Thin layer	No water	Not needed	Rooting depth	Depth to rock	Rooting depth.
Vinland part	Depth to rock	Thin layer	No water	Not needed	Rooting depth, slope.	Depth to rock	Rooting depth.
Stony steep land: Sx	Depth to rock, slope.	Thin layer, rock outcrop.	No water	Not needed	Rooting depth, slope.	Depth to rock, slope.	Rock outcrop, slope.
Thurman: [1] Tc	Seepage	Seepage, piping	No water	Not needed	Fast intake, soil blowing.	Not needed	Not needed.
Vinland: [1] Vc, [1] Vh	Depth to rock	Thin layer	No water	Not needed	Rooting depth, slope.	Depth to rock	Rooting depth.
[1] Vm:							
Vinland part	Depth to rock	Thin layer	No water	Not needed	Rooting depth, slope.	Depth to rock	Rooting depth.
Martin part	Favorable	Shrink-swell, low strength.	No water	Not needed	Slow intake, slope.	Percs slowly	Favorable.
Wabash: Wc, Wh	Favorable	Shrink-swell, compressible, low strength.	Slow refill	Floods, percs slowly, wetness.	Slow intake, wetness, floods.	Percs slowly, wetness.	Percs slowly, wetness.
Woodson: Wo, Ws, Wx	Favorable	Low strength, shrink-swell.	No water	Wetness	Slow intake, wetness.	Wetness, percs slowly.	Percs slowly, wetness.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

Construction materials

The suitability of each soil as a source of road fill, sand, gravel, and topsoil is indicated in table 8 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 and described as the survey was made, generally about 6 feet.

Road fill is soil material used in embankments for roads. The ratings reflect the ease of excavating and working the material and the expected performance of the material after 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 soil properties that determine such performance is given in the descriptions of soil series.

The ratings apply to the soil profile between the A horizon and a depth of 5 or 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within the profile. The estimated engineering properties in table 10 provide more specific information about the nature of each horizon that can help determine its suitability for road fill.

According to the Unified soil classification system, soils rated *good* 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, moderate potential frost action, steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*, regardless of the quality of the suitable material.

Since soil survey interpretations are oriented to local roads and streets rather than highways, the ratings given in table 8 are evaluations of the soils as sources of road fill for low embankments, generally less than 6 feet high and less exacting in design than high embankments. The upper part of the road fill is considered as the subgrade (foundation) for the road.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 8 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 10.

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 sustain the growth of plants. Also considered is the damage that would result to the area from which the topsoil is taken.

Soils rated *good* have at least 16 inches of friable loamy material at the surface. They are free of stones, low in content of gravel and other coarse fragments, and gently sloping. They are low in soluble salts, which can limit plant growth. They are naturally fertile or respond well to fertilization. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy or firm loamy or clayey soils 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; very firm clayey soils; soils that have suitable layers less than 8 inches thick; soils that have 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 much preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 9 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 suitable for this use have low seepage potential, which is determined by the permeability and 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. Stones and organic matter in a soil lessen the suitability of a soil for use in embankments, dikes, and levees.

An *aquifer-fed excavated pond* is a body of water created by excavating a pit or dugout into a groundwater aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 9 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability, texture, structure, depth to claypan or other layers that influence 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 (fig. 8).

Irrigation is affected by such features as slope, sus-

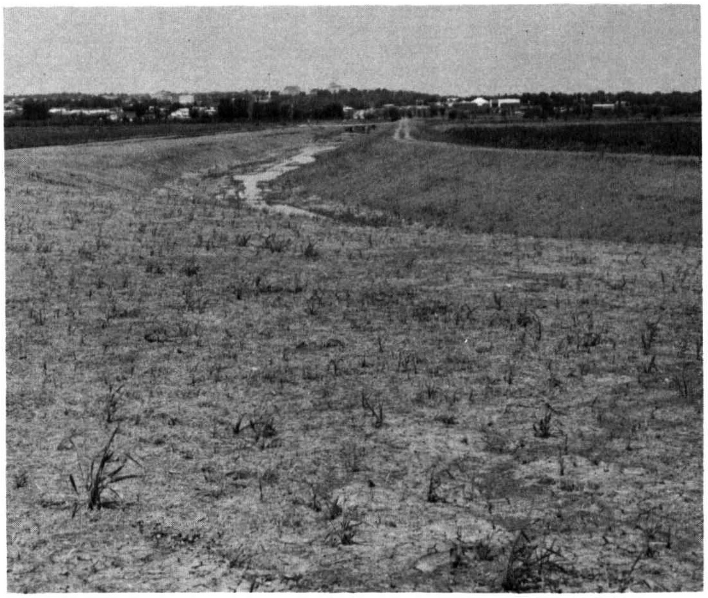

Figure 8.—**Floodway that has been constructed on Wabash soils. City of Lawrence is in background.**

Figure 9.—**Contour farming on a terrace, Woodson silt loam, 1 to 3 percent slopes.**

ceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff and allow the water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity of slope and steepness; depth to bedrock or other unfavorable material; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping (fig. 9).

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

Soil properties

Extensive data about soil properties collected during the soil survey 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 samples selected from representative soil profiles in the field.

When he makes soil borings during field mapping, the soil scientist can identify several important soil properties. He notes the seasonal soil moisture condition or the presence of free water and its depth in the profile. For each horizon, he notes the thickness of the soil and its color; the texture, or the amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or natural pattern of cracks and pores in the undisturbed soil; and the consistence of soil in-place under the existing soil moisture conditions. He records the root depth of existing plants, determines soil pH or reaction, and identifies any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to characterize 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 of the soil series are available from nearby areas.

Based on summaries of available field and laboratory data, and listed in tables 10, 11, 12, and 13 in this section, are estimated ranges in engineering properties and classifications and in physical and chemical properties for each major horizon of each soil in the survey area. Also, pertinent soil and water features, engineering test data, and data obtained from laboratory analyses, both physical and chemical, are presented.

Engineering properties and classification

Table 10 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area. These estimates are presented as ranges in values most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Information is presented for each of these contrasting horizons. Depth to the upper and lower boundaries of each horizon in a typical profile of each soil is indicated. More information about the range in depth and in properties of each horizon is given for each soil series in the section "Descriptions of the Soils."

Texture is described in table 10 in standard terms used by the United States Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than

TABLE 10.—*Engineering*

[The symbol < means less than; > means greater than.

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Basehor: [1] Be	0–12	Loam, fine sandy loam	ML, SM	A–4
	12	Unweathered bedrock.		
Eudora:				
Et	0–12	Silt loam	ML, CL	A–4
	12–72	Silt loam, very fine sandy loam	ML, CL	A–4
[1] Ev:				
Eudora part	0–12	Silt loam	ML, CL	A–4
	12–72	Silt loam, very fine sandy loam	ML, CL	A–4
Kimo part	0–6	Silty clay loam	CH, CL	A–7
	6–28	Silty clay loam, silty clay	CH, CL	A–7
	28–60	Silt loam	ML, CL	A–4
[1] Ew:				
Eudora part	0–12	Fine sandy loam	ML, SM	A–4
	12–72	Silt loam, very fine sandy loam	ML, CL	A–4
Kimo part	0–15	Fine sandy loam	ML, SM	A–4
	15–28	Silty clay loam, silty clay	CH, CL	A–7
	28–60	Silt loam	ML, CL	A–4
Gravelly land: Ge.				
Gymer: Gm, Gy	0–15	Silt loam	ML, CL	A–4, A–6
	15–68	Silty clay loam, silty clay	CL, CH	A–6, A–7
Judson: Ju	0–14	Silt loam	OL, CL, ML	A–6, A–7, A–4
	14–80	Silty clay loam, silt loam	CL, ML	A–6, A–7, A–4
Kennebec:				
Kb	0–10	Silt loam	CL	A–6, A–7, A–4
	10–60	Silt loam, silty clay loam	CL	A–6, A–7, A–4
[1] Kc	0–10	Silty clay loam, silt loam, loam	CL, ML	A–6, A–7, A–4
	10–60	Silt loam, silty clay loam	CL	A–6, A–7, A–4
Kimo: Km	0–6	Silty clay loam	CH, CL	A–7
	6–28	Silty clay loam, silty clay	CH, CL	A–7
	28–60	Silt loam	ML, CL	A–4
Leanna: Le	0–22	Silt loam	CL, CL–ML	A–4, A–6
	22–40	Silty clay, silty clay loam	CH, CL	A–7
	40–78	Silty clay loam, silty clay	CL, CH	A–6, A–7
Martin:				
Mb, Mc, [1] Mh	0–14	Silty clay loam	CL	A–6, A–7
	14–80	Silty clay, clay	CH, CL	A–7
[1] Mo:				
Martin part	0–14	Silty clay loam	CL, CL–ML	A–6, A–7
	14–80	Silty clay, clay	CH, CL	A–7
Oska part	0–9	Silty clay loam	ML, CL	A–6, A–7
	9–40	Clay, silty clay, silty clay loam	CH, CL	A–7–6
	40	Unweathered bedrock.		
Morrill: Mr, Ms	0–10	Clay loam	ML, CL	A–4, A–6
	10–56	Clay loam, sandy clay loam	CL, SC	A–4, A–6
	56–66	Loam, sandy clay loam, clay loam	CL, ML, SC	A–4, A–6
Oska: Oe	0–9	Silty clay loam	ML, CL	A–6, A–7
	9–40	Silty clay, silty clay loam	CH, CL	A–7–6
	40	Unweathered bedrock.		

