Series 1959, No. 36 Issued May 1964

SOIL SURVEY

Gage County, Nebraska

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
in cooperation with the
UNIVERSITY OF NEBRASKA
Conservation and Survey Division

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Gage County will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, and other structures; aid those interested in establishing or improving woodland; and add to our knowledge of soils.

Locating areas on the soil map

Use the index to map sheets to locate areas on the soil map. The index is a small map of the county that shows what part of the county is represented on each sheet of the soil map. When the correct sheet of the soil map is found, it will be seen that boundaries of the soils are outlined and that each soil is identified by a symbol. All areas marked with the same symbol are the same kind of soil. Suppose, for example, an area has the symbol CrA. The legend shows that this symbol identifies Crete silty clay loam, 0 to 3 percent slopes. This soil and all the others mapped in the county are described in the section "Descriptions of the Soils."

Finding information

Different parts of the report will interest different groups of readers.

Farmers and those who work with farmers can learn about the soils in the section "Descriptions of the Soils," and can find suggestions for agricultural management of the soils in the subsection "Capability Groups of Soils." From the subsection "Estimated Yields" they can find what yields can be expected from each kind of soil under a specified level of management.

Foresters and others interested in woodland management can refer to the subsection "Woodland," in which the soils of the county are grouped according to their suitability for trees, and factors affecting the management of woodland are explained.

Engineers can refer to the subsection "Engineering Properties of the Soils." Tables in that subsection show characteristics of the soils that affect engineering.

Scientists and others who are interested can find information about how the soils were formed and how they are classified in the section "Genesis, Classification, and Morphology of Soils."

Students, teachers, and other users can find information about the soils and their management in various parts of the report, depending on their particular interest.

Newcomers in Gage County will be especially interested in the section "General Soil Map," which describes the broad patterns of soils. They may also wish to read the section "General Nature of the County," which describes the climate, physiography, relief, and drainage, and gives some statistics on agriculture.

* * * * *

Fieldwork for this survey was completed in 1959. Unless otherwise indicated, all statements in the report refer to conditions at that time. The soil survey of Gage County was made as part of the technical assistance furnished by the Soil Conservation Service and the Conservation and Survey Division of the University of Nebraska to the Gage County Soil and Water Conservation District.

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SOIL SURVEY OF GAGE COUNTY, NEBRASKA

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SURVEY BY THOMAS E. BEESLEY, ROBERT JORDON, WARREN FAIRCHILD, AND LYLE DAVIS, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE UNIVERSITY OF NEBRASKA CONSERVATION AND SURVEY DIVISION

GAGE COUNTY is in the southeastern part of Nebraska (fig. 1). Beatrice, the county seat and largest town, is in the central part of the country, about 35 miles south of Lincoln and about 80 miles southwest of Omaha. The county is approximately 24 miles wide and 36 miles long.

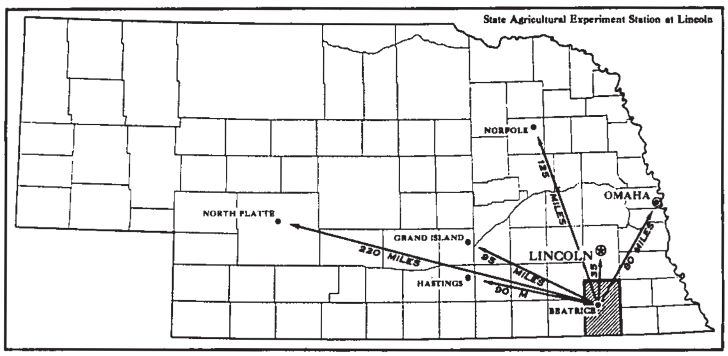

Figure 1.—**Location of Gage County in Nebraska.**

Gage County is essentially agricultural. In general, the farming is diversified. The climate and most of the soils are suitable for growing staple crops common to the region and for raising livestock. Most of the acreage is cultivated rather intensively. Corn, wheat, oats, sorghums, and alfalfa are the chief crops. Minor crops include rye, barley, sweetclover, red clover, bromegrass, soybeans, fruits, and vegetables. Wheat and part of the corn crop are usually sold for cash. The bulk of the field crops generally is used locally as feed for livestock. Native grass pasture occupies about one-fifth of the county. On many farms, livestock and livestock products are the chief source of revenue.

Beginning with the first settlers, farmers in Gage County have been active in cooperative organizations that have as their purpose the improvement of farming methods. The Gage County Soil and Water Conservation District was organized in 1943. Through this district the farmers receive technical assistance from the Soil Conservation Service in planning for the use and conservation of the soils on their farms.

How Soils Are Named, Mapped, and Classified

Soil scientists made this survey to learn what kinds of soils are in Gage County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the material that has not been changed much by leaching or by roots.

To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, the major horizons of all the soils of one series are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Crete and Lancaster, 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 natural characteristics.

Many soil series contain soils that differ in the texture of their surface layer. According to this difference in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Judson fine sandy loam and Judson silt loam are two soil types in the Judson series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Crete silty clay loam, 0 to 3 percent slopes, is one of several phases of Crete silty clay loam, a soil type that ranges from nearly level to gently sloping.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. Aerial photographs were used for a base map because they show woodlands, buildings, field borders, trees, and similar details that greatly help in drawing boundaries accurately. The detailed soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or 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 other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientist has a problem of delineating areas where different kinds of soils occur in such small areas and in such an intricate pattern that it is not practical to show them separately on the map. Therefore, he shows this mixture of soils as one mapping unit and calls it a soil complex. Ordinarily, a soil complex is named for the major soil series in it, for example, Morrill complex. Occasionally two or more soils that are not geographically associated are shown as one mapping unit, if the differences between the soils are not sufficient to justify separation for the purposes of the soil survey report. Such a mapping unit is called an undifferentiated group. Shelby and Burchard soils is an example. Also, in most mapping, there are areas to be shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Rough broken land, and are called land types rather than soils.

Only part of the soil survey was done when the soil scientist had named and described the soil series and mapping units and had shown the location of the mapping units on the soil map. He still had to present the mass of detailed information he had recorded in different ways for different groups of users, among them farmers, managers of woodland and rangeland, and engineers. To do this efficiently, he had to consult with persons in other fields of work and with them prepare groupings that would be of practical value to different users. Such groupings are the capability classes, subclasses, and units, designed primarily for those interested in producing the short-lived crops and tame pasture; range sites, for those using large tracts of native grass; woodland suitability groups, for those who manage woodland; and the engineering classifications, for those who build highways or structures to conserve soil and water.

General Soil Map

After a study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils, called soil associations. Such a map is the colored general soil map in the back of this report. Each association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic although not strictly uniform.

The soils within any one association are likely to differ from each other in some or in many properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general soil map shows, not the kind of soil at any particular place, but patterns of soils, in each of which there are several different kinds of soils.

Each soil association is named for the major soil series in it, but, as already noted, soils of other series may also be present. The major soils of one soil association may also be present in another association, but in a different pattern.

The general map showing patterns of soils is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use.

1. Crete-Pawnee-Adair association

Soils of nearly level tablelands and sloping valley sides

This association is on the highest elevations of the loess and till uplands and on the high terraces. Here and there on the nearly level tablelands are level areas and small, shallow depressions. The slope is generally between 0 and 8 percent, but in a few places it is more than 8 percent. These soils are deep and generally well drained. This association contains about 225,000 acres, or about 41 percent of the county.

The Crete soils are the most extensive of the nearly level and gently sloping soils on tablelands. They developed in deep Peorian loess. The surface layer consists of dark-colored, medium silty clay loam and is about 10 inches thick. The subsoil is very firm, dark grayish-brown silty clay. The Crete soils generally have a lime zone 25 to 40 inches below the surface.

The Pawnee and Adair soils are the most extensive of the smooth, sloping soils on valley sides along drains. The Pawnee soils developed in Kansan till, and the Adair soils developed in material reworked from loess and till. The surface layer of both the Pawnee and Adair soils is moderately dark colored to dark colored and is about 6 inches thick. The subsoil of the Pawnee soils is very firm, dark grayish-brown or yellowish-brown clay. The subsoil of the Adair soils is reddish-brown clay. In many places the Pawnee and Adair soils cannot be mapped separately because they are closely associated in an intricate pattern.

The Butler and the Fillmore soils are also in this association. The Butler soils are in level areas, and the Fillmore soils are in shallow depressions. These soils are imperfectly to poorly drained and have a slowly permeable subsoil of heavy silty clay.

Some areas of the Geary soils and a few areas of the Wymore soils are also in this association.

Nearly all the soils in this association are slowly permeable. The surface layer of most of the soils is medium acid, and the subsoil is slightly acid or neutral. The substratum is mildly alkaline or neutral; it contains, at most, only a moderate amount of free lime.

These soils are moderately productive. The content of organic matter is moderate, and the surface layer is porous enough to absorb water readily.

Most of this soil association is cultivated. Yields of the common crops are moderate. Some of the more strongly sloping areas are in grass. Management problems are to preserve tilth and fertility, to maintain the supply of organic matter, to control erosion on the more strongly sloping soils, and to provide adequate surface drainage for the Butler and the Fillmore soils.

The farms are of the cash-grain type and grain-livestock types. Most farmers raise a few cows, hogs, and chickens for home use. A good supply of well water is not available in some places east of the Big Blue River.

2. Wymore-Pawnee-Adair association

Soils of gently sloping, rounded ridge crests and sloping valley sides

This association is on the loess and till uplands. Most of it is east of the Big Blue River. These soils are deep. The slope is generally between 3 and 12 percent; in only a few areas is it more or less. In most places these soils are well drained. Numerous small drains carry excess water to the Big Blue River and to the Big Nemaha River. Runoff is medium or rapid. This association contains about 205,000 acres, or about 37 percent of the county.

The Wymore soils are the most extensive of the gently sloping soils on rounded ridge crests and on high slopes. They developed in a thin layer of Peorian loess that overlies till. The surface layer is about 8 inches of dark-colored silty clay loam. The subsoil is firm silty clay. These soils generally lack a lime zone.

The Adair and Pawnee soils are the most extensive of the sloping soils along drains. The surface layer of the Adair soils is moderately dark colored or dark colored and is about 6 inches thick. The subsoil is very firm, reddish-brown clay. The subsoil of the Pawnee soils is dark grayish-brown or yellowish-brown clay. In places the Adair and Pawnee soils occur in an intricate pattern and cannot be mapped separately. Erosion has been slight to severe.

This association includes some areas of the Crete soils and small areas of the Geary, Morrill, Shelby, Burchard, Lancaster, Hedville, Labette, and Sogn soils and of Rough broken land and Rough stony land.

Nearly all of the soils in this association are slowly permeable. The surface layer is medium acid, and the subsoil is neutral or slightly acid. The substratum is neutral or mildly alkaline; it contains, at most, only a small amount of free lime.

These soils are productive. They are moderate in organic-matter content. They are eroded to a significant degree.

More than two-thirds of the acreage is cultivated. Yields of the common crops are good. Some of the more strongly sloping Adair and Pawnee soils and the sloping to steep minor soils in this association are used as grassland or pasture.

The main problem is to control sheet and gully erosion. It is important also to maintain tilth, fertility, and the supply of organic matter and, in pasture, to limit grazing and to select suitable sites for water.

The farms are mainly of the cash-grain and grain-livestock type. Most farmers raise a few cows, hogs, and chickens for home use. The supply of good-quality well water is limited in some places, but generally it is adequate for domestic use.

3. Shelby-Burchard-Morrill association

Sloping or moderately steep soils of till uplands

This association occurs on the lower part of the uplands, as irregular strips along the valleys of major creeks that drain to the Big Blue River and the Big Nemaha River. The slope is generally between 5 and 18 percent, but in a few places it is more or less. These soils are deep and well drained to excessively drained. Runoff is medium or rapid. This association contains about 85,000 acres, or about 15 percent of the county.

The Shelby and Burchard soils occur in an intricate pattern. They developed in limy till deposited by the Kansan glacier. The surface layer is about 8 inches of dark-colored clay loam. The subsoil is firm, dark grayish-brown, brown, or yellowish-brown clay loam. In the Shelby soils, lime is 30 to 60 inches below the surface. In the Burchard soils, it is at a depth of 14 to 30 inches.

The Morrill soils developed in reddish-brown loamy material. The surface layer is about 8 inches of dark-colored loam. The subsoil ordinarily consists of friable, reddish-brown clay loam, but in some places the subsoil is sandy loam and the substratum is sandy to gravelly. Permeability is moderately slow to moderate. The surface layer is medium or strongly acid, and the subsoil is slightly acid. The substratum is neutral to moderately alkaline.

This association includes the Steinauer soils, some areas of the Pawnee and Adair soils, and small areas of the Geary, Lancaster, Hedville, Labette, and Sogn soils and of Rough broken land and Rough stony land.

The soils in this association are medium in organic-matter content but are only fairly well suited to crop production. When cultivated, the moderately steep soils are highly susceptible to erosion, and the use of large machinery is somewhat limited. The moderately sloping soils are easily tilled, and good yields of the common crops are obtained. More than half of this association is grassland and pasture. These areas are mainly on the steeper slopes.

On the cultivated soils, the main problems are to control erosion and to maintain fertility and the supply of organic matter. In pastures, it is necessary to limit grazing, to maintain fertility, to select suitable sites for water, and to control gullies. It is also important to control erosion along roads and pipelines.

The farms are mainly of the grain-forage-livestock type. The supply of good-quality well water is limited in places, but generally it is adequate for domestic use.

4. Hobbs-Judson association

Level or nearly level soils of flood plains and foot slopes

This association is mainly on low valley bottoms, low terraces, and foot slopes. Some small areas of gently sloping and sloping soils are along terrace edges, streambanks, and old oxbows of streams. Except for stream overflow and a few low sloughs and backwater areas where surface drainage is slow, the soils are well drained. This association contains about 30,000 acres, or about 6 percent of the county.

The Hobbs soils are the most extensive of the soils on the bottom lands. They developed in deep, medium-textured alluvium deposited by streams. The surface layer is dark-colored, slightly acid silt loam. It is 10 to

24 inches thick. The subsoil is friable, very dark grayish-brown or dark grayish-brown heavy silt loam. In some areas of the Hobbs soils, the subsoil is underlain by either sandier or finer textured material.

Other soils on the bottom lands are the Cass, which have a surface layer of loam and a subsoil of sandy loam; the Colo, which are deep, dark-colored silty clay loams and have moderately slow drainage; and the Wabash, which are poorly drained, deep, dark-colored silty clays.

The Muir and Rokeby soils are inextensive and are on the low terraces. The Muir soils have a thick surface layer of slightly acid, dark-colored silt loam, and a subsoil of friable, dark-colored silty clay loam. The surface layer of the Rokeby soils is thick, slightly acid, dark-colored silty clay loam, and the subsoil is very firm, dark-colored clay.

The Judson soils are the most extensive of the soils on the foot slopes. These soils developed in dark-colored, medium-textured alluvium and colluvium. The 12- to 24-inch surface layer is dark-colored silt loam or fine sandy loam. This layer is medium acid. The subsoil is friable, dark-brown silt loam or clay loam.

Alluvial land and the Exline soils are also in this association. Alluvial land consists of layered stream sediments. The areas are along meandering stream channels and are subject to frequent overflow. The Exline soils are alkali. They occur as small areas on the low terraces and high bottom lands.

The soils in this association are highly productive. They are easily tilled, are medium in organic-matter content, take water readily, and store moisture well. Most of the acreage is cultivated. Yields of all crops commonly grown in the area are good. There are some woodland areas along streams.

Maintaining fertility is the main problem. Improvement of drainage and tilth increases yields on the imperfectly drained soils.

Farms are mainly of the cash-grain type, but most farmers raise a few cows, hogs, and chickens for home use. An abundant supply of well water can be obtained in most places.

5. Lancaster-Sogn association

Moderately deep, gently sloping or sloping soils, and shallow, strongly sloping to steep soils

This association consists of three small areas south of Big Indian Creek in the southwestern part of the county and one area southeast of Beatrice. The slope generally is between 5 and 25 percent. Narrow bands of the soils in this association occur on steep valley slopes in other parts of the county, but the areas are not large enough to be shown on the general soil map. This association contains about 6,000 acres, or about 1 percent of the county.

The association includes the Lancaster, Hedville, Lanham, Labette, and Sogn soils. Rough stony land is included also. Generally, no one soil is more extensive than the other soils in the association.

The Lancaster, Lanham, and Labette soils are deep over bedrock, and the Hedville and Sogn soils are shallow. The Lancaster soils are well drained and are gently sloping or sloping. They have a surface layer of dark-colored loam, a subsoil of reddish-brown loam, and a substratum of sandstone. The Hedville soils are excessively drained, are sloping to steep, have a surface layer of stony loam, and are shallow over sandstone. The Lanham soils are sloping to steep. They have a dark-colored surface layer, a subsoil of heavy clay, and a substratum of streaked shale. The Labette soils are sloping and have a surface layer that consists of dark-colored, firm silty clay loam and is 5 to 14 inches thick. The subsoil of brown light silty clay loam overlies bedded silty clay shale and limestone. The Sogn soils are excessively drained. They have a thin surface layer that consists of dark-colored clay loam, and they contain scattered stones and rocks. They are shallow over limestone.

Most of this association is too steep, too shallow, or too stony for tillage. Most of the acreage is in grass. Some of the steeper areas have scattered stands of trees. The Lancaster and Labette soils are suitable for cultivation, but in many places they occur as patches within areas of shallow or stony soils not suitable for tillage.

Descriptions of the Soils

In this section each soil series in Gage County is described. Each mapping unit within the series is then discussed and described. The present use of the soils, the limitations, and a few management requirements are also given for each mapping unit.

A list of mapping units and symbols is given in the "Guide to Mapping Units," which is at the back of the report, just ahead of the general soil map. The approximate acreage and proportionate extent of the soils are shown in table 1. The location and distribution of the individual soils, or mapping units, are shown on the detailed soil map.

Adair Series

The Adair series consists of deep, dark-colored, gently sloping and sloping soils on the glacial uplands. These soils formed under prairie vegetation of mid and tall grasses.

The surface layer is ordinarily about 8 inches thick but ranges from 2 to 16 inches in thickness. In texture, it ranges from clay to loam. It is very dark brown, is medium acid, and has a granular structure.

The subsoil ranges from 28 to 50 inches in thickness and from clay, silty clay, or sandy clay to heavy clay loam or sandy loam in texture. The upper part is predominantly clay; it is dark reddish brown and has a strong, fine and medium, angular blocky structure. The lower part is predominantly clay loam; it is yellowish red to dark brown and has a weak, coarse and medium, angular blocky structure. The upper part is more clayey and more compact than the lower part.

The parent material is reworked material from loess and till. It is generally free of lime.

The Adair soils are moderately well drained or well drained. Surface runoff is medium or rapid, and permeability is slow. These soils are medium to high in natural fertility. They are highly susceptible to water erosion.

The subsoil of the Adair soils is more clayey than that of the Morrill soils. It is reddish brown, while the subsoil of the Pawnee soils is yellowish brown. The Adair soils are more gritty than the Wymore soils, they con-

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Symbol	Soil	Area	Extent
		Acres	*Percent*
AdB2	Adair clay loam, 3 to 5 percent slopes, eroded	2, 134	0. 4
AdC2	Adair clay loam, 5 to 8 percent slopes, eroded	6, 477	1. 2
AdD2	Adair clay loam, 8 to 12 percent slopes, eroded	1, 751	. 3
APC3	Adair and Pawnee soils, 5 to 8 percent slopes, severely eroded	51, 703	9. 4
APD3	Adair and Pawnee soils, 8 to 12 percent slopes, severely eroded	16, 670	3. 0
BLg	Rough broken land	1, 865	. 3
Bt	Butler silty clay loam	7, 734	1. 4
Cm	Cass loam	496	. 1
CrA	Crete silty clay loam, 0 to 3 percent slopes	110, 244	20. 1
CrB	Crete silty clay loam, 3 to 5 percent slopes	1, 348	. 2
CrB2	Crete silty clay loam, 3 to 5 percent slopes, eroded	89, 369	16. 3
Ct	Colo silty clay loam	3, 248	. 6
E	Exline soils	103	(1)
Fm	Fillmore silt loam	873	. 2
GeB2	Geary silty clay loam, 3 to 5 percent slopes, eroded	3, 437	. 6
GeC2	Geary silty clay loam, 5 to 8 percent slopes, eroded	8, 020	1. 5
GeD3	Geary soils, 5 to 12 percent slopes, severely eroded	3, 391	. 6
Hb	Hobbs silt loam, seldom flooded	15, 846	2. 9
2Hb	Hobbs silt loam, occasionally flooded	14, 014	2. 6
Hv	Hedville stony loam	572	. 1
JfB	Judson fine sandy loam, 3 to 5 percent slopes	1, 888	. 3
JuA	Judson silt loam, 1 to 3 percent slopes	1, 883	. 3
JuB	Judson silt loam, 3 to 5 percent slopes	10, 902	2. 0
LcC	Lancaster loam, 3 to 8 percent slopes	408	. 1
LcD	Lancaster loam, 8 to 12 percent slopes	184	(1)
Lg	Lanham clay loam	441	. 1
LwD	Labette silty clay loam, 5 to 12 percent slopes	696	. 1
MC3	Morrill soils, 5 to 8 percent slopes, severely eroded	5, 121	. 9
ME3	Morrill soils, 8 to 18 percent slopes, severely eroded	3, 803	. 7
MrB2	Morrill loam, 3 to 5 percent slopes, eroded	981	. 2
MrC2	Morrill loam, 5 to 8 percent slopes, eroded	3, 234	. 6
MrD2	Morrill loam, 8 to 12 percent slopes, eroded	1, 208	. 2
MrE2	Morrill loam, 12 to 18 percent slopes, eroded	949	. 2
Mu	Muir silt loam	6, 615	1. 2
MxC	Morrill complex, 5 to 8 percent slopes	230	(1)
MxD	Morrill complex, 8 to 12 percent slopes	382	. 1
MxE	Morrill complex, 12 to 18 percent slopes	1, 113	. 2
MxC3	Morrill complex, 5 to 8 percent slopes, severely eroded	428	. 1
MxD3	Morrill complex, 8 to 18 percent slopes, severely eroded	1, 177	. 2
PwB2	Pawnee clay loam, 3 to 5 percent slopes, eroded	4, 104	. 7
PwC2	Pawnee clay loam, 5 to 8 percent slopes, eroded	14, 148	2. 6
PwD2	Pawnee clay loam, 8 to 12 percent slopes, eroded	3, 844	. 7
Rt	Rokeby silty clay loam	4, 251	. 8
Rv	Rough stony land	1, 294	. 2
SBB2	Shelby and Burchard clay loams, 3 to 5 percent slopes, eroded	1, 894	. 3
SBC2	Shelby and Burchard clay loams, 5 to 8 percent slopes, eroded	1, 826	. 3
SBD2	Shelby and Burchard clay loams, 8 to 12 percent slopes, eroded	4, 220	. 8
SBD3	Shelby and Burchard soils, 8 to 12 percent slopes, severely eroded	3, 098	. 6
SBE2	Shelby and Burchard clay loams, 12 to 18 percent slopes, eroded	4, 232	. 8
Sn	Sogn complex	2, 409	. 4
StE	Steinauer clay loam, 12 to 25 percent slopes	2, 011	. 4
StE3	Steinauer soils, 12 to 18 percent slopes, severely eroded	1, 221	. 2
Sy	Alluvial land	32, 814	6. 0
Wa	Wabash silty clay	353	. 1
WtA	Wymore silty clay loam, 0 to 3 percent slopes	2, 896	. 5
WtB	Wymore silty clay loam, 3 to 5 percent slopes	582	. 1
WtB2	Wymore silty clay loam, 3 to 5 percent slopes, eroded	17, 527	3. 2
WtC2	Wymore silty clay loam, 5 to 8 percent slopes, eroded	49, 979	9. 1
WtC3	Wymore soils, 5 to 8 percent slopes, severely eroded	9, 917	1. 8
WtD3	Wymore soils, 8 to 12 percent slopes, severely eroded	2, 619	. 5
	Water	2, 907	. 5
	Quarry	36	(1)
	Total	549, 120	100. 0

[1] Less than 0.1 percent.

tain more stones and pebbles, and they have a redder subsoil. The parent material of the Wymore soils is silty clay loam loess.

Adair clay loam, 3 to 5 percent slopes, eroded (AdB2).—This gently sloping soil occurs as scattered areas on rounded ridge crests on the uplands. Surface runoff is medium. Almost all of this soil is cultivated.

The surface layer is 7 to 10 inches thick. A few small areas that are still in native grass or have been plowed recently have a surface layer that is 10 to 16 inches thick. The subsoil is reddish-brown, very firm clay. It is about 40 inches thick.

This soil is best suited to close-growing crops and sorghums. Crop rotations, nitrogen and phosphate fertilizers, and lime generally are needed to help control erosion, to maintain good tilth, and to ensure high yields. (Capability unit IIIe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Adair clay loam, 5 to 8 percent slopes, eroded (AdC2).—This soil occurs as scattered areas. When it is clean tilled and when the cover of vegetation is sparse, runoff is rapid. Most of the acreage is cultivated.

The surface layer is 5 to 10 inches thick. A few small areas that are still in native grass or have been plowed recently have a surface layer that is 10 to 16 inches thick. In some cultivated areas, part of the subsoil has been mixed with the surface layer. The subsoil is about 35 inches thick. The upper part is clay, and the lower part is silty clay loam or sandy clay loam. The subsoil is very firm when moist and very hard when dry. It is slowly permeable to water, air, and roots.

Because of its dense clay subsoil, this soil is best suited to close-growing crops, such as wheat, clover, and oats, and to grain sorghum. Corn can be grown in sequence with these crops.

Terraces and grassed waterways, a good cropping system, nitrogen and phosphate fertilizers, and lime are needed to control runoff, to maintain good tilth, and to ensure high yields. (Capability unit IIIe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Adair clay loam, 8 to 12 percent slopes, eroded (AdD2).—This sloping or strongly sloping soil occurs mainly as narrow bands along drains on the uplands. Surface runoff is rapid. Most of the acreage is in grass, but some of it is cultivated. Areas that are used as pasture have been moderately eroded.

The surface layer is dark colored and is 5 to 8 inches thick. In a few small native-hay meadows, the surface layer is more than 8 inches thick. The subsoil, about 25 inches thick, consists of very firm clay, and is slowly permeable to water, air, and roots.

Because of its slope and its dense clay subsoil, this soil is not well suited to cultivated crops. It is highly susceptible to erosion. Controlling gullies and maintaining waterways are difficult. If fertilizers are applied and erosion is controlled, fair yields of small grains, grasses, and legumes are obtained. Good management, however, is costly, and pasture is the best use for this soil. Pastures need to be well managed, because the soil is erodible. Yields of forage are low in pastures that are overgrazed. (Capability unit IVe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Adair and Pawnee soils, 5 to 8 percent slopes, severely eroded (APC3).—These soils have rapid runoff and poor tilth. Some areas are cultivated, but many have been abandoned as cropland and are now idle land or poor-quality pasture. Small rills and shallow gullies are numerous.

These soils have lost most or all of their original surface layer, and a layer of clay that was once the subsoil is now at or near the surface. The present surface layer, which is 2 to 5 inches of heavy clay loam or clay, is difficult to till. The clay subsoil, which is about 35 inches thick, is very firm when moist and very hard when dry. It is slowly permeable to water, air, and roots. At least half of the soil material in the present surface layer was originally part of the subsoil.

These soils are not well suited to cultivated crops, because of poor tilth, low fertility, a dense clay subsoil, and the severe hazard of erosion. Practices that improve tilth, permeability, and productivity include (1) constructing terraces and grassed waterways, (2) growing legumes, grasses, and other close-growing crops, (3) adding lime, (4) and applying manure and fertilizer.

It is better to use these soils for grasses and legumes than for grain. Pastures require fertilization and good grazing practices. (Capability unit IVe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Adair and Pawnee soils, 8 to 12 percent slopes, severely eroded (APD3).—These strongly sloping soils occur mainly along drains on the uplands. Surface runoff is rapid, and tilth is poor. Part of the acreage is cultivated, some is used as pasture, and some has been cultivated but is now either idle land or poor-quality pasture.

The surface layer is 2 to 5 inches of clay loam or clay. The subsoil is about 25 inches of clay that is very firm when moist and very hard when dry. It is slowly permeable to air, water, and roots.

These soils are best suited to perennial grasses for hay or for pasture. There are many side rills. In places, gullies have formed in the natural drains. Most of these gullies can be shaped, seeded, and used as grassed waterways. In a few places, dams or other structures are needed. (Capability unit VIe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Alluvial Land

Alluvial land consists of areas of mixed river sediments, or alluvium, recently deposited along streams. This material is generally stratified. It varies in texture and is subject to change each time the streams overflow. It is made up of silty sediments derived mainly from eroding surface soil and of sediments washed from raw banks and gullies in the surrounding glacial and loessal uplands. Some areas contain layers of sandy or clayey material washed from sandy, gravelly, or clayey strata of the adjacent uplands.

Alluvial land (Sy).—This land type generally is not suitable for cultivation. Most of the areas are cut by winding streams and are frequently flooded. Plants are washed out or covered up by overflow after heavy rains. Also, annual weeds are hard to control. Some of the larger areas have been cleared of trees and leveled, generally at considerable expense; these areas make excellent cropland if they are protected from overflow. Narrow areas at the headwaters of streams are used as pasture. Wider areas along the lower reaches of streams are used for wildlife or for timber. There are sand and gravel pits in some areas, chiefly along the Big Blue River. (Capability unit VIw–1; range site, Wet Land; tree-planting site, Wet Land).

Burchard Series

The Burchard series consists of moderately sloping and moderately steep soils on the glacial uplands.

The surface layer is dark-colored clay loam. It is about 8 inches thick, is slightly acid or medium acid, and has a granular structure. The subsoil is clay loam.

In this county the Burchard soils are closely associated with the Shelby soils. They are mapped with the Shelby soils, and the mapping units are described under the Shelby series. The Burchard soils are on the more rounded slopes. Their surface layer is similar to that of the Shelby soils. Their subsoil is thinner, lighter colored, and more limy (fig. 2) than that of the Shelby soils. In the Burchard soils, depth to lime is 14 to 30 inches. In the Shelby soils, it is 30 to 60 inches. The Burchard soils are leached of lime to a greater depth than are the Steinauer soils, which lack a true subsoil but have limy parent material near the surface.

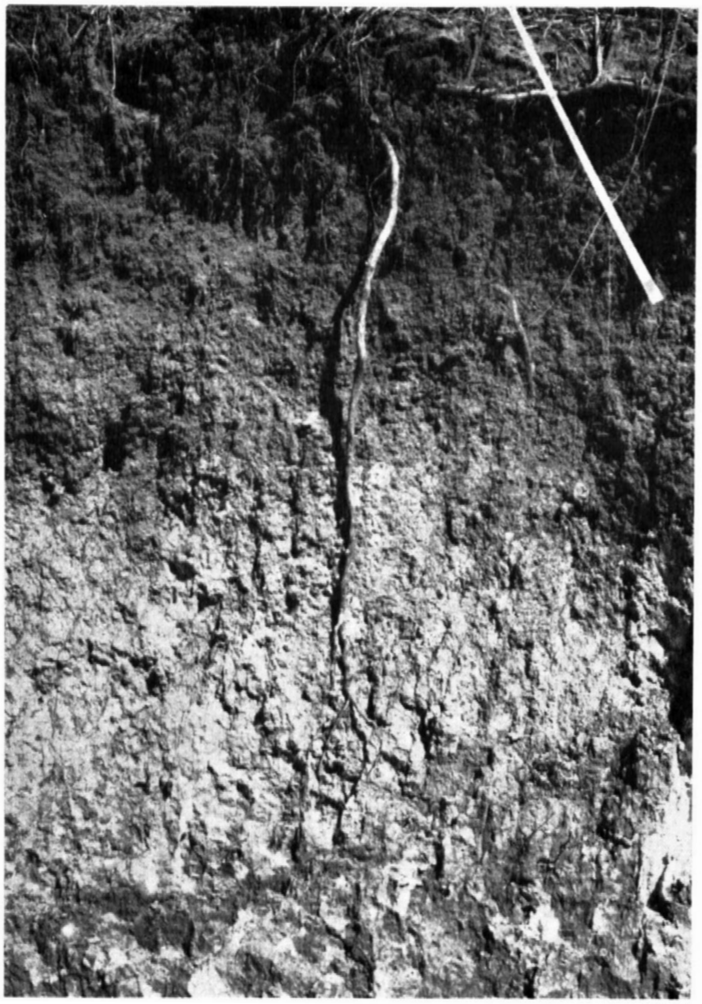

Figure 2.—**A profile of Burchard clay loam to a depth of 48 inches. Lime is 22 inches from the surface.**

Butler Series

The Butler series consists of deep, dark-colored, level soils on the loess-mantled uplands. These soils formed under prairie vegetation of tall grasses.

The surface layer is ordinarily about 12 inches thick but ranges from 8 to 18 inches in thickness. In texture it ranges from heavy silt loam to silty clay loam. It is very dark brown or black, is medium acid or strongly acid, and has a granular structure. In places there is a faint gray layer in the lower part, just above the subsoil. The lower boundary is abrupt.

The subsoil is 20 to 40 inches thick. The upper part is silty clay; it is very dark gray and has a moderate, coarse, blocky and strong, medium and fine, angular blocky structure. The lower part is heavy silty clay loam; it is dark grayish brown and calcareous and has a moderate, medium, angular blocky structure. The upper part is more clayey and more compact than the lower part.

The parent material is friable loess of silty clay loam or silt loam texture. It contains slight to moderate amounts of lime.

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Surface runoff and permeability are slow. The soils are susceptible to slight ponding during wet seasons.

The Butler soils are better drained than the Fillmore soils and have a less distinct gray layer above the subsoil. The Butler soils have slower runoff than the Crete soils and are darker colored in the upper part of the subsoil.

Butler silty clay loam (Bt).—This soil occurs as scattered areas on the level uplands, mainly in the western half of the county. Surface runoff is slow, and this soil is not eroded. Nearly all of the acreage is cultivated.

The surface layer is about 12 inches thick. There is a faint gray layer in the lower part. The boundary between the surface layer and the subsoil is abrupt. The subsoil is about 30 inches thick. The upper part is silty clay, and the lower part is silty clay loam. This layer is slowly permeable to water, roots, and air. Lime occurs at a depth of 30 to 60 inches.

Included with this soil on the map are a few small areas of Fillmore silt loam and of Crete silty clay loam, 0 to 3 percent slopes.

This soil is best suited to wheat and grain sorghum. Tillage is difficult in places. Fertilizers are required for high yields. (Capability unit IIIw-2; range site, Clayey; tree-planting site, Moderately Wet)

Cass Series

The Cass series consists of deep, dark-colored, nearly level soils on the bottom lands.

The surface layer is ordinarily about 12 inches thick but ranges from 8 to 18 inches in thickness. In texture it ranges from silt loam to fine sandy loam. This layer is very dark grayish brown, is very friable, and has a granular structure. In reaction it ranges from slightly acid to mildly alkaline.

The subsoil extends to a depth of 50 inches. It consists of sandy stream sediments. The upper part is fine sandy loam or sandy loam; it is dark grayish brown and has a weak, coarse, blocky structure. The lower part, below a depth of 30 inches, is coarse sandy loam; it is grayish brown or brown and has a weak, coarse, blocky structure. In places, the subsoil contains layers of loam, fine sand, or sand.

The Cass soils are naturally well drained but subject to overflow. Surface runoff is slow, and permeability is moderately rapid. The natural fertility is high.

The Cass soils have a sandier subsoil than the nearby Hobbs soils. The Hobbs soils have a silty subsoil.

Cass loam (Cm).—This soil occurs as scattered areas, mainly along the Big Blue River. It is nearly level, and surface runoff is slow. Permeability is moderately rapid. Nearly all of the acreage is cultivated.

The surface layer is 8 to 18 inches thick. It is dark colored, very friable, and easily worked. The subsoil is fine sandy loam or sandy loam, and in some places it contains thin layers of loam, fine sand, or sand.

This soil is suited to all crops commonly grown in the county. It is one of the better soils for corn and legumes. It can be tilled over a wide range of moisture conditions. The use of fertilizers according to soil tests and to the needs of crops is required for high yields. (Capability unit I-1; range site, Overflow; tree-planting site, Silty to Clayey)

Colo Series

The Colo series consists of deep, dark-colored, level and nearly level soils on the bottom lands.

The surface layer is ordinarily about 12 inches thick but ranges from 10 to 24 inches in thickness. In texture it ranges from silt loam to clay loam. This layer is very dark gray or black, has a granular structure, and ranges from slightly acid to moderately alkaline.

The subsoil extends to a depth of 46 inches. It consists of clayey stream sediments. The upper part is silty clay loam; it is very dark grayish brown and has a moderate, fine, subangular blocky structure. The lower part, below a depth of 32 inches, is silty clay loam; it is dark gray and has a weak, coarse, subangular blocky structure. At a depth of 46 to 58 inches, there is a layer of black silty clay, which is the surface layer of a buried soil. In places the subsoil contains layers of either loam or silty clay.

The Colo soils are imperfectly drained or moderately well drained and subject to overflow. Surface runoff is slow, and permeability is moderately slow. Natural fertility is high.

The Colo soils have a more clayey subsoil than the nearby Hobbs soils and are more poorly drained. They have a less clayey subsoil than the Wabash soils and are better drained.

Colo silty clay loam (Ct).—This level or nearly level soil occurs mainly on the bottom lands of major streams that drain into the Big Blue River and the Big Nemaha River. It is subject to flooding. Surface runoff is slow, and permeability is moderately slow. Nearly all of the acreage is cultivated.

The surface layer is 10 to 24 inches thick. To a depth of about 45 inches, the subsoil is silty clay loam, but below 45 inches it is generally very firm silty clay. In places the subsoil contains layers of loam, silt loam, or silty clay.

This soil is best suited to corn, grain sorghum, and alfalfa. It tends to dry slowly in spring, and it is suitable for tillage within only a limited range of moisture conditions. Small grains are likely to drown or to grow rank and then to lodge before harvest.

Drainage can be improved by (1) row direction, (2) surface bedding, (3) diversion terraces, (4) grading, and (5) open drainage ditches or grassed waterways. (Capability unit IIw-4; range site, Subirrigated; tree-planting site, Moderately Wet)

Crete Series

The Crete series consists of deep, dark-colored, nearly level and gently sloping soils on the loess-mantled uplands. These soils formed under a prairie vegetation of mid and tall grasses.

The surface layer is ordinarily about 10 inches thick but ranges from 5 to 16 inches in thickness. In texture it ranges from silt loam to heavy silty clay loam. This layer is very dark gray, very dark brown, or black. It is medium acid or strongly acid and has a granular structure. The boundary between the surface layer and the subsoil is clear (fig. 3).

***Figure 3.*—A profile of Crete silty clay loam.**

The subsoil is ordinarily about 30 inches thick but ranges from 24 to 44 inches in thickness. The upper part is predominantly silty clay; it is very dark grayish brown or dark grayish brown and has a moderate, coarse, prismatic and strong, medium, blocky structure. The lower part is predominantly silty clay loam; it is olive or pale olive, is calcareous, and has a weak, coarse, blocky structure. The upper part is more clayey and more compact than the lower part.

The parent material is silty loess. It is friable and contains slight to moderate amounts of lime.

The Crete soils are well drained. Surface runoff is medium, and permeability is slow. These soils are high in natural fertility. They are slightly or moderately susceptible to erosion.

The Crete soils have better surface drainage than the nearby Butler and Fillmore soils and are browner in the upper part of the subsoil. The Crete soils have fewer mottles than the Wymore soils, and they have a lime zone in the lower part of the profile.

Crete silty clay loam, 0 to 3 percent slopes (CrA).—This is the most extensive of the nearly level soils on the uplands. The individual areas are large. Surface runoff is generally medium but is a little slower in some places. This soil is not eroded. Nearly all of it is cultivated.

The surface layer is 8 to 16 inches thick. It is friable and easily worked. The subsoil is about 30 inches thick. The upper part is silty clay, and the lower part is silty clay loam. This layer is slowly permeable to water, roots, and air. Lime occurs at a depth of 25 to 40 inches.

Included with this soil on the map are a few small areas of Butler silty clay loam.

This soil is suited to all crops commonly grown in the area. The main crops are corn, wheat, grain sorghum, clover, and alfalfa. Corn is the crop most likely to be adversely affected by dry weather. With the use of lime and fertilizers according to needs, a good cropping system, and maintenance of good tilth, yields of crops are high. Where the slope is 2 or 3 percent, contour farming and terracing are needed. (Capability unit IIs–2; range site, Clayey; tree-planting site, Silty to Clayey)

Crete silty clay loam, 3 to 5 percent slopes (CrB).—This gently sloping soil is mainly on the uplands. The areas are small and scattered. Surface runoff is medium but is more rapid than on Crete silty clay loam, 0 to 3 percent slopes. This soil is slightly eroded. Some of it is cultivated, and some is in grass.

The surface layer is 8 to 12 inches thick. The subsoil is about 25 inches thick. The upper part of the subsoil is silty clay, and the lower part is silty clay loam. This layer is slowly permeable to air, roots, and water. Lime occurs at a depth of 25 to 35 inches.

Corn yields are likely to be low in dry years. Conservation measures, such as terracing, contour farming, crop rotation, and the use of lime and fertilizers generally are needed for continuous high yields. (Capability unit IIIe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Crete silty clay loam, 3 to 5 percent slopes, eroded (CrB2).—This is a fairly extensive, gently sloping soil on the uplands. Surface runoff is classed as medium but approaches rapid. Almost all of this soil is cultivated.

The surface layer is 5 to 8 inches thick. The subsoil is about 25 inches thick. The upper part of the subsoil is very firm silty clay, and the lower part is firm silty clay loam. This layer is slowly permeable to air, roots, and water. Lime is at a depth of 25 to 30 inches.

The main crops grown on this soil are corn, wheat, oats, grain sorghum, clover, and alfalfa. Corn and alfalfa are the crops most likely to be adversely affected by dry weather. Practices that improve tilth and productivity and help to control runoff and erosion include (1) constructing terraces and grassed waterways, (2) using crop rotations, (3) growing green-manure crops, (4) adding lime, and (5) applying nitrogen and phosphate fertilizers. (Capability unit IIIe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Exline Series

The Exline series consists of deep, rather light-colored, nearly level and gently sloping, alkali soils on the low terraces and bottom lands. These soils formed in material deposited by streams.

The surface layer ordinarily is only about 3 inches thick, but it ranges from 0 to 6 inches. The texture ranges from silt loam to silty clay. This layer is gray, is medium acid or slightly acid, and has a thin platy and fine granular structure. The lower boundary is abrupt.

The subsoil is ordinarily about 20 inches thick but ranges from 12 to 30 inches in thickness. It contains a moderate amount of exchangeable sodium. The upper part is silty clay; it is very dark gray and has a strong, medium, columnar and moderate, fine and medium, angular blocky structure. It is extremely hard when dry and very firm when moist. The lower part is also silty clay, but it is dark grayish brown and has a moderate, coarse, prismatic and weak, medium, angular blocky structure. It is very hard when dry and firm to very firm when moist. It contains salt crystals and lime. It is less compact than the upper part.

The parent material contains salt and is high in exchangeable sodium. It consists of stratified stream sediments of clay, silty clay, silty clay loam, and loam texture.

The Exline soils are somewhat poorly drained. In most places runoff is slow or very slow. Permeability is very slow. The natural fertility is low.

The Exline soils are more alkaline than the nearby Rokeby soils and have a thinner, lighter colored surface layer.

Exline soils (E).—These nearly level or gently sloping, alkali soils are on the low terraces and bottom lands. The areas are small, and some are within areas of tillable soils. Surface runoff is generally slow but approaches rapid where the soils are gently sloping. Some of the acreage is cultivated, and some is in grass.

The surface layer consists of silty clay loam. It is 0 to 6 inches thick. The subsoil, which is about 20 inches thick, is very firm silty clay. It is extremely hard when dry and very slowly permeable to roots, air, and water. In cultivated areas, the subsoil makes up about 75 percent of the present plow layer. Salt crystals and lime occur at a depth of 12 to 36 inches.

These soils are more commonly known as "slick" or "alkali" areas. They are not suited to cultivated crops but are suited to alkali-tolerant grasses. Growing legumes and applying barnyard manure are the best ways of improving the tilth and permeability of the small areas that are within areas of tillable soils. Because these soils are inextensive and occur only as small areas, they are not assigned to a range site. (Capability unit VIs–1)

Fillmore Series

The Fillmore series consists of deep, dark-colored soils on the loess-mantled uplands. These soils formed in depressions under a cover of tall grasses.

The surface layer is silt loam. It is ordinarily about 14 inches thick but ranges from 10 to 16 inches in thickness. The upper part of this layer is darker colored than the lower part; the upper part is black or very dark brown, and the lower part is gray. This gray layer is generally 2 to 8 inches thick, but in a few places it is not distinct. The entire surface layer has a platy structure and is medium acid or strongly acid. Lime occurs at a depth of 30 to 50 inches. The boundary between the surface layer and the subsoil is abrupt.

The subsoil is about 30 inches thick. The upper part is silty clay; it is black and has a moderate, coarse, blocky structure and strong, fine and medium, angular blocky structure. It is more clayey and more compact than the lower part. The lower part is silty clay loam;

it is dark grayish brown and calcareous and has a moderate, medium, angular blocky structure.

The parent material is loess of silt loam or silty clay loam texture. It generally contains slight to moderate amounts of lime.

Surface runoff is very slow or ponded, and permeability is slow. Natural fertility is high.

The Fillmore soils are more poorly drained than the nearby Butler soils and have a more distinct gray layer above the subsoil.

Fillmore silt loam (Fm).—This soil occurs in basinlike depressions on the uplands. The areas are small and scattered. Surface runoff is very slow or ponded. Some areas are cultivated and others are not, depending upon the availability of drainage outlets, the season of the year, and the amount of precipitation.

The surface layer is 10 to 16 inches thick. It is very friable and easily tilled. The subsoil is about 30 inches thick. The upper part is silty clay, and the lower part is silty clay loam. This layer is slowly permeable to water, air, and roots. Lime occurs at a depth of 30 to 50 inches.

Included with this soil on the map are a few small areas of Butler silty clay loam.

If this soil is drained, it is best suited to wheat and sorghums. Tillage is difficult during wet weather, even if the soil is drained. Drainage can be improved by proper row direction, by surface bedding, and by grading. Areas of this soil may be used as feeding and nesting places for upland game birds. It can also be used for grazing after crops have been harvested on the surrounding acreages. (Capability unit IIIw–2; range site, Overflow; tree-planting site, Wet Land)

Geary Series

The Geary series consists of deep, dark-colored, gently sloping and sloping soils on the loess-mantled uplands. These soils formed under prairie vegetation of mid and tall grasses.

The surface layer is ordinarily about 9 inches thick but ranges from 3 to 16 inches in thickness. In texture it ranges from loam to silty clay loam. This layer is very dark brown or dark brown, is medium acid, and has a granular structure. The boundary between the surface layer and the subsoil is gradual.

The subsoil is ordinarily about 30 inches thick but ranges from 20 to 40 inches in thickness. In texture it ranges from heavy silty clay loam to silt loam. It is dark reddish brown or reddish brown and has a moderate, coarse, prismatic structure that breaks to moderate, fine, subangular blocky. This layer is slightly acid. It is hard when dry and friable when moist.

The parent material is reddish loess of silty or loamy texture. It contains no lime. In some places old stream deposits or wind-worked sands occur below a depth of 4 or 5 feet.

The Geary soils are well drained. Surface runoff is medium or rapid, and permeability is moderately slow or moderate. These soils are high in natural fertility. They are highly susceptible to water erosion.

The Geary soils are reddish brown, and the nearby Crete soils are grayish brown. The Geary soils have a less clayey subsoil than the Crete and Adair soils. They lack the lime zone that is characteristic of the Crete soils.

Geary silty clay loam, 3 to 5 percent slopes, eroded (GeB2).—This gently sloping soil is on ridge crests and valley sides. It is scattered throughout the county but is mainly in the western part. Surface runoff is medium. Almost all of this soil is cultivated.

The surface layer is 7 to 10 inches thick. A few small areas that have been plowed recently or are still in native grass have a surface layer that is 10 to 16 inches thick. This layer is friable and easily worked. The subsoil, which is about 30 inches thick, consists of silty clay loam. It is moderately slowly permeable.

This upland soil is one of the more productive soils in the county. It is suited to all crops commonly grown, and it responds to good management. (Capability unit IIe–1; range site, Clayey; tree-planting site, Silty to Clayey)

Geary silty clay loam, 5 to 8 percent slopes, eroded (GeC2).—This moderately sloping soil is on valley sides along small streams. It is scattered throughout the county but occurs mainly in the western part. Surface runoff is medium but is more rapid than on Geary silty clay loam, 3 to 5 percent slopes, eroded. Nearly all of this soil is cultivated.

The surface layer is 5 to 9 inches thick. A few small areas that have been plowed recently or are still in native grass have a surface layer that is more than 9 inches thick. This layer is moderately slowly permeable to water and air. Roots penetrate the subsoil readily.

This soil responds to good management and is suited to the crops commonly grown in the county. (Capability unit IIIe–1; range site, Clayey; tree-planting site, Silty to Clayey)

Geary soils, 5 to 12 percent slopes, severely eroded (GeD3).—These sloping or strongly sloping soils occur on valley sides along streams. The areas are small and scattered. Most are in the western part of the county. The slope generally is between 5 and 8 percent. Surface runoff is classed as medium but approaches rapid. Some areas are cultivated, but some have been abandoned as cropland and are now poor-quality pasture.

The surface layer is silty clay loam. It is 3 to 5 inches thick. In areas that have been cultivated, about half of the material in this layer was originally the upper part of the subsoil. The present subsoil is friable or slightly firm silty clay loam and is about 25 inches thick.

Because of low fertility and the severe hazard of erosion, these soils are only fair for crops. They respond to good management, however. Practices that improve productivity include (1) constructing terraces and grassed waterways, (2) growing legumes, green-manure crops, and other close-growing crops, (3) adding lime, and (4) applying fertilizers. Pastures require fertilization and proper grazing management. (Capability unit IVe–8; range site, Clayey; tree-planting site, Silty to Clayey)

Hedville Series

The Hedville series consists of sloping and steep soils on the uplands. These soils are shallow over sandstone.

The surface layer is ordinarily about 6 inches thick but ranges from 2 to 18 inches in thickness. In texture it ranges from clay loam to sandy loam. In places this layer contains sandstone fragments. It is dark brown, is medium acid, and has a granular structure.

The thin subsoil consists of soft, weathered, dark-brown sandstone. It is generally about 10 inches thick but ranges from 5 to 14 inches in thickness. It contains many fragments of hard ironstone. The thickness of this layer depends upon the denseness of the bedrock.

The substratum is ordinarily at a depth of about 16 inches. It consists of broken and slightly weathered, reddish-brown sandstone (fig. 4).

The Hedville soils are somewhat excessively drained. Surface runoff is rapid, and the soils are highly susceptible to erosion.

The Hedville soils are shallower than the nearby Lancaster soils. They are shallower than the Lanham soils, which have parent material of clay shale. The Hedville soils differ from the Sogn soils in that they are shallow over sandstone instead of limestone.

Hedville stony loam (Hv).—This sloping or steep soil is on valley sides where bedrock is near the surface. It is not extensive. The areas are small and scattered. Most are in the southern part of the county. Nearly all of the acreage is in grass.

The surface layer is 2 to 18 inches thick and contains many sandstone fragments. The subsoil consists of weathered sandstone of sandy loam texture and contains many ironstone fragments. The bedrock is broken and slightly weathered sandstone.

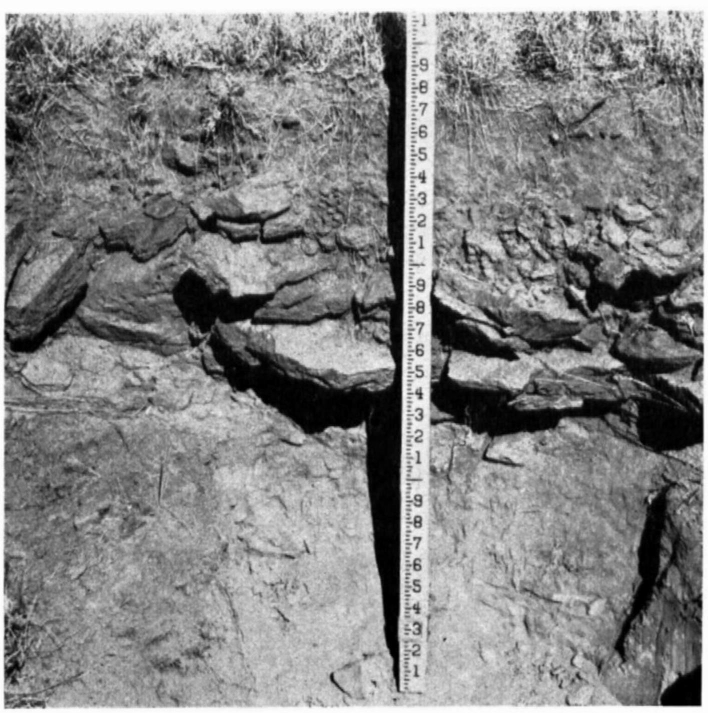

Figure 4.—**A profile of Hedville stony loam.**

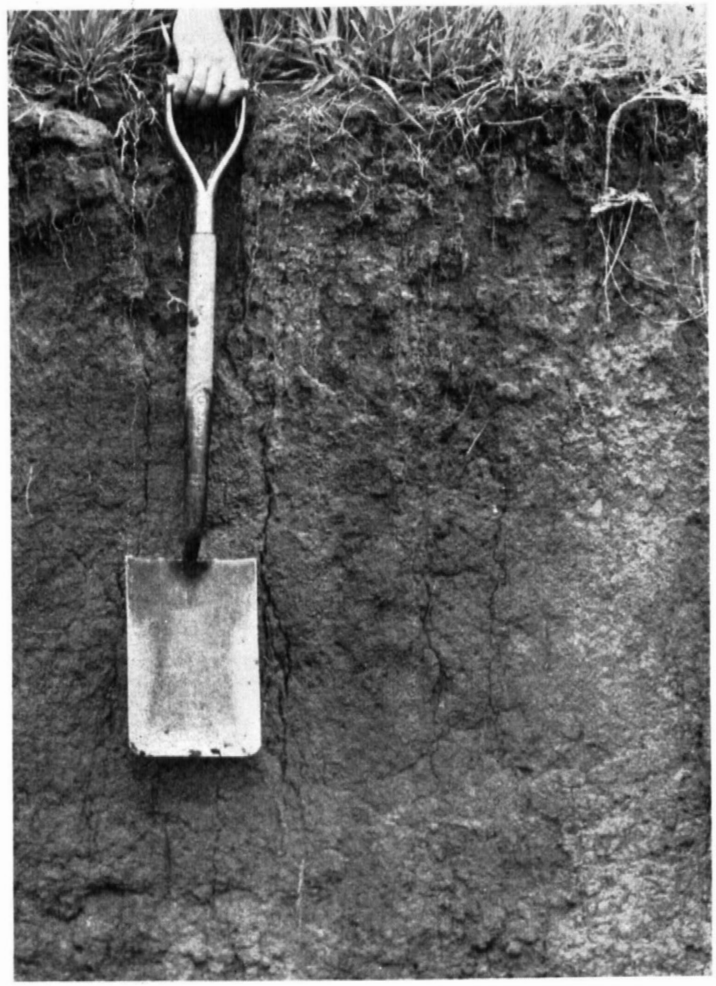

Figure 5.—**A profile of Hobbs silt loam. The spade is 36 inches long.**

Included in the areas mapped are a few small areas of Lancaster loam, 8 to 12 percent slopes. This soil is best suited to native grass. (Capability unit VIs-4; range site, Shallow Nonlimy)

Hobbs Series

The Hobbs series consists of deep, dark-colored, nearly level soils on the bottom lands.

The surface layer is ordinarily about 18 inches thick but ranges from 10 to 24 inches in thickness. In texture it ranges from very fine sandy loam to silty clay loam. This layer is generally very dark brown, but in places it is lighter colored because of recent overwash. It is neutral or slightly acid and has a granular structure.

The subsoil extends to a depth of 60 inches (fig. 5). It consists of silty stream sediments. The upper part is silt loam; it is very dark grayish brown and has a weak, coarse, prismatic structure. The lower part, below a depth of 30 inches, is heavy silt loam; it is dark gray or dark grayish brown and has a weak, coarse and medium, blocky (cloddy) structure. In reaction, the subsoil is neutral. In many places it has alternating thin layers of sandy loam, loam, silty clay loam, and silt loam. In places there is a dark-colored layer that is the surface layer of a buried soil.

The Hobbs soils are well drained but are subject to flooding in some places. Surface runoff is slow, and permeability is moderate. Natural fertility is high.

The subsoil of the Hobbs soils is more stratified and less clayey than that of the nearby Muir soils, which are on low terraces. The Hobbs soils have better internal drainage than the Colo soils and have a less clayey subsoil. They differ from the Cass soils in that their subsoil is silty instead of sandy.

Hobbs silt loam, seldom flooded (Hb).—This is a fairly extensive soil on the high bottom lands. It is nearly level, and surface runoff is slow. Almost all of the acreage is cultivated.

The surface layer is 10 to 24 inches thick. It is dark colored, friable, and easily tilled. The subsoil is silt loam. It is moderately permeable to water and air. Roots penetrate this layer easily. In many places the subsoil has alternating thin layers of silt loam, sandy loam, loam, and silty clay loam.

This soil is fertile and productive. It is suited to all crops commonly grown in the county, but corn is the main crop. Crop rotations and the use of fertilizers according to soil tests ensure satisfactory yields year after year. (Capability unit I–1; range site, Overflow; tree-planting site, Silty to Clayey)

Hobbs silt loam, occasionally flooded (2Hb).—This is a fairly extensive soil on the low bottom lands. It is nearly level and occurs mainly in the valleys of tributaries of the Big Blue River and the Big Nemaha River. Surface runoff is slow, but floodwater drains readily after the streams go down.

The surface layer is 10 to 24 inches thick. It is friable and easily worked. In places this layer is light colored because of recent overwash. The subsoil is silt loam. It is moderately permeable to water and air. Roots penetrate this layer easily. In most places the subsoil has alternating thin layers of silt loam, sandy loam, loam, and silty clay loam.

This soil is fertile and productive. It is suited to all crops commonly grown in the county. It is least well suited to small grains, because of the flood hazard, which is its main limitation. Row direction, diversion terraces, and upstream water control help to control flooding. (Capability unit IIw–3; range site, Overflow; tree-planting site, Moderately Wet)

Judson Series

The Judson series consists of deep, dark-colored, nearly level and gently sloping soils on the foot slopes.

The surface layer is ordinarily about 20 inches thick but ranges from 12 to 24 inches in thickness. In texture it ranges from silt loam to fine sandy loam. It is very dark brown or black, is medium acid to neutral, and has a granular structure. The lower boundary is gradual.

The subsoil consists of silty to clayey, neutral, dark-colored material that worked down from the adjoining uplands. This layer extends to a depth of 50 inches. The upper part is silt loam; it is very dark brown and has a strong, granular structure. The lower part, below a depth of 30 inches, is clay loam; it is dark brown or dark grayish brown and has a moderate, fine and medium, blocky structure. This lower part ranges from silt loam to clay in texture.

The Judson soils are well drained. Surface runoff is slow or medium, and permeability is moderate or moderately slow. Natural fertility is very high.

The Judson soils have less distinct layers than the nearby Muir soils, but they have a thicker surface layer. The Judson soils are deeper over sandy layers than the Hobbs soils, which are on the nearby bottom lands, and they have a more uniform subsoil.

Judson fine sandy loam, 3 to 5 percent slopes (JfB).—This gently sloping soil occurs as scattered areas on the foot slopes and on the valley sides along drains. Surface runoff is medium. Some areas are cultivated, but irregular and isolated areas along drains are used as pasture.

The surface layer is 8 to 18 inches thick. It is very friable and is easily tilled. To a depth of 30 inches, the subsoil is silt loam. It is moderately permeable to water and air. Roots penetrate this layer easily. Below 30 inches, the subsoil is clay loam.

This soil is fertile and productive. It is suitable for all crops grown in the county. Corn and alfalfa yield well if adequately fertilized. Oats sometimes lodge because of rank growth.

Runoff from adjacent slopes is a hazard on this soil. It causes deep rilling and gullying of natural waterways. Either grassed waterways or diversion terraces are required. If this soil is well managed, it is excellent for pasture. (Capability unit IIe–3; range site, Silty; tree-planting site, Sandy)

Judson silt loam, 1 to 3 percent slopes (JuA).—This nearly level or very gently sloping soil occurs as scattered areas adjacent to small drains and streams. Surface runoff is slow. Some areas along meandering streams are used as pasture because they are isolated and difficult to cultivate. Other areas are cultivated.

The surface layer is 12 to 24 inches thick. It is friable and easily worked. To a depth of 30 inches, the subsoil is silt loam. Roots, water, and air penetrate this layer easily. Below 30 inches, the subsoil is clay loam.

This soil is fertile and is suitable for all crops commonly grown in the county. If adequately fertilized, corn and alfalfa yield well. Oats sometimes lodge because of rank growth. Erosion is not a problem except in a few places where runoff from higher slopes causes gullying. This soil is excellent for pasture. (Capability unit I–1; range site, Silty; tree-planting site, Silty to Clayey)

Judson silt loam, 3 to 5 percent slopes (JuB).—This gently sloping soil is fairly extensive. It occurs as scattered areas on the foot slopes at the base of uplands and on the valley sides along small drains. Surface runoff is medium. Most of the acreage is cultivated, but many irregularly shaped areas along drains are used as pasture.

The surface layer is 12 to 18 inches thick. It is friable and easily tilled. To a depth of 30 inches, the subsoil is silt loam. Roots, water, and air penetrate this layer easily. Below 30 inches, the subsoil is clay loam.

This soil is fertile and productive. It is suitable for all crops commonly grown in the area. Corn and alfalfa yield well if adequately fertilized. Oats and other small grains sometimes lodge because of rank growth. Runoff from the adjacent uplands is a hazard in cultivated areas. It causes deep rilling and gullying and deepening of natural waterways. Either grassed waterways or diversion terraces are required. This soil makes excellent pasture if it is well managed. (Capabilty unit IIe-1; range site, Silty; tree-planting site, Silty to Clayey)

Labette Series

The Labette series consists of sloping and strongly sloping, deep and moderately deep soils over shale bedrock. These soils are on the uplands. They formed under prairie vegetation of mid and tall grasses.

The surface layer is ordinarily about 10 inches thick but ranges from 5 to 14 inches in thickness. In texture it ranges from silt loam to silty clay loam. It is very dark grayish brown or dark brown, is medium acid, and has a granular structure. The lower boundary is clear.

The subsoil is about 25 inches thick. In texture it ranges from silty clay loam to silty clay. The upper part is silty clay loam; it is dark brown and has a moderate, fine, subangular blocky structure. The lower part is silty clay; it is brown and has a moderate, coarse and medium, angular blocky structure. The upper part is less clayey and less compact than the lower part. This transition is gradual. The layers in the subsoil are nondistinct or only slightly distinct as they grade to the parent material. The texture of the surface layer and that of the subsoil vary according to the location of the soils in the county and to the degree of erosion.

The parent material consists of silty clay weathered from clay shale. It contains lime. The substratum, at a depth of 30 to 60 inches, consists of slightly weathered, interbedded limestone and shale.

Labette silty clay loam, 5 to 12 percent slopes (LwD).—This sloping or strongly sloping soil is on the lower part of valley slopes where shale and limestone are near the surface. It is not extensive. The areas are small and scattered. Most are in the southern part of the county. Almost all of the acreage is in grass.

The surface layer is 5 to 14 inches thick. In a few places it contains a scattering of limestone fragments. The subsoil is about 25 inches thick. The upper part is silty clay loam, and the lower part is silty clay. In some places limestone fragments are scattered through this layer. The subsoil is slowly permeable to water, air, and roots.

Included in the areas mapped are a few small areas of Sogn complex. This soil is excellent for pasture if properly managed but is only fair for cultivated crops. It is highly susceptible to erosion. Good yields of wheat, oats, legumes, and grasses can be obtained. Corn can be grown to a limited extent, in rotation with other crops. (Capability unit IVe-1; range site, Clayey; tree-planting site, Silty to Clayey)

Lancaster Series

The Lancaster series consists of gently sloping and sloping soils on the uplands. These soils are deep and moderately deep over sandstone. They formed under prairie vegetation of mid and tall grasses.

The surface layer is ordinarily about 10 inches thick but ranges from 6 to 14 inches in thickness. In texture it ranges from silt loam to fine sandy loam. It is very dark brown, is medium acid, and has a granular structure.

The subsoil is ordinarily about 10 inches thick but ranges from 8 to 20 inches in thickness. It is predominantly loam but ranges from clay loam to sandy loam in texture. This layer is dark reddish brown, is slightly acid, and has a weak, coarse, blocky structure that breaks to moderate, fine, subangular blocky.

The parent material is yellowish-red sandy loam weathered from the underlying sandstone. It contains no lime. The substratum is at a depth of 30 to 60 inches. It is reddish-brown, slightly weathered, layered but broken sandstone.

The Lancaster soils are well drained. Surface runoff is medium, and permeability is moderate. The soils are medium in natural fertility. They are highly susceptible to erosion.

The Lancaster soils are deeper than the nearby Hedville soils. They are also deeper than the Sogn soils, which overlie limestone. The Lancaster soils have a loamy subsoil, the Lanham soils have a heavy clay subsoil, and the Labette soils have a silty clay subsoil.

Lancaster loam, 3 to 8 percent slopes (LcC).—This gently sloping or sloping soil is mainly in the southern part of the county west of the Big Blue River. The areas are small and scattered. Surface runoff is medium. Most of the acreage is in grass.

The surface layer is 6 to 14 inches thick and is very friable. The subsoil is 8 to 20 inches thick. Its texture is loam. Roots, water, and air penetrate this layer easily. The parent sandstone is at a depth of 30 to 60 inches. It is either soft and weathered or hard and rich in iron.

This soil is suited to all crops grown in the county. Many areas, however, are either too small for practical tillage or are within areas of nonproductive soils. If cultivated, this soil needs to be fertilized and protected from erosion. It is good for pasture if properly managed. (Capability unit IIIe-1; range site, Silty; tree-planting site, Silty to Clayey)

Lancaster loam, 8 to 12 percent slopes (LcD).—This strongly sloping soil occurs as small, scattered areas in the southern part of the county west of the Big Blue River. Surface runoff is classed as medium but approaches rapid. Most of the acreage is in grass.

The surface layer is 6 to 12 inches thick and is very friable. The subsoil is loam. It is 8 to 12 inches thick. Roots, water, and air penetrate this layer easily. The parent sandstone is at a depth of 30 to 60 inches. It is either soft and weathered or hard and rich in iron.

This soil is suitable for cultivation but needs to be protected against erosion. Fair yields of wheat, oats, legumes, and grasses can be obtained. Because of low fertility and the severe hazard of erosion, this soil is not well suited to corn. It is best suited to grass or to a grass-legume mixture because the areas generally are small and are within areas of soils that are not suitable for cultivation. This soil is good for pasture if it is well managed. (Capability unit IVe-1; range site, Silty; tree-planting site, Silty to Clayey)

Lanham Series

The Lanham series consists of moderately deep, dark-colored, strongly sloping and moderately steep soils on the uplands. These soils are underlain by clay shale. They formed under prairie grass.

The surface layer is ordinarily about 8 inches thick but ranges from 5 to 14 inches in thickness. In texture it ranges from clay loam to sandy loam. This layer is very dark brown, is medium acid, and has a granular structure. In places it contains scattered fragments of sandstone and limestone. The boundary between this layer and the subsoil is abrupt and wavy.

The subsoil is clay. It is ordinarily about 12 inches thick but ranges from 8 to 20 inches in thickness. This layer is slightly acid, is reddish brown or dark brown, and has a moderate, coarse and medium, blocky structure. It is extremely hard when dry and extremely firm when moist. The boundary between this layer and the parent material is gradual and irregular.

The parent material is extremely firm clay weathered from clay shale. It contains no lime. This material is coarsely streaked with light gray, yellowish brown, light brown, pinkish gray, and dark red.

Surface runoff is rapid, and permeability is very slow. The soils are low in natural fertility and are highly susceptible to water erosion.

The Lanham soils differ from the nearby Lancaster, Hedville, Labette, and Sogn soils in that they are streaked and have a subsoil and parent material of heavy clay.

Lanham clay loam (Lg).—This strongly sloping and moderately steep soil is on valley sides, mainly in the southwestern part of the county along Big Indian Creek. Surface runoff is rapid. The total acreage is small, and all of it is in grass.

The surface layer is 5 to 14 inches thick. The subsoil is about 12 inches thick. Its texture is clay, and it is very slowly permeable to water, air, and roots. The parent material is at a depth of 20 to 35 inches. It is extremely firm clay and is streaked with various colors.

This soil is best suited to native grass. If well managed it is fair for pasture. (Capability unit VIe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Morrill Series

The Morrill series consists of deep, dark-colored, gently sloping and moderately steep soils on the uplands. These soils formed under prairie vegetation of mid and tall grasses.

The surface layer is ordinarily about 8 inches thick but ranges from 3 to 16 inches in thickness. In texture it ranges from heavy sandy loam or gravelly loam to loam or clay loam. It is very dark brown, is medium acid or strongly acid, and has a granular structure. There is a gradual boundary between this layer and the subsoil.

The subsoil is slightly acid. It is ordinarily about 30 inches thick but ranges from 10 to 40 inches in thickness. In texture it ranges from heavy clay loam or sandy clay loam to loam or sandy loam. The upper part is clay loam or gritty clay loam; it is dark reddish brown and has a weak, coarse, prismatic structure that breaks to moderate, medium and fine, subangular blocky. The lower part is gritty clay loam; it is reddish brown and has a weak, coarse, angular blocky structure.

The parent material is reddish-brown, reworked loamy material. This material is at a depth of 18 to 50 inches. Pockets of sand and gravel occur in places.

The Morrill soils are naturally well drained or somewhat excessively drained. Surface runoff is medium or rapid. Permeability ranges from moderately slow to moderately rapid. These soils are medium to high in natural fertility. They are highly susceptible to erosion.

The subsoil of the Morrill soils is more acid than that of the Shelby and Burchard soils. It is reddish brown, and that of the Shelby and Burchard soils is yellowish brown. It is less clayey than that of the Adair soils.

Morrill loam, 3 to 5 percent slopes, eroded (MrB2).—This gently sloping soil occurs as a few scattered areas on rounded ridge crests. Surface runoff is medium. Except for a few small areas of grass, all of the acreage is cultivated.

The surface layer is 7 to 10 inches thick. It is friable and easily worked. A few small areas that are still in native grass or that have been plowed recently have a surface layer that is 10 to 16 inches thick. The subsoil consists of gritty clay loam. It is friable to firm and is about 30 inches thick. Permeability is moderately slow, but roots penetrate this layer easily.

This is a productive soil. It needs some protection against erosion. It is suited to all crops commonly grown in the county. Yields are good if lime, nitrogen, and phosphate are applied and legumes are included in the rotation. (Capability unit IIe–1; range site, Silty; tree-planting site, Silty to Clayey)

Morrill loam, 5 to 8 percent slopes, eroded (MrC2).—This sloping soil is on valley sides. The areas are scattered. Surface runoff is medium. Except for a few small areas of grass, all of the acreage is cultivated.

The surface layer is 5 to 10 inches thick. It is friable and easily tilled. A few small areas that are still in native grass and the areas that have been plowed recently have a surface layer that is 10 to 16 inches thick. In some cultivated areas, part of the subsoil has been mixed with the surface layer. The subsoil is about 30 inches thick. It consists of gritty clay loam that is friable to slightly firm. Permeability is moderately slow, but roots, water, and air penetrate this layer readily.

This soil is suited to all crops commonly grown in the area. Terraces, grassed waterways, legumes, lime, and nitrogen and phosphate fertilizers are required to maintain productivity. (Capability unit IIIe–1; range site, Silty; tree-planting site, Silty to Clayey)

Morrill loam, 8 to 12 percent slopes, eroded (MrD2).—This strongly sloping soil is on valley sides. The areas are scattered. Surface runoff approaches rapid. About 70 percent of this soil is cultivated and is eroded. About 20 percent is in native grass.

The surface layer is 5 to 8 inches thick. It is friable and easily worked. In the areas still in native grass, the surface layer is more than 8 inches thick. In some cultivated areas, part of the subsoil has been mixed with the surface layer. The subsoil is about 25 inches thick. It consists of friable to firm gritty clay loam. Permeability is moderately slow, but roots penetrate this layer easily.

This soil is fairly productive. It is best suited to close-growing crops, such as wheat, clover, grasses, and legumes. Corn can be grown to a limited extent. Terraces, grassed waterways, and fertilizers are required for continuous good yields. If properly managed, this soil is good for pasture. (Capability unit IIIe–1; range site, Silty; tree-planting site, Silty to Clayey)

Morrill loam, 12 to 18 percent slopes, eroded (MrE2).—This moderately steep soil is on valley sides. The areas are small and scattered. Surface runoff is rapid. Almost all of the acreage is in grass, but some of it has been cultivated in the past.

The surface layer is 5 to 10 inches thick. The subsoil is about 20 inches thick. It consists of friable to firm gritty clay loam. It is moderately slow in permeability but is readily penetrated by roots, water, and air.

If properly managed, this soil is fairly productive of cultivated crops, but it is best suited to grasses and legumes. Yields are good if pastures and hayfields are well managed. Gullying of the natural drains can be controlled by grassed waterways or by dams or other structures. (Capability unit IVe-1; range site, Silty; tree-planting site, Silty to Clayey)

Morrill complex, 5 to 8 percent slopes (MxC).—This complex consists of a mixture of Morrill soils and other soils that have many characteristics of Morrill soils. The soils in this complex are sloping and occur on valley sides. The areas are small and scattered. About 55 percent of this complex consists of a soil that is moderately deep over sand and gravel; about 30 percent consists of various deep sandy soils; about 10 percent is Morrill loam, 5 to 8 percent slopes, eroded; and the rest is Morrill loam, 3 to 5 percent slopes, eroded.

The moderately deep soil is shallower over coarse sediments than the typical Morrill soils. The surface layer is loam. It is 8 to 14 inches thick, friable, and easily worked. The coarse sediments are at a depth of about 30 inches. Roots, water, and air penetrate the upper layers of this soil easily.

The deep sandy soils generally occur in patches on rounded knolls. The surface layer is fine sandy loam. It is 8 to 14 inches thick and very friable. To a depth of 50 inches, the subsoil consists of fine sandy loam, loamy fine sand, or sand, or it is layered with combinations of these textures.

Morrill loam, 5 to 8 percent slopes, eroded, and Morrill loam, 3 to 5 percent slopes, eroded, are on smooth valley sides and on concave slopes around the edges of rounded knolls.

All crops and grasses commonly grown in the county can be grown on these soils. Legumes, green-manure crops, lime, and nitrogen and phosphate fertilizers are required for high yields. Terraces and grassed waterways help to control erosion. (Capability unit IIIe-3; range site, Silty; tree-planting site, Sandy)

Morrill complex, 8 to 12 percent slopes (MxD).—This complex consists of a mixture of Morrill soils and other soils that have many characteristics of Morrill soils. The soils in this complex are on strongly sloping uplands. The areas are small and scattered.

About 50 percent of this complex consists of a soil that is moderately deep over sand and gravel; about 40 percent consists of various deep sandy soils; 5 percent is a soil that is shallow over coarse sediments; and the other 5 percent is Morrill loam, 8 to 12 percent slopes, eroded.

The moderately deep soil is shallower over coarse sediments than the typical Morrill soils. The surface layer consists of 8 to 14 inches of loam that is friable and easily worked. The subsoil is gritty clay loam or loam. Sand and gravel are at a depth of about 30 inches.

The deep sandy soils generally occur as scattered spots or patches on rounded knolls. The surface layer consists mainly of fine sandy loam and is 8 to 14 inches thick. To a depth of 50 inches, the subsoil is fine sandy loam, loamy fine sand, or sand. In places it is layered with all of these textures.

The soil that is shallow over coarse sediments has a surface layer of loam, gravelly loam, or sandy loam. This layer is 8 to 14 inches thick. The subsoil, to a depth of about 18 inches, is loam, gravelly loam, or sandy loam. Sand and gravel are at a depth of about 18 inches.

Because these soils are steep and mixed, they are best suited to close-growing crops, such as wheat, clover, grasses, and legumes. A row crop, such as corn, can be grown to a limited extent in the rotation. Lime and fertilizers increase yields if applied according to the needs shown by soil tests. (Capability unit IVe-3; range site, Silty; tree-planting site, Sandy)

Morrill complex, 12 to 18 percent slopes (MxE).—This complex consists of a mixture of Morrill soils and other soils that have many characteristics of Morrill soils. These soils are moderately steep. The areas are small and scattered.

About 80 percent of this complex consists of a Morrill soil that is moderately deep over sand and gravel; about 10 percent consists of a soil that is shallow over coarse sediments; about 5 percent is made up of deep sandy soils; and the other 5 percent is Morrill loam, 12 to 18 percent slopes, eroded.

The Morrill soil that is moderately deep over coarse sediments has a surface layer of friable loam. This layer is 8 to 12 inches thick. The upper part of the subsoil is gravelly clay loam or loam, and the lower part is sandy loam. Sand and gravel are at a depth of about 30 inches.

The soil that is shallow over coarse sediments has a surface layer of loam, gravelly loam, or sandy loam. This layer is 8 to 10 inches thick. The subsoil, to a depth of about 18 inches, is loam, gravelly loam, or sandy loam. Sand and gravel are at a depth of about 18 inches.

The deep sandy soils occur as scattered spots. The surface layer is 8 to 12 inches thick. It consists mainly of fine sandy loam. To a depth of 45 inches, the subsoil is fine sandy loam, loamy fine sand, or sand.

These soils are best suited to native grasses. Yields are good when pastures are well managed. (Capability unit VIe-3; range site, Silty; tree-planting site, Sandy)

Morrill complex, 5 to 8 percent slopes, severely eroded (MxC3).—This complex consists of a mixture of Morrill soils and other severely eroded soils that have many characteristics of the Morrill soils. The soils in this complex are sloping and occur on valley sides. The areas are small and scattered.

About 70 percent of this complex consists of a soil that is moderately deep over coarse sediments; about 8 percent consists of a shallow soil; about 17 percent is made up of various deep sandy soils; and the other 5 percent consists of Morrill soils, 5 to 8 percent slopes, severely eroded.

The moderately deep soil is similar to the Morrill soils, but it is shallower over sand and gravel. The surface layer is loam. It is 3 to 8 inches thick. The subsoil is loam or gravelly clay loam. The coarse sediments are at a depth of 25 inches.

The shallow soil occurs in scattered spots. The surface layer consists of loam, sandy loam, or gravelly loam and is 3 to 8 inches in thickness. The thin subsoil, to a depth of about 16 inches, is sandy loam or gravelly loam. Sand or gravel is at a depth of about 16 inches.

The deep sandy soils occur as scattered spots, generally on rounded knolls. In most places the surface layer is fine sandy loam, but in some places it is loam or loamy fine sand. This layer is 3 to 8 inches thick. To a depth of 45 inches, the subsoil is fine sandy loam, loamy fine sand, or fine sand, or it is layered with combinations of these textures.