Footnote is at end of table.

properties and classifications

Absence of an entry means data were not estimated]

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0–20	80–100	80–100	70–95	40–75	<30	[2] NP–10
0	100	100	95–100	60–98	20–35	2–10
0	100	100	95–100	60–98	10–25	NP–10
0	100	100	95–100	60–98	20–35	2–10
0	100	100	95–100	60–98	10–25	NP–10
0	100	100	95–100	90–100	40–55	15–30
0	100	100	95–100	90–100	40–55	15–30
0	100	100	95–100	60–100	<25	NP–10
0	100	100	90–100	45–70	<26	NP–6
0	100	100	95–100	60–98	10–25	NP–10
0	100	100	90–100	45–70	<25	NP–10
0	100	100	95–100	90–100	40–55	15–30
0	100	100	95–100	60–100	<25	NP–10
0	100	100	90–100	75–100	25–40	5–15
0	100	100	90–100	85–98	35–55	15–25
0	100	100	100	95–100	25–50	5–25
0	100	100	100	95–100	25–50	5–25
0	100	100	95–100	90–100	30–50	5–25
0	100	100	95–100	90–100	30–50	5–20
0	100	100	90–100	80–100	25–50	5–25
0	100	100	95–100	90–100	30–50	5–20
0	100	100	95–100	90–100	40–55	15–30
0	100	100	95–100	90–100	40–55	15–30
0	100	100	95–100	60–100	<25	NP–10
0	100	100	95–100	85–100	30–40	5–15
0	100	100	95–100	90–100	45–65	25–40
0	100	100	95–100	90–100	35–55	25–40
0	100	100	95–100	80–99	35–50	15–25
0	100	100	95–100	80–98	41–70	25–40
0	100	100	95–100	80–99	35–50	15–25
0	100	100	95–100	80–98	41–70	25–40
0	100	100	96–100	90–100	38–50	12–22
0	100	100	96–100	95–100	45–60	20–35
0	100	100	94–100	50–85	20–35	2–15
0	100	100	90–100	55–85	30–45	8–20
0	100	100	90–100	55–85	25–35	2–15
0	100	100	96–100	90–100	38–50	12–22
0	100	100	96–100	95–100	45–60	20–35

TABLE 10.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Pawnee: Pb, Pc, Ph	0–14	Clay loam	CL	A–6
	14–54	Clay, clay loam	CH	A–7
	54–72	Clay loam, sandy clay loam, clay	CL, CH	A–7, A–6
Reading: Re	0–9	Silt loam	ML, CL	A–4, A–6
	9–64	Silty clay loam	CL	A–6, A–7
Riverwash: Ro.				
Sarpy:				
[1] Sb:				
Sarpy part	0–8	Loamy fine sand	SM	A–2
	8–48	Loamy fine sand, fine sand	SM	A–2
	48–60	Silt loam, loam, fine sandy loam	ML, SM	A–4
Eudora part	0–12	Silt loam	ML, CL	A–4
	12–72	Silt loam, very fine sandy loam	ML, CL	A–4
Sharpsburg: Sc, Sd	0–12	Silt loam	ML, CL	A–6
	12–36	Silty clay loam, silty clay	CH	A–7, A–6
	36–60	Silty clay loam	CL	A–7, A–6
Sibleyville: Sh, So, [1] Ss, [1] St, [1] Sv	0–7	Loam	ML, CL	A–4, A–6
	7–15	Loam, clay loam, sandy clay loam	ML, CL, SC	A–4, A–6
	15–27	Channery loam, channery clay loam, channery sandy clay loam.	ML, CL, SC	A–2, A–6
	27	Weathered bedrock.		
Sogn:				
[1] Sw:				
Sogn part	0–12	Silty clay loam	CL	A–6, A–7
	12	Unweathered bedrock.		
Vinland part	0–17	Silty clay loam	ML, CL	A–6, A–7
	17	Weathered bedrock.		
Stony steep land: Sx.				
Thurman: [1] Tc	0–22	Loamy fine sand	SM, SP–SM	A–2, A–3
	22–60	Loamy fine sand, fine sand	SM, SP–SM	A–2, A–3
Vinland:				
[1] Vc, [1] Vh	0–17	Silty clay loam	ML, CL	A–6, A–7
	17	Weathered bedrock.		
[1] Vm:				
Vinland part	0–17	Silty clay loam	ML, CL	A–6, A–7
	17	Weathered bedrock.		
Martin part	0–14	Silty clay loam	CL	A–6, A–7
	14–80	Silty clay, clay	CH, CL	A–7
Wabash:				
Wc	0–16	Silty clay loam	CL, CH	A–6, A–7
	16–70	Silty clay, clay	CH, MH–CH	A–7
Wh	0–16	Silty clay	CH, MH–CH	A–7
	16–70	Silty clay, clay	CH, MH–CH	A–7
Woodson:				
Wo, Ws	0–11	Silt loam	ML, CL	A–4, A–6
	11–45	Silty clay, clay	CH	A–7–6
	45–78	Silty clay, clay loam, silty clay loam	CH, CL	A–7–6, A–6
Wx	0–11	Silty clay loam	ML, CL	A–4, A–6
	11–45	Silty clay, clay	CH	A–7–6
	45–78	Silty clay, clay loam, silty clay loam	CH, CL	A–7–6, A–6

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

[2] NP stands for nonplastic.

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	95–100	95–100	85–100	70–90	30–40	10–20
0	95–100	95–100	85–100	70–85	50–70	25–45
0	95–100	95–100	80–100	70–90	35–55	20–40
0	100	100	90–100	85–100	25–40	8–20
0	100	100	95–100	90–100	35–50	15–30
0	100	100	60–80	15–35	----------	NP
0	100	100	60–80	15–35	----------	NP
0	100	100	80–95	40–80	----------	NP–10
0	100	100	95–100	60–98	20–35	2–10
0	100	100	95–100	60–98	10–25	NP–10
0	100	100	100	95–100	25–40	10–20
0	100	100	100	95–100	35–60	20–35
0	100	100	100	95–100	35–50	20–30
0	100	100	85–100	60–80	20–35	5–15
0	100	100	80–90	40–60	20–40	8–25
0–20	70–90	70–90	60–80	20–60	20–40	5–15
0	85–100	85–100	85–100	80–95	25–45	11–23
0	85–100	85–100	80–100	75–95	35–50	11–25
0	100	100	90–100	5–30	----------	NP
0	100	100	85–100	5–25	----------	NP
0	85–100	85–100	80–100	75–95	35–50	11–25
0	85–100	85–100	80–100	75–95	35–50	11–25
0	100	100	95–100	80–99	35–50	15–25
0	100	100	95–100	80–98	41–70	25–40
0	100	100	100	95–100	30–55	12–35
0	100	100	100	95–100	52–78	30–55
0	100	100	100	95–100	52–75	30–55
0	100	100	100	95–100	52–78	30–55
0	100	100	90–100	85–100	25–40	5–20
0	100	98–100	95–100	90–100	50–65	30–45
0	100	98–100	95–100	90–100	45–60	25–40
0	100	100	90–100	85–100	25–40	5–20
0	100	98–100	95–100	90–100	50–65	30–45
0	100	98–100	95–100	90–100	45–60	25–40

TABLE 11.—*Physical and chemical properties of soils*

[Dashes indicate data were not available. The symbol < means less than; > means greater than. The erosion tolerance factor (T) is for the entire profile. Absence of an entry means data were not estimated]

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*						
Basehor: [1] Be	0–12	2.0–6.0	0.17–0.21	5.1–6.5	Low	Low	Moderate	---	---	3
	12									
Eudora:										
Et	0–12	0.6–2.0	0.20–0.24	6.1–7.3	Low	Low	Low	0.32	5	5
	12–72	0.6–2.0	0.17–0.22	6.6–8.4	Low	Low	Low	0.32		
[1] Ev:										
Eudora part	0–12	0.6–2.0	0.20–0.24	6.1–7.3	Low	Low	Low	0.32	5	5
	12–72	0.6–2.0	0.17–0.22	6.6–8.4	Low	Low	Low	0.32		
Kimo part	0–6	0.06–0.2	0.13–0.22	6.6–8.4	High	High	Low	0.43	5	4
	6–28	0.06–0.2	0.13–0.22	6.6–8.4	High	High	Low	0.43		
	28–60	0.6–6.0	0.17–0.22	6.6–8.4	Low	Low	Low	0.43		
[1] Ew:										
Eudora part	0–12	0.6–2.0	0.16–0.18	6.1–7.3	Low	Low	Low	0.32	5	3
	12–72	0.6–2.0	0.17–0.22	6.6–8.4	Low	Low	Low	0.32		
Kimo part	0–15	0.6–2.0	0.16–0.18	6.6–8.4	Low	Low	Low	0.43	5	3
	15–28	0.06–0.2	0.13–0.22	6.6–8.4	High	High	Low	0.43		
	28–60	0.6–6.0	0.17–0.22	6.6–8.4	Low	Low	Low	0.43		
Gravelly land: Ge	---	---	---	5.6–7.3	Low	Low	Low	---	---	---
Gymer: Gm, Gy	0–15	0.6–2.0	0.22–0.24	5.1–6.5	Low	Low	Moderate	0.37	5–4	6
	15–68	0.2–0.6	0.12–0.20	5.6–6.5	Moderate	Moderate	Low	0.37		
Judson: Ju	0–14	0.6–2.0	0.21–0.23	6.1–7.3	Moderate	Moderate	Low	0.32	5	7
	14–80	0.6–2.0	0.21–0.23	6.1–7.8	Moderate	Moderate	Low	0.37		
Kennebec: Kb, [1] Kc	0–10	0.6–2.0	0.22–0.24	5.6–6.5	Moderate	Moderate	Low	0.37	5	6
	10–60	0.6–2.0	0.20–0.22	6.1–7.3	Moderate	Moderate	Low	0.37		
Kimo: Km	0–6	0.06–0.2	0.13–0.22	6.6–8.4	High	High	Low	0.43	5	4
	6–28	0.06–0.2	0.13–0.22	6.6–8.4	High	High	Low	0.43		
	28–60	0.6–6.0	0.17–0.22	6.6–8.4	Low	Low	Low	0.43		
Leanna: Le	0–22	0.2–0.6	0.22–0.24	5.1–6.5	Low	High	Moderate	0.49	5	6
	22–40	<0.06	0.11–0.18	5.1–6.5	High	High	Moderate	0.49		
	40–78	0.06–2.0	0.11–0.18	5.6–7.3	High	High	Low	0.49		
Martin:										
Mb, Mc, [1] Mh	0–14	0.2–0.6	0.21–0.23	5.6–6.5	Moderate	High	Low	0.43	5–4	7
	14–80	0.06–0.2	0.12–0.18	5.6–7.8	High	High	Low	0.43		
[1] Mo:										
Martin part	0–14	0.2–0.6	0.21–0.23	5.6–6.5	Moderate	High	Low	0.43	5–4	7
	14–80	0.06–0.2	0.12–0.18	5.6–7.8	High	High	Low	0.43		
Oska part	0–9	0.2–0.6	0.18–0.20	5.6–6.5	Moderate	Moderate	Moderate	0.43	2	7
	9–40	0.06–0.2	0.14–0.18	5.6–8.4	High	Moderate	Low	0.43		
	40									
Morrill: Mr, Ms	0–10	0.6–2.0	0.14–0.21	5.1–6.5	Low	Low	Moderate	0.32	5–4	6
	10–56	0.2–0.6	0.15–0.19	5.1–6.5	Moderate	Moderate	Moderate	0.32		
	56–66	0.2–2.0	0.15–0.18	5.1–7.3	Low	Low	Moderate	0.32		
Oska: Oe	0–9	0.2–0.6	0.18–0.20	5.6–6.5	Moderate	Moderate	Moderate	---	2	7
	9–40	0.06–0.2	0.14–0.18	5.6–8.4	High	Moderate	Low	---		
	40									
Pawnee: Pb, Pc, Ph	0–14	0.2–0.6	0.17–0.19	5.6–6.5	Moderate	Moderate	Low	0.49	2	6
	14–54	0.06–0.2	0.09–0.11	6.1–8.4	High	High	Low	0.49		
	54–72	0.2–0.6	0.14–0.16	7.9–8.4	High	High	Low	0.49		

See footnote at end of table.

TABLE 11.—*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*						
Reading: Re	0–9	0.6–2.0	0.21–0.23	5.6–7.3	Low	Low	Low	0.32	5	6
	9–64	0.2–2.0	0.18–0.20	5.6–7.3	Moderate	Moderate	Low	0.32		
	64–79	0.2–2.0	0.13–0.20	6.1–8.4	Moderate	Moderate	Low	0.32		
Riverwash: Ro.										
Sarpy:										
[1] Sb:										
Sarpy part	0–8	>6.0	0.05–0.09	6.6–8.4	Low	Low	Low	0.17	4	1
	8–64	>6.0	0.05–0.09	7.4–8.4	Low	Low	Low	0.17		
Eudora part	0–12	0.6–2.0	0.20–0.24	6.1–7.3	Low	Low	Low	0.32	5	5
	12–72	0.6–2.0	0.17–0.22	6.6–8.4	Low	Low	Low	0.32		
Sharpsburg: Sc, Sd	0–12	0.6–2.0	0.21–0.23	5.1–6.5	Moderate	Moderate	Moderate	0.37	4	6
	12–36	0.2–0.6	0.18–0.20	5.1–6.0	High	Moderate	Moderate	0.43		
	36–60	0.2–0.6	0.18–0.20	6.1–6.5	High	Moderate	Low	0.43		
Sibleyville: Sh, So, [1] Ss, [1] St, [1] Sv.	0–7	0.6–2.0	0.18–0.21	5.6–7.3	Low	Low	Moderate	0.32	3	6
	7–15	0.6–2.0	0.16–0.19	5.1–7.3	Low	Low	Moderate	0.32		
	15–27	0.6–2.0	0.12–0.15	5.1–7.3	Low	Low	Moderate	0.32		
	27									
Sogn:										
[1] Sw:										
Sogn part	0–12	0.6–2.0	0.17–0.22	6.1–8.4	Moderate	Low	Low	0.32	1	4L
	12									
Vinland part	0–17	0.6–2.0	0.21–0.24	5.6–7.8	Moderate	Moderate	Low	0.32	2	6
	17									
Stony steep land: Sx.										
Thurman: [1] Tc	0–22	6.0–20.0	0.10–0.12	6.1–7.3	Low	Low	Low	0.17	5	2
	22–60	6.0–20.0	0.06–0.11	6.1–7.3	Low	Low	Low	0.17		
Vinland:										
[1] Vc, [1] Vh	0–17	0.6–2.0	0.21–0.24	5.6–7.8	Moderate	Moderate	Low	0.32	2	6
	17									
[1] Vm:										
Vinland part	0–17	0.6–2.0	0.21–0.24	5.6–7.8	Moderate	Moderate	Low	0.32	2	6
	17									
Martin part	0–14	0.2–0.6	0.21–0.23	5.6–6.5	Moderate	High	Low	0.43	5–4	7
	14–80	0.06–0.2	0.12–0.18	5.6–7.8	High	High	Low	0.43		
Wabash:										
Wc	0–16	0.06–0.2	0.21–0.24	5.6–7.3	High	High	Moderate			4
	16–70	<0.06	0.08–0.12	5.6–7.8	Very high	High	Moderate			
Wh	0–16	<0.06	0.12–0.14	5.6–7.3	Very high	High	Moderate			4
	16–70	<0.06	0.08–0.12	5.6–7.8	Very high	High	Moderate			
Woodson: Wo, Ws, Wx	0–11	0.2–0.6	0.22–0.24	5.6–6.5	Low	Moderate	Low	0.43	4–3	6
	11–45	<0.06	0.12–0.15	5.6–7.3	High	High	Low			
	45–78	<0.2	0.10–0.15	6.1–7.8	High	High	Moderate			