Because the soils of this complex are mixed, coarse textured, and severely eroded, they are best suited to close-growing crops, such as wheat, rye, vetch, clover, grasses, and legumes. A row crop, such as corn, can be grown to a limited extent. Terraces are impratical because of the nature of the soils and the lay of the land. Lime and fertilizers increase yields if applied according to the needs shown by soil tests. (Capability unit IVe-3; range site, Silty; tree-planting site, Sandy)

Morrill complex, 8 to 18 percent slopes, severely eroded (MxD3).—This complex consists of a mixture of Morrill soils and other soils that have many characteristics of the Morrill soils. The soils in this complex are sloping or moderately steep. The areas are scattered.

About 48 percent of this complex consists of a moderately deep Morrill soil; about 25 percent consists of a shallow soil; about 2 percent is a very shallow soil; and the other 25 percent is made up of various deep sandy soils.

The moderately deep Morrill soil has a surface layer of loam that is 3 to 8 inches thick. The upper part of the subsoil is loam or gravelly clay loam, and the lower part is sandy loam or gravelly sandy loam. Sand or gravel is at a depth of about 25 inches.

The shallow soil occurs in scattered areas. Its surface layer consists of loam, gravelly loam, or sandy loam. It is 3 to 8 inches thick. The thin subsoil, to a depth of about 16 inches, is gravelly loam or sandy loam.

The very shallow soil occurs as small spots. Its surface layer is gravelly sandy loam. It is 3 to 8 inches thick and overlies sand or gravel.

The deep sandy soils occur as scattered areas, generally on rounded knolls. The surface layer is mainly fine sandy loam. It is 3 to 8 inches thick. The subsoil, to a depth of 45 inches, is fine sandy loam, loamy fine sand, or fine sand, or it is layered with various proportions of these textures.

These soils are best suited to native grasses for hay or pasture. Grasses respond to good management. (Capability unit VIe-3; range site, Silty; tree-planting site, Sandy)

Morrill soils, 5 to 8 percent slopes, severely eroded (MC3).—These sloping soils are on valley sides. The areas are scattered. Surface runoff is classed as medium but approaches rapid. Some areas are cultivated, but others have been abandoned as cropland and are now poor-quality pasture. Deep rills are numerous.

The surface layer is heavy loam or clay loam. It is 3 to 5 inches thick. In cultivated areas, at least half of the material in this layer was originally the upper part of the subsoil. The present subsoil, which is about 25 inches thick, is gritty clay loam. Permeability is somewhat slow, but water, roots, and air penetrate this layer readily.

These soils respond to good management. Practices that improve tilth, fertility, and productivity include (1) constructing terraces and grassed waterways, (2) growing wheat, clover, grasses, and other close-growing crops, (3) adding lime, and (4) applying fertilizers. Capability unit IVe-8; range site, Silty; tree-planting site, Silty to Clayey)

Morrill soils, 8 to 18 percent slopes, severely eroded (ME3).—These strongly sloping or moderately steep soils are on valley sides. Surface runoff is rapid. The areas are scattered. Some areas are cultivated, but others have been abandoned as cropland and are now poor-quality pasture. Rills and shallow gullies are numerous. Deep gullies have formed in some of the natural drains.

In some places the surface layer is loam, but in others it is clay loam. It is 3 to 5 inches thick. In cultivated areas, at least half of the material in this layer was originally the upper part of the subsoil. The present subsoil, which is about 20 inches thick, is gritty clay loam. Permeability is somewhat slow, but roots penetrate this layer readily.

These soils are not suited to cultivated crops, because of steep slopes and the severe hazard of erosion. Controlling gullies and maintaining waterways are difficult. If erosion is controlled and fertilizers are applied, fair yields of grasses are obtained. These soils are good for pasture when properly managed. (Capability unit VIe-8; range site, Silty; tree-planting site, Silty to Clayey)

Muir Series

The Muir series consists of deep, dark-colored, nearly level soils on low alluvial terraces. These soils formed under prairie vegetation of tall grasses.

The surface layer is ordinarily about 14 inches thick but ranges from 10 to 18 inches in thickness. In texture it ranges from light silt loam to heavy silt loam. It is very dark brown or black, is slightly acid, and has a granular structure. There is a gradual boundary between this layer and the subsoil.

The subsoil is ordinarily about 20 inches thick but ranges from 12 to 30 inches in thickness. This layer consists of silty clay loam; it is very dark grayish brown or dark brown and has a weak, coarse, prismatic structure that breaks to moderate, fine, subangular blocky. In places a dark-colored layer that is the surface layer of a buried soil is at a depth of 36 to 60 inches.

The parent material is silty alluvium. It is free of lime, friable, and easily penetrated by roots.

The Muir soils are well drained. Surface runoff is slow, and permeability is moderate. Natural fertility is very high.

The Muir soils have a less clayey subsoil than the nearby Rokeby soils. They have a slightly more clayey subsoil than the Hobbs soils and are less stratified. The Muir soils have more distinct and more uniform layers than the Judson soils.

Muir silt loam (Mu).—This level or nearly level soil is extensive on low terraces in the major valleys. In a few small areas along terrace edges, it is gently sloping. Runoff is slow. Nearly all of the acreage is cultivated.

The surface layer is 10 to 18 inches thick, friable, and easily worked. The subsoil, which is about 20 inches thick, is silty clay loam. It has good structure and many pore spaces. This layer is moderately permeable to water and air, and roots penetrate it easily.

This soil is fertile and productive. It is suited to all crops commonly grown in the county, but corn is the main crop. Fertilizing according to soil tests ensures good yields year after year. (Capability unit I-1; range site, Silty; tree-planting site, Silty to Clayey)

Pawnee Series

The Pawnee series consists of deep, dark-colored, gently sloping and strongly sloping soils on the glacial uplands. These soils formed under prairie vegetation of tall grasses.

The surface layer is ordinarily about 8 inches thick but ranges from 2 to 16 inches in thickness. In texture it ranges from loam to clay loam, depending on the degree of erosion. It is very dark brown, is medium or strongly acid, and has a granular structure.

The subsoil is ordinarily about 36 inches thick but ranges from 30 to 50 inches in thickness. The upper part is predominantly clay; it is dark brown or dark yellowish brown and has a moderate, coarse, blocky structure and moderate, medium, angular blocky structure. The lower part is predominantly clay or clay loam; it is light olive brown, is calcareous, and has a weak, coarse, blocky structure (fig. 6). The upper part is more clayey and more compact than the lower part.

The parent material is till of clay loam texture. It contains slight to moderate amounts of lime.

The Pawnee soils are moderately well drained or well drained. Surface runoff is medium or rapid, and permeability is slow. The soils are medium to high in natural fertility. They are highly susceptible to water erosion.

The Pawnee soils have a less red subsoil than the nearby Adair soils. They have a more clayey subsoil than the Shelby and Burchard soils. The Pawnee soils are more gritty and contain more stones and pebbles than the Wymore soils, which have parent material of silty to clayey loess.

Pawnee clay loam, 3 to 5 percent slopes, eroded (PwB2).—This gently sloping soil is on rounded ridge crests on uplands. Surface runoff is medium. The areas are small and scattered. Nearly all of the acreage is cultivated.

The surface layer is 2 to 10 inches thick, friable, and easily tilled. A few small areas that are still in native grass or have been plowed recently have a surface layer that is 10 to 16 inches thick. The subsoil, which is about 40 inches thick, is clay. It is slowly permeable to roots, water, and air, and it is extremely hard when dry and very firm when moist.

This soil is suited to all crops commonly grown in the county. Legumes, lime, and fertilizers are required to maintain good tilth and to ensure high yields. Terracing and contour farming help to control erosion. (Capability unit IIIe-2; range site, Clayey; tree-planting site, Silty to Clayey)

Pawnee clay loam, 5 to 8 percent slopes, eroded (PwC2).—This sloping soil is on valley sides. When it is tilled or when it is not protected by a vegetative cover, surface runoff is rapid. About 70 percent of the acreage is cultivated.

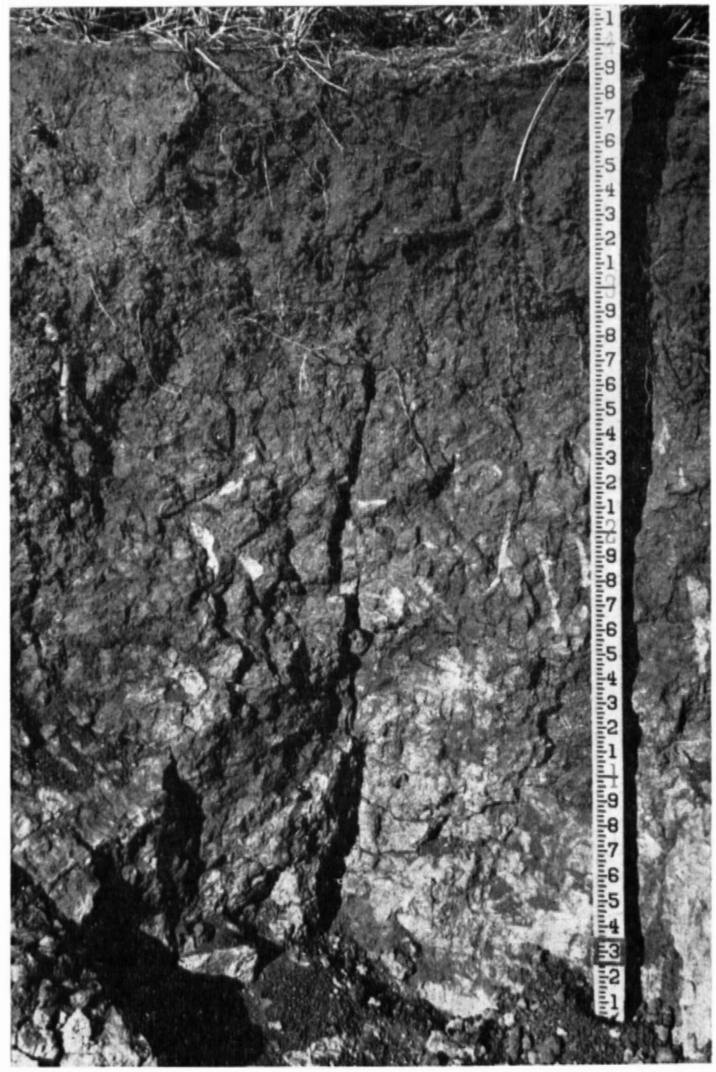

***Figure 6.*—A profile of Pawnee clay loam to a depth of 48 inches. The blocky clay subsoil becomes extremely hard and cracks when dry.**

The surface layer is 5 to 10 inches thick. In some cultivated areas, part of the subsoil has been mixed with the surface layer. About 20 percent of the total acreage is still in native grass or has been plowed recently and has a surface layer that is 10 to 16 inches thick. The subsoil is about 35 inches thick. The upper part is clay, and the lower part is heavy clay loam or clay. This layer is slowly permeable to roots, water, and air.

This soil is suited to all crops commonly grown in the area. Because of its dense clay subsoil, it is best suited to close-growing crops, such as wheat, oats, and clover, and to grain sorghum. Corn can be grown in sequence with these crops.

Terraces, contour farming, and grassed waterways are needed to help control runoff and erosion. Legumes, lime, and fertilizers are required to maintain tilth and to ensure high yields. (Capability unit IIIe-2; range site, Clayey; tree-planting site, Silty to Clayey)

Pawnee clay loam, 8 to 12 percent slopes, eroded (PwD2).—This sloping or strongly sloping soil occurs mainly as narrow bands along drains. Surface runoff is rapid. Some of the acreage is cultivated, but most of it is in grass. Areas used as pasture are moderately eroded.

The surface layer is 5 to 8 inches thick. In cultivated areas, part of the subsoil has been mixed with the surface layer. A few areas that are still in native grass have a surface layer that is more than 8 inches thick. The subsoil is very firm clay. It is about 25 inches thick. This layer is extremely hard when dry and slowly permeable to water, air, and roots.

Because of its dense clay subsoil, its steep slope, and the severe hazard of erosion, this soil is not well suited to cultivated crops. Controlling gullies and maintaining waterways are difficult. Fair yields of small grains and high yields of grasses and legumes are obtained if this soil is protected from erosion and fertilized according to needs. Good management, however, is costly, and pasture is the best use for this soil. Pastures need to be well managed because this soil is erodible. Yields of forage are low in pastures that are overgrazed. (Capability unit IVe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Rokeby Series

The Rokeby series consists of deep, dark-colored, nearly level soils on low alluvial terraces. At one time, they were affected by wetness and salinity. Later, underground drainage improved and prairie vegetation of tall grasses became established.

The surface layer is ordinarily about 12 inches thick but ranges from 8 to 16 inches in thickness. In texture it ranges from heavy silt loam to silty clay loam. It is very dark gray or very dark brown, is medium acid or strongly acid, and has a granular structure. There is a faint gray layer in the lower part just above the subsoil. The lower boundary is abrupt.

The subsoil is about 30 inches thick. The upper part is predominantly clay; it is very dark gray and has a moderate, coarse, blocky structure that breaks to strong, fine and medium, angular blocky. The lower part is predominantly silty clay loam; it is grayish brown and calcareous and has a weak, medium, subangular blocky structure. The upper part is more clayey and more compact than the lower part.

The parent material consists of layered or uniform stream deposits. These deposits are silty and friable and contain little or no lime.

The Rokeby soils are imperfectly drained or moderately well drained. Surface runoff and permeability are slow. The soils are high in natural fertility. They are subject to slight ponding during wet seasons.

The Rokeby soils have a more clayey subsoil than the nearby Muir soils, are less permeable, are darker colored, have a thicker surface layer, and contain smaller amounts of alkali salts.

Rokeby silty clay loam (Rt).—This level or nearly level soil occurs as scattered areas on low terraces of the larger valleys. Surface runoff is slow. Nearly all of the acreage is cultivated. Included with this soil are a few small areas of Exline soils.

The surface layer is silty clay loam. It is 8 to 16 inches thick. There is a faint gray layer in the lower part just above the subsoil. The lower boundary is abrupt. The subsoil is about 30 inches thick. The upper part is clay, and the lower part is silty clay loam. This layer is slowly permeable to water, air, and roots. Lime occurs at a depth of 30 to 60 inches. In places there is, at a depth of 36 to 70 inches, a dark-colored layer that is the surface layer of a buried soil.

This soil is suited to all crops commonly grown in the county. Lime, fertilizers, and crop rotations that include legumes are required for high yields. (Capability unit IIs–2; range site, Clayey; tree-planting site, Silty to Clayey)

Rough Broken Land

Rough broken land consists of very steep land along drains. The parent material is a mixture of till, loess, and colluvium. This material is generally clayey, but it ranges from clay to loam in texture. Runoff is rapid.

Rough broken land (Blg).—This land type occurs as irregular narrow strips of abrupt breaks along upland drains. It is in grass or in trees. The areas are small and scattered.

Soil slipping is common, and the steep slopes have a succession of short, vertical exposures, called "catsteps." This land type is fair for grazing or for timber and good for wildlife. (Capability unit VIIe–1; range site, Thin Clayey)

Rough Stony Land

Ledges of limestone, shale, and sandstone bedrock and stones scattered on the surface characterize this land type. As much as 90 percent, but ordinarily about 50 percent, of the surface consists of stones or rock. Between the ledges, however, are strips of soil on which there are few if any stones.

Rough stony land (Rv).—This land type occurs as scattered, irregular, narrow strips of abrupt breaks along upland drains. The slopes are steep, and runoff is rapid. The areas are fair for grazing and for timber and good for wildlife. (Capability unit VIIs–3; range site, Thin Breaks)

Shelby Series

The Shelby series consists of deep, dark-colored, gently sloping to moderately steep soils on the glacial uplands. These soils formed under prairie vegetation of mid and tall grasses.

The surface layer is ordinarily about 8 inches thick but ranges from 4 to 16 inches in thickness. In texture it ranges from loam to clay loam or gravelly clay loam. The texture varies according to the degree of erosion.

The subsoil is ordinarily about 30 inches thick but ranges from 24 to 40 inches in thickness. This layer is heavy clay loam; it is dark brown or dark yellowish brown and has a weak, coarse, blocky and prismatic structure that breaks to moderate, fine and medium, subangular blocky.

The parent material is till of clay loam texture. It contains small to large amounts of lime.

Shelby and Burchard clay loams, 3 to 5 percent slopes, eroded (SBB2).—These gently sloping soils are on rounded ridge crests on the uplands. The areas are scattered. Surface runoff is medium. Nearly all of the acreage is cultivated.

The surface layer is 7 to 10 inches thick. It is friable. A few small areas that are still in native grass or that have been plowed recently have a surface layer that is 10 to 16 inches thick. The subsoil is clay loam. It is 15 to 40 inches thick, friable to firm, and moderately slow in permeability. This layer absorbs and releases water readily. Roots penetrate it easily. Lime is at a depth of 20 to 60 inches.

These soils are suited to all crops commonly grown in the county. Legumes, lime, and fertilizers are required to maintain good tilth and to ensure high yields. Terracing and contour farming help to control erosion. (Capability unit IIe-1; range site, Clayey; tree-planting site, Silty to Clayey)

Shelby and Burchard clay loams, 5 to 8 percent slopes, eroded (SBC2).—These sloping soils are on valley sides. Surface runoff is medium. Nearly all of the acreage is cultivated.

The surface layer is 5 to 10 inches thick. It is friable. A few small areas that are still in native grass or that have been plowed recently have a surface layer that is 10 to 16 inches thick. The subsoil is 15 to 40 inches of clay loam. It is moderately slow in permeability. Roots, water, and air penetrate it readily. Lime is at a depth of 18 to 60 inches.

These soils are good for crops, pasture, and hay. For continuous high yields, they require legumes in the crop rotation, lime and fertilizers according to needs, terraces, and grassed waterways. (Capability unit IIIe-1; range site, Clayey; tree-planting site, Silty to Clayey)

Shelby and Burchard clay loams, 8 to 12 percent slopes, eroded (SBD2).—These strongly sloping soils occur as scattered areas on valley sides. Surface runoff is rapid when these soils are clean tilled.

The surface layer is 5 to 10 inches thick. It is friable. Some areas that are still in native grass or that have been plowed recently have a surface layer that is 10 to 16 inches thick. The subsoil is 15 to 40 inches of clay loam. It is moderately slow in permeability. Roots, water, and air penetrate it easily. Lime is at a depth of 16 to 50 inches.

These soils are good for pasture and hay. Because of the steep slopes and the severe hazard of erosion, they are fair for crops. They respond to good management, nevertheless. Wheat, clover, oats, alfalfa, and grass are the best crops, but corn can be grown to a limited extent as part of a rotation. Terraces, contour farming, and grassed waterways are needed to help control runoff and erosion. (Capability unit IIIe-1; range site, Clayey; tree-planting site, Silty to Clayey)

Shelby and Burchard soils, 8 to 12 percent slopes, severely eroded (SBD3).—These strongly sloping soils occur as small, scattered areas on valley sides. Part of the acreage is cultivated, and part of it has been cultivated but is now in grass.

The surface layer is about 4 inches of clay loam. About half of this layer consists of material that was originally part of the upper subsoil. The present subsoil is 10 to 30 inches of clay loam. It is moderately slow in permeability, and roots penetrate it easily. Lime is at a depth of 14 to 48 inches.

Because of steep slopes, low fertility, and the severe hazard of erosion, these soils are only fair for crops. They respond to good management, nevertheless. Practices that improve productivity include (1) constructing terraces and grassed waterways, (2) growing legumes, green-manure crops, and other close-growing crops, (3) adding lime, and (4) applying fertilizers. Pastures require fertilization and regulation of grazing. (Capability unit IVe-8; range site, Clayey; tree-planting site, Silty to Clayey)

Shelby and Burchard clay loams, 12 to 18 percent slopes, eroded (SBE2).—These soils are moderately steep. Surface runoff is rapid when the soils are clean tilled. The areas are scattered.

The surface layer is 5 to 12 inches thick. The areas that are still in native grass have a surface layer that is more than 12 inches thick. The subsoil is 10 to 30 inches of clay loam. Permeability is moderately slow. Lime is at a depth of 14 to 48 inches.

Because of the steep slopes, the severe hazard of erosion, and limitations on the use of large machinery, these soils are best suited to perennial grasses and legumes. They are good for pasture or hay. (Capability unit IVe-1; range site, Clayey; tree-planting site, Silty to Clayey)

Sogn Series

The Sogn series consists of strongly sloping and steep soils on the uplands. These soils are shallow over limestone.

The surface layer is ordinarily about 8 inches thick but ranges from 2 to 15 inches in thickness (fig. 7). In texture it ranges from clay loam to silt loam. It is very

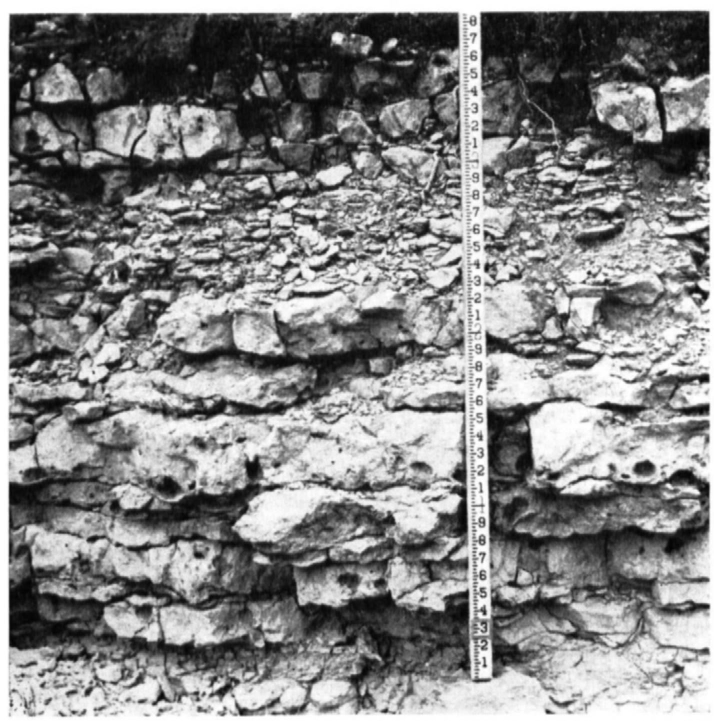

Figure 7.—**A profile of Sogn soils. The texture is stony clay loam.**

dark brown, is neutral in reaction, and has a granular structure. It contains fragments of limestone. The lime content ranges from none to high. The boundary between this layer and the underlying limestone varies from gradual and smooth to abrupt and very irregular, depending upon the denseness of the bedrock.

The substratum is at a depth of 8 to 16 inches. It consists of somewhat weathered, level-bedded limestone that is broken by vertical joints and cracks. Thin layers of clayey shale are interbedded with the limestone at a depth of 16 to 30 inches.

The Sogn soils are excessively drained, and surface runoff is rapid. The soils are highly susceptible to erosion.

The Sogn soils are shallower than the nearby Labette soils. They differ from the Hedville soils in that they are shallow over limestone instead of sandstone.

Sogn complex (Sn).—This complex occurs as small, scattered areas, mainly in the southern part of the county. The slopes are generally moderately steep or steep, and surface runoff is rapid.

About 65 percent of this complex consists of Sogn soils, about 18 percent of Hedville stony loam, and about 17 percent of Lanham clay loam. A few small areas of Labette silty clay loam, 5 to 12 percent slopes, are also included.

The Sogn soils have a surface layer that ranges from 2 to 15 inches in thickness and from clay loam or silty clay loam to loam or silt loam in texture. In places this layer contains rock fragments. The substratum is interbedded with limestone and with clayey shale that ranges from very dense and hard to only slightly hard or earthy.

These soils are fair to good for native grasses, and some areas are excellent for wildlife. Pastures and hayfields require good management. (Capability unit VIs-4; range site, Shallow Limy)

Steinauer Series

The Steinauer series consists of deep, moderately dark colored, moderately steep and steep soils on the glacial uplands. These soils formed under prairie grass.

The surface layer is ordinarily about 6 inches thick but ranges from 3 to 10 inches in thickness. In texture it ranges from clay loam to gravelly clay loam. This layer is very dark grayish brown or dark brown, is neutral or mildly alkaline, and has a granular structure. The boundary between this layer and the parent material is gradual and wavy.

The parent material is slightly altered till of clay loam texture. It is deep, is yellowish brown, is friable to firm, has a weak, coarse and medium, blocky structure, and contains many soft pieces and streaks of white lime (fig. 8).

The Steinauer soils are somewhat excessively drained. Surface runoff is rapid, and permeability is moderately slow. The soils are medium in natural fertility and are highly susceptible to erosion. The depth to lime ranges to as much as 14 inches.

The Steinauer soils are thinner and lighter colored than the nearby Burchard soils and are leached of lime to a lesser depth.

Steinauer clay loam, 12 to 25 percent slopes (StE).—This moderately steep and steep soil occurs as scattered

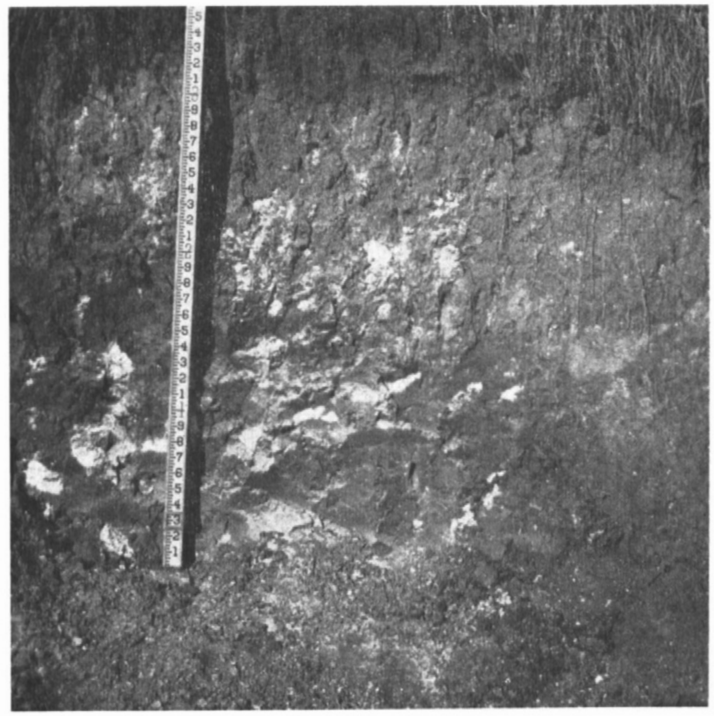

Figure 8.—**A profile of Steinauer clay loam to a depth of 44 inches.**

areas on valley sides. In most places, surface runoff is rapid. Nearly all of the acreage is in permanent grass.

The surface layer is about 6 inches thick. In some places it is gravelly. Below the surface layer is the parent material, which was deposited by glaciers. This material is moderately slow in permeability but is easily penetrated by roots.

Because of the steep slopes, the severe hazard of erosion, and the difficulty of using large machinery, this soil is best suited to native grass. It is excellent for native grass if properly managed. In overgrazed pastures, gullies are forming in natural drains, the soil is eroding, and the yields of grass are low. (Capability unit VIe-9; range site, Thin Clayey; tree-planting site, Silty to Clayey)

Steinauer soils, 12 to 18 percent slopes, severely eroded (StE3).—These moderately steep soils occur as small areas on valley sides. In most places surface runoff is rapid. A few areas are cultivated, but most of the acreage has been abandoned as cropland and is now in tame grass.

The surface layer is 3 to 5 inches of clay loam or gravelly clay loam. It is limy and rather light colored. From 50 to 75 percent of this layer consists of material that was originally part of the parent material and that has been mixed with the surface layer during cultivation. Below the surface layer is the parent material, which was deposited by glaciers. This material is easily penetrated by roots.

Because of steep slopes, low fertility, the severe hazard of erosion, and limitations on the use of large machinery, these soils are best suited to native grasses. (Capability unit VIe-8; range site, Thin Clayey; tree-planting site, Silty to Clayey)

Wabash Series

The Wabash series consists of deep, dark-colored, level and nearly level, clayey soils on the bottom lands. These soils formed under tall grasses.

The surface layer is ordinarily about 14 inches thick but ranges from 8 to 20 inches in thickness. In texture it ranges from heavy silty clay loam to silty clay. It is black, is slightly acid, and has a granular structure.

The subsoil extends to a depth of 50 inches and consists of clayey stream sediments. The upper part is silty clay; it is black or very dark gray and has a moderate, fine, blocky structure. The lower part, below a depth of 30 inches, is silty clay; it is very dark gray or very dark grayish brown and has a moderate, coarse and medium, angular blocky structure. In some places, lime concretions occur 48 inches or more below the surface.

The surface layer and the subsoil are not clearly differentiated, because both have a clayey texture. The Wabash soils are imperfectly drained or poorly drained and subject to overflow. Surface runoff and permeability are slow. The soils are susceptible to ponding. Natural fertility is high.

The Wabash soils have a more clayey subsoil than the nearby Colo soils and are more poorly drained.

Wabash silty clay (Wa).—This poorly drained soil occurs as small, scattered areas on the bottom lands along the major streams. It is level or nearly level, and surface runoff is slow.

The surface layer is 8 to 20 inches thick. It is firm or very firm. The subsoil extends to a depth of 50 inches, and its texture is silty clay. It is very firm and is slowly permeable to water, air, and roots. In some places, there is a water table at a depth of 4 feet.

This soil is not well suited to crops because it is poorly drained and has poor tilth. Fair yields are obtained if the soil is drained. Where drainage is difficult or impractical, this soil is good for hay or for wildlife.

Drainage can be improved by row direction, surface bedding, diversion terraces, open drainage ditches, and grassed waterways. (Capability unit IIIw–1; range site, Subirrigated; tree-planting site, Moderately Wet)

Wymore Series

The Wymore series consists of deep, dark-colored, nearly level and strongly sloping soils on the loess-mantled uplands. These soils formed under prairie vegetation of mid and tall grasses.

The surface layer is ordinarily about 7 inches thick but ranges from 4 to 15 inches in thickness. In texture it ranges from light silty clay loam to light silty clay. The texture varies according to the degree of erosion. This layer is very dark brown, is medium acid or slightly acid, and has a granular structure.

The subsoil is ordinarily about 35 inches thick but ranges from 25 to 40 inches in thickness. The upper part is predominantly silty clay; it is very dark brown or very dark grayish brown and has a moderate, medium to very fine, blocky structure. The lower part is silty clay loam; it is a mixture of dark grayish brown, olive brown, and grayish brown and has a weak, coarse, prismatic structure that breaks to moderate, medium, blocky. The upper and middle parts are more clayey and more compact than the lower part.

The parent material is a thin mantle of loess of silty clay loam texture. It is generally free of lime.

The Wymore soils are well drained. Surface runoff is medium or rapid, and permeability is slow or moderately slow. These soils are high in natural fertility. They are highly susceptible to erosion.

The Wymore soils have a more grayish and more mottled subsoil than the nearby Crete soils. They are less gritty than the Pawnee and the Adair soils.

Wymore silty clay loam, 0 to 3 percent slopes (WtA).—This nearly level soil is on tablelands. It is not extensive, and the areas are scattered. Nearly all the acreage is cultivated. Included are a few small areas of Crete silty clay loam, 0 to 3 percent slopes.

The surface layer is 10 to 15 inches thick. The subsoil is about 40 inches thick. The upper and lower parts of the subsoil are silty clay loam, and the middle part is silty clay. Permeability is moderately slow to slow, but roots, water, and air penetrate this layer readily.

Although slightly droughty, this soil is productive. It is suited to all crops commonly grown in the county. It requires only a good cropping system and applications of lime and fertilizers according to needs. (Capability unit IIs–2; range site, Clayey; tree-planting site, Silty to Clayey)

Wymore silty clay loam, 3 to 5 percent slopes (WtB).—This gently sloping soil is on tablelands. It is not extensive, and the areas are scattered. Surface runoff is medium.

The surface layer is 8 to 15 inches thick. It is friable and easily worked. The subsoil is about 35 inches thick. The upper and lower parts of the subsoil are silty clay loam, and the middle part is silty clay. This layer is moderately slowly and slowly permeable but is easily penetrated by roots.

This is one of the more productive soils of the county. Conservation practices are easily applied. Yields of crops are high if legumes are included in the rotation, terraces are built, and lime and fertilizers are applied according to the results of soil tests. (Capability unit IIIe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Wymore silty clay loam, 3 to 5 percent slopes, eroded (WtB2).—This gently sloping soil is extensive on the rounded tablelands in the eastern part of the county. Surface runoff is medium. Nearly all of the acreage is cultivated. Included are a few small areas of Crete silty clay loam, 3 to 5 percent slopes, eroded.

The surface layer is 5 to 10 inches thick. In some cultivated areas, some of the subsoil has been mixed with the surface layer. The present subsoil, which is about 32 inches thick, is silty clay. It is firm, has a blocky structure, and is slowly permeable.

This soil is well suited to corn, oats, wheat, clover, grain sorghum, and alfalfa. Corn and alfalfa are the crops most likely to be adversely affected by extremely dry weather. Terraces are needed to control runoff and erosion, and legumes, lime, and fertilizers are needed for high yields. (Capability unit IIIe–2; range site, Clayey; tree-planting site, Silty to Clayey)

Wymore silty clay loam, 5 to 8 percent slopes, eroded (WtC2).—This moderately sloping soil is on valley sides, mainly in the high uplands in the eastern part of the county. Surface runoff generally is medium, but it is rapid when this soil is clean tilled. Most of the acreage is cultivated.

The surface layer is 5 to 10 inches thick. In some cultivated areas, part of the subsoil has been mixed with the surface layer. A few small areas that are still in native grass or that have been plowed only recently have a surface layer that is 10 to 15 inches thick. The subsoil, which is about 30 inches thick, is silty clay. It is firm and has a blocky structure. This layer is slowly permeable but is easily penetrated by plant roots.

This soil is well suited to the crops commonly grown and it responds to good management. Because of erosion and the dense subsoil, corn and alfalfa are adversely affected by dry weather. Rills and gullies are common. Where the soil is not protected from erosion by terraces and grassed waterways, legumes, lime, and fertilizers are needed to maintain tilth and to ensure high yields. (Capability unit IIIe-2; range site, Clayey; tree-planting site, Silty to Clayey)

Wymore soils, 5 to 8 percent slopes, severely eroded (WtC3).—These moderately sloping soils occur as scattered areas on valley sides, mainly in the high uplands. Surface runoff is medium or rapid. Some of the acreage is cultivated, but some has been abandoned as cropland and is now in tame grass.

The surface layer is about 4 inches of heavy silty clay loam or silty clay. It has poor tilth. More than half of the material in this layer was originally the upper part of the subsoil and has been mixed with the surface layer during cultivation. The present subsoil is about 25 inches of silty clay. It is slowly permeable.

Because of the severe hazard of erosion, poor tilth, and dense subsoil, these soils are best suited to small grains, clover, and grasses. Fair to satisfactory yields are obtained if the soils are properly managed. Pastures require proper grazing management. (Capability unit IVe-2; range site, Clayey; tree-planting site, Silty to Clayey)

Wymore soils, 8 to 12 percent slopes, severely eroded (WtD3).—These strongly sloping soils occur on the high uplands, as narrow bands next to drains. Surface runoff is rapid. Nearly all of the acreage is in tame grass. Rills and gullies are numerous.

The surface layer is about 4 inches of heavy silty clay loam or silty clay. It has poor tilth. The subsoil is about 25 inches of silty clay. This layer is slowly permeable.

These soils are best suited to perennial grasses and legumes, but small grains can be grown in some places. In most areas controlling gullies and maintaining waterways are difficult. Good management of pastures and hayfields is important. In overgrazed pastures these soils are eroding, gullies are forming, and yields of forage are low. (Capability unit VIe-2; range site, Clayey; tree-planting site, Silty to Clayey)

Use and Management of the Soils

This section discusses the use and management of soils for crops, grass, trees, and wildlife. The soil characteristics that affect engineering uses are also given.

Management of Cropland

On the cultivated soils in Gage County, it is important to conserve moisture, to control erosion, to preserve fertility and tilth, and to maintain the supply of organic matter. A discussion of practices applicable to most of the cropland in the county follows.

Cropping systems

A cropping system consists of a sequence of crops grown on a given area over a period of time. The objectives are to maintain soil structure and tilth, to protect the soils from erosion, and to control weeds, insects, and diseases.

A good cropping system includes grasses and legumes or other high-residue crops. If the crop is not a legume, it is advisable to use nitrogen fertilizer to speed decomposition of the residues and to prevent a nitrogen deficiency in the succeeding crop.

Legumes should be selected to suit the soil. Red clover and lespedeza are more tolerant of acid soils; and sweetclover and alfalfa grow better on soils that contain sufficient lime.

Minimum tillage

Soils must be worked to prepare a seedbed, to control weeds, and to provide a favorable place for plants to grow. Excessive tillage breaks down the soil structure. If soil is cultivated when too wet, it tends to puddle and to crust at the surface, to take in less water and air, and to store less moisture for plants. Consequently, it is advisable to time tillage operations properly and to limit operations to those essential to produce a crop and control runoff and erosion. Any reduction in tillage operations reduces the cost of producing crops. Plow planting, wheel-track planting, mulch planting, and till planting are among the methods of minimum tillage that are suitable for the soils of Gage County. Mulch planting can be used to seed grasses.

Residue management

Plant residues can be utilized to help conserve soil and water. The soil is tilled and crops are planted and harvested in such a way as to keep residues on the surface until the next growing crop provides protection. The residues protect the surface of the soil from wind and from the impact of raindrops. They increase the capacity of the soil to take moisture and reduce its tendency to form a surface-sealing crust.

The method of residue management depends on the kind of soil, the cropping system, the amount of residue, the season, and the tilth and structure of the soil. The amount of residue required to protect the soil depends on the kind of residue, the height of the stubble, the texture and cloddiness of the soil, and the roughness of the surface.

Contouring

Contour farming is tilling and planting across the slope on the contour or parallel to terraces. Furrows, ridges, and wheel tracks are then nearly on the level. The furrows and ridges hold rain (fig. 9) where it falls and thus decrease runoff and erosion. Because additional water

Figure 9.—Water held in contour rows on a terraced field.

is absorbed and made available for crops, yields are increased. Moreover, somewhat less power is required for contour farming than for farming up and down the hill.

Contouring is most effective when combined with other conservation practices, such as stubble mulching, terracing, and sodding waterways.

Grassed waterways

Grassed waterways are drainageways that are protected by a permanent grass cover. They carry runoff from adjacent cultivated areas.

A permanent grass cover is one of the best ways to help prevent water erosion. The vegetative growth above the ground slows down the force of the water, and the roots bind the soil particles together and help to hold the soil in place.

Figure 11.—Newly shaped and seeded waterway. Dikes protect the waterway and the new grass seedlings from washing. These dikes are removed after the grass is established.

Little was known about the hazard of gully erosion when the soils of Gage County were first plowed from native sod. Nearly all of the natural drainageways within areas of smooth slopes were plowed and farmed and later became ditches or gullies (fig. 10) that were difficult to control.

Grass can be established in most waterways that are not too steep. Gullies have to be leveled and filled by bulldozers and other earth-moving equipment. All waterways need to be shaped according to the size of the drainage area (fig. 11) and then seeded to a mixture of suitable grasses (fig. 12).

Figure 10.—Gully formed in a small natural drain after the protective grass cover was plowed.

Figure 12.—Waterway seeded to Reed canarygrass.

If grassed waterways are fertilized and well maintained, they control gullying, produce good hay or grass seed, and furnish protection for upland game birds.

Terracing

Terraces are ridges that are constructed across slopes to intercept runoff. They help to control erosion and to conserve moisture that would otherwise be lost as runoff.