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 12.—*Soil and water features*

[Absence of an entry indicates the feature is not a concern. See text for descriptions of symbols and such terms as "rare," "brief," and "perched." The symbol < means less than; > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			Seasonal high water table			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	
					Ft			*In*		
Basehor: [1] Be	D	None			>6.0			10–20	Hard	Moderate.
Eudora:										
Et	B	Rare	Very brief	Mar-June	>6.0			>60		High.
[1] Ev:										
Eudora part	B	Rare	Very brief	Mar-June	>6.0			>60		High.
Kimo part	C	Rare			2.0–6.0	Apparent	Mar-June	>60		High.
[1] Ew:										
Eudora part	B	Rare	Very brief	Mar-June	>6.0			>60		High.
Kimo part	C	Rare			2.0–6.0	Apparent	Mar-June	>60		High.
Gravelly land: Ge	B	None			>6.0			>60		Low.
Gymer: Gm, Gy	C	None			>6.0			>60		Moderate.
Judson: Ju	B	None			>6.0			>60		High.
Kennebec: Kb, [1] Kc	B	Common	Brief	Mar-June	2.0–5.0	Apparent	Nov-May	>60		High.
Kimo: Km	C	Rare			2.0–6.0	Apparent	Mar-June	>60		High.
Leanna: Le	D	Occasional	Very brief	Jan-Dec	0.5–2.0	Perched	Dec-June	>60		Low.
Martin:										
Mb, Mc, [1] Mh	C	None			>6.0			>60		High.
[1] Mo:										
Martin part	C	None			>6.0			>60		High.
Oska part	C	None			>6.0			20–40	Hard	Moderate.
Morrill: Mr, Ms	B	None			>6.0			>60		Moderate.
Oska: Oe	C	None			>6.0			20–40	Hard	Moderate.
Pawnee: Pb, Pc, Ph	D	None			>6.0			>60		High.
Reading: Re	C	Rare			>6.0			>60		High.
Riverwash: Ro	A	Frequent	Brief to long	Jan-Dec	0.0–5.0	Apparent	Jan-Dec	>60		Low.
Sarpy:										
[1] Sb:										
Sarpy part	A	Rare	Brief to long	Nov-June	>6.0			>60		Low.
Eudora part	B	Rare	Very brief	Mar-June	>6.0			>60		High.
Sharpsburg: Sc, Sd	B	None			>6.0			>60		High.

Sibleyville: Sh, So, [1]Ss, [1]St, [1]Sv.	B	None			>6.0			20–40	Rippable	Moderate.
Sogn:										
[1]Sw:										
Sogn part	D	None			>6.0			4–20	Hard	Moderate.
Vinland part	C	None			>6.0			10–20	Rippable	Moderate.
Stony steep land: Sx	D	None			>6.0			0–10	Hard	Low.
Thurman: [1]Tc	A	None			>6.0			>60		Low.
Vinland:										
[1]Vc, [1]Vh	C	None			>6.0			10–20	Rippable	Moderate.
[1]Vm:										
Vinland part	C	None			>6.0			10–20	Rippable	Moderate.
Martin part	C	None			>6.0			>60		High.
Wabash: Wc, Wh	D	Common	Brief to long	Nov-May	0–1.0	Perched	Nov-May	>60		Moderate.
Woodson: Wo, Ws, Wx	D	None			>6.0			>60		Moderate.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 13

[Tests performed by the State Highway Commission of Kansas in accordance with standard procedures of the

Soil name and location	Parent material	Report No. 571 Kansas—	Depth from surface	Moisture-density[1]	
				Maximum dry density	Optimum moisture
			Inches	*Pounds per cubic foot*	*Percent*
Martin silty clay loam: 1,850 feet north and 750 feet west of SE. corner of sec. 31, T. 13 S., R. 18 E. (Modal)	Residuum from silty and clayey shale.	23–1–1	0–10	101	19
		23–1–4	22–30	97	23
		23–1–6	42–52	100	20
Reading silt loam: 2,200 feet south and 100 feet east of NW. corner of sec. 8, T. 14 S., R. 18 E. (Modal)	Alluvium.	23–2–1	0–9	103	17
		23–2–3	19–33	101	19
		23–2–5	46–64	101	21
Wabash silty clay: 1,175 feet west and 2,000 feet north of SE. corner of sec. 18, T. 13 S., R. 20 E. (Modal)	Clayey alluvium.	23–4–1	10–16	94	20
		23–4–2	16–28	91	22
		23–4–3	52–70	95	24
Woodson silt loam: 750 feet west and 820 feet south of NE. corner of sec. 7, T. 15 S., R. 21 E. (Modal)	Clayey sediment.	23–3–3	11–20	95	24
		23–3–4	20–33	95	23
		23–3–7	58–78	106	17

[1] Based on Moisture-density Relations of Soils Using 5.5-lb. Rammer and 12-inch Drop, AASHTO Designation T99–61, Method A, with the following variations: all material is ovendried at 230° F; all material is crushed in laboratory crusher after drying; and no time is allowed for dispersion of moisture after mixing with the soil material.

[2] Mechanical analyses according to AASHTO Designation T88–57 with the following variations: all material is ovendried at 230° F and crushed in laboratory crusher; sample is not soaked prior to dispersion; sodium silicate is used as dispersing agent; and dispersing time, in minutes, is established by dividing the plasticity index value by 2 (the maximum time is 15 minutes, and the minimum is 1 minute). Results by this procedure may frequently differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydro-

2 millimeters in diameter (*14*). "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 used by USDA are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (USCS) and the American Association of State Highway and Transportation Officials Soil Classification System (AASHTO). In table 10, soils in the survery area are classified according to both systems.

The USCS system classifies soils according to properties that affect their use as construction material (*2*). 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. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes 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 (*1*). 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 as 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 more for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 13. The estimated classification, without group index numbers, is given in table

Engineering test data

American Association of State Highway and Transportation Officials (AASHTO) except as stated in footnotes 1 and 2]

Mechanical analysis [2]							Liquid limit	Plasticity index	Classification	
Percentage less than 3 inches passing sieve—			Percentage smaller than—						AASHTO [3]	Unified [4]
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
							Percent			
100	99	96	92	68	32	23	35	12	A-6(9)	CL–ML
100	99	98	96	83	56	47	64	38	A-7-6(20)	CH
100	99	95	92	77	49	40	54	31	A-7-6(19)	CH
100	100	96	87	59	30	21	35	12	A-6(9)	CL–ML
100	100	97	90	68	39	30	41	19	A-7-6(12)	CL
100	99	94	89	71	43	33	44	22	A-7-6(14)	CL
100	100	98	97	92	67	50	60	31	A-7-6(20)	MH–CH
100	100	97	95	91	74	59	65	35	A-7-5(20)	MH–CH
100	100	97	95	91	71	56	68	42	A-7-6(20)	CH
100	100	97	95	82	54	45	53	28	A-7-6(18)	CH
100	100	96	93	82	57	45	56	31	A-7-6(19)	CH
100	100	70	64	52	35	26	32	15	A-6(9)	CL

meter method, and the various grain-sized 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-sized fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed. 8): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHTO Designation M145-49.

[4] Based on the Unified Soil Classification System.

10. Also in table 10, the percentage, by weight, of cobbles or of rock fragments more than 3 inches in diameter are estimated for each major horizon. These estimates are determined largely by observing volume percentage in the field and then converting it, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four standard sieves 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 consistency of soil. These indexes are used in both the USCS 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 estimates 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.

Physical and chemical properties

Table 11 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 representative profile 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 between 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 water movement in a vertical direction when the soil is saturated. Not considered in the estimates are lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in the planning and design of 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 organic-matter content, 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 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 other soils it was estimated on the basis of the kind of clay and on measurements of similar soils. Size of imposed loadings and the magnitude of changes in soil moisture content are also important factors that 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, as used in table 11, 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 rating of soils for corrosivity to concrete is based mainly on the sulfate content, soil texture, and acidity. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the amount of erosion that will result from specific kinds of land treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest values are the most erodible. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or wind, that may occur without reducing crop production or environmental quality.

Wind erodibility groups are used to predict the susceptibility of soils to blowing and to predict the amount of soil lost by blowing. The groups consist of soils that have similar properties that affect soil blowing, principally those that determine the stability of aggregates that resist breakdown by tillage and abrasion by wind. Among properties of soils that affect their placement in wind erodibility groups are texture; size and stability of aggregates; organic matter content; content of calcium carbonate; soil moisture; mineralogical composition; and susceptibility to frost action.

Soil and water features

Features that relate to runoff or infiltration of water, to flooding, to grading and excavation, and to subsidence and frost action of each soil are indicated in table 12. This information is helpful in planning land uses and engineering projects that are likely to be affected by the amount of runoff from watersheds, by flooding and a seasonal high water table, by the presence of bedrock in the upper 5 or 6 feet of the soil, or by frost action.

Hydrologic groups are used to estimate runoff after rainfall. Soil properties that influence the minimum rate of infiltration into the bare soil after prolonged wetting are depth to a water table, water intake rate and permeability after prolonged wetting, and depth to layers of slowly or very slowly permeable soil.

Flooding is rated in general terms that describe the frequency, duration, and period of the year when flooding is most likely. The ratings are based on evidences 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; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about floodwater heights and the extent of flooding; and local knowledge that relates the unique landscape position of each soil 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.

A seasonal high water table is the highest level of a saturated zone more than 6 inches thick in soils 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 soils and the depth to free water observed during the course of the soil survey. Indicated are the depth to the seasonal high water table; the kind of water table, whether perched, artesian, or the upper part of the ground water table, and the months of the year that the high water is present. Only those 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, specific kinds of drainage systems, and footing drains to insure dry basements. Such information is also needed to decide whether or not to construct basements 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, a limited range in 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 made during the soil mapping. The kind of bedrock and its relative 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.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action is defined as freezing temperatures in the soil and movement of soil moisture into the freezing zone, which causes the formation of ice lenses. Soil texture, temperature, moisture content, porosity, permeability and organic-matter content are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artifically drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Soil test data

Table 13 contains engineering test data for some of the major soil series in Douglas County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

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

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material as has been explained for table 10.

Formation and Classification of Soils

This section consists of two main parts: in the first, the factors of soil formation that have affected the development of soils in Douglas County are explained; in the second, the system of soil classification currently used is explained and each soil series is placed in the classes of that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the physical and mineral composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed 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 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 of the processes of soil development are unknown. Soils are never absolutely stable or completely developed, but are in a constant state of change.

Parent material

Parent material is the unconsolidated material from which the soil develops. It is a result of the physical and chemical weathering of large rocks to gravel-, sand-, silt-, and clay-sized particles. Parent material affects the texture and most other properties of the soil. Soils differ mainly because of the differences in their parent material. The parent materials of the soils of Douglas County are residuum weathered from lime, stone, sandstone, and shale of the Upper and Middle Pennsylvanian System and sediment of the Quaternary System (*13*) transported by water, glaciers, and wind.

Upper and Middle Pennsylvanian limestone, sandstone, and shale is the bedrock system from which the parent materials for most of the soils of the county have weathered. This bedrock ranges from Topeka Limestone, which crops out in the Big Springs area of the northwestern part of the county, to Plattsburg Limestone, which crops out along Captain Creek in the northeastern part.

Martin, Sibleyville, Oska, Sogn, and Vinland soils formed in residuum weathered from the bedrock. Martin and Vinland soils formed in material weathered from loamy and clayey shale. Sibleyville soils formed in material weathered from sandstone and interbedded loamy shale. Sogn soils formed in material weathered from limestone. Oska soils formed in material weathered from limestone or from shale that is closely associated with limestone.

Old and recent alluvium consists of sediment transported by water to their present location. The old alluvial sediment (Illinoian and Kansan stages) are on high terraces along the Kansas and Wakarusa Rivers. Gymer soils formed in the loamy sediment on these terraces, and Woodson soils formed in the clayey sediment. Recent alluvial sediment is on low flood plains and high flood plains or low terraces, such as Newman terrace, along the Kansas River, its tributaries, and other streams in the county. Soils on the low flood plains are Sarpy soils, formed in sandy sediment; Eudora soils, formed in loamy sediment; Kennebec soils formed in loamy sediment; and Kimo soils, formed in clayey sediment. Soils on the high flood plains or low terraces are Judson soils, formed in loamy sediment on the Newman terrace along the Kansas River; Reading soils, formed in loamy sediment; and Wabash and Leanna soils, formed in clayey sediment.

Kansas till and glaciofluvial deposits were transported to Douglas County during the Kansan stage of the Pleistocene age. The Kansas glacier covered approximately the northern half of Douglas County. Most deposits are concentrated in such areas as the Hesper area, and on crests of landscapes. Morrill soils formed in loamy till deposits and in loamy glaciofluvial sediment in some places. Pawnee soils formed mostly in clayey glaciofluvial sediment.

Loveland and Peoria Formations are eolian sediment (loess) that were deposited during the Illinoian and early Wisconsin stages of the Pleistocene age. Gymer soils formed in the loamy sediment of the Loveland Formation. Sharpsburg soils formed in the loamy eolian sediment of the Peoria Formation and are along bluffs of the Kansas River Valley. In some places, Woodson soils formed in thin deposits of the Peoria Formation.

Climate

Climate influences both physical and chemical weathering processes and the biological forces at work in the parent material. The downward movement of water is a major factor in transforming the parent material into a soil that has distinct horizons. The amount of water that percolates through the soils depends mainly on temperature, type and intensity of precipitation, and humidity, and to a lesser extent, on relief and nature of the soil material. Soil-forming processes are most active when the soil is warm and moist; in Douglas County these processes are most active during the warmer months. Soil structure is modified by freezing and thawing. Alternate wetting and drying occurs frequently in the subhumid climate of the county and is an important process in creating soil structure.

Climate is an important factor in causing differences in soils over a wide region, but differences in soils as a consequence of climate in a small area such as Douglas County are slight.

Plant and animal life

Soil formation is accompanied by changes in plant and animal life. As soil features change, the biological life adjusts itself accordingly. In a given climatic region, the particular kinds of plant and animal life are determined by the other factors of soil formation.

Plants provide a cover for the soil, add energy for animals in the form of organic materials, and bring nutrients from lower layers to the surface layer. Trunks, stems, leaves, and roots of plants are decomposed by plant and animal micro-organisms to form organic matter. Organic matter physically and chemically influences color, structure, and other soil properties, and it creates a more favorable environment for biological activity within the soil. Most of the soils in Douglas County formed with the influence of tall prairie grasses. Some of the soils, such as those of the Sogn series, formed with the influence of a combination of tall and mid prairie grasses. The soils formed from recent alluvium were influenced by a combination of tall prairie grasses and lowland plains hardwood.

Animals influence soil formation by aiding in decomposition of organic materials and weathering of the parent material. Worms, for example, influence the color and structure of soils.

Man has a great effect on the development of soils. The use of soils by man has in most places increased erosion, increased or decreased organic-matter content, and changed the relief by land leveling and industrial or urban development, and thereby changed or offset the normal processes of soil formation.

Relief

Relief influences soil formation through runoff, drainage, and other effects of water, including normal and accelerated erosion. The amount of water that moves into the soil depends partly on topography. Generally, less water enters steep soils than gently sloping soils, and more soil material is lost by erosion. Level or depressional topography generally influences the amount of moisture available because extra water runs off of higher parts of the landscape. Because of this additional water, the upper layers of the soil profile are gray or mottled and are thicker. Level or gently sloping soils on uplands generally have more strongly developed profiles than soils on steeper slopes. Runoff is slowed on the level soils, and more water has a chance to percolate through the soil or to pond on it. Most of the nearly level soils formed in alluvium have had additional sediment deposited on them during flooding.

Time

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

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (*16*).[8]

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measureable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. The same property or subdivisions of this property may be used in several different categories. In table 14 the soil series of Douglas County are placed in three categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER.—Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Moll-i-sol).

SUBORDER.—Each order is subdivided into suborders using those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than are the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth; soil climate; the accumulation of clay, iron, or organic carbon in the upper solum; cracking of soils caused by a decrease in soil moisture; and fine stratification. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquoll* (Aqu, meaning water or wet, and *oll*, from Mollisol).

GREAT GROUP.—Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed; and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are soil acidity, soil climate, soil composition, and soil color. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquoll (*Hapl*, meaning simple horizons, *aqu* for wetness or water, and *oll*, from Mollisols).

SUBGROUP.—Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups may have soil properties unlike those of any other great group, subgroup, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquolls (a typical Haplaquoll).

FAMILY.—Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae (table 14). An example is the coarse-loamy, mixed, mesic family of Typic Haplaquolls.