Contouring and other conservation practices should be used along with terracing. Each row planted on the contour between terraces is a miniature terrace that holds back some water to soak into the soil. Terracing and contouring help to increase yields and to decrease the loss of soil and of water. The horizontal distance needed between terraces is determined by the slope and the kind of soil.

Grassed waterways are needed as outlets for surplus water from the terraces. Generally, it is advisable to establish grassed waterways before terracing.

Fertilizers

All the cultivated soils in the county need fertilizers. The amounts used should be based on soil tests and related information from the Nebraska Agricultural Experiment Station. Most of the soils in this county need lime for high yields, especially of alfalfa and sweetclover.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable they are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soils are grouped at three levels: the capability class, the subclass, and the unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclass is indicated 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 a close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no erosion hazard but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils 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 of soils for making many statements about their management. Capability units are generally identified by numbers assigned locally, for example, IIe–1 or IIIe–2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible, but unlikely, major reclamation projects.

The eight classes in the capability system, and the subclasses and units in this county, are described in the list that follows:

Class I.—Soils that have few limitations that restrict their use.

- Unit I–1.—Deep, nearly level, permeable, well-drained soils on the bottom lands and foot slopes.

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

- Subclass IIe.—Soils subject to moderate erosion if they are not protected.
  - Unit IIe–1.—Deep, gently sloping, moderately permeable soils on the uplands and foot slopes.
  - Unit IIe–3.—Deep, gently sloping, permeable soils on foot slopes; sandy surface layer.
- Subclass IIw.—Soils that have moderate limitations because of excess water.
  - Unit IIw–3.—Deep, well-drained soils on the bottom lands; occasionally flooded.
  - Unit IIw–4.—Deep, moderately well drained soils on the bottom lands.
- Subclass IIs.—Soils that have moderate limitations of moisture capacity or tilth.
  - Unit IIs–2.—Deep, nearly level, moderately well-drained soils on the uplands and terraces; slowly permeable subsoil.

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

- Subclass IIIe.—Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe–1.—Deep, moderately sloping soils on the uplands; moderately permeable subsoil.
  - Unit IIIe–2.—Deep, gently sloping and moderately sloping soils on the uplands; slowly permeable subsoil.
  - Unit IIIe–3.—Deep and moderately deep, moderately sloping, permeable soils on the uplands.
- Subclass IIIw.—Soils that have severe limitations because of excess water.
  - Unit IIIw–1.—Deep, poorly drained soils on the bottom lands; high water table; subject to frequent flooding.
  - Unit IIIw–2.—Deep, nearly level, poorly drained soils on the uplands and terraces; slowly permeable claypan subsoil.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, or require very careful management, or both.

Subclass IVe.—Soils subject to very severe erosion if they are cultivated and not protected.

Unit IVe-1.—Deep, strongly sloping and moderately steep, moderately permeable soils on the uplands.

Unit IVe-2.—Eroded and severely eroded, moderately sloping and strongly sloping clayey soils on the uplands; slowly permeable claypanlike subsoil.

Unit IVe-3.—Deep and moderately deep, moderately sloping and strongly sloping, moderately permeable soils on the uplands.

Unit IVe-8.—Severely eroded, moderately sloping and strongly sloping soils on the uplands; moderately permeable subsoil.

Class V.—Soils susceptible to little or no erosion but having other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife food and cover. (None in Gage County.)

Class VI.—Soils that have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass VIe.—Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.

Unit VIe-2.—Severely eroded, strongly sloping and moderately steep, slowly permeable clayey soils on the uplands.

Unit VIe-3.—Moderately deep, moderately steep and steep, permeable soils on the uplands.

Unit VIe-8.—Severely eroded, moderately steep, moderately permeable soils on the uplands.

Unit VIe-9.—Deep, moderately steep and steep, moderately permeable soils on the uplands; thin surface layer.

Subclass VIw.—Soils severely limited by excess water and generally unsuitable for cultivation.

Unit VIw-1.—Deep, nearly level soils on bottom lands; subject to frequent flooding.

Subclass VIs.—Soils severely limited by low moisture capacity, shallowness, or other soil features.

Unit VIs-1.—Saline-alkali soils on high bottom lands and low terraces.

Unit VIs-4.—Shallow and moderately deep, sloping to steep soils on the uplands.

Class VII.—Soils that have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture, woodland, or wildlife.

Subclass VIIe.—Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.

Unit VIIe-1.—Very steep areas of deep and mixed soil material, on the uplands.

Subclass VIIs.—Soils very severely limited by shallowness or other soil features.

Unit VIIs-3.—Deep and moderately deep, steep and very steep soils, and soils that are shallow and very shallow over bedrock.

Class VIII.—Soils and landforms that have limitations that preclude their use for commercial production of plants and restrict their use to recreation, wildlife, water supply, or esthetic purposes. (None in Gage County.)

In the following pages each capability unit is described, the soils in each are listed, and suggestions are given on how to use and manage the soils of each unit.

Capability unit I-1

Deep, nearly level, permeable, well-drained soils on the bottom lands and foot slopes make up this unit. These soils are—

Cass loam.
Hobbs silt loam, seldom flooded.
Judson silt loam, 1 to 3 percent slopes.
Muir silt loam.

These soils are easily worked. They absorb and hold water and release it readily to plants. The natural fertility is high and is easily maintained. The slope is generally less than 2 percent but is adequate for good surface drainage. Most of the time the water table is 4 to 6 feet or more below the surface. The soils are subject to only minor overflow.

These soils can be farmed intensively without risk of damage if the fertility is maintained. Corn, wheat, oats, rye, barley, sorghum, legumes, and grasses are the crops commonly grown. Small grains are less well suited than most other crops because they tend to grow rank, to lodge, and to fall down before harvest time.

Corn is the chief crop grown, but the rotation may include a crop of small grain, sorghum, or occasionally a legume. The legume crop can be used for hay or green manure. Moisture is generally adequate for corn several years in succession, but control of insects and plant diseases is necessary, and also maintenance of fertility and soil structure.

Adequate amounts of lime and fertilizers provide the proper balance of plant nutrients. Crop residues supply organic matter. Results are best if the residues are worked into the soil by stubble mulching and minimum surface tillage. Proper use of crop residues helps to control soil blowing and crusting and the loss of soil moisture by evaporation. It also increases the water-intake rate.

Grassed field borders can be used as turnrows, roadways, and wildlife areas. Such areas can be planted to bromegrass and alfalfa to provide hay or winter pasture and to help keep down weeds.

The soils in this unit are also well suited to the kinds of trees that are commonly planted for windbreaks. They are not well suited to farm ponds, because they occupy broad areas of bottom land and are nearly level.

Most of the acreage is used intensively for production of crops, mainly corn, wheat, sweetclover, and alfalfa. Garden and truck crops are also grown.

Capability unit IIe-1

Deep, gently sloping, moderately permeable soils on the uplands and foot slopes make up this unit. These soils are—

Geary silty clay loam, 3 to 5 percent slopes, eroded.
Judson silt loam, 3 to 5 percent slopes.

Morrill loam, 3 to 5 percent slopes, eroded.
Shelby and Burchard clay loams, 3 to 5 percent slopes, eroded.

These soils are well drained, easily worked, and easily managed. They absorb and hold water and release it readily to plants. Runoff is moderate, and these soils wash unless they are protected.

These soils are well suited to corn, wheat, oats, rye, barley, sorghum, legumes, and grasses.

Rotations should include not more than three consecutive row crops, such as corn. A legume-grass crop every 10 to 15 years can be used for hay or pasture. Results are best if the legume-grass mixture is allowed to remain on the soil for 2 or more years.

Generally, a good crop rotation, lime and fertilizers, and contour farming are the major requirements for maintaining high production on these soils. In a number of places, however, terraces are needed to serve as guidelines for contour farming and to protect lower lying soils against erosion. Diversions may be needed on Judson silt loam, 3 to 5 percent slopes, to intercept runoff and protect the adjacent bottom lands. Grassed waterways are needed in a few areas to carry surplus water from terrace outlets along natural drains, field borders, or other areas where water collects. Grassed field borders are needed in places, as turnrows and roadways, to guard against erosion and to control weeds.

These soils are suited to permanent hay and pasture and to windbreaks, but they are generally used for cultivated crops. They are also good for garden crops. Only a few sites are suitable for farm ponds or structures.

Capability unit IIe-3

One deep, gently sloping, moderately permeable soil that has a sandy surface layer makes up this unit. This soil is on foot slopes. It is—

Judson fine sandy loam, 3 to 5 percent slopes.

This soil is well drained, easily worked, and easily managed. It absorbs and holds water and releases it readily to plants. Runoff from higher lying slopes is a hazard, and unless controlled it will cause erosion. There is a slight hazard of wind erosion where the vegetative cover is sparse or lacking.

Because of its sandy surface layer, this soil can be worked over a wide range of moisture content. Generally, it can be worked early in spring and soon after rains. It warms earlier in spring than the more clayey soils.

Row crops, such as corn, should not be grown for more than 3 consecutive years. A legume-grass crop every 10 to 15 years can be used for hay or pasture. Results are best if the legume-grass mixture is allowed to remain for 2 or more years.

Generally, a good crop rotation, lime and fertilizers, and good management of crop residues are the major requirements for maintaining high production. In places terraces are needed. Diversion terraces may be needed to intercept runoff from higher slopes and also to protect the adjacent bottom lands.

Crop residues should not be burned or removed but should be worked into the soil by minimum surface tillage or left on the surface by the use of stubble-mulch tillage.

Grassed waterways may be needed in places to carry surplus water from terrace outlets along natural drains, field borders, or other areas where water collects. Grassed field borders can be used to good advantage as turnrows and roadways. These grassed borders guard against erosion and help control weeds.

This soil is suited to permanent hay or pasture and to windbreaks, but it is generally used for cultivated crops. Good sites for farm ponds are lacking. Excellent garden crops are grown.

Capability unit IIw-3

One deep, well-drained soil on the bottom lands makes up this unit. This soil is—

Hobbs silt loam, occasionally flooded.

This soil is easily worked and highly productive. It is medium to high in organic-matter content and retains plant nutrients. Crops are occasionally damaged by floods and deposits of soil. Floodwaters recede readily as the streams subside. Most of the time, the water table is 6 feet or more below the surface, but the supply of soil moisture is adequate.

This soil can be farmed intensively without risk of damage if fertility is maintained. Small grains are less well suited than most other crops because they tend to grow rank, to lodge, and to fall down before harvest time. Moreover, the most serious floods occur in midsummer, at or near harvest time.

Corn is the chief crop, but the rotation may include a crop of small grain, sorghum, or occasionally a legume. The legume crop can be used for hay, pasture, or green manure. Moisture is generally adequate for corn several years in succession. Maintenance of fertility and soil structure is necessary, and also control of insects, plant diseases, and weeds.

Crop residues supply organic matter. For best results, they should be worked into the soil by minimum surface tillage. Adequate amounts of fertilizers and lime provide the proper balance of plant nutrients, which is essential for satisfactory yields.

Most of the acreage is along streams; therefore, grassed waterways are seldom needed. Dikes and diversions may be useful in places to divert floodwaters. Flooding can best be controlled by conservation measures applied upstream and by the use of flood-control structures. Earthen structures and farm ponds generally hold water satisfactorily, but suitable sites are not always available. Artificial improvement of drainage, by such practices as straightening creek channels, is seldom needed.

Areas on the narrow bottom lands of meandering streams, adjacent to other soils that are not suitable for cultivation, are used for permanent hay or pasture. There are only scattered trees, although trees would grow well. Locally, where the hazard of flooding is not too serious, this soil is excellent for garden crops.

Capability unit IIw-4

One deep, moderately well drained soil on the bottom lands makes up this unit. It is occasionally flooded. This soil is—

Colo silty clay loam.

This soil is medium to high in organic-matter content, and it retains plant nutrients, but it can be tilled only within a limited range of moisture content, and it tends to dry slowly in spring. Corn, sorghum, and alfalfa are the crops best suited. Small grains tend to drown or to grow rank and to lodge before harvest.

Rotations can consist mainly of row crops, but legumes or a mixture of legumes and grasses should be grown every 10 to 15 years to maintain or to improve fertility and tilth.

Artificial drainage improves tilth. It is not always practical, however, because of lack of outlets. Drainage can be improved by row direction, surface bedding, diversion terraces, grading, and open ditches. Flooding is best controlled by conservation measures applied upstream and by flood-control structures upstream.

Crop residues should be worked into the soil by minimum surface tillage. Lime and fertilizers, applied according to needs, provide the proper balance of plant nutrients.

This soil is suitable for windbreaks, wildlife areas, permanent hay, pasture, or woodland, depending upon the practices needed on particular farms. It is fair to good for garden crops.

Capability unit IIs-2

Deep, nearly level, moderately well drained soils on the uplands and terraces make up this unit. These soils have a slowly permeable, tight clay subsoil that is almost like a claypan. They are—

Crete silty clay loam, 0 to 3 percent slopes.
Rokeby silty clay loam.
Wymore silty clay loam, 0 to 3 percent slopes.

These soils retain moisture and plant nutrients but absorb and release water slowly. The clayey subsoil restricts the movement of air, roots, and water. Some crops, corn for example, are adversely affected by the lack of moisture. In most places, runoff and erosion are only slight.

These soils are suitable for many of the common crops and for trees and grasses. Most of the acreage is cultivated. If management is good and rainfall is adequate, fair to good yields are obtained, especially of small grains, legumes, grasses, grain sorghum, and corn.

Generally, row crops can be grown year after year, without restriction. Maintenance of fertility and soil structure is needed, and also control of insects, plant diseases, and weeds. During droughts, yields of grain sorghum are better than yields of corn. The best crop rotation is one in which a legume-grass crop is grown every 10 to 15 years and allowed to remain for 2 or more years. To avoid depleting the supply of moisture in the subsoil, alfalfa should be grown for not more than 4 or 6 years and preferably for not more than 3 or 4 years.

Proper amounts of lime and fertilizers provide a balance of plant nutrients, which is essential for satisfactory yields. Heavy fertilization may not be profitable in dry years, because the soils lack the moisture needed to mature crops.

Terraces and contour rows generally are not needed, except where the slope exceeds 2 percent. Grassed waterways to carry runoff are needed only locally. Grassed field borders may be used for turnrows, roadways, and wildlife areas. They also help to control weeds. Sites for farm ponds are lacking.

These soils are suitable for hay and pasture, for windbreaks, and for wildlife. They are fair to good for garden crops.

Capability unit IIIe-1

Deep, moderately sloping to strongly sloping soils on the uplands make up this unit. These soils have a moderately permeable subsoil. They are—

Geary silty clay loam, 5 to 8 percent slopes, eroded.
Lancaster loam, 3 to 8 percent slopes.
Morrill loam, 5 to 8 percent slopes, eroded.
Morrill loam, 8 to 12 percent slopes, eroded.
Shelby and Burchard clay loams, 5 to 8 percent slopes, eroded.
Shelby and Burchard clay loams, 8 to 12 percent slopes, eroded.

These soils are well drained. They are fairly easy to work and manage but will erode further unless protected. If well managed, they absorb and retain water and release it readily to plants, and they also retain plant nutrients. Runoff is medium or moderately rapid.

These soils are moderately productive of the crops grown in the county, if properly managed. They are also suited to trees and grasses.

Rotations should include more close-growing crops than row crops. Row crops can be grown successfully if fields are terraced and contour farmed, but they should not be grown for more than 2 consecutive years. The best crop rotation is one in which a legume-grass crop is grown every 8 to 12 years and allowed to remain for 2 or more years.

Lime and fertilizers are needed. Growing legumes, utilizing crop residues, farming on the contour, and using proper methods of tillage are important. Grassed borders along roadways and turnrows help to control weeds as well as to control erosion.

These soils can be used for woodland, windbreaks, permanent hay, permanent pasture, or wildlife. They are fair to good for garden crops. Some sites are suitable for farm ponds or other structures.

Capability unit IIIe-2

Deep, gently sloping and moderately sloping soils on the uplands make up this unit. These soils have a slowly permeable subsoil. They are—

Adair clay loam, 3 to 5 percent slopes, eroded.
Adair clay loam, 5 to 8 percent slopes, eroded.
Crete silty clay loam, 3 to 5 percent slopes.
Crete silty clay loam, 3 to 5 percent slopes, eroded.
Pawnee clay loam, 3 to 5 percent slopes, eroded.
Pawnee clay loam, 5 to 8 percent slopes, eroded.
Wymore silty clay loam, 3 to 5 percent slopes.
Wymore silty clay loam, 3 to 5 percent slopes, eroded.
Wymore silty clay loam, 5 to 8 percent slopes, eroded.

These soils are moderately well drained or well drained. They are fairly easy to work and manage but wash easily unless they are protected (fig. 13). They retain plant nutrients and water moderately well but absorb and release water slowly.

These soils are moderately well suited to many of the common crops and to trees and grasses. Controlling runoff and erosion is the major problem. If the soils are properly managed and rainfall is adequate, fair to average

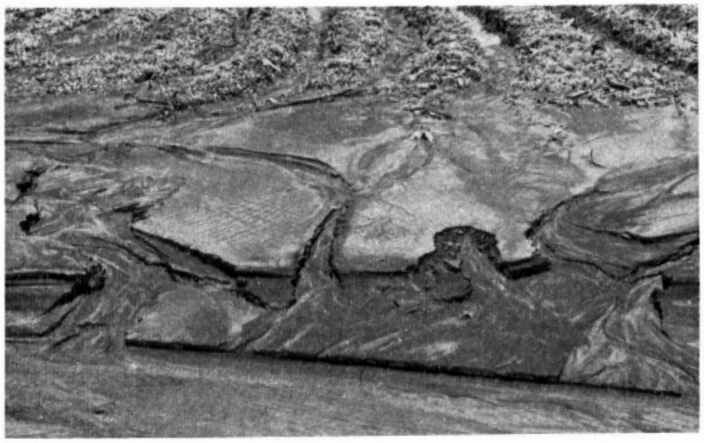

Figure 13.—**Evidence of water erosion on Crete silty clay loam, 3 to 5 percent slopes, eroded. This soil is highly susceptible to erosion.**

yields of small grains, legumes, grasses, grain sorghum, and corn are obtained. These crops thrive and mature mainly on moisture in the surface layer. In dry seasons, corn is adversely affected by the lack of moisture in the subsoil.

Because of the low moisture reserve and the hazard of runoff and erosion, rotations should consist mainly of such close-growing crops as small grains, legumes, and grasses. Row crops can be grown successfully if terraces and contour tillage are used (fig. 14), but they should not be grown for more than 2 successive years. Grain sorghum is a good substitute for corn.

Lime and fertilizers are needed as well as the practices that conserve soil and moisture. Heavy applications of fertilizers in dry years may not increase yields, because the heavy clay subsoil releases moisture slowly.

Surface tillage and stubble mulching leave a cover of crop residues that protect the surface while a new vegetative cover is growing. Grassed field borders along turnrows and roadways, as well as grassed waterways, help to control erosion and weeds. Some sites are suitable for farm ponds.

These soils can be used for permanent hay, pasture, woodland, or wildlife. Generally, they are more profitably used for crops and rotation hay. The soils are fair to good for garden crops.

Capability unit IIIe–3

A complex of deep and moderately deep, moderately sloping, permeable soils on the uplands make up this unit. This one mapping unit is—

Morrill complex, 5 to 8 percent slopes.

The soils in this complex are easily worked. They are moderately retentive of plant nutrients. They absorb and hold water and release it readily to plants. Fertility is medium. Runoff is slow or medium, and the soils wash unless they are well managed and protected. There is a slight hazard of wind erosion where the vegetative cover is sparse or lacking. Blowing of the surface layer makes it difficult to establish small grains and grasses, especially in dry years.

The soils in this complex can be farmed intensively if they are protected from erosion. They are well suited to many of the common crops and to trees and grasses.

Because of their sandy texture, these soils can be worked easily over a wide range of moisture content. Generally they can be worked early in spring and soon after rains. They warm earlier in spring than the more silty and clayey soils.

Rotations should include close-growing crops as often as practical, as protection against erosion. Corn can be grown if legumes and grasses are grown often enough to maintain fertility and if all crop residues are utilized. Row crops should not be grown for more than 2 years in succession, and a grass-legume crop should be grown every 8 to 12 years and allowed to remain for 2 or more years.

Crop residues supply organic matter. Results are best if the residues are worked into the soil by minimum surface tillage or are left on the surface through stubble-mulch tillage.

Lime and fertilizers should be applied according to the needs of the soils and the crops. Light and fairly frequent applications are needed because of the possibility of losses through leaching on these sandy soils. Terraces, contour rows, grassed waterways, and grassed field borders are generally needed for maximum production. Only a few sites are suitable for farm ponds and structures.

These soils are used mostly for cultivated crops, tame hay, or rotation pasture. They are excellent for garden crops.

Capability unit IIIw–1

One deep, poorly drained soil on the bottom lands is in this unit. This soil has a high water table and is subject to frequent flooding. This soil is—

Wabash silty clay.

This soil is medium to high in organic-matter content, and it retains plant nutrients. It is difficult to work and manage because it is wet and poorly drained and has a heavy, clayey texture. Floodwaters drain off slowly, and the water table is within 3 to 6 feet of the surface most of the time.

Of the cultivated soils on bottom lands, this soil is the most difficult to work and to manage. Because it is wet or even ponded for considerable periods, it is limited

Figure 14.—**A well-managed cornfield on Pawnee clay loam, 5 to 8 percent slopes, eroded. It is terraced and is farmed on the contour.**

chiefly to hay crops or other crops that can be seeded and harvested late in summer, after the rainy season. Drained areas are productive of corn and grain sorghum, but the drainage systems require expert maintenance. It is often difficult to get crops established.

Artificial drainage is essential in most places for satisfactory yields, but it may be neither practical nor possible because of lack of suitable outlets. Drainage can be improved by row direction in tillage, surface bedding, diversion terraces, and open drainage ditches. Building dikes and diversions to divert floodwaters is generally not practical.

Legumes and grasses, manure, and lime are needed mainly to improve soil structure. Crop residues should be plowed under soon after harvest to add humus to the soil, to improve tilth, and to prevent the residues from floating away or accumulating and causing damage when the soils are flooded.

With or without drainage, crops are limited chiefly to corn, grain sorghum, and alfalfa. There is no danger of depleting the supply of moisture by growing corn year after year. Small grains are not well suited. Many areas are used for hay and pasture and for wildlife. This soil is not suitable for garden crops.

Capability unit IIIw–2

Deep, nearly level, poorly drained soils on the uplands and terraces make up this unit. These soils have a slowly permeable claypan subsoil. They are—

Butler silty clay loam.
Fillmore silt loam.

These soils are on slightly depressed, broad flats where surface water collects and stands after rains and after the snow melts. The subsoil absorbs and releases water slowly and is not easily penetrated by air and roots. During extended dry periods, these soils are droughty.

These soils are not well suited to cultivation, because of the changes in moisture content. Small grains grow fairly well in some years, but corn is often difficult to manage because the soils are wet for long periods in spring and in the early part of summer, especially after heavy rains. Grain sorghum, which can be grown after the rainy season, is best suited. Small grains and legumes sometimes drown out or fail.

Generally, row crops can be grown year after year, without restriction. Maintenance of fertility and soil structure is necessary, and also control of insects, plant diseases, and weeds. Grain sorghum generally is the best row crop, but corn can be grown on areas that are drained. A crop of legumes or of legumes and grasses should be grown every 10 to 15 years and should be allowed to remain for 2 or more years.

In wet years all crop residues should be plowed under, and in dry years they should be worked into the soil by minimum tillage. These soils should not be worked when too wet.

Artificial drainage improves the tilth of these soils and increases productivity. It is not always practical or even possible, however, because of lack of suitable outlets. Drainage can be improved by row direction in tillage, by surface bedding, and by grading.

Drainage, as well as the needs of the crops and the soils, should be considered in determining the amounts of lime and fertilizers to be applied. Heavy applications are of little value in especially wet or especially dry years.

Some areas should be used for hay meadows or for fall and winter pasture. These areas are small and isolated and are surrounded by good cropland; thus, they cannot be used according to their suitability. Grassed areas provide excellent protection and nesting places for upland game birds.

Capability unit IVe–1

Deep, strongly sloping and moderately steep, moderately permeable soils on the uplands make up this unit. These soils are—

Labette silty clay loam, 5 to 12 percent slopes.
Lancaster loam, 8 to 12 percent slopes.
Morrill loam, 12 to 18 percent slopes, eroded.
Shelby and Burchard clay loams, 12 to 18 percent slopes, eroded.

These soils absorb and release water readily and are fairly easy to work. Runoff is rapid, and the erosion hazard is severe. The steep slopes generally limit the use of farm machinery and make the construction and maintenance of terraces and waterways difficult.

If properly managed, these soils are fairly productive of the crops grown in the county. They are well suited to legumes and grasses.

Rotations should consist chiefly of such close-growing crops as small grains, legumes, and grasses. The objective is to grow grasses or legumes one-third of the time and to protect the soil with a crop cover two-thirds of the time. Generally, restrict row crops to 1 year in the cropping sequence. A short rotation might consist of clover, 2 years, and wheat, 4 years. A longer rotation might consist of alfalfa or an alfalfa-grass mixture, 4 years; corn or sorghum, 1 year; and clover, 1 or 2 years. The row crop-clover sequence can be repeated several times before alfalfa is planted again. Grass can be substituted for alfalfa and used for pasture.

Some lime and fertilizer is needed, but lime and fertilizers are less important than the supply of organic matter and of moisture. Barnyard manure should be added to these soils, and green-manure crops should be grown.

Most of the natural drains can be made into grassed waterways. Terracing and contour farming are also needed. Grassed field borders help to control weeds along turnrows and roadways. A few gullies need to be controlled by dams or other structures.

These soils are suited to permanent hay, pasture, and woodland. They are not well suited to garden crops. Some sites are suitable for farm ponds, and some for wildlife areas.

Capability unit IVe–2

Eroded and severely eroded, moderately sloping and strongly sloping, clayey soils on the uplands make up this unit. These soils have a slowly permeable subsoil that is almost like a claypan. They are—

Adair clay loam, 8 to 12 percent slopes, eroded.
Adair and Pawnee soils, 5 to 8 percent slopes, severely eroded.
Pawnee clay loam, 8 to 12 percent slopes, eroded.
Wymore soils, 5 to 8 percent slopes, severely eroded.

Most of the original surface layer of these soils is gone. The present surface layer consists of material that was once the subsoil. Runoff is rapid, and further erosion is likely. The subsoil resembles a claypan and is not easily penetrated by air, water, or roots. When dry, these soils harden and crack, especially where they lack a vegetative cover.

These soils are only moderately well suited to cultivation. They are droughty and are not well suited to corn. Small grains, legumes, grain sorghum, trees, and grasses grow fairly well if an adequate supply of moisture can be maintained in the subsoil. Tillage is difficult because of the heavy clay texture of the surface layer. Controlling runoff and erosion is the major problem. Terraces, grassed waterways, and contour farming are needed when these soils are used for cultivated crops.

Rotations should consist chiefly of such close-growing crops as small grains, legumes, and grasses. The objective is to grow grasses or legumes one-half of the time and to protect the soil with a crop cover three-fourths of the time. Generally, restrict row crops to 1 year in the cropping sequence. A short rotation might consist of clover, 2 years, and wheat, 2 years. A longer rotation might consist of alfalfa or an alfalfa-grass mixture, 4 years; corn or sorghum, 1 year; clover, 2 years; and corn or sorghum, 1 year. Grass can be substituted for alfalfa and used for pasture.

The amounts and kinds of fertilizers to be applied should be determined according to the supply of soil moisture and to the needs of the crops and soils. Heavy applications should be avoided in dry years because the clayey subsoil does not absorb and release enough moisture to enable plants to utilize the fertilizers. Yields are determined largely by the supply of moisture.

All crop residues should be kept on or near the surface by stubble mulching or minimum tillage. This practice reduces crusting and evaporation, adds organic matter, and makes the soils easier to work and more absorbent and more retentive of water. Manure should be applied whenever possible and is especially needed in the most eroded areas. Manuring is an excellent practice for small bodies of these soils that occur within areas of more productive soils.

These soils are better suited to permanent hay, pasture, woodland, or wildlife than to cultivated crops. They are not suited to garden crops. Some sites are suitable for farm ponds and erosion control structures.

Capability unit IVe-3

Deep and moderately deep, moderately sloping and strongly sloping, moderately permeable soils on the uplands make up this unit. These soils are—

Morrill complex, 5 to 8 percent slopes, severely eroded.
Morrill complex, 8 to 12 percent slopes.

These soils absorb water fairly well but hold only limited amounts because of their sandy subsoil and substratum. Deep gullies form quickly. Wind erosion is a slight hazard during dry seasons, especially where a vegetative cover is sparse or lacking. Most eroded areas are low in organic-matter content.

These soils are suited to close-growing crops, mainly small grains, legumes, and grasses, and to trees. They are not well suited to row or garden crops.

Maintaining a vegetative cover is the chief need. Vegetation helps to control soil blowing and evaporation of moisture, and it also retards runoff and water erosion. Utilizing crop residues by stubble mulching or other methods is important in protecting these soils. Terraces, contour rows, and grassed waterways are also effective, even though the soils are sandy and permeable.

Rotations should consist chiefly of such close-growing crops as small grains, legumes, and grasses. The objective is to grow grasses or legumes one-half of the time and also to protect the soil with a crop cover three-fourths of the time. Generally, limit row crops to 1 year in the cropping sequence. A short rotation might consist of clover, 2 years, and wheat, 2 years. A longer rotation might consist of alfalfa or an alfalfa-grass mixture, 4 years; corn or sorghum, 1 year; clover, 2 years; and corn or sorghum, 1 year. Grass can be substituted for alfalfa and used for pasture.

Applications of lime and fertilizers should be moderate and frequent to prevent excessive loss by leaching. The amounts should be adequate for the needs of the soils and the crops.

Because of the sandy soils and substrata, grassed waterways are difficult to establish and to maintain, especially along gullies. Farm ponds are also difficult to maintain, because of seepage. Many gullies require erosion control structures. All field borders should be grassed.

Many areas of these soils are used for permanent hay, pasture, woodland, or wildlife.

Capability unit IVe-8

Severely eroded, moderately sloping and strongly sloping soils on the uplands make up this unit. These soils have a moderately permeable subsoil. They are—

Geary soils, 5 to 12 percent slopes, severely eroded.
Morrill soils, 5 to 8 percent slopes, severely eroded.
Shelby and Burchard soils, 8 to 12 percent slopes, severely eroded.

Most of the original surface layer has been washed from these soils. The organic-matter content is low, and fertility is low. Runoff is moderately rapid. These soils wash and gully unless protected.

If properly managed these soils are fairly productive of many of the common crops and of trees and grasses. They should be used for row crops only occasionally, because they are strongly sloping and highly susceptible to water erosion. They are easy to work but need skillful management for the maintenance of fertility. They improve under good management.

Rotations should consist chiefly of close-growing crops, mainly small grains, legumes, and grasses. The objective is to grow grasses or legumes one-third of the time and to protect the soils with a crop cover two-thirds of the time. Generally, restrict row crops to 1 year in the cropping sequence. A short rotation might consist of clover, 2 years, and wheat, 4 years. A longer rotation might consist of alfalfa or an alfalfa-grass mixture, 4 years; corn or sorghum, 1 year; and clover, 1 or 2 years. The row crop-clover sequence can be repeated several times before alfalfa is planted again. Grass can be substituted for alfalfa and used for pasture.

Lime and fertilizers are needed as well as conservation of soil and moisture. Crop yields depend mainly on the supply of organic matter, of moisture, and of plant nutrients. Green-manure crops should be grown, and barnyard manure should be applied to eroded areas whenever possible. Manuring is an excellent practice for small bodies of these soils that occur within areas of more productive soils.

Grassed field borders help to control weeds along turnrows and roadways. Most drainageways can be made into grassed waterways. They should be used with terraces, contour farming, and crop-residue management. A few gullies require erosion control structures. Some gullies are suitable sites for farm ponds.

On many farms these soils are used for permanent hay, pasture, woodland, or wildlife. They are not well suited to garden crops.

Capability unit VIe-2

Severely eroded, strongly sloping and moderately steep, slowly permeable clayey soils on the uplands make up this unit. These soils are—

Adair and Pawnee soils, 8 to 12 percent slopes, severely eroded.
Lanham clay loam.
Wymore soils, 8 to 12 percent slopes, severely eroded.

Because of steep slopes and slow permeability, most areas of these soils are severely eroded. The soils are not easily penetrated by roots and moisture. Gullies form readily because of rapid runoff. Fertility is low, and the organic-matter content is low.

These soils are best suited to native grasses for either hay or pasture and are highly productive if properly managed. They are not suited to cultivation, because of the slope and the hazard of erosion.

The chief management need is to maintain a protective cover of grass at all times, mainly by proper seeding and by regulated mowing and grazing. Such practices are effective in regulating runoff and in controlling erosion.

Additional seeding with adapted grasses is needed in many areas, including many now established as pasture but once used for cultivated crops. Grazing and mowing should be regulated so as to leave an adequate protective cover of sod. Mowing or spraying eliminates most of the weeds and undesirable plants.

Terraces may be needed to retard runoff on some gullied areas until an adequate grass cover can be established. Most drainageways can be made into grassed waterways, but it may be difficult to convert those that are gullied. Many gullies require erosion control structures.

These soils can be used for woodland and wildlife, depending upon the needs of the particular farm. Some sites are suitable for farm ponds. Most of the acreage is used for permanent hay or pasture.

Capability unit VIe-3

Moderately deep, moderately steep and steep, permeable soils on the uplands make up this unit. These soils are—

Morrill complex, 12 to 18 percent slopes.
Morrill complex, 8 to 18 percent slopes, severely eroded.

These soils absorb and release water readily, but they are droughty because they have a moderately low water-holding capacity. Roots penetrate easily, but seldom beyond the sand and gravel substratum, which is at a depth of 30 to 36 inches. Runoff is moderately rapid. Gullies form readily and are difficult to control because the soils are sandy.

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These soils are best suited to native grasses. They are only moderately productive, mainly because they are sandy and droughty. Good management increases production.

The chief management need is to conserve soil and moisture by controlling runoff and erosion. A protective cover of grass should be maintained by seeding and by regulation of grazing and mowing. No more than half the current growth should be removed by mowing or grazing. Weeds and undesirable plants should be controlled by spraying or mowing.

These soils are excellent for woodland or wildlife, but most of the acreage is in native grass for hay or pasture. In places, haying is difficult because of the slope. Farm ponds are difficult to maintain because of seepage.

Capability unit VIe-8

Severely eroded, moderately steep, moderately permeable soils on the uplands make up this unit. These soils are—

Morrill soils, 8 to 18 percent slopes, severely eroded.
Steinauer soils, 12 to 18 percent slopes, severely eroded.

If properly managed, these soils absorb and hold water and release it to plants fairly well. They retain plant nutrients. Roots penetrate easily and deeply. Because of rapid runoff on the steep slopes, gullies form easily. These eroded soils are low in organic-matter content.

Because these soils are steep and highly susceptible to water erosion, they are not suited to cultivation. They are best suited to native grasses. They are highly productive and easy to manage, but they require careful management.

The chief management need is to maintain an adequate vegetative cover by proper seeding and by well-regulated mowing and grazing. A grass cover is effective in controlling runoff and erosion.

Grazing should be regulated. Only half of the current growth of the desirable grasses should be grazed. Mowing or spraying helps to keep down weeds and undesirable plants. Under good management, the more desirable seeded grasses become dominant.

Terraces may be needed in some gullied areas in order to establish a protective cover of grass. Most drainageways can be made into grassed waterways. Because of the slope and rapid runoff, erosion control structures may be required to stabilize gullies in natural waterways.

These soils are used mostly for permanent hay or pasture, but they are also suitable for windbreaks or woodland. In some places haying is difficult because of the steep slopes. Sites are available for farm ponds and wildlife areas.

Capability unit VIe-9

One deep, moderately steep to steep, moderately permeable soil that normally has a thin surface layer makes up this unit. This soil is on the uplands. It is—

Steinauer clay loam, 12 to 25 percent slopes.

If properly managed, this soil absorbs and holds water and releases it to plants fairly well. It retains plant nutrients. Roots penetrate easily and deeply.

Because this soil is steep and highly susceptible to runoff and water erosion, it is not suited to cultivation. It is best suited to native grasses. It is highly productive and easy to manage and responds to good grass management.

The chief need is to maintain an adequate vegetative cover by well-regulated grazing. Prairie grasses are effective in controlling runoff and erosion. Many areas, including those in permanent pasture, need additional seeding with adapted grasses.

For best results, grazing should be regulated so that only half of the current growth of desirable grasses is grazed. Mowing or spraying helps to control weeds and woody plants. Under good management, the more desirable grasses become dominant.

This soil is used mostly for permanent pasture or hay, but it is also suitable for windbreaks or woodland. In some places, haying is difficult because of the steep slopes. There are suitable sites for farm ponds and other structures and for wildlife areas.

Capability unit VIw-1

One land type makes up this unit. It is on nearly level bottom lands and is subject to frequent flooding. This land type is—

Alluvial land.

The texture is predominantly loam, silt loam, or very fine sandy loam, but it ranges from clay to sand. This soil material absorbs water well and holds it for plants. In places, floodwaters drain off slowly. In other places, they drain off readily, but they damage crops and grasses. The flood hazard has been reduced in some areas by upstream structures and by other conservation measures. Erosion does little damage except for occasional bank cutting by the meandering streams.

Because of wetness and the flood hazard, this land type generally is best suited to grasses or trees. The areas that are most frequently flooded, that have a high water table, or that are sandy are better suited to woodland or wildlife, because it is difficult to establish a grass cover.

Much of the acreage is fertile enough to be excellent for crops in places where floodwaters do not interfere, but the crooked streams make farming difficult. Excellent grass can be grown.

Two types of general management are needed. One type is needed for the areas that are used primarily for pasture, and another type for areas used primarily for woodland.

The chief management requirement for pasture is to maintain a grass cover at all times, by seeding and by regulated grazing. Spraying may be necessary to eliminate weeds and woody plants. Once established, the better pasture plants will maintain themselves if protected from overgrazing. Including legumes in the seeding mixture improves the quality of the forage. Rotation of grazing between alternate pastures helps to maintain the better pasture plants. Otherwise, the undesirable plants become more vigorous and crowd out the good grasses, especially if livestock continue feeding on the depleted plants.

The chief management requirement for woodland is to maintain a stand of desirable species. Properly managed stands of black walnut or other suitable species can be a source of income. Other requirements include protection from grazing and burning, removal of less desirable and poorly formed trees, supplemental planting, and pruning.

Capability unit VIs-1

Saline-alkali soils on the high bottom lands and low terraces make up this unit. These soils are—

Exline soils.

These soils have poor surface drainage because of slow permeability and a clayey surface layer. The organic-matter content is low, and fertility is low. Salts and alkali restrict the growth of plants. The surface tends to seal over so that moisture is not absorbed.

These soils are not suited to cultivation and are poorly suited to grasses. Most of the acreage is in pasture, but part of it is cultivated. The quality of the pasture is poor. Yields of grasses are low, and yields of cultivated crops are negligible. Most of the cultivated areas are small patches within large fields of arable soils, where separate use and management are difficult. Many areas are regarded as wasteland. The sparse cover of native grass in pastures gives little protection against erosion.

The chief management need is to reduce the salinity and alkalinity enough so that crops or grasses can be grown successfully. This is likely to be difficult, impractical, and economically unfeasible. Conditions vary, and each local area presents a special problem that requires study by experts. Applications of gypsum or sulfur improve some areas. In most places improvement of drainage is needed to remove seepage water, but this too is likely to be impractical. Large quantities of organic matter, such as manure, crop residues, and other vegetal debris, generally improve soil structure, tilth, moisture-holding capacity, and fertility. All organic materials applied have to be hauled in, because these soils support so little vegetation. Many areas remain practically barren, regardless of treatment. These soils are not suited to trees.