[8] See also the unpublished working document "Selected Chapters from the Unedited Text of the Soil Taxonomy" available at the SCS State Office, Salina, Kansas.

Environmental Factors Affecting Soil Use

In this section the history and development and the physiography, relief, and drainage of Douglas County are discussed. Also given is information about climate, water supply, vegetation, transportation, industry, natural resources, and land use. The statistics on agriculture and population are from Census of Agriculture and Kansas State Board of Agriculture reports.

History and Development

The area now known as Douglas County was part of the Shawnee Indian Reservation until May 15, 1854, when it was made available for settlement. In July 1855, the First Territorial Legislature established Douglas County as one of the original 33 counties of Kansas. The Kansas River was the northern boundary of the county until Grant Township was added in 1867, and this established the present boundaries of Douglas County.

The population of the county in 1860 was 8,637. It grew rapidly at first, and in 1870 the population was 20,592. After the initial increase, the population grew slowly until 1965; since then it has increased by about 65 percent.

Lawrence was established in October, 1854, and it was named the county seat in 1857. Lecompton was the first county seat.

Physiography, Relief, and Drainage

Douglas County lies within the Dissected Till Plain and the Osage Plains sections of the Central Lowlands physiographic province (*13*). The major topographic features are the east-trending Kansas and Wakarusa River Valleys and the upland cuestas formed by differential erosion of the limestone, shale, and sandstone beds. Locally, as in the Hesper area in the eastern part of the county, plains developed from glaciofluvial deposits are minor topographic features.

The northern three-fourths of the county is drained by the Kansas River and its tributaries; the southern one-fourth is drained by tributaries of the Marais des Cygnes River. The highest point in the county is about 1.200 feet above sea level in the southwestern part of the county, and the lowest point is about 778 feet above

TABLE 14.—*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	Family	Subgroup	Order
Basehor	Loamy, siliceous, mesic	Lithic Dystrochrepts	Inceptisols.
Eudora	Coarse-silty, mixed, mesic	Fluventic Hapludolls	Mollisols.
Gymer	Fine, montmorillonitic, mesic	Typic Argiudolls	Mollisols.
Judson	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kimo	Clayey over loamy, montmorillonitic, mesic	Aquic Hapludolls	Mollisols.
Leanna	Fine, mixed, thermic	Typic Argialbolls	Mollisols.
Martin	Fine, mixed, mesic	Aquic Argiudolls	Mollisols.
Morrill	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Oska	Fine, montmorillonitic, mesic	Typic Argiudolls	Mollisols.
Pawnee	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Reading	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Sarpy	Mixed, mesic	Typic Udipsamments	Entisols.
Sharpsburg	Fine, montmorillonitic, mesic	Typic Argiudolls	Mollisols.
Sibleyville	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Sogn	Loamy, mixed, mesic	Lithic Haplustolls	Mollisols.
*Thurman	Sandy, mixed, mesic	Udorthentic Haplustolls	Mollisols.
Vinland	Loamy, mixed, mesic, shallow	Typic Hapludolls	Mollisols.
Wabash	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Woodson	Fine, mixed, thermic	Abruptic Argiaquolls	Mollisols.

sea level along the Kansas River in the northeastern part of the county. The average gradient of the Kansas River is about two feet per mile.

Climate[9]

Douglas County, because of its location in the interior of a large land mass in the middle latitudes, has a typical continental climate. Such climates are characterized by large diurnal and annual variations in temperature. This feature of the climate is similar for all of Kansas and indeed for much of the area between the Rockies to the west and the Appalachian Mountains to the east.

Douglas County lies in the region classified as moist subhumid by Thornthwaite (*18*). Precipitation often exceeds evapotranspiration in this region, and the surplus goes into runoff and ground water recharge. Moist subsoils are commonly present in these regions. This part of the state is frequently under the influence of moisture-laden air currents from the Gulf of Mexico (*4*). As a consequence, Douglas County receives only slightly less precipitation than southeast Kansas, where precipitation is highest for the state.

Climatological records have been kept at Lawrence, Kansas since 1868. This is one of the longest records of weather data in the State. The description of the climate for Douglas County is based on an analysis of the Lawrence records.

Annual precipitation in Douglas County averages 37 or 38 inches. More than 70 percent of this falls during the growing season, from April through September. Measurable amounts of precipitation fall on an average of 95 days of the year. May and June have an average of 11 days of precipitation, and the other summer months average 8 or 9 days each. Precipitation on most of these days is very light. This is because 50 per cent of the annual rainfall is received in the 13 wettest days each year, and the other 50 percent is spread over 80 rain days. Although annual rainfall totals are adequate for crop production almost every year, the distribution is often erratic. It is not uncommon to have 2 or 3 weeks of dry weather between showers. These dry spells can produce stress conditions in cultivated crops, pastures, and meadows.

Most of the annual precipitation comes from convective shower activity. Thunderstorms moving across the county generally in the evening or at night account for most of the summer precipitation. Rain from these storms is generally intense and of short duration. The intensity is great enough to make runoff a regular occurrence. Ten percent of the rains each year exceed 1 inch, and several showers exceeding 3 inches occur in most years. Almost 60 percent of the rains are less than 0.25 inch and contribute little to the moisture budget.

Snowfall averages about 18 to 20 inches a year in Douglas County. Amounts are about equal every month from December through March, but more generally falls in February than in any other month. In general, the snow cover does not remain on the ground for more than a week, but there are occasional exceptions. In 1960, snow accumulated to a depth of 20 inches during mid-March, and the ground was covered with snow for 5 weeks. Blizzard conditions are infrequent and of short duration.

Temperatures range widely in a continental climate. Annual extremes generally range from below zero to above 100° F in Douglas County. These extremes are generally of short duration and do not have great importance to the overall climate. Extremely cold periods commonly occur when the ground is covered with snow and the nights are clear. Fortunately, the snow acts as an insulating blanket for winter wheat, lawns, and other dormant plants. The average temperatures shown

[9] By L. DEAN BARK, climatologist for Kansas, National Weather Service, U.S. Department of Commerce.

in table 15 illustrate the rather short transitional seasons of spring and fall that occur in Kansas. Winter is from December through February, and the average daily temperature is in the 30's. Summer conditions and the warm temperatures necessary for plant growth occur from late in April to early in October. The average growing season (freeze-free period) is 185 days in Douglas County. The probability of freezes of differing severity in spring and fall are given in table 16.

The prevailing wind direction is southerly, but in January and February northerly winds are more frequent. Winds in March tend to be easterly. Winds in northeastern Kansas generally have less velocity than those in the western part of the state. Strong, blustery winds do occur at times, particularly late in winter and early in spring.

Tornadoes and severe windstorms, associated with the passage of squall lines through the area, occur occasionally in Douglas County. This area is somewhat removed from the center of maximum severe storm occurrence in east-central Oklahoma, and thus the threat is correspondingly lower. When they do occur, these storms are generally local in extent and of short duration, so the risk is small. Hail occurs most frequently late in spring and early in summer. Although individual hail storms can do great damage, their local nature and infrequent occurrence lessen their importance as a climatic hazard. Douglas County is far removed from the center of maximum hail damage, which is in the northwestern part of the state.

Droughts are common in east-central Kansas. For the period 1931–68, droughts classified as mild, moderate, severe, or extreme were recorded in 163 months (*7*). Severe or extreme droughts occurred in 69 months, or 15 percent of the total period. These figures are quite likely higher than average because the period of study was selected to compare the well-known droughts of the thirties and fifties. A longer period of study would reduce the percentage of time in which severe and extreme drought conditions existed.

Water Supply

The Kansas River Valley is the most important source of ground water in the county (*13*). About four-fifths of the pumped ground water comes from a six-square-mile area of the Kansas River Valley.

Fresh ground water occurs locally to a depth of about 500 feet. Water from Quaternary deposits is generally good, except for carbonate hardness and locally excessive iron content. Ireland and Tonganoxie sandstones yield calcium and magnesium bicarbonate water of good quality in water table areas, and in the downdip or downgradient artesian areas, they yield a sodium bicarbonate water that is generally soft but high in dissolved solids. Only small quantities of water are available from other bedrock aquifers in this county.

Natural Vegetation

The original vegetation on the uplands was mostly tall prairie grasses, but a small area north of Baldwin had a savannah-type plant association of post and

TABLE 15.—*Temperature and precipitation*

[Recorded at Lawrence]

Month	Temperature				Precipitation		
	Average daily maximum[1]	Average daily minimum[1]	Two years in 10 will have about 4 days with— Maximum temperature equal to or higher than—[2]	Two years in 10 will have about 4 days with— Minimum temperature equal to or lower than—[2]	Average monthly total[1]	One year in 10 will have— Totals less than—[3]	One year in 10 will have— Totals greater than—[3]
	°F	°F	°F	°F	Inches	Inches	Inches
January	39.9	20.6	59.7	0.3	1.10	0.16	2.60
February	45.8	25.1	63.5	9.0	1.18	.38	2.17
March	54.7	32.4	76.9	15.3	2.40	.68	4.07
April	68.3	45.4	83.6	31.4	3.76	1.41	6.63
May	77.0	55.2	89.1	42.1	4.23	1.98	6.34
June	84.8	64.2	95.6	54.5	6.04	1.18	10.01
July	89.9	68.3	101.3	59.5	4.68	.84	8.28
August	89.1	67.1	98.9	57.4	4.20	1.31	7.15
September	81.4	58.3	95.1	45.1	3.76	.75	6.69
October	71.4	48.2	86.7	33.8	3.04	.40	5.59
November	55.5	35.0	72.1	19.5	1.57	.13	4.87
December	43.3	25.2	62.1	8.2	1.44	.35	2.11
Year	66.9	45.2	[4] 101.4	[5] −4.8	37.40	22.36	45.89

[1] Data for period 1941–70.

[2] Data for period 1931–60.

[3] Data for period 1931–70.

[4] Average annual highest temperature, 1941–70.

[5] Average annual lowest temperature, 1941–70.

TABLE 16.—*Probabilities of last freezing temperature in spring and first in fall (3)*

Probability	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	March 25	April 2	April 9	April 19	May 2
2 years in 10 later than	March 19	March 27	April 4	April 14	April 27
5 years in 10 later than	March 7	March 17	March 26	April 4	April 17
Fall:					
1 year in 10 earlier than	November 14	November 6	October 26	October 17	October 8
2 years in 10 earlier than	November 20	November 11	October 30	October 22	October 12
5 years in 10 earlier than	December 2	November 22	November 8	October 31	October 22

blackjack oak with an understory of tall prairie grasses.

The original vegetation on the bottom lands and along the small drainageways was mostly lowland plains hardwoods, but some areas where the soils are poorly drained were in water-tolerant tall prairie grasses.

The present vegetation on the uplands that are grazed is an excessively used savannah-type plant association. It consists of poor-quality woody plants, an understory of weedy plants, and a small percentage of tall prairie grasses. About 8,000 acres of the uplands are well managed and are dominated by big and little bluestems. The area north of Baldwin has a vegetative cover somewhat like the original vegetation, but the understory has been excessively used and has a higher percentage of weedy plants.

The present vegetation on the uncultivated bottom lands is somewhat like the original vegetation, but the more desirable trees have been harvested.

Industry and Natural Resources

Several chemical industries in Douglas County produce ammonia, urea, ammonium nitrate, phosphates, and phosphoric acid. Electric power and compressed gas plants are located in the county. Lawrence has an organ manufacturing plant and a paper box company. Mobile homes, greeting cards, and food canning and processing are other industries in the county. Several large warehouses are near Lawrence. Businesses that service and sell farm machinery and other farm supplies are also in the area.

Water is the most important natural resource. Other natural resources are sand, gravel, and limestone. Sand and gravel are pumped from the Kansas River. Limestone is quarried and then crushed for use in making concrete and in surfacing roads. Some of the crushed limestone is used as agricultural lime.

Markets for the agricultural products are readily available. Most of the crops that are not fed to livestock are sold at local elevators in Douglas County and surrounding counties. Most of the livestock is marketed in Kansas City, Missouri or at local livestock sale barns.

Transportation Facilities

Douglas County is served by main lines of the Union Pacific, Chicago, Rock Island, and Pacific Railroads. Branch lines of the Atchison, Topeka and Santa Fe Railway System also serve Lawrence and Baldwin. The Kansas Turnpike, a four-lane, limited access highway, crosses the county in an east-west direction and so do U.S. Highways 40, 56, and 24. U.S. Highway 59 crosses in a north-south direction. In addition, Kansas Highway 32 extends about two-tenths of a mile into the northeastern corner of the county, and Kansas Highway 33 connects with U.S. Highway 56 in the southeastern part of the county. Air taxi service is available to Kansas City International Airport.

Community Facilities

All rural areas of Douglas County are included in unified elementary and high school districts. The University of Kansas, a four-year accredited university, and Haskell Indian Junior College are in Lawrence. Baker University, a four-year accredited college, is in Baldwin.

More than 70 churches of various denominations are throughout the county. Telephone service and electricity are available to all residents. Hospital facilities are available in Lawrence.

Many types of recreational facilities are available in the county. These include lakes for water sports, golf courses, parks, baseball and softball diamonds, tennis courts, bowling alleys, and others.

Land Use and Trends

The farming in this county is based on cash crops and livestock. About 50 percent of farm income in 1972 came from cash crop products (*11*). The present trend is an increase in cropland as indicated by these figures: in 1962, 124,550 acres of cropland were harvested; and in 1972, 133,430 acres were harvested (*10, 11*).

About 50 percent of the farm income in 1972 came from the sale of livestock products (*11*). The present trend is an increase in numbers of both cattle and hogs but a small decrease in acres of pasture and hay (*9, 10, 11*).

The present trend of the population in Douglas County is toward an increase as indicated by these figures: 32,067 in 1955, 37,919 in 1965, and 59,375 in 1973.

The future trend of land use will be a decrease in acres used for farming production and an increase in acres for urban or other uses. The completion of the Clinton Dam will take about 19,840 acres from farming uses.

Literature Cited

(1) American Association of State Highway (and Transportation) Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.
(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487–69. In 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.
(3) Bark, L. Dean. 1959. When to expect late-spring and early-fall freezes in Kansas. Kans. State Univ., Coll. Agric. & Appl. Sci., Kans. Agric. Exp. Stn. Bull. 415, 23 pp., illus.
(4) Bark, L. Dean. 1961. Rainfall patterns in Kansas. Kans. State Univ., Coll. Agric. & Appl. Sci., Kans. Agric. Exp. Stn., vol. 37, no 12, pp. 6-8, illus.
(5) Bartelli, Lindo J. and others. 1966. Soil surveys and land use planning. Soil Sci. Am. & Am. Soc. Agron., 196 pp., illus.
(6) Broadfoot, W. M. 1960. Field guide for evaluating cottonwood sites. U.S. Dep. Agric., Forest Serv., South. Forest Exp. Stn. Occas. Pap. 178, 6 pp., illus.
(7) Brown, Merle J. and L. Dean Bark. 1971. Drought in Kansas. Kans. State Univ., Coll. Agric. & Appl. Sci., Kans. Agric. Exp. Stn. Bull. 547, 12 pp., illus.
(8) Extension Service, Kansas State University. 1967. What shall I plant? Dep. Hortic., Kans. Agric. Exp. Stn. Contrib. 302.
(9) Kansas State Board of Agriculture. 1952. Farm facts. Kans. State Board Agric., 76 pp., illus.
(10) ——— 1962. Farm facts. Kans. State Board Agric., 96 pp., illus.
(11) ——— 1972. Farm facts. Kans. State Board Agric., 96 pp., illus.
(12) Kansas State Department of Health. 1970. A manual of recommended standards for locating, constructing, and operating septic-tank systems for rural homes. Bull. 4-2.
(13) O'Connor, Howard G. 1960. Geology and groundwater resources of Douglas County, Kansas. Univ. Kans., Publication & State Geol. Surv. Kans. Bull. 148, 200 pp.
(14) Portland Cement Association. 1962. PCA soil primer. 52 pp., illus.
(15) Schnur, G. Luther. 1937. Yield, stand, and volume tables for even-aged upland oak forest. U.S. Dep. Agric. Tech. Bull. 560, 88 pp., illus. (Reprinted 1961.)
(16) Simonson, Roy W. 1962. Soil classification in the United States. Sci. 137: 1027-1034.
(17) Strickler, John K. and Clarence D. Chase. 1968. Kansas woodlands. U.S. Dep. Agric., Forest Serv. Resourc. Bull. NC-4, 50 pp.
(18) Thorntwaite, C. W. 1941. Atlas of climatic types in the United States. 1900–39. U.S. Dep. Agric., Misc. Publ. 421, pp. 55, illus.
(19) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]
(20) ——— 1961. Land capability classification. U.S. Dep. Agric. Hanb. 210, 21 pp.
(21) United States Department of Health, Education, and Welfare. 1957. Manual of septic tank practices. Public Health Serv. Publ. 526, 93 pp., illus.