Capability unit VIs-4

Sloping to steep soils that are shallow and moderately deep over bedrock make up this unit. These soils are on the uplands. They are—

Hedville stony loam.
Sogn complex.

Most areas are in native grasses and have scattered patches of trees, but some of the steepest slopes are forested. Some areas have been moderately eroded. Rock outcrops alternate with areas that have only a few stones on the surface. Runoff is rapid, and the soils tend to be droughty.

Although these soils are only moderately well suited to grasses, they are used mainly for pasture. A few small acreages are used for hay. In places the grass cover is sparse because of the low moisture reserve. Many areas are suitable for wildlife or recreation. There are some rock quarries.

The chief need is to establish and maintain a cover of grasses or trees. Regulation of grazing and control of brush are the main requirements for establishing and maintaining grasses. The areas that have few stones on the surface are suitable for seeding and haying. Brush control, selective cutting, and protection from fire and grazing are needed to maintain stands of trees.

Most gullies are shallow and stabilized. Diversions at the base of slopes help to protect lower lying and generally more productive soils from runoff and overflow. Because of the lack of deep soil material, the diversions ordinarily must be built near the base of slopes, on the better soils. Farm ponds can be constructed at the base of slopes near the mouth of drainageways, but many such ponds have seepage problems.

Capability unit VIIe-1

A land type that is very steep and consists of deep and mixed soil material makes up this unit. It is on the uplands. This one mapping unit is—

Rough broken land.

Most areas are in trees and brush. Some areas have an understory of grasses. Runoff is rapid.

Although poorly suited to grasses, this land type is used mainly for pasture. Because of the very steep slopes, severe erosion hazard, and present tree cover, these areas are ideal for wildlife.

The chief need is to establish and maintain a cover of grasses or trees. Limited grazing and brush control are the main requirements for establishing and maintaining grasses. Selective cutting and protection from fire and grazing are needed to maintain good stands of trees.

Most gullies are shallow and stabilized. Farm ponds can be constructed at the base of slopes near the mouth of drainageways, but many such ponds have seepage problems.

Capability unit VIIs-3

A land type that consists of a shallow layer of soil material over bedrock makes up this unit. This land type is on the uplands. The slopes are very steep. The one land type in this unit is—

Rough stony land.

Most areas are in trees and brush and have an understory of native grasses. Rock outcrops are common. Runoff is rapid.

Although poorly suited to grasses, this land type is used mainly for pasture. In most places the grass cover is sparse because of the low moisture reserve. Many areas should be used for wildlife. Rock quarries are numerous.

The chief need is to develop and maintain a cover of grasses or trees. Regulation of grazing and control of brush are the main requirements for establishing and maintaining grasses. Brush control, selective cutting, and protection from fire and grazing are needed to maintain stands of trees.

Most gullies are shallow and stabilized. Diversions at the base of slopes help to protect lower lying and generally more productive soils from runoff and overflow. Because of the lack of soil material, the diversions must ordinarily be built near the base of slopes, on the better soils. Farm ponds can be constructed at the base of slopes near the mouth of drainageways, but many such ponds have seepage problems.

Estimated Yields

Table 2 shows the estimated average acre yields of the principal crops grown in the county under two levels of management. These estimates are based mainly on information obtained from farmers, from agricultural workers, and from others who have observed yields.

Yields in columns A are those obtained by many farmers in the county, under a system of management that does not include regular cropping systems, improved tillage methods, or the adequate use of lime, fertilizers, and crop residues.

Yields in columns B are obtained under management that includes the use of adequate amounts of fertilizers, improved tillage methods, regular cropping systems, green-manure crops, crop residues, and other practices for soil and water conservation. Yields higher than those shown in columns B are not uncommon in favorable seasons.

TABLE 2.—*Estimated average acre yields of the principal crops under two levels of management*

[In columns A are yields under common management; in columns B are yields under improved management. Absence of figure indicates the crop is not suited to the soil or is not commonly grown]

Symbol	Soil	Corn		Wheat		Oats		Grain sorghum		Alfalfa	
		A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
AdB2	Adair clay loam, 3 to 5 percent slopes, eroded	25	50	20	35	25	40	30	60	2.5	4.0
AdC2	Adair clay loam, 5 to 8 percent slopes, eroded	20	45	20	30	25	35	30	55	2.0	3.5
AdD2	Adair clay loam, 8 to 12 percent slopes, eroded	15	30	15	20	15	30	15	35	1.5	3.0
APC3	Adair and Pawnee soils, 5 to 8 percent slopes, severely eroded	15	25	15	20	15	25	15	35	1.0	3.0
APD3	Adair and Pawnee soils, 8 to 12 percent slopes, severely eroded									1.0	2.0
Sy	Alluvial land									2.5	3.0
Bt	Butler silty clay loam	15	35	15	30	20	40	25	55	1.5	3.0
Cm	Cass loam	30	60	15	20	20	30	35	65	3.0	4.0
Ct	Colo silty clay loam	40	80	15	30	20	35	35	70	3.5	4.5
CrA	Crete silty clay loam, 0 to 3 percent slopes	30	45	25	35	30	45	35	60	2.0	3.0
CrB	Crete silty clay loam, 3 to 5 percent slopes	30	45	25	35	30	45	35	60	2.0	3.0
CrB2	Crete silty clay loam, 3 to 5 percent slopes, eroded	25	45	20	35	25	45	30	60	2.5	3.5
E	Exline soils										
Fm	Fillmore silt loam	15	30	10	25	15	30	20	45	1.5	3.0
GeB2	Geary silty clay loam, 3 to 5 percent slopes, eroded	30	50	20	35	25	40	40	60	2.5	3.5
GeC2	Geary silty clay loam, 5 to 8 percent slopes, eroded	25	45	20	30	25	35	35	60	2.0	3.5
GeD3	Geary soils, 5 to 12 percent slopes, severely eroded	15	25	15	25	20	35	20	35	1.0	3.0
Hv	Hedville stony loam										

TABLE 2.—*Estimated average acre yields of the principal crops under two levels of management*—Continued

[In columns A are yields under common management; in columns B are yields under improved management. Absence of figure indicates the crop is not suited to the soil or is not commonly grown]

Symbol	Soil	Corn		Wheat		Oats		Grain sorghum		Alfalfa	
		A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Hb	Hobbs silt loam, seldom flooded	40	80	20	30	25	40	50	80	3. 5	5. 0
2Hb	Hobbs silt loam, occasionally flooded	40	80	15	25	20	35	40	70	3. 5	4. 5
JfB	Judson fine sandy loam, 3 to 5 percent slopes	40	75	20	30	25	40	35	60	3. 5	4. 5
JuA	Judson silt loam, 1 to 3 percent slopes	45	85	20	30	25	40	50	80	3. 5	5. 0
JuB	Judson silt loam, 3 to 5 percent slopes	40	80	25	35	30	45	40	70	3. 5	4. 5
LwD	Labette silty clay loam, 5 to 12 percent slopes	15	25	10	20	15	25	20	35	1. 5	3. 5
LcC	Lancaster loam, 3 to 8 percent slopes	15	45	15	25	20	30	25	55	1. 0	2. 5
LcD	Lancaster loam, 8 to 12 percent slopes	10	25	10	20	15	20	15	35	1. 0	2. 0
Lg	Lanham clay loam										
MrB2	Morrill loam, 3 to 5 percent slopes, eroded	30	50	20	35	25	40	40	60	2. 5	4. 0
MrC2	Morrill loam, 5 to 8 percent slopes, eroded	25	45	20	30	20	40	30	60	2. 0	3. 5
MrD2	Morrill loam, 8 to 12 percent slopes, eroded	20	40	15	25	20	30	25	50	1. 5	2. 0
MrE2	Morrill loam, 12 to 18 percent slopes, eroded	15	30	15	20	15	25	20	35	1. 0	3. 0
MxC	Morrill complex, 5 to 8 percent slopes	20	40	20	30	20	35	25	50	1. 5	2. 5
MxD	Morrill complex, 8 to 12 percent slopes	15	30	10	20	15	20	20	40	1. 0	2. 0
MxE	Morrill complex, 12 to 18 percent slopes										
MxC3	Morrill complex, 5 to 8 percent slopes, severely eroded	15	30	10	20	15	20	20	40	1. 0	2. 0
MxD3	Morrill complex, 8 to 18 percent slopes, severely eroded										
MC3	Morrill soils, 5 to 8 percent slopes, severely eroded	20	35	15	25	20	30	20	45	1. 5	2. 5
ME3	Morrill soils, 8 to 18 percent slopes, severely eroded										
Mu	Muir silt loam	45	80	20	30	25	40	50	80	3. 5	5. 0
PwB2	Pawnee clay loam, 3 to 5 percent slopes, eroded	30	50	20	35	25	40	35	60	2. 5	3. 5
PwC2	Pawnee clay loam, 5 to 8 percent slopes, eroded	25	45	20	30	20	40	30	55	2. 0	3. 0
PwD2	Pawnee clay loam, 8 to 12 percent slopes, eroded	15	30	15	20	15	25	15	35	1. 5	3. 0
Rt	Rokeby silty clay loam	25	40	20	35	25	45	35	60	3. 0	4. 0
BLg	Rough broken land										
Rv	Rough stony land										
SBB2	Shelby and Burchard clay loams, 3 to 5 percent slopes, eroded	40	50	20	35	25	40	45	65	3. 0	4. 5
SBC2	Shelby and Burchard clay loams, 5 to 8 percent slopes, eroded	30	45	20	30	20	40	35	60	2. 5	4. 5
SBD2	Shelby and Burchard clay loams, 8 to 12 percent slopes, eroded	25	40	15	25	20	30	30	50	2. 0	4. 0
SBE2	Shelby and Burchard clay loams, 12 to 18 percent slopes, eroded	20	30	15	20	15	25	25	40	1. 5	4. 0
SBD3	Shelby and Burchard soils, 8 to 12 percent slopes, severely eroded	15	30	10	25	15	30	20	40	1. 5	4. 0
Sn	Sogn complex										
StE	Steinauer clay loam, 12 to 25 percent slopes										
StE3	Steinauer soils, 12 to 18 percent slopes, severely eroded										
Wa	Wabash silty clay	10	30	15	25	10	20	20	40	2. 0	3. 0
WtA	Wymore silty clay loam, 0 to 3 percent slopes	45	70	25	35	30	45	45	75	2. 5	4. 5
WtB	Wymore silty clay loam, 3 to 5 percent slopes	45	65	25	35	30	45	45	70	2. 5	4. 5
WtB2	Wymore silty clay loam, 3 to 5 percent slopes, eroded	35	60	20	35	30	45	40	65	2. 5	4. 5
WtC2	Wymore silty clay loam, 5 to 8 percent slopes, eroded	30	55	20	30	25	40	35	60	2. 5	4. 0
WtC3	Wymore soils, 5 to 8 percent slopes, severely eroded	20	35	15	25	20	30	25	40	1. 5	3. 5
WtD3	Wymore soils, 8 to 12 percent slopes, severely eroded									1. 5	3. 0

Native Grassland [1]

Practically all of Gage County was grassland at the time of settlement. Trees grew only on steep, rocky slopes and on bottom lands along rivers and streams. Much of the acreage has been plowed and cultivated, but about one-fifth is still native grassland. The major part of this is in the southern part of the county. Here, beef cattle are grazed on sizable tracts of range. Elsewhere in the county, the native grassland consists of small farm pastures on which a few beef or dairy cattle are grazed. Most of the range has been overgrazed and is now in poor condition, but it could be restored through proper management.

[1] This section prepared by LORENZ F. BREDEMEIER, range conservationist, Soil Conservation Service.

Range sites and range condition

Soils vary in their capacity to produce native grasses and other range plants. Soils that can produce about the same kinds and amounts of native grasses make up what is called a range site. Each range site is sufficiently uniform in climate, soils, and topography to produce a particular kind of climax vegetation.

Climax vegetation is the stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment remains unchanged. This vegetation may be destroyed or altered, but the range site retains its ability to reproduce this combination of plants unless materially altered by physical deterioration. Thus, managers of rangeland can predict the kind of vegetation a range site is capable of producing. If a site is not producing the kinds or amounts it originally produced, it is in less than excellent condition.

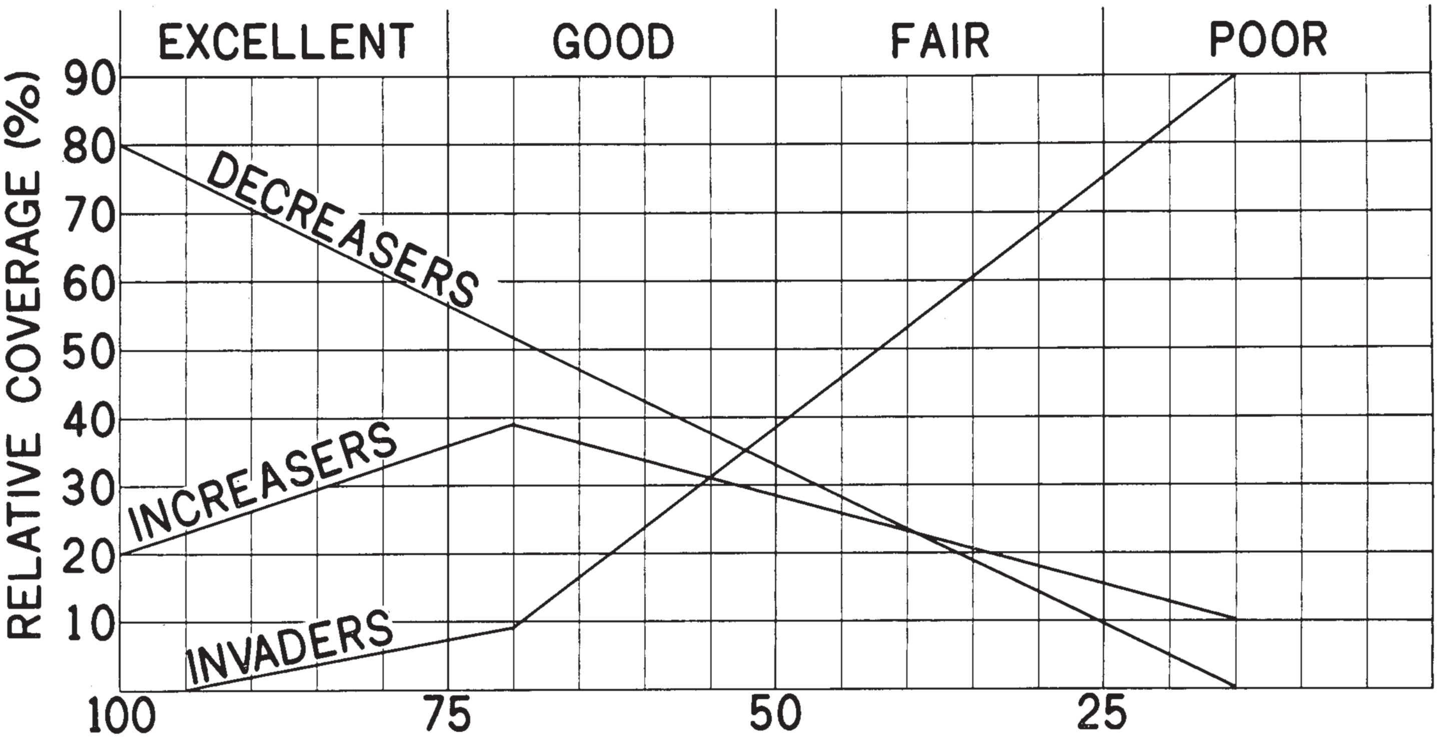

***Figure 15.*—Range condition classes are determined by the percentage of decreasers, increasers, and invaders as measured from the climax.**

Range is classified as being in *excellent*, *good*, *fair*, or *poor* condition, depending on the composition of the present vegetation compared with that of the climax vegetation (*2*) (*3*) [2] These classifications indicate the response of the plants in the climax vegetation to grazing. Those plants that livestock prefer tend to decrease in relative abundance when grazed. They are called decreasers. Other plants increase in abundance as the decreasers are weakened by grazing. They are called increasers. Prolonged excessive grazing eventually eliminates the increasers, and they are then replaced by invaders, which were not part of the climax vegetation.

Figure 15 illustrates how the climax plants respond to grazing. This chart can be used to determine the range condition class of an area of range.

Descriptions of range sites

There are nine range sites in Gage County. This section describes the sites, lists the soils in each site, and gives the estimated yields of herbage. (Exline soils are not assigned to a range site, because they are inextensive and occur only as small areas. They should be used and managed the same as the adjacent, more extensive soils are.)

CLAYEY RANGE SITE

This site consists of moderately deep and deep, moderately fine textured soils on the uplands. These soils are—

Adair clay loam, 3 to 5 percent slopes, eroded.
Adair clay loam, 5 to 8 percent slopes, eroded.
Adair clay loam, 8 to 12 percent slopes, eroded.
Adair and Pawnee soils, 5 to 8 percent slopes, severely eroded.
Adair and Pawnee soils, 8 to 12 percent slopes, severely eroded.
Butler silty clay loam.
Crete silty clay loam, 0 to 3 percent slopes.
Crete silty clay loam, 3 to 5 percent slopes.
Crete silty clay loam, 3 to 5 percent slopes, eroded.
Geary silty clay loam, 3 to 5 percent slopes, eroded.
Geary silty clay loam, 5 to 8 percent slopes, eroded.
Geary soils, 5 to 12 percent slopes, severely eroded.
Labette silty clay loam, 5 to 12 percent slopes.
Lanham clay loam.
Pawnee clay loam, 3 to 5 percent slopes, eroded.
Pawnee clay loam, 5 to 8 percent slopes, eroded.
Pawnee clay loam, 8 to 12 percent slopes, eroded.
Rokeby silty clay loam.
Shelby and Burchard clay loams, 3 to 5 percent slopes, eroded.
Shelby and Burchard clay loams, 5 to 8 percent slopes, eroded.
Shelby and Burchard clay loams, 8 to 12 percent slopes, eroded.
Shelby and Burchard clay loams, 12 to 18 percent slopes, eroded.
Shelby and Burchard soils, 8 to 12 percent slopes, severely eroded.
Wymore silty clay loam, 0 to 3 percent slopes.
Wymore silty clay loam, 3 to 5 percent slopes.
Wymore silty clay loam, 3 to 5 percent slopes, eroded.
Wymore silty clay loam, 5 to 8 percent slopes, eroded.
Wymore soils, 5 to 8 percent slopes, severely eroded.
Wymore soils, 8 to 12 percent slopes, severely eroded.

Much of the acreage is farmed. Native vegetation occurs on the steeper slopes, on the narrow ridges adjacent to the Thin Clayey range site, and on small areas dissected by ravines (fig. 16).

The climax vegetation is predominantly big bluestem, Indiangrass, switchgrass, prairie dropseed, and little bluestem. If overgrazed, these grasses decrease and are replaced by less desirable grasses, shrubs, and weeds.

[2] Italic numbers in parentheses refer to Literature Cited, p. 73.

Figure 16.—**Native grass pasture on some of the steeper slopes of the county. The Clayey range site is on the slopes in the foreground, and the Thin Clayey range site is on the steeper slopes in the background.**

If the vegetation is in good condition, this site produces from 1,800 pounds of herbage per acre in years of low rainfall to 3,500 pounds in years of high rainfall.

OVERFLOW RANGE SITE

This site consists of medium-textured and moderately fine textured soils on the bottom lands and in depressions on the uplands. These soils are subject to flooding. They are—

Cass loam.
Fillmore silt loam.
Hobbs silt loam, seldom flooded.
Hobbs silt loam, occasionally flooded.

Most of the acreage is cultivated. Native grasses grow where trees have encroached. The principal grasses in the climax vegetation are switchgrass, big bluestem, and Indiangrass.

If the vegetation is in good condition, this site produces from 2,500 pounds of herbage per acre in years of low rainfall to 4,500 pounds in years of high rainfall.

SHALLOW LIMY RANGE SITE

This site consists of medium-textured and moderately fine textured soils on broad ridge tops and on steep slopes along drainageways. These soils are shallow over limestone. The only mapping unit is—

Sogn complex.

In most places these soils are shallow, but in some places they are moderately deep and deep. The slope is as much as 20 percent.

The climax vegetation consists principally of little bluestem, big bluestem, side-oats grama, and forbs. Some stunted trees grow in places.

If the vegetation is in good condition, this site produces from 1,500 pounds of herbage per acre in years of low rainfall to 3,000 pounds in years of high rainfall.

SHALLOW NONLIMY RANGE SITE

This site consists of one shallow, stony, medium-textured soil on valley slopes. This soil is—

Hedville stony loam.

The slope is as much as 20 percent. Sandstone bedrock is generally less than 20 inches below the surface. Joints in the bedrock make it possible for shrubs and stunted trees to grow in spots.

The climax vegetation consists principally of little bluestem, big bluestem, switchgrass, Indiangrass, side-oats grama, and forbs.

If the vegetation is in good condition, this site produces from 800 pounds of herbage per acre in years of low rainfall to 2,000 pounds in years of high rainfall.

SILTY RANGE SITE

This site consists of deep and moderately deep, medium-textured and moderately coarse textured soils. These soils are—

Judson fine sandy loam, 3 to 5 percent slopes.
Judson silt loam, 1 to 3 percent slopes.
Judson silt loam, 3 to 5 percent slopes.
Lancaster loam, 3 to 8 percent slopes.
Lancaster loam, 8 to 12 percent slopes.
Morrill loam, 3 to 5 percent slopes, eroded.
Morrill loam, 5 to 8 percent slopes, eroded.
Morrill loam, 8 to 12 percent slopes, eroded.
Morrill loam, 12 to 18 percent slopes, eroded.
Morrill complex, 5 to 8 percent slopes.
Morrill complex, 5 to 8 percent slopes, severely eroded.
Morrill complex, 8 to 12 percent slopes.
Morrill complex, 8 to 18 percent slopes, severely eroded.
Morrill complex, 12 to 18 percent slopes.
Morrill soils, 5 to 8 percent slopes, severely eroded.
Morrill soils, 8 to 18 percent slopes, severely eroded.
Muir silt loam.

Most of the acreage is cultivated. A few small areas that have never been plowed and are used as pasture occur near farmsteads. Most of these small pastures have been grazed so closely for many years that the vegetation is now mainly invaders and weeds and the range is in poor condition.

The principal climax grasses are big bluestem, little bluestem, Indiangrass, and switchgrass.

If the vegetation is in good condition, this site produces from 1,800 pounds of herbage per acre in years of low rainfall to 3,500 pounds in years of high rainfall.

SUBIRRIGATED RANGE SITE

This site consists of deep, fine textured and moderately fine textured soils that have a high water table. These soils are—

Colo silty clay loam.
Wabash silty clay.

These soils are rarely flooded, but the water table is within easy reach of plant roots during the growing season. Some areas are adjacent to the Wet Land range site.

The principal climax grasses are big bluestem, switchgrass, and Indiangrass.

If the vegetation is in good condition, this site produces from 3,000 pounds of herbage per acre in years of low rainfall to 6,000 pounds in years of high rainfall.

THIN BREAKS RANGE SITE

This site consists of spots of shallow soil between rock outcrops on abrupt breaks along upland drains. The only mapping unit is—

Rough stony land.

About half of the surface consists of ledges of limestone, shale, and sandstone bedrock. The soil between the rocks is of variable depth. The entire acreage is in grass or trees.

The climax vegetation consists principally of side-oats grama, little bluestem, big bluestem, Indiangrass, switchgrass, and woody plants.

If the vegetation is in good condition, this site produces from 1,200 pounds of herbage per acre in years of low rainfall to 2,500 pounds in years of high rainfall.

THIN CLAYEY RANGE SITE

This site consists of medium-textured and moderately fine textured soils that are moderately steep and steep. These soils are—

Rough broken land.
Steinauer clay loam, 12 to 25 percent slopes.
Steinauer soils, 12 to 18 percent slopes, severely eroded.

Most of the acreage is in native grass that is used for hay or pasture.

The principal climax grasses are big bluestem, Indiangrass, switchgrass, little bluestem, and prairie dropseed.

If the vegetation is in good condition, this site produces from 1,600 pounds of herbage per acre in years of low rainfall to 3,000 pounds in years of high rainfall.

WET LAND RANGE SITE

This site consists of areas that are on the bottom lands and are frequently flooded. The soil material is of various textures. The only mapping unit is—

Alluvial land.

This site is wet because of flooding and because of seepage from the base of hills. The water table is within easy reach of plant roots during the growing season.

The climax vegetation consists principally of prairie cordgrass and tall sedges.

If the vegetation is in good condition, this site produces from 3,500 pounds of herbage per acre in years of low rainfall to 7,500 pounds in years of high rainfall.

Managing rangeland

Maintaining the stand and producing the maximum amount of forage are the objectives of range management.

The basic practice for improving or maintaining range condition is control of grazing. Range that is grazed during the growing season can be kept in good or excellent condition by leaving about half of the current year's growth. This degree of use furnishes ample grazing and at the same time allows the most desirable species to maintain themselves.

Deferment of grazing for part or all of the growing season hastens the improvement of rangeland. If none of the current growth is removed, a mulch accumulates, the invader plants die, and conditions favorable for the growth of the preferred decreasers are created. Grazing should be deferred for as long as is necessary to restore the range to excellent condition. Periods of less than 3 months have little effect.

The kinds of range plants, their periods of growth, and the need for range improvement determine when native pasture can be grazed safely.

Grazing should be distributed to avoid overuse of some areas and underuse of others. Salt and minerals can be placed so as to attract livestock to underused areas. Properly located supplies of water and fences that divide large pastures or separate different range sites help to distribute grazing.

Some rangeland is so depleted that it can be restored more quickly and more economically by seeding than by deferment of grazing or other less intensive methods of range improvement. Rangeland should be seeded to a mixture of adapted strains of the grasses originally present, in proportions that will result in a stand as nearly like the climax vegetation as possible.

Tame Grass Pasture [3]

Tame grass pasture is grown on soils suitable for cultivation, in rotation with cultivated crops. It is used to supplement native pasture and thereby to provide a longer grazing season and to make it possible to keep the native grassland in good or excellent condition.

The management of tame pasture is geared to grazing when the forage is at the peak in quantity and quality. Maintaining the stand is a secondary consideration. Tame pastures yield more forage than range but are more costly. Consequently, only soils of fairly high productivity should be used.

Introduced grasses are used for tame grass plantings. Bromegrass is the species most commonly used in this county. The wheatgrasses and tall fescues are grown to some extent. Including one or two native grasses in the plantings is often desirable.

Best results are obtained by plowing out stands when they begin to deteriorate. By then, other fields will have been seeded, so that pasture will be available continuously. For this reason, it is important that tame pasture grasses be planted on soils that can be plowed and reseeded without danger of excessive runoff and erosion.

Established pastures should not be grazed early in spring. Until the grasses reach a height of 5 or 6 inches, they are growing on food reserves stored in their roots and rhizomes. Also, the grasses should be 6 to 8 inches tall before the killing frosts in fall. During this time they store food for growth the next spring.

Weeds can be controlled by the use of chemicals. Mowing clips off the taller grasses and may do as much damage to the grasses as the weeds do.

Soil tests and estimates of the amount of available soil moisture should be used as guides to determine the amounts and kinds of fertilizers to apply. Grasses are likely to need nitrogen. If a legume has been included in the pasture mixture, phosphate fertilizers are generally essential.

It is important to avoid overgrazing tame grass pastures. Sudangrass can be seeded to provide temporary pastures for grazing during July and August. These are the months when most cool-season grasses are semidormant. A combination of cool-season pastures, warm-season pastures, and temporary pastures of sudangrass provide grazing for livestock throughout the growing season.

[3] By ERVIN O. PETERSON, conservation agronomist, Soil Conservation Service.

Woodland [4]

Forest originally covered nearly all of the bottom lands, benches, and steep slopes along streams in Gage County. Much of this forest has now been cleared and replaced with annual grain crops or grass. Now, only about 2 percent of the land in farms is forested.

Native woodland

Three major forest types are represented in the native woodland of Gage County: The elm-ash-cottonwood type, the oak-hickory type, and the bur oak type.

The elm-ash-cottonwood type occurs chiefly on a narrow strip of Cass soils and Alluvial land, on the low bottom lands along the Big Blue River. This type varies in composition. In addition to elm, ash, and cottonwood, it includes willow, hackberry, black walnut, boxelder, and honeylocust.

The oak-hickory type (fig. 17) ranges in location from slopes that are nearly as dry as those occupied by stands of bur oak to bottom lands that are more commonly covered with elm-ash-cottonwood stands. It occurs chiefly on Wabash silty clay and Hobbs silt loam. These soils are on the bottom lands of all minor streams and in narrow strips along the main streams. The composition varies. Besides oak and hickory, the stands may include elm, soft maple, ash, boxelder, black walnut, hackberry, sycamore, coffeetree, willow, cottonwood, black cherry, honeylocust, and mulberry.

Nearly pure stands of bur oak grow on the dry, exposed slopes of Shelby and Burchard clay loams along the larger streams in the county. Bur oak grows better, and is associated with other species, on Muir silt loam, at the lower ends of the main tributaries of the Blue River, where moisture is more plentiful.

[4] This section prepared by SIDNEY S. BURTON, woodland conservationist, Soil Conservation Service.

Figure 17.—Large hackberry trees in an oak-hickory forest on the bottom lands of Plum Creek.

Eastern redcedar is scattered in wooded areas and pastures and along fence rows throughout the county. Osage-orange, which has been planted in hedgerows, has spread to some extent into pastures.

The county lacks wood-using industries, and little use is made of the native timber. Some oak is cut for barrel staves, and locally owned portable sawmills produce small amounts of lumber.

At present, much of the native woodland is being damaged by grazing and becoming overstocked with undesirable species. Black walnut, which has a ready market and a high value, is being depleted rapidly. Under proper management the woodland stands could be made a source of income as well as a means of controlling erosion on bottom lands and along streambanks. A simple management plan that would involve little effort or investment would include the following practices.

1. Excluding livestock and protecting the areas from fire.
2. Removing trees of less desirable species, large "wolf" trees, and leaning, forked, fire-scarred, or poorly formed trees that are crowding or shading young walunt trees.
3. Planting walnut trees in openings, to supplement natural reproduction.
4. Frequent, light pruning of young trees, to produce straight, knot-free stems.

Tree plantings

Trees have been planted in Gage County for the purpose of establishing wind barriers for protection of farmsteads and feedlots, shelterbelts for the protection of cropland, and living fences.

WINDBREAKS

Trees have been planted for windbreaks on nearly all farms in the county. In many places they have failed to give adequate protection because of improper location, insufficient size, or poor choice of species.

Tree plantations should be carefully planned as to size, shape, composition, and location. The benefits from windbreaks are many, and they more than repay the planter for the expense and labor involved in establishing them. They prevent snow from drifting in yards, reduce fuel costs, provide shelter for livestock, reduce feed costs, prevent soil blowing, attract insect-eating birds and other wildlife, protect gardens, and beautify the home.

Windbreaks for farmsteads and feedlots.—Windbreaks for winter protection of farmsteads and feedlots should be wide enough to hold most of the snow within the windbreak. From 7 to 10 rows of trees are required. The trees should be planted on the northern and western sides of the area to be protected, and not less than 100 feet from the main buildings.

A combination of low shrubs, shrubs or trees of medium height, and tall-growing trees provides a satisfactory wind barrier. For adequate density in winter and for longer life of the windbreak, at least half of the trees should be evergreens. Redcedar, which has dense growth to the ground, is excellent for the outside rows.

Field windbreaks or shelterbelts.—Because of the rolling topography in this county, only limited use can be made of field windbreaks. On the more nearly level acreages in cultivation, windbreaks help to control soil blowing, increase the supply of soil moisture by holding snow on the fields, prevent damage to crops from strong winds, reduce evaporation, and furnish food and cover for wildlife.

LIVING FENCES

In the past, many fences of Osage-orange were planted on farm and field boundaries, but these are rapidly being removed because this plant saps moisture from the adjacent fields and interferes with telephone and power lines.

Except that it does not produce fenceposts, multiflora rose serves the same purpose as Osage-orange and probably provides better travel lanes for upland game birds. Planted 12 to 18 inches apart in single rows, multiflora rose (fig. 18) produces a stockproof fence in about 4 years.

Figure 18.—**A fence of multiflora rose. Such fences provide perfect cover for quail.**

Planting sites

The soils of Gage County are grouped into four tree-planting sites. These groupings are based on the ability of the soils to sustain the growth of similar species. Table 3 describes the sites and lists the soils in each site and suitable species for each site.

Strongly saline or alkali soils, marshland, badlands, undifferentiated sand and gravel, riverwash, and very shallow soils are not suited to plantings. In this group are Exline soils, Hedville soils, Rough broken land, Rough stony land, and Sogn complex.

The amount of preparation necessary for successful planting of trees varies for different soils. Summer fallow is advisable in areas that have been used for grasses or alfalfa, to allow the soils to store moisture and to kill the perennial vegetation. Fall or spring plowing and spring disking are generally adequate preparation for stubble ground. Soils that are susceptible to blowing may need to be protected through the winter by a cover crop of oats.

Young trees should be clean cultivated until they are large enough to shade out competing weeds. This generally takes 5 or 6 years. For 2 years after planting, all seedlings that die should be replaced. Trees planted for wind barriers need complete and permanent protection from livestock and poultry.

Technical assistance and advice in the preparation of a site, the choice of species, the spacing of trees, planting methods, and maintenance requirements can be obtained from the county agent, the State forester, or local representatives of the Soil Conservation Service.

TABLE 3.—*Planting sites and suitable species*

Planting sites and soil series	Suitable species		
	Shrubs	Conifers	Broadleaf trees
Silty to Clayey site Deep, well-drained, silty, clayey, or claypan soils, except the saline-alkali soils: Cass, Hobbs, Judson, Muir, Geary, Shelby, Burchard, Crete, Rokeby, Wymore, Lancaster, Morrill, Adair, Pawnee, Labette, Steinauer, Lanham.	Cotoneaster, Tatarian honeysuckle, lilac, multiflora rose, Nemaha plum.	Arborvitae, redcedar, Rocky Mountain juniper, Austrian pine, ponderosa pine.	Russian-olive, Russian mulberry, green ash, hackberry, thornless honeylocust, bur oak, red oak, Siberian (Chinese) elm, soft maple.
Sandy site Slightly sandy, nearly level, very sandy soils: Judson, Morrill.	Lilac, honeysuckle, Nemaha plum, three-leaved sumac.	Arborvitae, redcedar, Rocky Mountain juniper, ponderosa pine, Scotch pine, Austrian pine.	Russian-olive, Russian mulberry, green ash, thornless honeylocust, Siberian (Chinese) elm.
Moderately Wet site Bottom lands, benches, and upland depressions that are occasionally wet because of a high water table and frequent flooding. Colo, Hobbs, Wabash, Butler.	Purple willow, red-osier dogwood, buffaloberry, chokecherry, Nemaha plum, multiflora rose.	Redcedar, Scotch pine	Russian-olive, diamond willow, green ash, thornless honeylocust, white willow, cottonwood, black walnut, sycamore, basswood, soft maple, golden willow.
Wetland site Bottom lands, benches, and upland depressions that are extremely wet because of flooding, high water table, or poor drainage. Fillmore, Alluvial land.	Purple willow, red-osier dogwood.	None	Diamond willow, golden willow, white willow, cottonwood.

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Wildlife [5]

To the early settlers in Gage County, wildlife was a source of food and of income. At present, it is important mainly for the recreational opportunities provided by hunting and fishing. Trapping for beaver, mink, and muskrat provide some income to local residents.

The capacity of an area to support wildlife depends largely on the vegetation. Of the many kinds of wildlife common when the area was settled, some vanished when the natural vegetation was removed and crops were planted, and others became more abundant.

Deer are the only hoofed animals remaining of a wildlife population that once included antelope, elk, and buffalo. Beaver, which were scarce for a number of years, are now plentiful. Raccoon, weasel, mink, opossum, badger, fox, squirrel, skunk, and cottontail rabbit are common.

Waterfowl and other migratory birds pass through during spring and fall flights, and broods of teal and mallard are common on farm ponds. The most important game bird of the uplands is the bobwhite quail, which finds suitable habitats in many parts of the county. Pheasant have been introduced, but conditions are not suitable for a heavy population.

Flathead and channel catfish are to be found in the Big Blue River, and farm ponds have been stocked with black bass, bluegill, and channel catfish.

When grassland is put under cultivation, there is a loss of the kind of cover needed by certain kinds of animals, but an increased supply of food for other kinds becomes available. Windbreaks, farm ponds, and herbaceous and woody plantings around ponds provide food and cover for many kinds of wildlife (fig. 19). Irregular areas in gullies or on steep slopes, and other areas unsuitable for farming, may be developed as wildlife habitats if the natural vegetation is protected from grazing and from fire.

Technical assistance in planning wildlife conservation practices on farms in Gage County is available from the Soil Conservation Service through the local Soil Conservation District. Fish for stocking ponds are available from the Nebraska Game, Forestation and Parks Commission and from the Bureau of Sports, Fisheries and Wildlife. These agencies also provide technical assistance on specific problems of wildlife management.

[5] By C. V. BOHART, biologist, Soil Conservation Service.

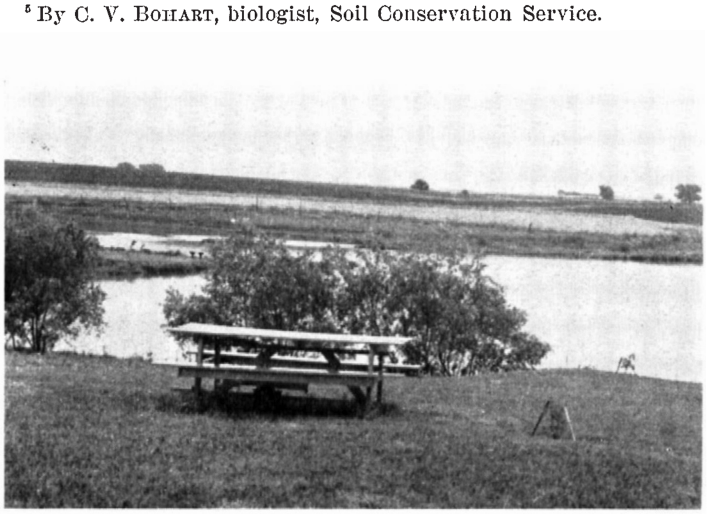

Figure 19.—Farm pond in Indian Creek watershed. Such developments provide habitats for wildlife and recreational areas.

Engineering Properties of the Soils [6]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of highways, airports, pipelines, building foundations, earth dams for water storage, erosion control structures, irrigation and drainage systems, sewage disposal systems, and measures for soil and water conservation. Some of the soil properties important to the engineer are texture, permeability, shear strength, plasticity, compacted density, compressibility, workability, and water-holding capacity. Topography, depth to the water table, and depth to bedrock or to sand and gravel are also important.

This soil survey report contains information that can be used to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the soil properties that are important in planning and designing structures and measures for soil and water conservation.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways and airports and in planning detailed investigations at the selected locations.
4. Estimate drainage areas and runoff characteristics for use in culvert and bridge design.
5. Classify soils along the proposed highway route and use this information in making preliminary estimates of required thickness for flexible pavement.
6. Estimate the need for clay to stabilize the surfacing on roads that are not paved.
7. Locate deposits of sand, gravel, rock, mineral filler, and soil binder for use in constructing subbase courses, base courses, and surface courses for flexible pavements for highways and structures.
8. Make preliminary evaluations of terrain conditions, such as topography, surface drainage, subsurface drainage, and height of the water table, that have to be considered in designing highway embankments, subgrades, and pavements.
9. Correlate performance of engineering measures and structures with types of soil to develop information that will be useful in designing and maintaining these measures and structures.
10. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
11. Supplement the information obtained from other published maps and reports and aerial photo-

[6] LEE E. SMEDLEY, assistant state conservation engineer, Soil Conservation Service, prepared this section with the assistance of WILLIAM J. RAMSEY, senior geologist, Division of Materials and Tests, Nebraska Department of Roads. The work performed by the Nebraska Department of Roads was under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

graphs to make maps and reports that can be used readily by engineers.