Glossary

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—

Very low	0 to 3
Low	3 to 6
High	More than 9

Bedding. Plowing, grading, or otherwise elevating the surface of a flat field into a series of broad beds, or "lands," so as to leave shallow surface drains between the beds.

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

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

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay 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.

Clayey soil. Soil with sandy clay, silty clay, or clay texture.

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.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

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.

Cropping sequence. A planned sequence of crops growing in a regular recurring succession on the same area of land, as contrasted to continuous culture of one crop or growing different crops in haphazard order.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Deep to water. When used in the tables of this soil survey, "deep to water" means deep to a permanent water table during dry seasons.

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 continous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

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.

Erosion hazard. The relative susceptibility of the soil to the prevailing agents of erosion.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

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.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

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.

Landscape. All the natural characteristics that distinguish a certain kind of area on the earth's surface and give it a distinguishing pattern, in contrast to other kinds of areas. Any one kind of soil is said to have a characteristic natural landscape, and under different uses it has one or more characteristic cultural landscapes.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loamy soil. A general expression for soils of intermediate texture between the coarse-textured or sandy soil on the one hand and the fine or clayey soils on the other.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Management, crop residue. The operation and management of cropland to maintain stubble, stalks, and other crop residue on the surface to prevent soil blowing and water erosion, conserve water, and decrease evaporation.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

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).

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

Piping. Formation by moving water of subsurface tunnels or pipelike cavities.

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.

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.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly	9.1 and higher

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

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.

Sandy soils. A broad term for soils of the sand and loamy sand classes; soil material that is more than 70 percent sand and less than 15 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shear strength. The resistance to sliding within the soil mass.

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.

Slow intake. The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: very coarse sand (2.0 millimeters to 1.0 millimeter); coarse sand (1.0 to 0.5 millimeters); 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 (0.005 to 0.002 millimeter); and clay (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

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).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. Technically, the A1 or Ap horizon.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tillage, minimum. The minimum soil manipulation necessary for crop production or meeting tillage requirements under the existing soil and climatic conditions.

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.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

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.

Wetness. When used in the tables of this soil survey, "wetness" indicates that the soil is wet during the period of use.

GUIDE TO MAPPING UNITS

For a complete description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs.

Map symbol	Mapping unit	Described on page	Capability unit		Range site	Pasture suitability group	Woodland group
			Symbol	Page	Name	Symbol	Symbol
Be	Basehor complex, 7 to 15 percent slopes--	8	VIe-3	27	Shallow Savannah	G	5d
Et	Eudora silt loam------------------------	8	I-1	24	Loamy Lowland	A-1	2o
Ev	Eudora-Kimo complex---------------------	9	IIw-1	24	----------------	---	--
	Eudora part-------------------------	--	-------	--	Loamy Lowland	A-1	2o
	Kimo part---------------------------	--	-------	--	Clay Lowland	E	3o
Ew	Eudora-Kimo fine sandy loams, overwash---	9	IIw-1	24	----------------	---	--
	Eudora part-------------------------	--	-------	--	Loamy Lowland	A-1	2o
	Kimo part---------------------------	--	-------	--	Clay Lowland	E	3o
Ge	Gravelly land---------------------------	9	VIe-1	27	Loamy Upland	H	--
Gm	Gymer silt loam, 1 to 3 percent slopes---	10	IIe-2	24	Loamy Upland	A-2	--
Gy	Gymer silt loam, 3 to 8 percent slopes---	10	IIIe-1	25	Loamy Upland	A-2	--
Ju	Judson silt loam------------------------	10	I-1	24	Loamy Lowland	A-1	2o
Kb	Kennebec silt loam----------------------	11	IIw-2	25	Loamy Lowland	A-1	2o
Kc	Kennebec soils, channeled---------------	11	VIw-1	27	Loamy Lowland	A-1	2o
Km	Kimo silty clay loam--------------------	11	IIw-3	25	Clay Lowland	E	3o
Le	Leanna silt loam------------------------	12	IIw-3	25	Loamy Lowland	E	3w
Mb	Martin silty clay loam, 1 to 3 percent slopes--------------------------------	12	IIe-1	24	Loamy Upland	A-2	--
Mc	Martin silty clay loam, 3 to 7 percent slopes--------------------------------	12	IIIe-3	25	Loamy Upland	A-2	--
Mh	Martin soils, 3 to 7 percent slopes, eroded--------------------------------	13	IVe-4	26	Clay Upland	C	--
Mo	Martin-Oska silty clay loams, 3 to 6 percent slopes------------------------	13	IVe-3	26	Loamy Upland	A-2	--
Mr	Morrill clay loam, 3 to 7 percent slopes--------------------------------	13	IIIe-1	25	Loamy Upland	A-2	--
Ms	Morrill clay loam, 7 to 12 percent slopes--------------------------------	14	IVe-5	26	Loamy Upland	A-2	--
Oe	Oska silty clay loam, 3 to 6 percent slopes--------------------------------	14	IIIe-1	25	Loamy Upland	A-2	--
Pb	Pawnee clay loam, 1 to 3 percent slopes--	15	IIe-1	24	Loamy Upland	A-2	--
Pc	Pawnee clay loam, 3 to 7 percent slopes--	15	IIIe-3	25	Loamy Upland	A-2	--
Ph	Pawnee clay loam, 3 to 7 percent slopes, eroded--------------------------------	15	IVe-4	26	Clay Upland	C	--
Re	Reading silt loam-----------------------	16	I-1	24	Loamy Lowland	A-1	2o
Ro	Riverwash-------------------------------	16	VIIIs-1	27	----------------	---	--
Sb	Sarpy-Eudora complex, overwash-----------	16	IIIw-2	26	----------------	---	--
	Sarpy part--------------------------	--	-------	--	Sandy Lowland	B	5s
	Eudora part-------------------------	--	-------	--	Loamy Lowland	A-1	2o
Sc	Sharpsburg silt loam, 1 to 4 percent slopes--------------------------------	17	IIe-2	24	Loamy Upland	A-2	4o
Sd	Sharpsburg silt loam, 4 to 10 percent slopes--------------------------------	17	IIIe-1	25	Loamy Upland	A-2	4o
Sh	Sibleyville loam, 3 to 7 percent slopes--	17	IIIe-1	25	Loamy Upland	A-2	--
So	Sibleyville loam, 3 to 7 percent slopes, eroded--------------------------------	17	IVe-6	26	Loamy Upland	A-2	--
Ss	Sibleyville complex, 3 to 7 percent slopes--------------------------------	18	IVe-2	26	Loamy Upland	G	--
St	Sibleyville complex, 3 to 7 percent slopes, eroded------------------------	18	VIe-1	27	Loamy Upland	G	--
Sv	Sibleyville complex, 7 to 15 percent slopes--------------------------------	18	VIe-1	27	Loamy Upland	G	--

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site	Pasture suitability group	Woodland group
			Symbol	Page	Name	Symbol	Symbol
Sw	Sogn-Vinland complex, 5 to 20 percent slopes----------------------------------	19	VIe-2	27	----------------	H	--
	Sogn part--------------------------	--	-------	--	Shallow Limy	---	--
	Vinland part-----------------------	--	-------	--	Loamy Upland	---	--
Sx	Stony steep land------------------------	19	VIIe-1	27	Breaks	H	--
Tc	Thurman complex, 4 to 10 percent slopes--	19	IVe-7	27	Savannah	B	5s
Vc	Vinland complex, 3 to 7 percent slopes---	20	IVe-3	26	Loamy Upland	G	--
Vh	Vinland complex, 3 to 7 percent slopes, eroded---------------------------------	20	VIe-1	27	Loamy Upland	G	--
Vm	Vinland-Martin complex, 7 to 15 percent slopes---------------------------------	20	VIe-1	27	Loamy Upland	G	--
Wc	Wabash silty clay loam-------------------	21	IIw-3	25	Clay Lowland	E	4w
Wh	Wabash silty clay------------------------	21	IIIw-1	25	Clay Lowland	E	4w
Wo	Woodson silt loam, 0 to 1 percent slopes---------------------------------	21	IIs-1	24	Clay Upland	C	--
Ws	Woodson silt loam, 1 to 3 percent slopes---------------------------------	22	IIIe-2	25	Clay Upland	C	--
Wx	Woodson silty clay loam, 1 to 3 percent slopes, eroded------------------------	22	IVe-1	26	Clay Upland	C	--

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