12. Develop other preliminary estimates for construction purposes, pertinent to the particular area.

It is not intended that this report will eliminate the need for detailed field investigations prior to design and construction of specific engineering works. It should be used primarily for planning detailed field investigations to determine the condition of the soil material in place at the proposed site.

Some of the terms used by soil scientists may not be familiar to the engineer, and some words—for example, soil, clay, silt, sand, and aggregate—may have special meanings in soil science. These terms are defined in the Glossary.

To make the best use of the soil map and the soil survey report, the engineer should know the physical properties of the soil materials and the in-place condition of the soil. After testing the soil materials and observing behavior of each soil when used in engineering structures and foundations, the engineer can develop recommendations for each soil unit delineated on the map.

Engineering classification systems

Two systems of classifying soils are in general use among engineers. Both are used in this report. It is assumed that persons using this report will be familiar with these systems or will have available reference material on these two classification systems.

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (AASHO) (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, which is made up of clay soils having low strength when wet. Within each group, the relative engineering value of the soil material is indicated by a group index number. The group index for the soil groups A–1 and A–3 is 0. For the poorest soils in group A–2, the group index is 4; in group A–4, the poorest soils have a group index of 8; in group A–5, the poorest soils have a group index of 12; in group A–6, the poorest soils have a group index of 16; and in group A–7, the poorest soils have a group index of 20. In table 4 the group index number is shown in parentheses after the soil group symbol.

Some engineers prefer to use the Unified soil classification system (*10*). This system is based on identification of soils according to their texture and plasticity, and the soils are grouped according to their performance as engineering construction materials. The system establishes 15 soil groups. The soil materials are identified as coarse grained (8 classes), fine grained (6 classes), and highly organic (1 class). Boundary classifications are provided for soils that have characteristics of two groups. The system provides for both a simple field method and a laboratory method to determine the amount and type of basic constituents of the soils. Both methods are based on gradation and plasticity and vary only in degree of accuracy. The laboratory method uses mechanical analyses, liquid limit data, and plasticity indexes for an exact classification. A plasticity chart on which the liquid limit and the plasticity index may be plotted is used for a more accurate classification of the soils having plasticity. Classification of the tested soils according to the Unified system is given in table 4.

Engineering test data

Table 4 shows engineering test data for samples of 12 different soils from 16 sites. Each soil was sampled by natural horizons. Samples tested by the Nebraska Department of Roads were obtained and tested during soil surveys made for highway projects located in the county. Samples tested by the Bureau of Public Roads were obtained by personnel of the Soil Conservation Service in their survey of Pawnee County, Nebr. The terminology used by the Nebraska Department of Roads in describing each horizon differs somewhat from that used by the Soil Conservation Service. The Department of Roads describes the horizons as the upper layer, the middle layer, and the lower layer or parent material. The Soil Conservation Service designates horizons as A, B, and C. The upper layer is approximately equivalent to the A horizon, the middle layer is equivalent to the B horizon, and the lower layer or parent material is equivalent to the C horizon. Further explanation of the horizon designations generally used by soil scientists can be found in the Glossary of this report.

The soils listed in table 4 were sampled in one or more locations. Data for a particular soil sampled in only one location indicate the engineering characteristics of that soil at that specific location. It must be recognized that there may be variations in the physical characteristics of this soil at other locations in the county. Even though a soil is sampled in more than one location, the test data may not show the maximum degree of variation in the properties of the soil materials.

The engineering soil classifications in table 4 are based on data obtained by mechanical analyses and by tests made to determine the liquid limit and the plastic limit. Mechanical analyses were made by combining the sieve and hydrometer methods.

The liquid limit and plastic limit tests measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a solid to a semisolid, or plastic, state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content, expressed as a percentage of the ovendry weight of the soil, at which the material passes from a solid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition. Some silty and sandy soils are nonplastic, that is, they will not become plastic at any moisture content.

Table 4 also gives moisture-density, or compaction, data for the samples tested. 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, the density decreases as the moisture content increases. The highest dry density obtained in the compaction test is called maximum dry density. Moisture-density data are important in earthwork, for, as a rule, the soil is most stable if it is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

There is considerable variation in the texture of soils formed on alluvium, bedrock, and glacial till materials. Because of this variation, the data and engineering classification shown in table 4 for a particular soil may not be

TABLE 4.—*Engineering*

[Tests performed by the Division of Materials and Tests, Nebraska Department of Roads, and the U.S. Department of Commerce, Bureau cate information is not applicable

Soil name and location	Parent material	Nebraska Department of Public Roads or Bureau of Public Roads sample no.[1]	Depth	Horizon	Moisture-density [2]	
					Maximum dry density	Optimum moisture
			Ft.		*Lb. per cu. ft.*	*Pct.*
Adair clay loam, 5 to 8 percent slopes, eroded: 1,195 feet E. and 160 feet S. of NW. corner sec. 5, T. 3 N., R. 8 E.	Outwash and till	S-57-1055	0 to 0.8	Upper layer		
		S-57-1056	0.8 to 3.5	Middle layer		
Adair[6] and Pawnee soils, 5 to 8 percent slopes, severely eroded: 1,835 feet E. and 50 feet S. of NW. corner sec. 9, T. 6 N., R. 7 E.	Till and outwash	S-60-1528	0 to 1.2	Upper layer	96. 7	21. 2
		S-60-1532	1.2 to 4.0	Middle layer	98. 6	18. 5
Butler silty clay loam: 1,170 feet E. and 30 feet S. of NW. corner sec. 7, T. 6 N., R. 7 E.	Peorian loess	S-60-1527	0 to 1.5	Upper layer		
		S-60-1531	1.5 to 3.5	Middle layer		
Cass loam: 1,042 feet W. and 30 feet N. of SE. corner sec. 25, T. 11 N., R. 10 W., Hall County, Nebr.	Sandy alluvium	S-59-3186	0 to 1.0	Upper layer		
		S-59-3192	1.0 to 3.0	Middle layer		
		S-59-3171	3.0 to 4.5	Parent material.		
Crete silty clay loam, 0 to 3 percent slopes: 925 feet N. and 40 feet E. of SW. corner sec. 6, T. 4 N., R. 5 E.	Peorian loess	S-55-5145	0 to 1.2	Upper layer		
		S-55-5146	1.2 to 3.0	Middle layer		
		S-55-5147	3.0 to 4.0	Lower layer		
Geary silty clay loam, 5 to 8 percent slopes, eroded: 4,465 feet W. on U.S. Highway No. 77 from E. sec. line sec. 15, T. 2 N., R. 6 E. (50 feet N. of highway).	Loveland loess	S-57-3539	0 to 1.0	Upper layer		
		S-57-3540	1.0 to 4.5	Middle layer		
		S-57-3541	4.5 to 8.5	Lower layer		
Geary silty clay loam, 5 to 8 percent slopes, eroded: 1,880 feet N. and 40 feet E. of SW. corner sec. 28, T. 1 N., R. 7 E.	Loveland loess	S-57-3573	0 to 1.0	Upper layer		
		S-57-3574	1.0 to 4.0	Middle layer		
		S-57-3575	4.0 to 9.5	Lower layer		
Hobbs silt loam, occasionally flooded: 430 feet E. and 335 feet N. of SW. corner sec. 32, T. 4 N., R. 8 E.	Silty alluvium	S-57-1053	0 to 3.0	Upper layer		
Judson silt loam, 3 to 5 percent slopes: 3,725 feet N. and 40 feet E. of SW. corner sec. 6, T. 4 N., R. 5 E.	Colluvial-alluvial silts.	S-55-5142	0 to 4.0	Upper layer		
Morrill loam, 5 to 8 percent slopes, eroded: 3,125 feet W. and 50 feet N. of SE. corner sec. 23, T. 6 N., R. 8 E.	Till and till outwash	S-57-4854	0 to 1.0	Upper layer		
		S-57-4855	1.0 to 6.0	Middle layer		
Muir silt loam: 3, 725 feet W. and 50 feet N. of SE. corner sec. 23, T. 6 N., R. 8 E.	Alluvial silts	S-57-4852	0 to 1.8	Upper layer		
		S-57-4853	1.8 to 3.0	Middle layer		
Muir silt loam: 2,950 feet E. on State Highway No. 4 from NW. corner sec. 26, T. 4 N., R. 5 E. (20 feet S. of highway).	Alluvial silts	S-53-918	0 to 2.5	Upper layer		
		S-53-919	2.5 to 4.0	Middle layer		
		S-53-920	4.0 to 6.0	Lower layer		

See footnotes at end of table.

the same as data for the same soil at a different location. Information on the geology of Gage County is given in the subsection "Factors of Soil Formation."

Engineering information about each soil in the county is given in the tables in this section. Additional detailed information on the soils is given in the section "Descriptions of the Soils" and the subsection "Geology, Physiography, Relief, and Drainage."

test data

of Public Roads, in accordance with standard procedures of the American Association of State Highway Officials (AASHO). Dashes indi-
or was not determined]

Mechanical analysis [3]												Liquid limit	Plasticity index	Classification	
Percentage passing sieve—								Percentage smaller than—							
¾-in.	⅜-in.	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 50 (0.297 mm.)	No 60 (0.25 mm.)	No. 200 (0.074 mm.)	0. 05 mm.	0. 02 mm.	0.005 mm.	0.002 mm.			AASHO [4]	Unified [5]
------	------	------	100	99	99	------	98	94	------	39	------	43	18	A-7-6(12)	ML-CL.
------	------	------	------	100	99	------	98	94	------	44	------	48	23	A-7-6(15)	CL.
------	------	------	------	------	100	------	99	------	------	29	------	43	19	A-7-6(12)	CL.
------	------	------	100	99	99	------	97	------	------	44	------	54	30	A-7-6(19)	CH.
------	------	------	------	------	100	------	98	------	------	34	------	38	14	A-6(10)	ML-CL.
------	------	------	------	------	100	------	99	------	------	56	------	66	45	A-7-6(20)	CH.
------	------	------	100	94	92	------	82	59	------	7	------	30	6	A-4(8)	ML-CL.
------	------	------	100	99	98	------	94	71	------	8	------	29	6	A-4(8)	ML-CL.
100	99	98	95	58	50	------	24	12	------	1	------	(7)	(7)	A-2-4(0)	SM.
------	------	------	------	------	------	------	100	84	------	28	------	34	10	A-4(8)	ML-CL.
------	------	------	------	------	------	------	100	94	------	49	------	51	27	A-7-6(17)	CH.
------	------	------	------	------	------	------	100	90	------	47	------	59	35	A-7-6(20)	CH.
------	------	------	------	100	99	------	97	95	------	40	------	45	17	A-7-6(12)	ML-CL.
------	------	------	------	100	99	------	95	89	------	42	------	46	22	A-7-6(14)	CL.
------	------	------	100	98	96	------	88	80	------	38	------	45	22	A-7-6(14)	CL.
------	------	------	------	------	100	------	95	91	------	42	------	46	17	A-7-6(12)	ML.
------	------	------	------	------	100	------	85	78	------	40	------	44	20	A-7-6(13)	CL.
------	------	------	------	------	100	------	70	59	------	29	------	38	18	A-6(11)	CL.
------	------	------	100	99	98	------	96	90	------	26	------	37	14	A-6(10)	ML-CL.
------	------	------	100	99	99	------	98	88	------	27	------	35	11	A-6(8)	ML-CL.
------	------	------	100	98	97	------	98	88	------	25	------	33	9	A-4(8)	ML-CL.
------	------	------	100	96	92	------	74	63	------	29	------	41	17	A-7-6(11)	ML-CL.
------	------	------	100	99	99	------	96	88	------	23	------	32	6	A-4(8)	ML.
------	------	------	100	98	96	------	89	80	------	23	------	34	9	A-4(8)	ML-CL.
------	------	------	------	------	100	------	92	80	------	12	------	28	7	A-4(8)	CL-ML.
------	------	------	------	------	100	------	91	75	------	12	------	26	5	A-4(8)	CL-ML.
------	------	------	100	99	97	------	89	85	------	24	------	45	21	A-7-6(13)	CL.

TABLE 4.—*Engineering*

Soil name and location	Parent material	Nebraska Department of Public Roads or Bureau of Public Roads sample no.[1]	Depth	Horizon	Moisture-density [2]	
					Maximum dry density	Optimum moisture
			Ft.		*Lb. per cu. ft.*	*Pct.*
Pawnee clay loam, 5 to 8 percent slopes, eroded: 0.2 mile W. and 160 feet S. of center of sec. 19, T. 2 N., R. 12 E., Pawnee County, Nebr.	Till	S-34226	0 to 0.6	Alp	103	19
		S-34227	1.4 to 2.3	B21	99	22
		S-34228	4.0 to 5.3	C	105	19
Pawnee clay loam, 5 to 8 percent slopes, eroded: 0.3 mile W. and 350 feet S. of NE. corner sec. 2, T. 2 N., R. 11 E., Pawnee County, Nebr.	Till	S-34229	0 to 0.5	Alp	104	19
		S-34230	1.2 to 2.0	B21	95	25
		S-34231	4.4 to 5.3	C	105	20
Wabash silty clay: 400 feet E. and 70 feet N. of center of sec. 7, T. 3 N., R. 12 E., Pawnee County, Nebr.	Clayey alluvium	S-34256	0 to 0.7	Alp	94	24
		S-34257	1.4 to 2.4	A1-3	94	26
		S-34258	3.6 to 5.0	A3-2	99	22
Wymore silty clay loam, 5 to 8 percent slopes, eroded: 2,265 feet E. and 40 feet N. of SW. corner sec. 1, T. 6 N., R. 6 E.	Peorian loess	S-60-1526	0 to 0.8	Upper layer		
		S-60-1530	0.8 to 4.0	Middle layer		
		S-60-1534	4.0 to 6.5	Lower layer		

[1] Nos. S-34226 to S-34231 and S-34256 to S-34258 were tested by the Bureau of Public Roads. All other samples were tested by the Nebraska Department of Roads.

[2] Based on the Moisture-density Relations of Soils, Using 5.5-lb Rammer and 12-in. Drop. AASHO Designation: T 99-57. Method A was used by the Bureau of Public Roads, and Method C by the Nebraska Department of Roads.

[3] Mechanical analysis according to the American Association of State Highway Officials Designation: T 88. Results obtained by this procedure frequently differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils. The percentages of 0.02 millimeter and 0.002 millimeter size particles are not determined by the Nebraska Department of Roads.

test data—Continued

Mechanical analysis [3]												Liquid limit	Plasticity index	Classification	
Percentage passing sieve—								Percentage smaller than—						AASHO [4]	Unified [5]
¾-in.	⅜-in. mm.)	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 40 (0.2 mm.)	No. 50 (0.297 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
------	------	------	100	96	------	91	82	79	58	32	28	34	12	A-6(9)	ML-CL.
------	------	------	100	94	------	90	82	79	66	50	45	65	40	A-7-6(20)	CH.
------	------	------	100	93	------	87	75	72	60	48	41	55	35	A-7-6(19)	CH.
------	------	------	100	96	------	91	80	76	54	33	28	34	12	A-6(9)	ML-CL.
99	97	95	91	86	------	83	76	73	61	48	44	66	39	A-7-6(20)	CH.
------	------	------	100	94	------	88	76	72	56	42	36	53	33	A-7-6(19)	CH.
------	------	------	------	------	------	------	100	98	78	51	41	52	26	A-7-6(17)	CH.
------	------	------	------	------	------	------	100	98	83	57	48	64	37	A-7-6(20)	CH.
------	------	------	------	------	------	100	99	98	78	52	41	53	30	A-7-6(19)	CH.
------	------	------	------	------	100	------	99	------	------	34	------	47	23	A-7-6(15)	CL.
------	------	100	99	98	98	------	96	------	------	47	------	59	35	A-7-6(20)	CH.
------	------	------	------	------	100	------	99	------	------	38	------	50	28	A-7-6(17)	CL.

[4] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed. 7): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes. AASHO Designation: M 145-49.

[5] Based on the Unified Soil Classification System, Technical Memorandum No. 3-357, V. 1. Waterways Experiment Station, Corps of Engineers, March 1953.

[6] Only Adair soil was sampled and tested.

[7] NP=Nonplastic.

Estimated physical properties

Because of the normal variation in texture, particularly in soils formed on alluvium, bedrock, and glacial till materials, it is important that special field studies be made for engineering structures to be constructed on these soils, in order to determine the specific materials present.

As shown in table 5, surface runoff rates vary widely in the county. The soils are mostly fine textured, and infiltration rates are relatively low. Exceptions are the alluvial silts such as the Hobbs, Judson, and Muir soils.

Therefore, variation in the rate of surface runoff may reflect topographic differences as well as soil characteristics which affect runoff.

Permeability refers to movement of water through the soil material in its undisturbed state. It depends largely on soil texture and structure. The permeability ratings shown in table 5 are based on the following classification:

Inches per hour	*Rate*
0.05 to 0.20	Slow
0.20 to 0.80	Moderately slow
0.80 to 2.50	Moderate
2.50 to 5.0	Moderately rapid
5.0 to 10.0	Rapid
Over 10.0	Very rapid

Available water, measured in inches per inch of soil depth, is the water available for plants. It is the water held in the range between field capacity and wilting point.

TABLE 5.—*Brief descriptions of soils and*

[Descriptions of the soils and site and the classification and properties as shown are

Map symbol	Soil	Description of soils and site					
		Topography and position	Parent material	Surface runoff	Depth to water table [1]	Depth to bedrock [2]	Depth from surface
					Ft.	*Ft.*	*In.*
AdB2	Adair clay loam, 3 to 5 percent slopes, eroded.[3]	Gently sloping to strongly sloping uplands.	Outwash	Medium to rapid.	([4])	20+	0 to 10
AdC2	Adair clay loam, 5 to 8 percent slopes, eroded.						10 to 42
AdD2	Adair clay loam, 8 to 12 percent slopes, eroded.						
APC3	Adair and Pawnee soils, 5 to 8 percent slopes, severely eroded.[3] [5]	Sloping to strongly sloping uplands.	Till and outwash.	Rapid	([4])	20+	0 to 18
APD3	Adair and Pawnee soils, 8 to 12 percent slopes, severely eroded.						18 to 48
Sy	Alluvial land	Dissected bottom lands.	Mixed alluvium.	Slow	2 to 10	4 to 15	([6])
Bt	Butler silty clay loam (nearly level).	Nearly level uplands.	Peorian loess	Slow	([4])	20+	0 to 12 12 to 42
Cm	Cass loam	Nearly level bottom lands.	Sandy alluvium.	Slow	5 to 15	3 to 8	0 to 12 12 to 36 36 to 54
Ct	Colo silty clay loam	Nearly level bottom lands.	Silty and clayey alluvium.	Slow	3 to 8	20+	0 to 14 14 to 40 40 to 60
CrA	Crete silty clay loam, 0 to 3 percent slopes.[3]	Nearly level to gently sloping uplands.	Peorian loess	Slow to medium.	([4])	20+	0 to 14 14 to 36 36 to 48
CrB	Crete silty clay loam, 3 to 5 percent slopes.						
CrB2	Crete silty clay loam, 3 to 5 percent slopes, eroded.						
E	Exline soils	Nearly level to gently sloping terraces and bottom lands.	Clayey and silty alluvium.	Slow to rapid.	6 to 20	20+	0 to 6 6 to 26 26 to 48
Fm	Fillmore silt loam	Upland depressions.	Peorian loess.	Ponded	([4])	20+	0 to 10 10 to 30 30 to 60
GeB2	Geary silty clay loam, 3 to 5 percent slopes, eroded.[3]	Gently sloping to moderately sloping uplands.	Loveland loess.	Medium to rapid.	([4])	20+	0 to 12 12 to 54 54 to 102
GeC2	Geary silty clay loam, 5 to 8 percent slopes, eroded.						

See footnotes at end of table.

The reaction of soils in this county generally ranges from pH 5.5 to pH 6.5 in the surface layer to as high as pH 8.0 in the parent material.

The soils generally have little or no salinity. Exceptions are the soils of the Exline series, which are moderately to strongly saline-alkali.

Dispersion is not a common problem in this county, but it is moderate to high in certain small areas of the Exline soils.

The shrink-swell potential, which indicates the volume change to be expected with a change in moisture content, varies widely in the county. It is shown in table 5 and is based on the estimated soil plasticity, as follows:

	Rating
Nonplastic	None
Plasticity index less than 10	Low
Plasticity index more than 10, less than 25	Moderate
Plasticity index more than 25	High

Engineering interpretations

The adaptability of the soils to winter grading varies from year to year, depending on the moisture content of the soils and on temperatures during the winter months. Few soils in this county are suited to winter grading even when they receive only the normal amount of moisture in fall. Most of the soils are fine grained, that is, they are relatively high in silt and clay. More-

their estimated physical properties

based on tests of these soils or similar soils and on the author's knowledge of these soils]

USDA texture	Classification		Percentage passing sieve—			Permeability	Available water capacity	Shrink-swell potential
	Unified	AASHO	No. 4	No. 10	No. 200			
						In. per hr.	*In. per in. of depth*	
Clay loam	CL	A-6 or A-7-6.	100	100	75 to 100	0.20 to 0.80	0.175	Moderate.
Clay	CL	A-7-6	100	100	75 to 100	0.05 to 0.20	.183	Moderate.
Clay loam or clay	CL	A-6 or A-7-6.	100	100	75 to 100	0.05 to 0.20	.175 to .183	Moderate.
Clay	CH	A-7-6	100	100	75 to 100	0.05 to 0.20	.183	High.
(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6).
Silty clay loam	ML or CL	A-4 or A-6	100	100	95 to 100	0.20 to 0.80	.175	Moderate.
Silty clay	CH	A-7-6	100	100	95 to 100	0.05 to 0.20	.183	High.
Loam	ML	A-4	100	100	80 to 85	0.80 to 2.50	.167	Low.
Sandy loam	SM	A-2 or A-4	100	100	30 to 40	2.50 to 5.0	.146	Low.
Sandy loam	SM	A-2-4	95 to 100	95 to 100	25 to 35	2.50 to 5.0	.146	None.
Silty clay loam	CL	A-6 or A-7-6	100	100	90 to 100	0.20 to 0.80	.175	Moderate.
Silty clay loam	CL	A-6 or A-7-6	100	100	95 to 100	0.20 to 0.80	.175	Moderate.
Silty clay	CL or CH	A-6 or A-7-6	100	100	95 to 100	0.05 to 0.20	.183	Moderate to high.
Silty clay loam	ML	A-4 or A-6	100	100	100	0.20 to 0.80	.175	Low.
Silty clay	CH	A-7-6	100	100	100	0.05 to 0.20	.183	High.
Silty clay loam	CH	A-7-6	100	100	100	0.20 to 0.80	.175	High.
Silty clay loam	ML or CL	A-6 or A-7-6	100	100	95 to 100	0. 20 to 0. 80	. 175	Moderate.
Silty clay	CH	A-7-6	100	100	98 to 100	0. 05 to 0. 20	. 183	High.
Silty clay loam	CL	A-6 or A-7-6	100	100	90 to 100	0. 20 to 0. 80	. 175	Moderate to high.
Silt loam	ML	A-4 or A-6	100	100	95 to 100	0. 80 to 2. 50	. 167	Low to moderate.
Silty clay	CH	A-7-6	100	100	95 to 100	0. 05 to 0. 20	. 183	Moderate to high.
Silty clay loam	CL	A-6 or A-7-6	100	100	95 to 100	0. 20 to 0. 80	. 175	Moderate.
Silty clay loam	ML or CL	A-6 or A-7-6	100	100	95 to 100	0. 20 to 0. 80	. 175	Moderate.
Silty clay loam	CL	A-7-6	100	100	95 to 100	0. 20 to 0. 80	. 175	Moderate.
Silty clay loam	CL	A-7-6	100	100	85 to 95	0. 20 to 0. 80	. 175	Moderate.

TABLE 5.—*Brief descriptions of soils and*

Map symbol	Soil	Description of soil and site					
		Topography and position	Parent material	Surface runoff	Depth to water table [1]	Depth to bedrock [2]	Depth from surface
					Ft.	*Ft.*	*In.*
GeD3	Geary soils, 5 to 12 percent slopes, severely eroded.	Moderately sloping to strongly sloping uplands.	Loveland loess.	Rapid	([4])	20+	0 to 12
							12 to 54
							54 to 102
Hv	Hedville stony loam (steep)	Sloping to steep uplands.	Sandstone (Dakota).	Rapid	([4])	0 to 1.5	0 to 16
							16 to 30
Hb 2Hb	Hobbs silt loam, seldom flooded Hobbs silt loam, occasionally flooded.	Nearly level bottom lands.	Silty alluvium	Slow	6 to 12	20+	0 to 36
JfB	Judson fine sandy loam, 3 to 5 percent slopes.	Gently sloping foot slopes.	Colluvial-alluvial silts.	Slow to medium.	10 to 20	20+	0 to 12
							12 to 48
JuA JuB	Judson silt loam, 1 to 3 percent slopes.[3] Judson silt loam, 3 to 5 percent slopes.	Nearly level to gently sloping foot slopes.	Colluvial-alluvial silts.	Slow to medium.	10 to 20	20+	0 to 48
LwD	Labette silty clay loam, 5 to 12 percent slopes.	Moderately sloping to strongly sloping uplands.	Shale and limestone.	Medium to rapid.	([4])	2.5 to 4.0	0 to 18
							18 to 32
							32 to 48
LcC LcD	Lancaster loam, 3 to 8 percent slopes.[3] Lancaster loam, 8 to 12 percent slopes.	Gently sloping to strongly sloping uplands.	Sandstone (Dakota).	Medium to rapid.	([4])	2.5 to 3.5	0 to 12
							12 to 36
							36+
Lg	Lanham clay loam (steep)	Strongly sloping to moderately steep uplands.	Shale	Rapid	([4])	1.75 to 2.5	0 to 8
							8 to 48
MrB2 MrC2 MrD2 MrE2	Morrill loam, 3 to 5 percent slopes, eroded.[3] Morrill loam, 5 to 8 percent slopes, eroded. Morrill loam, 8 to 12 percent slopes, eroded. Morrill loam, 12 to 18 percent slopes, eroded.	Gently sloping to moderately steep uplands.	Till and outwash.	Medium to rapid.	([4])	4 to 10	0 to 12
							12 to 72
MxC MxD MxE MxC3 MxD3	Morrill complex, 5 to 8 percent slopes.[3] Morrill complex, 8 to 12 percent slopes. Morrill complex, 12 to 18 percent slopes. Morrill complex, 5 to 8 percent slopes, severely eroded. Morrill complex, 8 to 18 percent slopes, severely eroded.	Sloping to moderately steep uplands.	Till and outwash.	Medium to rapid.	([4])	1 to 5	0 to 12
							12 to 30
							30+
MC3 ME3	Morrill soils, 5 to 8 percent slopes, severely eroded.[3] Morrill soils, 8 to 18 percent slopes, severely eroded.	Sloping to moderately steep uplands.	Till and outwash.	Medium to rapid.	([4])	3 to 8	0 to 12
							12 to 72
Mu	Muir silt loam (nearly level)	Nearly level terraces.	Alluvial silts	Slow	10 to 20	20+	0 to 14
							14 to 44

See footnotes at end of table.

their estimated physical properties—Continued

USDA texture	Classification		Percentage passing sieve—			Permeability	Available water capacity	Shrink-swell potential
	Unified	AASHO	No. 4	No. 10	No. 200			
						In. per hr.	*In. per in. of depth*	
Silty clay loam	ML or CL	A-6 or A-7-6	100	100	95 to 100	0. 20 to 0. 80	0. 175	Moderate.
Silty clay loam	CL	A-7-6	100	100	95 to 100	0. 20 to 0. 80	0. 175	Moderate.
Silty clay loam	CL	A-7-6	100	100	85 to 95	0. 20 to 0. 80	0. 175	Moderate.
Stony loam	ML to CL	A-4 or A-6	100	95 to 100	75 to 85	0.80 to 5.0	0.146 to .167	Low to moderate.
Sandstone	SM to SW	A-2	100	95 to 100	5 to 20	0.20 to 5.0	0.0625 to .146	None to low.
Silt loam	CL	A-6 or A-7-6	100	100	95 to 100	0.80 to 2.50	0.167	Moderate.
Fine sandy loam	ML or SM	A-2 to A-6	100	95 to 100	30 to 60	2.50 to 5.0	0.146	None to low.
Silt loam	ML or CL	A-4 or A-6	100	100	95 to 100	0.80 to 2.50	0.167	Low to moderate.
Silt loam	ML-CL or CL.	A-4 or A-6	100	100	95 to 100	0.80 to 2.50	0.167	Low to moderate.
Silty clay loam	CL	A-6 or A-7-6	100	100	95 to 100	0.20 to 0.80	0.175	Moderate to high.
Silty clay	CH	A-7-6	100	100	95 to 100	0.05 to 0.20	0.183	High.
Silty clay	CH	A-7-6	100	100	90 to 100	0.05 to 0.20	0.183	High.
Loam	ML	A-4	100	95 to 100	85 to 95	0.80 to 2.50	0.167	Low.
Loam or sandy loam.	ML to CL	A-4 or A-6	100	95 to 100	50 to 70	0.80 to 5.0	0.146 to .167	Low to moderate.
Sandstone	SW to SM	A-2-4 or A-3	100	95 to 100	5 to 20	0.20 to 5.0	0.0625 to .146	None to low.
Clay loam	CL	A-6 or A-7-6	100	100	98 to 100	0.20 to 0.80	0.175	Moderate to high.
Clay	CH	A-7-6	100	100	100	0.05 to 0.20	0.183	High.
Loam	ML	A-4 or A-6	100	100	80 to 90	0.80 to 2.50	0.167	Low to moderate.
Clay loam	CL	A-6 or A-7-6	100	100	70 to 80	0.20 to 0.80	0.175	Moderate.
Loam to silt loam	(6)	(6)	100	100	20 to 80	0.80 to 5.0	0.146 to .167	(6).
Clay loam to sand and gravel.			95 to 100	80 to 100	10 to 100	0.20 to 10.0	0.06 to .175	
Fine sandy loam to sand and gravel.			95 to 100	75 to 100	4 to 70	2.5 to 10.0	0.06 to .146	
Loam	ML	A-4 or A-6	100	100	80 to 90	0.80 to 2.50	0.167	Low to moderate.
Clay loam	CL	A-6 or A-7-6	100	100	70 to 80	0.20 to 0.80	0.175	Moderate.
Silt loam	ML	A-4 or A-6	100	100	90 to 95	0.80 to 2.50	0.167	Low to moderate.
Silty clay loam	CL	A-4 to A-7-6	100	100	85 to 95	0.20 to 0.80	0.175	Low to moderate.

TABLE 5.—*Brief description of soils and*

Map symbol	Soil	Description of soils and site: Topography and position	Parent material	Surface runoff	Depth to water table [1]	Depth to bedrock [2]	Depth from surface
					Ft.	*Ft.*	*In.*
PwB2 PwC2 PwD2	Pawnee clay loam, 3 to 5 percent slopes, eroded.[3] Pawnee clay loam, 5 to 8 percent slopes, eroded. Pawnee clay loam, 8 to 12 percent slopes, eroded.	Gently sloping to strongly sloping uplands.	Till	Medium to rapid.	(4)	20+	0 to 14 14 to 48 48 to 63
Rt	Rokeby silty clay loam	Nearly level terraces.	Clayey alluvium.	Slow	6 to 20	20+	0 to 12 12 to 42 42 to 60
BLg	Rough broken land (very steep)	Very steep uplands.	Till and outwash.	Very rapid	(4)	20+	(6)
Rv	Rough stony land (very steep)	Very steep uplands.	Limestone, shale, or sandstone.	Very rapid	(4)	0 to 1.5	(6)
SBB2 SBC2 SBD2	Shelby and Burchard [7] clay loams, 3 to 5 percent slopes, eroded.[3] Shelby and Burchard clay loams, 5 to 8 percent slopes, eroded. Shelby and Burchard clay loams, 8 to 12 percent slopes, eroded.	Gently sloping to strongly sloping uplands.	Till	Medium to rapid.	(4)	20+	0 to 10 10 to 30 30 to 48
SBD3	Shelby and Burchard soils, 8 to 12 percent slopes, severely eroded.	Strongly sloping uplands.	Till	Rapid	(4)	20+	0 to 10 10 to 30 30 to 48
Sn	Sogn complex (steep)	Steep uplands.	Limestone	Rapid	(4)	0 to 2	0 to 12
StE	Steinauer clay loam, 12 to 25 percent slopes.	Moderately steep to steep uplands.	Till	Rapid	(4)	20+	0 to 10 10 to 48
StE3	Steinauer soils, 12 to 18 percent slopes, severely eroded.	Moderately steep uplands.	Till	Rapid to very rapid.	(4)	20+	0 to 10 10 to 48
Wa	Wabash silty clay	Nearly level bottom lands.	Clayey alluvium.	Slow	3 to 15	20+	0 to 14 14 to 60
WtA WtB WtB2 WtC2	Wymore silty clay loam, 0 to 3 percent slopes.[3] Wymore silty clay loam, 3 to 5 percent slopes. Wymore silty clay loam, 3 to 5 percent slopes, eroded. Wymore silty clay loam, 5 to 8 percent slopes, eroded.	Nearly level to sloping uplands.	Peorian loess	Slow to medium.	(4)	20+	0 to 10 10 to 48 48 to 78
WtC3 WtD3	Wymore soils, 5 to 8 percent slopes, severely eroded.[3] Wymore soils, 8 to 12 percent slopes, severely eroded.	Sloping to strongly sloping uplands.	Peorian loess	Medium to rapid.	(4)	20+	0 to 10 10 to 48 48 to 78

[1] Depth to water table may vary considerably. Ranges shown are considered normal.
[2] Depth to bedrock may vary considerably. Ranges shown are considered normal.
[3] Classification and properties have been estimated for this phase. Except for rate of surface runoff, classification and properties of the other phases are approximately the same, even though the phases may differ in texture or differ slightly in thickness in certain horizons. The range in the rate of surface runoff shows the extreme variation in all phases of this soil type.

their estimated physical properties—Continued

USDA texture	Classification		Percentage passing sieve—			Permeability	Available water capacity	Shrink-swell potential
	Unified	AASHO	No. 4	No. 10	No. 200			
						In. per hr.	*In. per in. of depth*	
Clay loam	CL	A-6 or A-7-6	100	100	75 to 85	0.20 to 0.80	0.175	Moderate.
Clay	CH	A-7-6	100	100	75 to 90	0.05 to 0.20	0.183	High.
Clay loam	CH	A-7-6	100	100	70 to 85	0.20 to 0.80	0.175	High.
Silty clay loam	CL	A-6 or A-7-6	100	100	95 to 100	0.20 to 0.80	0.175	Moderate.
Silty clay	CH	A-7-6	100	100	95 to 100	0.05 to 0.20	0.183	High.
Silty clay loam	CL	A-6 or A-7-6	100	100	95 to 100	0.20 to 0.80	0.175	Moderate to high.
([6])	([6])	([6])	([6])	([6])	([6])	([6])	([6])	([6]).
([6])	([6])	([6])	([6])	([6])	([6])	([6])	([6])	([6].)
Clay loam	CL	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0.175	Moderate.
Clay loam	CL or CH	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0.175	Moderate to high.
Clay loam	CL or CH	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0.175	Moderate to high.
Clay loam	CL	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0.175	Moderate.
Clay loam	CL or CH	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0.175	Moderate to high.
Clay loam	CL or CH	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0.175	Moderate to high.
Clay loam	CL or CH	A-6 or A-7-6	100	100	90 to 100	0.20 to 0.80	0.175	Moderate to high.
Clay loam	CL	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0.175	Moderate to high.
Clay loam	CL or CH	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0.175	Moderate to high.
Clay loam	CL	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0. 175	Moderate to high.
Clay loam	CL or CH	A-6 or A-7-6	95 to 100	90 to 100	70 to 90	0.20 to 0.80	0. 175	Moderate to high.
Silty clay	CH	A-7-6	100	100	100	0.05 to 0.20	0. 183	High.
Silty clay	CH	A-7-6	100	100	95 to 100	0.05 to 0.20	0. 183	High.
Silty clay loam	CL	A-6 or A-7-6	100	100	95 to 100	0.20 to 0.80	0. 175	Moderate.
Silty clay	CH	A-7-6	100	100	100	0.05 to 0.20	0. 183	High.
Silty clay loam	CL	A-6 to A-7-6	100	100	85 to 100	0.20 to 0.80	0. 175	High.
Silty clay loam	CL	A-6 or A-7-6	100	100	95 to 100	0.20 to 0.80	0. 175	Moderate.
Silty clay	CH	A-7-6	100	100	100	0.05 to 0.20	0. 183	High.
Silty clay loam	CL	A-6 or A-7-6	100	100	85 to 100	0.20 to 0.80	0. 175	High.

[4] Water table is at extreme depths in soils of the uplands and consequently is not considered significant in the interpretation of engineering properties.

[5] Estimates of classifications and properties are for the Adair series. (See descriptions of the Adair and Pawnee series.)

[6] Not estimated because of variability.

[7] Estimates of classifications and properties are for the Burchard series. (See description of the Shelby series.)

over, the soils of the bottom lands are subject to occasional flooding.

The ratings given in table 6 for suitability of soils as sources of topsoil, sand, and gravel apply only to the soils in Gage County. Many of the soils are rated poor or fair as a source of topsoil because they are eroded, low in organic matter or natural fertility, or heavy and sticky and difficult to handle or work. Extensive exploration may be necessary to find well-graded sand or gravel, even in the soils rated good or fair as sources of these materials.

In table 6 the soils are rated according to their suitability for use in the upper part of the subgrade in a bituminous or concrete pavement, in that part of the subgrade that receives a gravel surfacing, and as road-fill. The ratings have been determined by the AASHO classification. The ratings given in the column headed "Paved" refer to the subgrade of the roadbed for bituminous and concrete pavement. Sands, when properly confined, are a good subgrade material for roads of this type. The subgrade was rated as good if the AASHO classification of the material was A–1, A–2, or A–3. If the soils are silt or clay, they are classified from A–4 to A–7–6 and rated as fair or poor.

The ratings in the column headed "Gravel" refer to that part of the subgrade that receives the gravel surfacing. Because sand is noncohesive, it does not provide a stable surface. Therefore, all soils classified A–3 and those classified A–1 and A–2 that lack adequate plasticity are rated as poor. Some soils classified A–1 and A–2 have adequate plasticity and are rated as good to fair. Silts and clays, which are classified from A–4 to A–7–6, are generally acceptable in that part of the upper subgrade that receives a gravel surfacing, and they are rated as good or fair.

The ratings in the column headed "Road fill" are based on the same criteria as the subgrade ratings for bituminous or concrete pavement.

The soils have been rated according to the extent to which certain properties affect specified agricultural practices and the construction and maintenance of agricultural engineering structures. The properties for which ratings are given in table 6 are based on the soil characteristics described in table 5.

Frost action is a common soil engineering problem in this county. The silt and clay content is high in many of the soils. The susceptibility of certain textures to frost action are rated in table 7. The ratings are based on the texture of both the surface layer and the subsoil, for the permeability of the subsoil is an important factor. The susceptibility of the soils to frost, as shown in table 6 in the column headed "Highway location," is based on the data shown in table 7.

In table 6, foundation bearing values and piping hazards are given for the horizon depths shown in table 5 for use in designing low dams and small concrete structures.

Soil properties affecting maintenance of relatively low dikes and levees also are shown in table 6. For larger works of this kind, a detailed investigation of sites should be made.

In this county reservoirs of relatively small earth dams generally hold water satisfactorily without sealing protection.

TABLE 7.—*Soil texture and susceptibility to frost action*

[Data from Control of Soils in Military Construction, TM 5–541

Proportion of particles between 0.074 and 0.005 mm. in diameter in the surface layer	Proportion of particles finer than 0.005 mm. in diameter in the subsoil	Susceptibility rating
Percent	*Percent*	
64 or more	Less than 44	Very high.
64 or more	44 or more	High.
50 to 63	Less than 44	High.
50 to 63	44 or more	Moderate.
35 to 49	Less than 50	Moderate.
35 to 49	50 or more	Low.
Less than 35:		
More than 3 percent finer than 0.02 mm.	Subsoil not considered.	Low.
3 percent or less finer than 0.02 mm.	Subsoil not considered.	Not susceptible.

Compacted embankments in this county are generally impervious and have fair to good stability. Toe drains may be required. Workability of soil materials ranges from good for clays of low or medium plasticity to poor for highly plastic clays.

Natural drainage is poor on some soils of the bottom lands because of a seasonally high water table or slow permeability. Several of these soils are subject to overflow. Others are flat, and surface runoff is slow. Soil permeability, topography, depth to the water table, and available outlets will determine the type of agricultural drainage that can be used effectively. Permeability ratings shown in table 5 are based on the classification that precedes table 5.

The soils of this county generally are not saline or saline-alkali, but Exline soils may be interspersed with small alkali areas, and salts may be present in some small areas of Rokeby silty clay loams. The effects of salts and alkali on engineering practices have not been shown in the table because of the small areas involved. "Irrigation Guide for Central and Eastern Nebraska, September 1959," of the Soil Conservation Service contains suggestions for soil amendments to correct alkali.

In the column headed "Irrigation," soil properties are given that affect available water, that is, the water-holding capacity and the rate of water intake. The water-holding capacity has been measured to a depth of 4 feet. It is described as high if the soils can hold more than 8 inches of water; moderate, if the capacity is 5 to 8 inches; low, if it is 3 to 5 inches; and very low, if less than 3 inches. The intake rate is indicated only as rapid or slow. A slow intake rate is less than half an inch per hour, and a rapid rate is 2 inches or more per hour. If the intake rate is not indicated, it falls between these two extremes. In all cases, the intake rate is based on border or sprinkler irrigation, with plant cover.

Irrigation hazards relating to slope are not shown. "Irrigation Guide for Central and Eastern Nebraska, September 1959," contains information on the suitability of various soils and slopes for irrigation.

Terraces are common protective measures in this county, because a major part of the cropland area is erodible. Although the slopes of terraces generally are erodible, costs of maintenance are not generally extremely high. Diversions are used extensively under terraced fields or grassland fields to protect lower lying soils, for many of these soils, although highly erodible, are very productive. Maintaining terraces and diversions may not be practical on rocky soils, such as the Sogn and Hedville, and on some of the severely eroded, highly plastic soils. Steepness of slope or hummocky topography may limit the use of terraces and diversions.

Constructing waterways is also a common practice in the county. Table 6 indicates the hazards involved in constructing waterways in highly plastic soils and the hazard of erosion after construction but before a good sod cover is established. The semihumid climate of this area is an advantage in establishing vegetation.

At many construction sites, major soil variations may occur within the depth of proposed excavation and several different kinds of soil may occur within a short distance. The soil maps and profile descriptions, as well as the engineering data and recommendations given in this section, should be used in planning detailed surveys of soils at construction sites. Information in the soil survey reports enables soil engineers to concentrate on the most suitable soil units. Then a minimum number of soil samples will be required for laboratory testing, and an adequate soil investigation can be made at minimum cost.

Genesis, Classification, and Morphology of Soils

This section contains a discussion of the factors of soil formation; a brief description of a system of classification based on natural characteristics of the soils; and a description of each soil series, including a modal profile of each.

In Gage County the local differences in soils can be ascribed principally to differences in parent material, relief, and time. The climate and plant and animal life are uniform throughout the area.

Factors of Soil Formation

The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent materials; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and vegetation are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into soil having differentiated 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 unless conditions are specified for the other four. Much is still to be learned about the processes of soil formation.

Parent materials

The parent materials of Gage County are of two general types, consolidated and unconsolidated rocks. The consolidated (hard) rocks are the limestones, shales, and sandstones (fig. 20). A relatively small acreage of soils has formed from bedrock materials because these materials generally are deeply covered. Where such soils occur, however, they are relatively shallow, because the solid rock is resistant to weathering. In Gage County, some of the soils formed from bedrock are the Hedville, Sogn, and Lanham. The principal unconsolidated (soft) rock parent materials are, in the order of their geologic age or deposition, till left by glaciers, glacial outwash deposited by water and later reworked by wind and water, silty loess deposited by wind, and alluvium deposited by streams.

Loess covers the high uplands and high terraces. It is dominantly of two types, Peorian and Loveland. The Peorian loess is grayish to yellowish in color. It is younger than the brownish to reddish Loveland loess and much more extensive. Peorian loess is the most extensive of the soil-forming materials in the county. Few different types of soils, however, have formed in Peorian loess, because the loess is uniform in texture and in other characteristics. The differences are caused mainly by slope, or relief, which influences drainage, aeration, runoff, and erosion. The Crete, Wymore, Butler, and Fillmore soils formed in Peorian loess.

The brownish to reddish Loveland loess, which underlies the Peorian loess, is a source of parent material on valley slopes in the high uplands. Soils formed in Loveland loess are of minor importance because this material is not exposed in extensive areas. The Geary soils formed in Loveland loess.

The Adair and the Morrill soils formed in reworked material from loess and till. This type of parent material is scattered throughout the area that was covered by the Kansan glacier. It is generally reddish to brownish in color. It contains stones, sand, and gravel.

Till of Kansan age contributes to many kinds of soils and to a large acreage on valley slopes in Gage County. It covers the bedrock in nearly all places. The till is generally grayish, yellowish, or brownish in color and contains silt, clay, sand, and gravel. It has been exposed to different degrees and ages of weathering. The Pawnee, Burchard, Shelby, and Steinauer soils formed in till.

Alluvium is a heterogeneous mixture of silt, clay, sand, gravel, and stones deposited by rivers and streams. It covers the bottom lands, low terraces, and foot slopes in Gage County and is still being deposited in many places. Soils developed in alluvium generally are young. They vary according to the material which was the source of alluvium. Alluvium is the parent material of the Hobbs, Judson, Colo, Cass, Exline, and Wabash soils. Alluvial land, also on flood plains, is composed of alluvium but is so frequently flooded or reworked that classification is not practical.

Climate

Differences in temperature, precipitation, and humidity account for differences among soils. Climatic influences have been more or less uniform throughout Gage County,

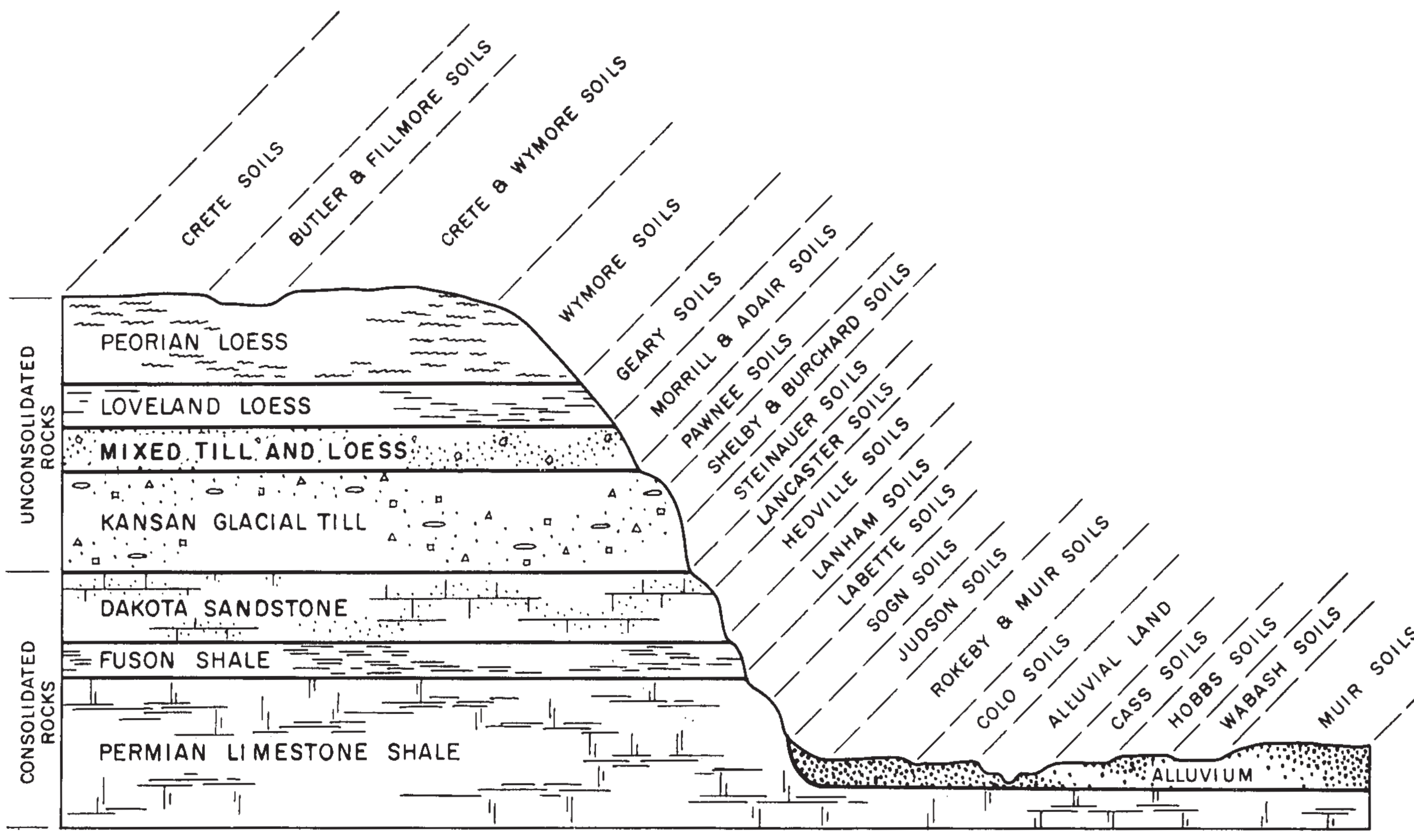

Figure 20.—**Schematic diagram showing the relationship of major soil series to parent materials in Gage County, Nebraska.**

but they have not been constant for the entire period of soil formation.

Because of seasonal differences, direct weathering and leaching are active only about half the year in Gage County. These processes are most active in the warmest months. Consequently, the soils differ in color, structure, and chemical and mineralogical composition from soils in areas where the temperature is warmer or colder than in Gage County but where precipitation and humidity are about the same.

Precipitation is sufficient to leach free carbonates from most of the soils and, consequently, to make the surface layer medium acid.

The effects of climate are modified by the nature of the parent material and by topography. Climate, in turn, affects soil formation indirectly through its influence on the type and variety of plant and animal life.

Plant and animal life

Plant and animal life has had a pronounced effect on soil formation in Gage County. The native vegetation, directly determined by climate, is one of the most important factors in soil formation. Animals may be less important, but their influence cannot be overlooked.

The influence of vegetation has been fairly uniform over the county. Bluestem prairies dominated the landscape. Trees occupied the flood plains and some of the steep valley slopes. In few places were the stands of trees dense enough to prevent the growth of grass. The stems, leaves, and roots of the tall grasses produced an abundance of organic materials. As a result nearly all the soils have a dark-colored, granular surface layer and a high organic-matter content. The exceptions are the eroded soils and the soils most recently formed. The nearly level and gently sloping soils generally have a deeper and darker colored surface layer than the steeper soils because they have more moisture and, consequently, a better growth of grass, and they have lost less soil material through erosion. Soils of the bottom lands are thick and dark colored mainly because the parent alluvium was dark colored.

Micro-organisms, ants, earthworms, and burrowing rodents have a beneficial effect on soil structure, fertility, and productivity, but animals have had less effect on the soils than vegetation has had.

Relief

Many differences among soils can be attributed to variations in relief. Relief affects soil formation mainly through its effect on drainage. Runoff is more rapid on steep slopes than nearly level slopes. Consequently, less water soaks into the soil, and there is less leaching. Erosion is more severe on steep slopes.

Nearly level soils, such as the Fillmore, Butler, and Wabash, have slow surface drainage and internal drainage. Although these soils of bottom lands are subject to overflow, they generally drain readily as the streams go down. Drainage is excessive on steep slopes; for example, on Rough broken land and Rough stony land and on the Sogn and Steinauer soils. Internal drainage is slow on soils that have a fine-textured subsoil, such as the Crete, Pawnee, and Adair, and runoff is rapid where the slopes are steep and bare of vegetation.

Time

Differences in the time a soil has been affected by soil-forming processes are commonly reflected in the properties of the soil. Mature, or normal, soils have well-defined A and B horizons. In Gage County, the Crete, Wymore, Pawnee, and Shelby soils are examples of mature soils. Immature, or young, soils lack clearly expressed horizons because their parent material has undergone little change. The Hobbs, Cass, and Colo soils are examples of immature soils of the bottom lands in Gage County, and the Steinauer soils are immature soils of the uplands.

Classification and Morphology of Soils

Soils are placed in narrow classes to facilitate the organization and application of knowledge about their use and management on individual farms and ranches and within counties. They are placed in broad, inclusive classes to facilitate study and comparison of large areas such as continents. In the comprehensive system of soil classification followed in the United States, the soils have been placed in six categories. Beginning with the most inclusive category, these are the order, the suborder, the great soil group, the family, the series, and the type. Subdivisions of soil types into phases provide finer distinctions significant to soil use and management. Soil series, type, and phase are defined in the section "How Soils are Named, Mapped, and Classified."

There are three orders and thousands of types. The concepts of suborder and family have never been fully developed. The type and the series are the categories most commonly used in discussing soils of a county or of other small areas. Series that are alike in fundamental characteristics are classified as one great soil group.

Classes in the highest category of the classification scheme are the zonal, intrazonal, and azonal orders.

Zonal soils have evident, genetically related horizons that reflect the influence of climate and living organisms in their formation. Intrazonal soils have evident, genetically related horizons that reflect the dominant influence of some local factor, such as topography, or parent material. Azonal soils lack distinct, genetically related horizons, commonly because of youth, resistant parent material, or steep topography.

The classification of soils in Gage County by order, great soil group, and series is shown in the following list:

ZONAL ORDER:
- Brunizems—
  - Adair.
  - Burchard.
  - Geary.
  - Judson.
  - Labette.
  - Lancaster.
  - Lanham.
  - Morrill.
  - Muir.
  - Pawnee.
  - Shelby.
  - Wymore.
- Chernozems—
  - Crete.

INTRAZONAL ORDER:
- Humic Gley soils—
  - Wabash.
- Planosols—
  - Butler.
  - Fillmore.
  - Rokeby.
- Solonetz soils—
  - Exline.

AZONAL ORDER:
- Alluvial soils—
  - Cass.
  - Colo.
  - Hobbs.
- Lithosols—
  - Hedville.
  - Sogn.
- Regosols—
  - Steinauer.

In the following pages the morphology of the soils of each series is discussed and a profile of a typical soil of each series is described.

ADAIR SERIES

The soils of the Adair series are moderately fine textured Brunizems of the uplands. They developed in reddish material reworked from loess and till. These soils are moderately sloping; the slope averages about 6 percent. In Gage County, the Adair soils generally occur on smooth valley slopes along streams. They are below the Crete and the Wymore soils, which developed in Peorian loess. In many places the Adair soils are intricately mixed with the Pawnee soils.

The B horizon of the Adair soils is redder than that of the Pawnee soils. The Adair soils are similar to the Morrill soils in color but have a finer textured B horizon. The B horizon is finer textured than that of the Shelby and Burchard soils, reddish brown instead of yellowish brown, and leached of lime to a greater depth. The Adair soils have a finer textured B horizon than the Geary soils, which developed in silty, reddish loess, and they contain more pebbles and stones.

The following profile of Adair clay loam is about 0.32 mile east of the northwest corner of section 2, T. 2 N., R. 6 E. The slope is about 5 percent. The vegetation is native grass.

A1—0 to 3 inches, dark-gray (10YR 4/1) light clay loam; very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft when dry, very friable when moist; medium acid; gradual, smooth boundary.

A12—3 to 9 inches, very dark grayish-brown (10YR 3/2) clay loam; very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; medium acid; gradual, smooth boundary.

A3—9 to 12 inches, dark-brown (7.5YR 4/2) clay loam; dark brown (7.5YR 3/2) when moist; strong, coarse, granular structure; hard when dry, friable when moist; medium acid; clear, smooth boundary.

B21—12 to 19 inches, reddish-brown (5YR 4/3) clay; dark reddish brown (5YR 3/2) when moist; weak, coarse, prismatic structure separating to moderate, very fine, angular blocky; very hard when dry, very firm when moist; medium acid; gradual, smooth boundary.

B22—19 to 29 inches, reddish-brown (5YR 4/4) clay; dark reddish brown (5YR 3/3) when moist; weak, coarse, prismatic structure separating to strong, medium, angular blocky; continuous clay films on faces of aggregates; extremely hard when dry, very firm when moist; slightly acid to neutral; gradual, smooth boundary.

B23—29 to 37 inches, reddish-brown (5YR 4/4) heavy clay loam; dark reddish brown (5YR 3/4) when moist; weak, coarse, prismatic structure separating to strong, medium, angular blocky; continuous clay films on aggregates; very hard when dry, very firm when moist; neutral; gradual, smooth boundary.

B3—37 to 50 inches, yellowish-red (5YR 5/6) heavy clay loam; dark reddish brown (5YR 3/4) when moist; weak, coarse and medium, angular blocky structure; thin, continuous clay films on aggregates; very hard when dry, firm when moist; mildly alkaline; gradual, smooth boundary.

C1—50 to 60 inches, strong-brown (7.5YR 5/6) clay loam; dark brown (7.5YR 4/4) when moist; moderate, medium, blocky (cloddy) structure; hard when dry, firm when moist; mildly alkaline.

The surface layer is 2 to 16 inches thick. The texture is predominantly clay loam, but where this layer is thickest, the texture in the uppermost 4 to 8 inches is silt loam or loam. The surface layer is thinnest in areas that have been severely eroded. In these areas, part or all of the present surface layer consists of material that was once the upper part of the B horizon, and the texture is heavy clay loam or clay. The present B horizon ranges from about 28 to 50 inches in thickness and from clay, silty clay, or sandy clay to heavy clay loam or sandy clay loam in texture. In some places, calcareous till occurs at a depth of 48 to 60 inches.

BURCHARD SERIES

The soils of the Burchard series are dark-colored Brunizems of the uplands. These soils developed in calcareous Kansan till of clay loam texture. They are predominantly moderately sloping and moderately steep (8 to 10 percent), but the range in slope is 3 to 18 percent. In Gage County, the Burchard soils generally are on valley slopes along streams. They are below the loess-derived Wymore and Geary soils and the till-derived Pawnee and Adair soils. The Burchard soils are intricately mixed with the Shelby soils.

The Burchard soils are leached of lime to a lesser depth than the Shelby soils and are less mature. They are leached of lime to a greater depth than the Steinauer soils, are more mature, and have a darker colored and thicker surface layer. The Burchard soils have a yellowish or brownish B horizon, and the Morrill soils have a reddish B horizon and lack lime in the lower subsoil. The Burchard soils have less clay in the B horizon than the Pawnee soils.

The following profile of Burchard clay loam is about 0.27 mile east of the southwest corner of section 35, T. 3 N., R. 8 E. The slope is about 8 percent. The vegetation is grass.

Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; medium acid; clear, smooth boundary.

A1—4 to 10 inches, very dark grayish-brown (10YR 3/2) clay loam; very dark brown (10YR 2/2) when moist; weak, coarse, blocky structure separating to weak, medium, granular; slightly hard when dry, friable when moist; medium acid; clear, smooth boundary.

B2—10 to 20 inches, grayish-brown (10YR 5/2) heavy clay loam; dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure separating to strong, fine and medium, subangular blocky; hard when dry, friable to firm when moist; neutral; clear, smooth boundary.

B3—20 to 28 inches, pale-brown (10YR 6/3) clay loam; brown (10YR 4/3) when moist; weak, coarse, prismatic structure separating to moderate, medium, subangular blocky; hard when dry, friable to firm when moist; calcareous; a few pockets of disseminated white lime; gradual, smooth boundary.

C—28 to 48 inches, 50 percent light brownish-gray (2.5Y 6/2) and 50 percent yellowish-brown (10YR 5/4) clay loam; dark grayish brown (2.5Y 4/2) and dark yellowish brown (10YR 4/4) when moist; strong, medium and coarse, blocky (cloddy) structure; hard when dry, firm when moist; calcareous; many pockets and channels of soft white lime; many, fine, yellowish-brown and dark-brown mottles.

The thickness of the darker colored surface layer averages about 8 inches but ranges from 3 to 14 inches. The texture is mostly clay loam, but in some places it is gravelly clay loam or loam. The surface layer is thinnest in areas that have been severely eroded. In these areas, part or all of the present surface layer consists of material that was once the upper part of the B horizon. The present B horizon ranges from about 8 to 26 inches in thickness. Depth to disseminated and segregated lime is about 14 to 30 inches.

BUTLER SERIES

The soils of the Butler series are somewhat poorly drained, dark-colored Planosols of the uplands. These soils developed from loess. They are level and occur in scattered areas throughout the county. Surface drainage is slow.

The Butler soils are better drained than the Fillmore soils and lack the pronounced A2 (gray) horizon. They have a darker colored upper B horizon than the Crete soils, and slower surface drainage.

The following profile of Butler silty clay loam is in a slight depression on a broad, flat, loess-covered upland divide, about 0.2 mile south of the northwest corner of section 15, T. 6 N., R. 6 E.

A11—0 to 3 inches, dark-gray (10YR 4/1) light silty clay loam; very dark gray (10YR 3/1) when moist; weak, thin, platy structure; soft when dry, friable when moist; strongly acid; gradual, wavy boundary.

A12—3 to 12 inches, dark grayish-brown (10YR 4/2) silty clay loam; very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; strongly acid; clear, smooth boundary.

A13—12 to 16 inches, gray (10YR 5/1) silty clay loam; dark grayish brown (10YR 4/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; medium acid; smooth boundary.

B2—16 to 28 inches, dark-gray (10YR 4/1) silty clay; very dark gray (10YR 3/1) when moist; moderate, coarse, blocky structure separating to strong, medium and fine, angular blocky; very hard when dry, very firm when moist; slightly acid to neutral; gradual, wavy boundary.

B3ca—28 to 42 inches, grayish-brown (10YR 5/2) heavy silty clay loam; dark grayish brown (10YR 4/2) when moist; moderate, medium, angular blocky structure; very hard when dry, firm when moist; calcareous; lime concretions and spots of white disseminated lime; few, faint, fine, brownish, grayish, and yellowish mottles; gradual, smooth boundary.

C1—42 to 60 inches, light brownish-gray (2.5Y 6/2) silty clay loam; grayish brown (2.5Y 5/2) when moist; weak, medium, blocky structure; slightly hard when dry, friable when moist; calcareous; few lime concretions; disseminated white lime in pores and cracks; few, distinct, medium, brownish, grayish, and yellowish mottles; gradual, smooth boundary.

C2—60 to 72 inches, pale-yellow (2.5Y 7/4) silt loam; light yellowish brown (2.5Y 6/4) when moist; massive; few lime concretions; disseminated white lime in pores and cracks.

The A horizon ranges from heavy silt loam to medium silty clay loam in texture and from about 8 to 18 inches in thickness. In some places there is a faint, gray layer (A2 horizon) just above the fine-textured B horizon. The B horizon ranges from 20 to 40 inches in thickness. The depth to lime is 30 to 60 inches. The parent loess is noncalcareous in some places.

CASS SERIES

The soils of the Cass series are dark-colored, well drained to moderately well drained Alluvial soils of the bottom lands. These soils are developing in stratified, coherent, sandy sediments deposited by streams. They occur adjacent to the Big Blue River in Gage County and are subject to flooding during periods of extremely high water.

The Cass soils differ from the Hobbs soils in that their subsoil is sandy instead of silty.

The following profile of Cass loam is in a nearly level, cultivated field about 0.4 mile south of the middle of section 19, T. 3 N., R. 7 E.

A11—0 to 6 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; soft when dry, very friable when moist; slightly acid; smooth boundary.

A12—6 to 10 inches, dark grayish-brown (10YR 4/2) very fine sandy loam; very dark grayish brown (10YR 3/2) when moist; weak, medium and fine, granular structure; soft when dry, very friable when moist; slightly acid; gradual, smooth boundary.

AC—10 to 17 inches, dark grayish-brown (10YR 4.5/2) fine sandy loam; very dark grayish brown (10YR 3.5/2) when moist; weak, coarse and medium, blocky structure separating to weak, fine, granular structure; soft when dry, very friable when moist; neutral; gradual, smooth boundary.

C1—17 to 30 inches, grayish-brown (10YR 5/2) sandy loam; dark grayish brown (10YR 4/2) when moist; weak, coarse, blocky (cloddy) structure; soft when dry, very friable when moist; mildly alkaline; gradual, smooth boundary.

C2—30 to 42 inches, light brownish-gray (10YR 6/2) coarse sandy loam; grayish brown (10YR 5/2) when moist; weak, coarse, blocky (cloddy) structure; loose when dry, very friable when moist; mildly alkaline; gradual, smooth boundary.

C3—42 to 50 inches, pale-brown (10YR 6/3) coarse sandy loam; brown (10YR 5/3) when moist; weak, medium, blocky (cloddy) structure; loose when dry, very friable when moist; mildly alkaline.

The A horizon ranges from 8 to 18 inches in thickness. The texture is mostly loam, but in some places it is silt loam or fine sandy loam. The underlying sandy sediments are intricately stratified in some places. They range from loam to noncoherent sand in texture. These soils have little free lime and are only moderately calcareous.

COLO SERIES

The soils of the Colo series are dark-colored, imperfectly drained, moderately fine textured Alluvial soils of the bottom lands. These soils are developing in stream sediments. In Gage County they occur along major streams in nearly level or slightly depressed areas where surface drainage is slow. The reaction is neutral.

The Colo soils are more poorly drained than the Hobbs soils and are finer textured. They are better drained than the Wabash soils and are coarser textured.

The following profile of Colo silty clay loam is in a nearly level, cultivated field near the southwest corner of section 9, T. 1 N., R. 6 E.

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silty clay loam; very dark gray (10YR 3/1) when moist; weak, very fine, granular structure; hard when dry, friable when moist; neutral; abrupt, smooth boundary.

A1—6 to 14 inches, very dark grayish-brown (10YR 3/2) silty clay loam; black (10YR 2/1) when moist; moderate, fine, granular structure; hard when dry, friable when moist; neutral; clear, smooth boundary.

C1—14 to 20 inches, dark grayish-brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; neutral; clear, smooth boundary.

C2—20 to 32 inches, gray (10YR 5/1) silty clay loam; very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; few, faint, grayish, yellowish, and brown mottles; neutral; clear, smooth boundary.

C3—32 to 46 inches, gray (10YR 6/1) silty clay loam; dark gray (10YR 4/1) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; few, coarse, grayish, yellowish, and brownish mottles; mildly alkaline.

A1b—46 to 58 inches, very dark grayish-brown (10YR 3/2) silty clay; black (10YR 2/1) when moist; massive; very hard when dry, very firm when moist; mildly alkaline.

The A horizon ranges from 10 to 24 inches in thickness. The texture is mostly silty clay loam, but in a few places it is silt loam or clay loam. In some places the underlying stream sediments are thinly layered and range in texture from loam to silty clay. The reaction is slightly acid to mildly alkaline.

CRETE SERIES

The soils of the Crete series are dark-colored Chernozems of the uplands. They developed in Peorian loess. These soils are well drained. They generally are nearly level, but in a few places the slope is as much as 5 percent. These soils are extensive in Gage County and occur as large areas throughout the tablelands.

The Crete soils are better drained than the Butler and the Fillmore soils. The upper part of the B horizon in the Crete soils is brownish, but in the Butler and the Fillmore soils it is grayish or nearly black. The Crete soils are browner than the Wymore soils, are less mottled, and have a lime zone in the lower part of the solum. They lack the iron segregation that is characteristic of the parent material of the Wymore soils.

The following profile of Crete silty clay loam is on a cultivated loess divide that has a long, very gentle westward slope of about 1 percent. It is 1,220 feet south and 370 feet east of the northwest corner of section 17, T. 6 N., R. 6 E.

Ap—0 to 5 inches, gray to dark-gray (10YR 4.5/1) silty clay loam; very dark gray to black (10YR 2.5/1) when moist; moderate, fine and very fine, granular structure; soft when dry, friable when moist; strongly acid; abrupt, smooth boundary.

A1—5 to 7½ inches, dark-gray (10YR 4/1) silty clay loam; very dark gray to black (10YR 2.5/1) when moist; weak, medium, blocky structure separating to moderate, fine and medium, granular; slightly hard when dry, friable when moist; medium acid; clear, smooth boundary.

AB—7½ to 10 inches, dark-gray (10YR 4/1) silty clay loam; very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure separating to strong, medium and fine, granular and very fine, subangular blocky; hard when dry, friable to slightly firm when moist; medium acid; clear to abrupt, smooth boundary.

B21—10 to 15 inches, dark grayish-brown (2.5Y 4/2) silty clay; very dark grayish brown (2.5Y 3/2) when moist; moderate, very coarse, prismatic structure separating to strong, fine and very fine, angular blocky; weak glaze on ped faces; very hard when dry, very firm when moist; many soft, fine and very fine, dark-brown to black, iron-manganese concretions, best seen on cut faces of peds; plant roots abundant; medium acid; gradual, smooth boundary.

B22—15 to 23 inches, grayish-brown (2.5Y 5/2) silty clay; dark grayish brown (2.5Y 3.5/2) when moist; moderate, very coarse, prismatic structure separating to strong, coarse and medium, blocky; strong glaze on ped faces; extremely hard when dry, very firm when moist; many soft, fine and very fine, dark-brown to black, iron-manganese concretions; plant roots common; slightly acid; gradual, smooth boundary.

B23—23 to 28 inches, light brownish-gray (2.5Y 6/2) silty clay; dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic and moderate, coarse and medium, blocky structure; moderate glaze on ped faces; extremely hard when dry, very firm when moist; many soft, very fine, brown and dark-brown, iron-manganese concretions; plant roots common to few; neutral; clear, wavy boundary.

B31ca—28 to 37 inches, pale-yellow (5Y 7/3) heavy silty clay loam; olive (5Y 5/3) when moist; weak, coarse, blocky structure; weak glaze on vertical faces of peds; hard when dry, firm when moist; calcareous; effervesces with dilute HCl only on the light sprinkling of soft and hard lime concretions; common, fine, faint to prominent, yellowish-brown and strong-brown mottles and a few dark-brown spots of iron-manganese; vacant root channels and a few plant roots; gradual, smooth boundary.

B32ca—37 to 47 inches, pale-yellow (5Y 8/3) silty clay loam; pale olive (5Y 6/3) when moist; weak, coarse, blocky structure with better defined vertical faces; hard when dry, firm when moist; soft and hard lime concretions, otherwise noncalcareous; common, faint to prominent, yellowish-brown and strong-brown mottles and a few dark-brown spots of iron-manganese; vacant root channels and pores common; a few fine roots; gradual, wavy boundary.

C—47 to 60 inches, white (2.5Y 8/2) silty clay loam; light brownish gray (2.5Y 6/2) when moist; massive except for a few widely spaced vertical cracking planes; hard when dry, friable when moist; noncalcareous except for a few faint films on vertical cracks that will effervesce weakly with dilute HCl; common, medium, prominent, yellowish-brown and strong-brown mottles and a few dark-brown spots of iron-manganese; a few fine pores, root channels, and fine roots.

The A horizon ranges from 5 to 16 inches in thickness. In reaction, it ranges from strongly acid to only slightly acid. The texture is mostly silty clay loam, but in a few places, where this horizon is thickest, the texture in the upper part is silt loam. The B horizon ranges from about 24 to 44 inches in thickness. The lower part is slightly to highly calcareous. The maximum clay content in the profile, ranging from about 44 to 52 percent, is commonly in the upper part of the B2 horizon. There is a sharp increase in clay content between the A3 or the AB horizon and the B2 horizon. Lime generally occurs at a depth of 25 to 42 inches. In most places the parent loess contains slight to moderate amounts of lime, but in a few places it contains none.

EXLINE SERIES

The soils of the Exline series are fine-textured Solonetz soils of the bottom lands and terraces. These soils developed in clays and in stratified clays and silts of glacio-alluvial origin. Surface drainage is slow or ponded in the level areas and rapid in the sloping areas. Internal drainage is very slow.

The Exline soils have thin, soft, grayish A1 and A2 horizons. The upper part of the B horizon is hard and has a columnar structure. There is an abrupt boundary between the A2 and the B horizon. Salt crystals and calcium carbonate have accumulated in the lower part of the B horizon. In Gage County, the Exline soils generally occur in small areas that are adjacent to or within areas of the Rokeby soils. They differ from the Rokeby soils in that they have a thin, light-gray surface layer and a strongly alkaline subsoil.

The following profile of Exline silty clay loam is 300 feet northeast of the road and about 0.25 mile east and 0.32 mile north of the southwest corner of section 33, T. 5 N., R. 5 E. The slope is about 1 percent.

A11—0 to 1 inch, light-gray (10YR 7/2) light silty clay loam; gray (10YR 5/1) when moist; weak, very thin, platy structure; soft when dry, friable when moist; medium acid; abrupt, smooth boundary.

A12—1 to 3 inches, light brownish-gray (10YR 6/2) light silty clay loam; dark gray (10YR 4/1) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; medium acid; abrupt, smooth boundary.

B2—3 to 18 inches, gray (10YR 5/1) silty clay; very dark gray (10YR 3/1) when moist; strong, medium, columnar structure separating to moderate, fine and medium, angular blocky; extremely hard when dry, very firm when moist; neutral in reaction; moderate to high in exchangeable sodium; few, coarse, grayish, yellowish, and brownish mottles; gradual, wavy boundary.

B3—18 to 27 inches, light olive-brown (2.5Y 5/4) silty clay; dark grayish brown (2.5Y 4/2) when moist; moderate, coarse, prismatic structure separating to weak, medium, angular blocky; very hard when dry, very firm when moist; moderate to high in exchangeable sodium; highly calcareous; coarse, grayish, yellowish, and brownish streaks; clear, smooth boundary.

C—27 to 45 inches, light brownish-gray (2.5Y 6/2) light silty clay loam; grayish brown (2.5Y 5/2) when moist; weak, subangular blocky structure; hard when dry, friable when moist; slightly calcareous; scattered lime concretions; high in exchangeable sodium; few, coarse, grayish, yellowish, and brownish mottles.

The light-colored surface layer is up to 6 inches thick over the columnar B horizon. The substratum consists of stream deposits of massive clay, stratified clay and silt, or laminated silt. In some places soluble salts have been leached into the lower part of the solum, but in other places salts occur throughout the B horizon.

FILLMORE SERIES

The soils of the Fillmore series are somewhat poorly drained and poorly drained, dark-colored Planosols of the uplands. These soils developed from loess. They are inextensive in Gage County and occur in small, shallow, basinlike depressions where they are subject to ponding.

The Fillmore soils are more poorly drained than the Butler soils, and they have a more distinct A2 (gray) horizon above the fine-textured B horizon.

The following profile of Fillmore silt loam is in a depression on a broad, flat divide, about 0.5 mile west of the southeast corner of section 18, T. 3 N., R. 5 E.

A11—0 to 4 inches, dark-gray (10YR 4/1) silt loam; very dark gray (10YR 3/1) when moist; weak, thin, platy structure; soft when dry, friable when moist; strongly acid; gradual, wavy boundary.

A12—4 to 12 inches, very dark gray (10YR 3/1) silt loam; black (10YR2/1) when moist; weak, thin and medium, platy structure; slightly hard when dry, friable when moist; strongly acid; clear, smooth boundary.

A2—12 to 16 inches, light-gray (10YR 7/1) silt loam; gray (10YR 5/1) when moist; weak, thin, platy structure; soft when dry, very friable when moist; strongly acid; abrupt, smooth boundary.

B2—16 to 28 inches, very dark gray (10YR 3/1) silty clay; black (10YR 2/1) when moist; moderate, coarse, blocky structure separating to strong, fine and medium, angular blocky; very hard when dry, very firm when moist; slightly acid to neutral; gradual, wavy boundary.

B3ca—28 to 40 inches, grayish-brown (10YR 5/2) heavy silty clay loam; dark grayish brown (10YR 4/2) when moist; moderate, medium, angular blocky structure; very hard when dry, firm when moist; calcareous; a few lime concretions and many spots and films of disseminated white lime; gradual, smooth boundary.

C1—40 to 60 inches, light brownish-gray (2.5Y 6/2) heavy silt loam; grayish brown (2.5Y 5/2) when moist; weak, medium and fine, blocky structure; slightly hard when dry, friable when moist; calcareous; few concretions and films of white lime; gradual, smooth boundary.

C2—60 to 72 inches, pale-yellow (2.5Y 7/4) silt loam; light yellowish brown (2.5Y 6/4) when moist; massive; soft when dry, very friable when moist; few lime concretions and films of white lime.

The A horizon ranges from 10 to 16 inches in thickness. The A2 horizon is nondistinct in a few places. In most places this layer is from about 2 to 8 inches in thickness. Depth to lime ranges from 30 to 50 inches. The parent loess is noncalcareous in some places.

GEARY SERIES

The soils of the Geary series are well-drained, moderately fine textured Brunizems of the uplands. They developed in reddish loess. These soils are gently sloping and sloping. They generally occur on valley sides where reddish Loveland loess underlies the Peorian loess cap. The Geary soils generally occur in positions above the Pawnee, Adair, Shelby, Burchard, and Morrill soils. The Geary soils are scattered throughout the county but occur principally on the upper part of valley sides along the Big Blue River and its tributaries in the western part of the county.

The Geary soils have a reddish, friable, moderately fine textured B horizon. Both the Crete and the Wymore soils have a brownish, very firm, fine-textured B horizon. The Geary soils lack the lime zone that occurs in the lower part of the Crete soils. They have fewer pebbles and stones than the Adair soils. Their B horizon is friable and moderately fine textured, and that of the Adair soils is very firm and fine textured. The Geary soils are similar to the Morrill soils, but the Morrill soils contain scattered pebbles, stones, or rocks and are on the lower part of valley slopes.

The following profile of Geary silty clay loam is in a cultivated field near the northeast corner of section 1, T. 2 N., R. 5 E. The slope is about 5 percent.

A1p—0 to 8 inches, dark grayish-brown (10YR 4/2) light silty clay loam; dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure separating to moderate, medium, granular; slightly hard when dry, friable when moist; medium acid; gradual, smooth boundary.

B1—8 to 18 inches, dark-brown to brown (7.5YR 4/2) silty clay loam; dark brown (7.5YR 3/2) when moist; moderate, coarse, prismatic structure separating to strong, coarse, granular; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

B2—18 to 35 inches, reddish-brown (5YR 4/3) silty clay loam; dark reddish brown (5YR 3/3) when moist; moderate, coarse, prismatic structure separating to moderate, fine, subangular blocky; hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

B3—35 to 45 inches, reddish-brown (5YR 5/3) silty clay loam; reddish brown (5YR 4/4) when moist; weak, coarse, prismatic structure separating to weak, fine, subangular blocky; hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

C1—45 to 60 inches, reddish-brown (5YR 5/4) light silty clay loam; reddish brown (5YR 4/4) when moist; weak, medium, blocky structure; slightly hard when dry, friable when moist; neutral; gradual, smooth boundary.

C2—60 to 72 inches, light reddish-brown (5YR 6/4) loam; reddish brown (5YR 5/4) when moist; massive; slightly hard when dry, friable when moist; neutral.

The A horizon ranges from 3 to 16 inches in thickness. The texture is mostly silty clay loam, but in a few places where this horizon is thickest, the texture of the upper part is silt loam or loam. This horizon is thinnest in severely eroded areas, where part or all of the material that was once the upper part of the B horizon is now mixed with the surface layer. The B horizon ranges from about 20 to 40 inches in thickness. Alluvial or eolian sands may occur below a depth of 4 or 5 feet.

HEDVILLE SERIES

The soils of the Hedville series are medium-textured and moderately coarse textured Lithosols of the uplands. These soils are shallow over sandstone. They are ordinarily moderately steep, but the range in slope is from 5 to 25 percent. These soils generally occur as small bands or irregularly shaped areas on valley sides along the Big Blue River and its tributaries in the southern part of Gage County.

The Hedville soils are much shallower than the Lancaster soils, which developed from the same kind of material. The Hedville soils differ from the Sogn soils in that they overlie sandstone instead of limestone. They are shallower than the Lanham soils, which developed in fine-textured, mottled and streaked, clay shale.

The following profile of Hedville stony loam is about 0.55 mile north and 300 feet east of the southwest corner of section 24, T. 3 N., R. 6 E. The slope is about 14 percent. The vegetation is grass.

A1—0 to 6 inches, brown (7.5YR 4/2) loam with numerous sandstone fragments; dark brown (7.5YR 3/2) when moist; weak, medium, granular structure; soft when dry, very friable when moist; medium acid; gradual, irregular boundary.

C—6 to 18 inches, brown (7.5YR 5/2) moderately weathered, soft sandstone of sandy loam texture; dark brown (7.5YR 4/2) when moist; an abundance of ironstone fragments; soft when dry, very friable when moist; slightly acid; abrupt, irregular boundary.

Dr—18 to 30 inches, reddish-brown, broken sandstone.

The A horizon ranges from 2 to 18 inches in thickness. In some places, both extremes occur within an area that has a radius of only 15 feet. The texture of the A horizon ranges from clay loam to sandy loam. In places there are sandstone fragments. In reaction, this layer is strongly acid to neutral. Extensions of the dark-colored A horizon fill crevices and pockets in the bedrock to a depth of about 18 inches. The boundary between the A horizon and bedrock ranges from gradual and smooth to abrupt and very irregular, depending upon the denseness and the consolidation of the bedrock. In some places the material below the A horizon is more yellowish or reddish than is indicated in the profile description.

HOBBS SERIES

The soils of the Hobbs series are well-drained, nearly level Alluvial soils that are on bottom lands and are subject to flooding. These soils are developing in medium-textured local sediments derived from Cretaceous material, loess, and till of the uplands.

The Hobbs soils are more stratified in the lower part of the solum than the Muir soils, which are on terraces, and they are also less mature than the Muir soils. The Hobbs soils are better drained than the Colo soils, which are forming in moderately fine textured alluvium. The Hobbs soils have a medium-textured subsurface layer, and the Cass soils a sandy one. The Hobbs soils differ from the Judson soils in that they have stratified layers in the lower part of the solum, are nearly level, and are on the bottom lands; the Judson soils are gently sloping and occur on the foot slopes.

The following profile of Hobbs silt loam is near the southwest corner of section 27, T. 2 N., R. 6 E. The slope is nearly level.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, friable when moist; neutral to slightly acid; abrupt, smooth boundary.

A1—8 to 20 inches, very dark grayish-brown (10YR 3/2) silt loam; very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure separating to weak, fine, granular; soft when dry, friable when moist; slightly acid; gradual, smooth boundary.

AC—20 to 30 inches, dark-gray (10YR 4/1) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure separating to weak, medium, granular; soft when dry, friable when moist; neutral; clear, smooth boundary.

C1—30 to 48 inches, gray (10YR 5/1) heavy silt loam; dark gray (10YR 4/1) when moist; weak, coarse, blocky structure separating to weak, fine, subangular blocky; slightly hard when dry, friable when moist; neutral; gradual, smooth boundary.

C2—48 to 60 inches, grayish-brown (10YR 5/2) heavy silt loam; dark grayish brown (10YR 4/2) when moist; weak, coarse and medium, blocky structure; hard when dry, friable when moist; neutral; few, faint, grayish, yellowish, and brownish mottles.

The A horizon ranges from 10 to 24 inches in thickness. The texture is mostly silt loam, but in a few places it is very fine sandy loam, loam, clay loam, or silty clay loam. The uppermost 4 to 10 inches is lighter colored in a few places than that described in the modal profile.

In places, the underlying stream sediments are highly stratified with material that ranges from coarse to moderately fine in texture. In a few places there is, at a depth of 3 to 6 feet, a dark-colored layer that is the surface layer of a buried soil. Also, in a few places, free lime occurs at a depth of 3 to 6 feet.

JUDSON SERIES

The soils of the Judson series are very dark colored, well-drained Brunizems that have some properties of Alluvial soils. These soils are on foot slopes. They are developing in dark-colored, medium-textured material that has worked down from the adjoining uplands. They are nearly level and moderately sloping; the slope is between 0 and 5 percent. In Gage County, these soils occur rather extensively along the outer edges of stream valleys.

The Judson soils have a less stratified subsoil than the Hobbs soils, which are on the nearby bottom lands. They also have a finer textured substratum than the Hobbs soils, are much deeper to a sandy substratum, and are flooded less often. The Judson soils are less mature than the Muir soils, lack a B horizon, and have a thicker surface layer.

The following profile of Judson silt loam is in a cultivated field about 0.25 mile north of the southwest corner of section 34, T. 2 N., R. 6 E. The slope is about 3 percent.

A11—0 to 10 inches, very dark grayish-brown (10YR 3/2) silt loam; very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; neutral to slightly acid; gradual, smooth boundary.

A12—10 to 20 inches, very dark gray (10YR 3/1) silt loam; black (10YR 2/1) when moist; moderate, fine, granular structure; soft when dry, very friable when moist; slightly acid; gradual, smooth boundary.

AC—20 to 30 inches, dark grayish-brown (10YR 4/2) heavy silt loam; very dark brown (10YR 2/2) when moist; strong, medium, granular structure; slightly hard when dry, friable when moist; neutral; gradual, smooth boundary.

C—30 to 47 inches, brown (10YR 4/3) clay loam; dark brown (10YR 3/3) when moist; moderate, fine and medium, blocky structure; hard when dry, friable to firm when moist; neutral in reaction.

The A horizon ranges from 12 to 24 inches in thickness and from silt loam to fine sandy loam in texture. The texture of the C horizon and underlying material is generally clay loam, silty clay loam, or silt loam, but it ranges to clay.

LABETTE SERIES

The soils of the Labette series are Brunizems of the uplands. They developed in interbedded limestone and calcareous shale. They are moderately sloping and moderately steep. In Gage County, they generally occur as scattered small areas adjacent to the bottom lands of the Big Blue River and its tributaries in the southern part of the county.

The Labette soils are much deeper than the Sogn soils, which are shallow over limestone. They have a finer textured subsoil and substratum than the Lancaster and the Hedville soils, which developed in sandstone. The Labette soils are more granular and friable than the Lanham soils, which developed in mottled and streaked, heavy clay shale, and they have a less clayey subsoil.

The following profile of Labette silty clay loam is about 0.33 mile south and 100 feet east of the northwest corner of section 33, T. 1 N., R. 8 E. The slope is about 7 percent. The vegetation is native grass.

A1—0 to 6 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; medium acid; clear, smooth boundary.

A12—6 to 10 inches, dark grayish-brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; slightly acid; clear, smooth boundary.

B1—10 to 18 inches, dark-brown (10YR 4/3) silty clay loam; dark brown (10YR 3/3) when moist; weak, coarse, blocky structure separating to moderate, fine, subangular blocky; hard when dry, friable when moist; neutral; clear, smooth boundary.

B2—18 to 32 inches, brown (7.5YR 5/2) light silty clay; dark brown (7.5YR 4/2) when moist; moderate, coarse and medium, angular blocky structure; very hard when dry, firm when moist; neutral to mildly alkaline; gradual, smooth boundary.

C—32 to 48 inches, brown (7.5YR 5/4) silty clay; brown (7.5YR 4/4) when moist; massive to weak, coarse, blocky structure; very hard when dry, very firm when moist; calcareous; few spots of white, grayish, and olive shale, and a few limestone fragments; abrupt, irregular boundary.

Dr—48 to 50 inches, interbedded shale and limestone bedrock.

The A horizon ranges from 5 to 14 inches in thickness. The texture of this layer is mostly silty clay loam, but in some places it is silt loam. The boundary of the B horizon is distinct to nondistinct as it grades to the lower layer of slightly weathered, moderately fine textured or fine textured shale. The texture of the B horizon ranges from light silty clay loam to silty clay. When dry, this horizon ranges from yellowish brown (10YR 5/4) to reddish brown (2.5YR 5/4), and when moist, from dark yellowish brown (10YR 4/4) to dark reddish brown (2.5YR 3/4). In some places there is a thin mantle of medium-textured or moderately fine textured colluvium or till. Depth to limestone ranges from about 2 feet to several feet.

LANCASTER SERIES

The soils of the Lancaster series are medium-textured to moderately coarse textured Brunizems of the uplands. These soils developed from sandstone. They are moderately sloping to moderately steep. They generally occur as scattered, small areas on valley slopes along the Big Blue River and its tributaries in the southern part of Gage County.

The Lancaster soils are deeper than the nearby Hedville soils, which are Lithosols that developed in sandstone. The subsoil and substratum of the Lancaster soils are medium textured to sandy, and the underlying material of the nearby Lanham soils is mottled and streaked heavy clay shale. The Lancaster soils have a sandier B horizon and substratum than the Labette soils. They are much deeper than the Sogn soils, which are shallow Lithosols over interbedded limestone and shale.

The following profile of Lancaster loam is about 0.6 mile north and 200 feet west of the southeast corner of section 23, T. 3 N., R. 6 E. The slope is about 6 percent. The vegetation is native grass.

A1—0 to 8 inches, very dark grayish-brown (10YR 3/2) loam; very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; medium acid; clear, smooth boundary.

A3—8 to 12 inches, reddish-brown (5YR 4/3) loam; dark reddish brown (5YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, very friable when moist; medium acid; clear, smooth boundary.

B2—12 to 21 inches, reddish-brown (5YR 4/4) heavy loam; dark reddish brown (5YR 3/4) when moist; weak, coarse, blocky structure separating to moderate, fine and medium, subangular blocky; hard when dry, friable when moist; slightly acid; gradual, wavy boundary.

C1—21 to 33 inches, reddish-brown (5YR 5/3) sandy loam; yellowish red (5YR 4/6) when moist; weak, coarse, blocky (cloddy) structure; soft when dry, very friable when moist; slightly acid; abrupt, irregular boundary.

Dr—33 to 40 inches, reddish-brown broken sandstone.

The A horizon ranges from 6 to 14 inches in thickness. The texture is mostly loam, but in some places it is silt loam or fine sandy loam. The B horizon is very weak to moderately distinct. This horizon ranges from 8 to 20 inches in thickness and from clay loam to sandy loam in texture. In some places it is more yellowish than is indicated in the profile description. The parent sandstone ranges from slightly indurated, light yellowish-brown sand to dark-brown or reddish-brown, hard, iron-rich sandstone.

LANHAM SERIES

The soils of the Lanham series are fine-textured Brunizems of the uplands. These soils developed in mottled and streaked, heavy Cretaceous shale. They are moderately sloping and moderately steep. In Gage County, these soils are minor in extent. They generally occur as narrow bands on slopes and in narrow upland valley troughs between areas of Lancaster and Hedville soils, which developed in sandstone, and areas of Sogn and Labette soils, which developed in interbedded limestone and shale.

The outstanding features of the Lanham soils are the heavy clay texture and the mottles and streaks in the subsoil and substratum.

The following profile of Lanham clay loam is near the northeast corner of section 16, T. 1 N., R. 5 E. The slope is about 10 percent.

A1—0 to 4 inches, dark-brown (10YR 4/3) clay loam; very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; medium acid; gradual, smooth boundary.

A12—4 to 8 inches, reddish-brown (5YR 4/3) clay loam; dark reddish brown (5YR 3/3) when moist; moderate, medium, granular structure; hard when dry, friable when moist; medium acid; abrupt, wavy boundary.

B2—8 to 20 inches, light reddish-brown (5YR 6/3) clay; reddish brown (5YR 4/3) when moist; moderate, coarse and medium, blocky structure; extremely hard when dry, extremely firm when moist; slightly acid; many, distinct, coarse mottles of weak red, brownish yellow, and dark brown; gradual, irregular boundary.

C—20 to 48 inches, variegated light-gray (10YR 7/1), yellow (10YR 7/6), pink (7.5YR 7/4), white (5YR 8/1), and red (2.5YR 4/6) clay; light brownish gray (10YR 6/2), yellowish brown (10YR 5/6), light brown (7.5YR 6/4), pinkish gray (5YR 7/2), and dark red (2.5YR 3/6) when moist; massive to weak, coarse and medium, blocky structure; extremely hard when dry, extremely firm when moist; neutral.

The A horizon ranges from 5 to 14 inches in thickness. The texture is clay loam, silt loam, loam, or sandy loam. The B horizon ranges from 8 to 20 inches in thickness. It is nondistinct in places because of the fine texture of the parent shale. There are places where fragments of sandstone and limestone are scattered throughout the upper part of the soil.

MORRILL SERIES

The soils of the Morrill series are Brunizems of the uplands. These soils developed in reddish, reworked loamy materials. They are moderately sloping; the slope averages about 8 to 12 percent but ranges from 3 to 18 percent. Morrill soils are scattered throughout Gage County. They generally occur on the lower part of valley slopes along streams.

The Morrill soils have a friable, moderately fine textured B horizon, and the Adair soils have a very firm, fine-textured one. The Morrill soils have a more acid and redder B horizon and substratum than the Shelby and Burchard soils. The subsoil is reddish, and that of the Shelby and Burchard soils is brownish or yellowish brown. The Morrill soils are similar to the Geary soils but are more gritty and contain more pebbles, stones, or rocks.

The following profile of Morrill loam is in a native hay meadow 0.5 mile east and 0.25 mile south of the northwest corner of section 22, T. 6 N., R. 8 E.

A11—0 to 3 inches, dark-gray (10YR 4/1) loam; very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft when dry, very friable when moist; strongly acid; gradual, smooth boundary.

A12—3 to 10 inches, dark-brown (7.5YR 3/2) loam; very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure separating to moderate, medium, granular; soft when dry, friable when moist; medium acid; gradual, smooth boundary.

B1—10 to 14 inches, dark reddish-gray (5YR 4/2) clay loam; dark reddish brown (5YR 3/2) when moist; weak coarse, prismatic structure separating to strong, coarse, granular; hard when dry, friable when moist; medium acid; gradual, smooth boundary.

B2—14 to 28 inches, reddish-brown (5YR 4/3) gritty clay loam; dark reddish brown (5YR 3/3) when moist; weak, coarse, prismatic structure separating to moderate, medium and fine, subangular blocky; hard when dry, friable to firm when moist; slightly acid; gradual, smooth boundary.

B3—28 to 40 inches, reddish-brown (5YR 5/4) gritty clay loam; reddish brown (5YR 4/4) when moist; weak, coarse, subangular blocky structure; hard when dry, friable to firm when moist; slightly acid; gradual, smooth boundary.

C1—40 to 51 inches, light reddish-brown (5YR 6/4) sandy clay loam; reddish brown (5YR 5/4) when moist; weak, coarse and medium, blocky structure; hard when dry, friable when moist; neutral; gradual, smooth boundary.

C2—51 to 58 inches, light-brown (7.5YR 6/4) sandy loam; brown (7.5YR 5/4) when moist; massive; slightly hard when dry, very friable when moist; neutral.

The surface layer ranges from 3 to 16 inches in thickness. The texture is mostly loam, but in some places it is clay loam, gravelly loam, or heavy sandy loam. In the severely eroded areas, part or all of the material that was once the upper part of the B horizon is now mixed with the surface layer. The present B horizon ranges from about 10 to 40 inches in thickness and from heavy clay loam or sandy clay loam to loam in texture. Depth to the C horizon is 18 to 50 inches. The texture of the underlying stratum ranges from clay loam to fine sand, but pockets of sand and gravel occur in places. The coarser sediments generally underlie the shallower profiles.

MUIR SERIES

The soils of the Muir series are silty to moderately fine textured, weakly developed Brunizems of the lower stream terraces. They developed in neutral or slightly acid alluvium. The slope generally is between 0 and 3 percent, but it is as much as 8 percent in small areas along terrace edges. In Gage County, these well-drained soils occur mainly along the outer edge of the Big Blue River Valley.

The Muir soils have a weakly developed B horizon. They are more mature and less stratified than the Hobbs soils, which are on the bottom lands. The Muir soils differ from the Rokeby soils in that they have a lighter colored, more permeable and friable, moderately fine textured B horizon. The Rokeby soils have a slowly permeable, very firm, fine-textured B horizon. The Muir soils are more mature than the Judson soils; they have more distinct layers but a thinner surface layer.

The following profile of Muir silt loam is in a nearly level, cultivated field near the northeast corner of section 3, T. 1 N., R. 6 E.

Ap—0 to 6 inches, dark-gray (10YR 4/1) silt loam; very dark gray (10YR 3/1) when moist; weak, coarse, blocky (cloddy) structure separating to weak, very fine, granular; soft when dry, very friable when moist; slightly acid; abrupt, smooth boundary.

A1—6 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam; very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure separating to moderate, fine, granular; soft when dry, friable when moist; slightly acid; gradual, smooth boundary.

B1—14 to 22 inches, dark grayish-brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure separating to moderate, very fine, subangular blocky; slightly hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

B2—22 to 34 inches, grayish-brown (10YR 5/2) silty clay loam; dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure separating to weak, fine, subangular blocky; hard when dry, friable when moist; neutral; gradual, smooth boundary.

C—34 to 50 inches, light grayish-brown (10YR 6/2) light silty clay loam; brown (10YR 5/3) when moist; weak, coarse and medium, blocky structure; slightly hard when dry, friable when moist; neutral; few, faint, grayish, yellowish, and brownish mottles.

The A horizon ranges from 10 to 18 inches in thickness. The texture is mostly medium silt loam, but in a few places it is light silt loam or heavy silt loam. The B horizon ranges from about 12 to 30 inches in thickness. In some places, a dark-colored layer that is the surface layer of a buried soil is at a depth of 3 to 6 feet.

PAWNEE SERIES

The soils of the Pawnee series are fine-textured Brunizems of the uplands. These soils developed in calcareous Kansan till. They are moderately sloping; the slope generally is about 6 percent. In Gage County, the Pawnee soils generally occur on smooth valley slopes along streams. They are below the Crete, the Wymore, and the Geary soils. In many places the Pawnee soils are intricately mixed with the Adair soils.

The B horizon of the Pawnee soils is yellowish brown, and that of the Adair soils is reddish brown. The Pawnee soils are more mature than the Shelby and Burchard soils and have a finer textured B horizon. The Pawnee soils differ from the Morrill soils in that they have a brownish, very firm, slowly permeable, fine-textured B horizon; the Morrill soils have a reddish, friable, and loamy B horizon. The Pawnee soils are more gritty than the Wymore soils, which developed in loess, and contain more stones and pebbles.

The following profile of Pawnee clay loam is about 0.2 mile north of the southwest corner of section 10, T. 1 N., R. 6 E. The slope is about 4 percent. The vegetation is grass.

A11—0 to 3 inches, dark-gray (10YR 4/1) light clay loam; very dark gray (10YR 3/1) when moist; weak, fine and very fine, granular structure; soft when dry, friable when moist; strongly acid or medium acid; gradual, smooth boundary.

A12—3 to 12 inches, dark grayish-brown (10YR 4/2) clay loam; very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; hard when dry, friable when moist; medium acid or strongly acid; clear, smooth boundary.

B21—12 to 22 inches, brown (10YR 5/3) clay; dark brown (10YR 4/3) when moist; moderate, fine and medium, angular blocky structure; very hard when dry, very firm when moist; medium acid or slightly acid; gradual, smooth boundary.

B22—22 to 38 inches, yellowish-brown (10YR 5/4) clay; dark yellowish brown (10YR 4/4) when moist; moderate, coarse, blocky and moderate, medium, angular blocky structure, extremely hard when dry, very firm when moist; neutral; gradual, smooth boundary.

B3—38 to 50 inches, light yellowish-brown (2.5Y 6/4) clay; light olive brown (2.5Y 5/4) when moist; weak, coarse, blocky structure; extremely hard when dry, very firm when moist; calcareous; few, soft, white lime concretions; gradual, smooth boundary.

C—50 to 60 inches, mottled, 50 percent light-gray (2.5Y 7/2) and 50 percent pale-yellow (2.5Y 7/4) heavy clay loam; light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) when moist; moderate, coarse and medium, blocky structure; very hard when dry, very firm when moist; calcareous; disseminated lime in large to small, white-lime masses.

The surface layer is 2 to 16 inches thick. The texture is predominantly clay loam, but where this layer is thickest, the texture in the uppermost 4 to 8 inches is silt loam or loam. The surface layer is thinnest in areas that have been severely eroded, where part or all of the present surface layer consists of material that was originally the upper part of the B horizon. In these places, the texture is heavy clay loam or clay. The B horizon ranges from about 30 to 50 inches in thickness. Depth to calcareous till is about 30 to 60 inches.

ROKEBY SERIES

The soils of the Rokeby series are somewhat poorly drained, dark-colored Planosols that developed in reworked alluvium. These soils are nearly level. They occur as scattered areas on low terraces adjacent to the flood plain of the Big Blue River.

The Rokeby soils are similar to the Butler soils, but they developed in reworked alluvium instead of in loess and are in lower terrace positions. They have a darker colored and finer textured B horizon than the nearby Muir soils. The Rokeby soils are darker colored than the Exline soils; they have a thicker surface layer, and are less alkaline.

The following profile of Rokeby silty clay loam is in a cultivated field on a level terrace 0.48 mile north of the southwest corner of section 24, T. 4 N., R. 5 E.

Ap—0 to 6 inches, dark-gray (10YR 4/1) light silty clay loam; very dark gray (10YR 3/1) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; strongly acid; abrupt, smooth boundary.

A1—6 to 12 inches, dark grayish-brown (10YR 4/2) silty clay loam; very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; hard when dry, friable when moist; strongly acid; gradual, smooth boundary.

A12—12 to 14 inches, gray (10YR 5/1) silt loam; dark grayish brown (10YR 4/2) when moist; weak, thin, platy structure; soft when dry, friable when moist; medium acid; abrupt, smooth boundary.

B2—14 to 28 inches, dark-gray (10YR 4/1) clay; very dark gray (10YR 3/1) when moist; moderate, coarse, blocky structure separating to strong, fine and medium, angular blocky; very hard when dry, very firm when moist; neutral or slightly acid; gradual, wavy boundary.

B2ca—28 to 33 inches, grayish-brown (10YR 5/2) silty clay; dark grayish brown (10YR 4/2) when moist; moderate, medium, angular blocky structure; very hard when dry, very firm when moist; calcareous; few, fine, faint, brownish, grayish, and yellowish mottles; gradual, smooth boundary.

B3ca—33 to 40 inches, light brownish-gray (10YR 6/2) silty clay loam; grayish brown (10YR 5/2) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; calcareous; slight amounts of disseminated lime; gradual, smooth boundary.

C—40 to 56 inches, very pale brown (10YR 7/3) silt loam; light yellowish brown (10YR 6/4) when moist; massive; soft when dry, friable when moist; calcareous; slight effervescence by dilute acid.

In some places a thin or a faint A2 horizon occurs above the fine-textured B horizon. The A horizon ranges from heavy silt loam to medium silty clay loam in texture and from about 8 to 16 inches in thickness. In some places a dark-colored paleosol underlies this soil at a depth of 36 to 70 inches.

SHELBY SERIES

The soils of the Shelby series are Brunizems of the uplands. They developed in calcareous Kansan till. Ordinarily, they are moderately sloping and moderately steep; the slope is between 3 and 18 percent. In Gage County, the Shelby soils generally are on valley slopes along streams below the loess-derived Crete, Wymore, and Geary soils and the till-derived Pawnee and Adair soils. They are intricately mixed with the Burchard soils. The Shelby soils are more mature than the Burchard soils and are leached of lime to a greater depth. The Shelby soils differ from the Adair and the Pawnee soils in that their subsoil is less clayey and much more friable. Also, the Shelby soils have a brownish or yellowish B horizon, and that of the Adair and Morrill soils is reddish.

The following profile of Shelby clay loam is about 0.7 mile south and 0.3 mile (1,560 feet) east of the northwest corner of section 35, T. 3 N, R. 8 E. The slope is about 5 percent. The vegetation is native grass.

A11—0 to 4 inches, very dark gray (10YR 3/1) light clay loam; black (10YR 2/1) when moist; weak, fine, granular structure; soft when dry, friable when moist; medium acid; gradual, smooth boundary.

A12—4 to 10 inches, very dark grayish-brown (10YR 3/2) clay loam; very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; medium acid; gradual, smooth boundary.

B1—10 to 14 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, very fine, subangular blocky structure; slightly hard when dry, friable when moist; medium acid; clear, smooth boundary.

B2—14 to 31 inches, brown (10YR 4/3) heavy clay loam; dark brown (10YR 3/3) when moist; weak, coarse, blocky and prismatic structure separating to moderate, fine and medium, subangular blocky; hard when dry, firm when moist; slightly acid; gradual, smooth boundary.

B3—31 to 42 inches, yellowish-brown (10YR 5/4) heavy clay loam; dark yellowish brown (10YR 4/4) when moist; moderate, coarse, blocky structure separating to moderate, medium, subangular blocky; hard

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when dry, friable to firm when moist; neutral; common to few, fine, faint, grayish-brown and strong-brown mottles; gradual, smooth boundary.

C1—42 to 50 inches, grayish-brown (2.5Y 5/2) clay loam; dark grayish brown (2.5Y 4/2) when moist; moderate, coarse and medium, blocky (cloddy) structure; hard when dry, friable to firm when moist; neutral or mildly alkaline; many, fine, distinct, yellowish-brown and dark-brown mottles.

C2—50 to 60 inches, 75 percent light brownish-gray (2.5Y 6/2) and 25 percent yellowish-brown (10YR 5/4) clay loam; dark grayish brown (2.5Y 4/2) and dark yellowish brown (10YR 4/4) when moist; strong, medium and coarse, blocky (cloddy) structure (slightly weathered till); hard when dry, firm when moist; coarse, faint to distinct, yellowish-brown and strong-brown mottles; few scattered lime concretions.

The surface layer ranges from about 4 to 16 inches in thickness. The texture is mostly clay loam, but in some places it is gravelly clay loam. Where this layer is thickest, the texture in the uppermost 4 to 8 inches is silt loam or loam. The surface layer is thinnest in cultivated areas that have been severely eroded. In these areas part or all of the material that was once the upper part of the B horizon has been mixed with the present surface layer. The present B horizon ranges from about 24 to 40 inches in thickness. Depth to calcareous till is about 30 to 60 inches.

SOGN SERIES

The soils of the Sogn series are dark-colored, shallow Lithosols of the uplands. These soils developed over limestone and interbedded shale. They are steep and generally occur as small, irregularly shaped areas or as narrow bands on valley slopes adjacent to the Big Blue River and its tributaries in the southern part of the county.

The Sogn soils are shallower over limestone than the Labette soils. They differ from the Hedville soils in that they overlie limestone instead of sandstone. The Sogn soils are much shallower than the Lancaster soils, which also developed from sandstone.

The following profile of Sogn rocky clay loam is about 0.2 mile east of the northwest corner of section 21, T. 1 N., R. 6 E. The slope is about 10 percent. The vegetation is grass.

A1—0 to 4 inches, very dark grayish-brown (10YR 3/2) clay loam; very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; neutral; clear, smooth boundary.

A3—4 to 8 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; neutral; abrupt, irregular boundary.

Dr1—8 to 16 inches, somewhat weathered, level-bedded limestone broken by vertical joints and cracks; extensions of overlying dark-colored horizons fill crevices.

Dr2—16 to 30 inches, somewhat weathered, interbedded clayey shale and limestone.

The A horizon ranges from 2 to 15 inches in thickness. In some places both extremes occur within an area that has a radius of only 10 feet. The texture of the A horizon ranges from clay loam or silty clay loam to loam and silt loam. Limestone fragments occur in places. The reaction is strongly calcareous to noncalcareous. The transition from the A horizon to bedrock ranges from gradual and smooth to abrupt and very irregular, depending on the denseness and consolidation of the bedrock. In some places there is a thin overburden of loamy to moderately fine textured materials of glacial or loessal origin.

STEINAUER SERIES

The soils of the Steinauer series are well-drained to somewhat excessively drained Regosols of the uplands. These soils developed in calcareous till of clay loam texture. They are ordinarily moderately steep; the slope is between 12 and 25 percent.

The Steinauer soils are thinner than the Burchard soils, less mature, lighter colored, and leached of lime to a lesser depth.

The following profile of Steinauer clay loam is in a native pasture about 0.25 mile north and 0.3 mile west of the southeast corner of section 35, T. 3 N., R. 8 E. The slope is about 12 percent.

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) light clay loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; slightly calcareous; clear, smooth boundary.

AC—6 to 10 inches, brown (10YR 5/3) clay loam; dark brown (10YR 3.5/3) when moist; moderate, medium, granular structure; hard when dry, friable when moist; calcareous; gradual, wavy boundary.

C—10 to 30 inches, light yellowish-brown (10YR 6/4) heavy clay loam containing a few pebbles and small rocks; yellowish brown (10YR 5/4) when moist; weak, coarse and medium, blocky (cloddy) structure; hard when dry, friable when moist; highly calcareous; many soft pieces and streaks of white lime.

The dark-colored surface layer ranges from 3 to 10 inches in thickness and from clay loam to gravelly clay loam in texture. The depth to lime ranges from 0 to 14 inches, but in most places the soil is calcareous at or near the surface. The number of small pebbles, rocks, and stones varies considerably from place to place.

WABASH SERIES

The soils of the Wabash series are dark-colored Humic Gley soils of the bottom lands. These soils developed in fine-textured alluvium. They are level and nearly level. Runoff is slow, and internal drainage is slow and very slow. In Gage County, these soils occur as small, scattered areas throughout the larger valleys.

The Wabash soils are finer textured than the Colo soils and more poorly drained.

The following profile of Wabash silty clay is in a level, narrow area about 100 feet east of the southwest corner of section 12, T. 4 N., R. 5 E.

Ap—0 to 6 inches, very dark gray (10YR 3/1) light silty clay; very dark brown (10YR 2/2) when moist; moderate, very fine, granular structure; hard when dry, firm when moist; slightly acid; abrupt, smooth boundary.

A11—6 to 14 inches, very dark gray (2.5Y 3/0) silty clay; black (2.5Y 2/0) when moist; strong, fine and medium, granular structure; very hard when dry, very firm when moist; slightly acid; gradual, smooth boundary.

A12—14 to 25 inches, very dark gray (2.5YR 3/0) silty clay; black (10YR 2/1) when moist; moderate, medium and fine, blocky structure; very hard when dry, very firm when moist; slightly acid; gradual, smooth boundary.

C1—25 to 44 inches, very dark gray to dark gray (10YR 3.5/1) silty clay; black to very dark gray (10YR 2.5/1) when moist; moderate, coarse and medium, angular blocky structure; sides of the blocks slicked; very hard when dry, very firm when moist; slightly acid; gradual, smooth boundary.

C2—44 to 56 inches, dark-gray (5Y 4/1) silty clay; very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, angular blocky structure; sides of the blocks slicked; very hard when dry, very firm when moist; neutral.

In places the A horizon is indistinct because of the fine texture of the alluvium. The texture of the surface layer ranges from heavy silty clay loam to silty clay. When moist, the underlying strata, below a depth of 36 inches, range from dark grayish brown (10YR 4/2) or dark brown (10YR 3/3) to very dark gray (5Y 3/1) or black (5Y 2/1). In some places lime concretions occur below a depth of 48 inches.

WYMORE SERIES

The soils of the Wymore series are Brunizems of the uplands. They developed in a rather thin mantle of moderately fine textured Peorian loess above the till plain. These soils are gently sloping. In Gage County, the Wymore soils generally occur on rounded ridges and valley sides above the till-derived Adair, Pawnee, Shelby, Burchard, and Morrill soils. The Wymore soils are principally east of the Big Blue River.

The Wymore soils have a more grayish and mottled B horizon and substratum than the Crete soils; they do not have a lime zone but may have lime concretions in the substrata. They have iron segregations in the parent material, which the Crete soils do not have.

The following profile of Wymore silty clay loam is in a cultivated field about 0.1 mile west of the southeast corner of section 34, T. 5 N., R. 7 E. The slope is about 5 percent.

Alp—0 to 6 inches, dark-gray (10YR 4/1) silty clay loam; very dark brown (10YR 2/2) when moist; weak thin, platy and weak, fine, granular structure; slightly hard when dry, friable when moist; medium acid; abrupt, smooth boundary.

B1—6 to 14 inches, very dark grayish-brown (10YR 3/2) silty clay; very dark brown (10YR 2/2) when moist; moderate, very fine, blocky structure; clay films on aggregate faces; slightly hard when dry, friable when moist; medium acid; clear, smooth boundary.

B21—14 to 18 inches, dark grayish-brown (10YR 4/2) silty clay; very dark grayish brown (10YR 3/2) when moist; moderate, medium and fine, blocky structure; clay films on aggregate faces; very hard when dry, firm when moist; medium acid; clear, smooth boundary.

B22—18 to 25 inches, dark-brown (10YR 4/3) silty clay; dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure separating to moderate, medium and fine, angular blocky; clay films on aggregate faces; very hard when dry, firm when moist; slightly acid; few, faint, dark yellowish-brown mottles; gradual, smooth boundary.

B23—25 to 33 inches, brown (10YR 5/3) light silty clay; dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure breaking to moderate, medium, angular blocky; clay films on aggregate faces; hard when dry, firm when moist; slightly acid; common, fine, faint, dark yellowish-brown mottles; clear, smooth boundary.

B3—33 to 41 inches, mottled 50 percent grayish-brown (2.5Y 5/2) and 50 percent light brownish-gray (2.5Y 6/2) heavy silty clay loam; olive brown (2.5Y 4/4) or grayish brown (2.5Y 5/2) when moist; moderate, medium and fine, blocky structure; patchy clay films on aggregate faces; hard when dry, friable when moist; neutral; few, fine, yellowish-brown mottles and common, fine, distinct, reddish-brown concretions of iron and manganese; clear, smooth boundary.

C—41 to 60 inches, light brownish-gray (2.5Y 6/2) silty clay loam; gray (5Y 5/1) when moist; weak, coarse and medium, blocky structure; slightly hard when dry, friable when moist; neutral; few, small, pipe-like, iron concretions.

The surface layer is 4 to 15 inches thick. The texture is predominantly medium silty clay loam, but where this layer is thickest, the texture in the upper part is heavy silt loam. The surface layer is thinnest in areas that have been severely eroded. In these areas part or all of the material that was once the upper part of the B horizon has been mixed with the remnants of the A horizon, and the texture is heavy silty clay loam or silty clay. The B horizon ranges from 25 to 40 inches in thickness. The maximum clay content in the profile, ranging from about 40 to 48 percent, is commonly in the middle part of the B2 horizon but may occur in the lower or upper part. In the contact zone between the C and D horizons are thin lenses of organic stains and concentrations of yellowish-brown iron stains.

Mechanical and Chemical Analyses

Data obtained by mechanical and chemical analyses of three selected soils are given in table 8. Samples of two of the soils were taken in Pawnee County, but the data apply to the same soils in Gage County. These data are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful in estimating water-holding capacity, fertility, tilth, and other properties that affect soil management.

FIELD AND LABORATORY METHODS.—All samples analyzed were collected from carefully selected pits. After the samples were dried, they were sieved, if necessary, and the rock fragments more than three-fourths of an inch in diameter were discarded. Then, the material made up of particles less than three-fourths of an inch in diameter was rolled, crushed, and seived by hand to remove rock fragments more than 2 millimeters in diameter. The fraction that consisted of particles between 2 millimeters and three-fourths of an inch in diameter was recorded in table 8 as the percentage more than 2 millimeters in size. This value was calculated from the total weight of the particles less than three-fourths of an inch in diameter. This fraction contains unaltered rock fragments that are more than 2 millimeters in diameter, but it does not contain slakeable clods of earthy material. All laboratory analyses were made on ovendry material that passed the 2-millimeter sieve.

Values for exchangeable sodium are for the amount of sodium that has been extracted by the ammonium acetate method minus the amount that is soluble in the saturation extract.

Standard methods of the Soil Survey Laboratory were used to obtain most of the data given in table 8. Determinations of clay were made by the pipette method (*5, 6, 7*). The reactions of the 1:1 and 1:10 water suspensions were measured with a glass electrode.

The content of organic carbon was determined by wet combustion, using a modification of the Walkley-Black

TABLE 8.—*Analytical*

[Analyses made at Soil Survey

Soil, location, and sample and laboratory numbers	Horizon depth	Particle-size distribution (diameter)							
		Very coarse sand (2.0–1.0 mm.)	Coarse sand (1.0–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (Less than 0.002 mm.)	Clay (More than 2 mm.)
Crete silty clay loam	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Location: 1,220 feet S. and 370 feet E. of NW. corner sec. 17, T. 6 N., R. 6 E., Gage County, Nebr. *Sample No.* S55–Neb–34–1–(1 to 9). *Laboratory Nos.* 3336, 3344.	0 to 5	--------	0.2	0.2	0.4	3.8	67.7	27.7	--------
	5 to 7½	--------	.2	.2	.3	2.8	62.9	33.6	--------
	7½ to 10	--------	.1	.1	.3	2.5	57.3	39.7	--------
	10 to 15	0.1	.1	.1	.1	1.8	47.1	50.7	--------
	15 to 23	--------	.1	.1	.1	2.1	51.7	45.9	--------
	23 to 28	--------	.1	.1	.1	2.3	55.0	42.4	--------
	28 to 37	1.0	.4	.1	.3	2.9	61.5	33.8	--------
	37 to 47	.1	.1	.1	.2	2.5	65.2	31.8	--------
	47 to 60	--------	.2	.1	.2	2.5	66.6	30.4	--------
Pawnee clay loam									
Location: 0.3 mile W. and 350 feet S. of NE. corner sec. 2, T. 2 N., R. 11 E.; about 4 miles N. of Pawnee City, Pawnee County, Nebr. *Sample No.* S58–Neb–67–3–(1 to 8). *Laboratory Nos.* 9148, 9155.	0 to 6	[1] 1.2	[1] 4.1	[1] 5.6	[1] 8.9	[1] 4.9	50.0	25.3	(2)
	6 to 10	[1] 2.3	[1] 4.1	[1] 4.7	[1] 7.0	[1] 4.2	45.5	32.2	(2)
	10 to 14	[1] 2.2	[1] 3.6	[1] 4.0	[1] 6.5	[1] 4.3	42.7	36.7	(2)
	14 to 24	[1] 2.1	[1] 4.1	[1] 3.5	[1] 6.1	[1] 3.8	32.7	47.7	(2)
	24 to 32	[1] 4.3	[1] 4.2	[1] 4.2	[1] 7.5	[1] 5.0	29.5	45.3	4.3
	32 to 45	[3] 3.2	[3] 5.2	[3] 5.2	[3] 8.9	[3] 5.8	30.0	41.7	2.8
	45 to 53	[3] 2.2	[3] 4.8	[3] 5.1	[3] 9.8	[3] 6.5	30.6	41.0	(2)
	53 to 63	[3] 2.9	[3] 4.5	[3] 5.4	[3] 9.9	[3] 7.0	31.8	38.5	(2)
Wymore silty clay loam									
Location: 1,170 feet W. and 580 feet S. of NE. corner sec. 1, T. 1. N., R. 11 E.; about 1 mile E. and 1 mile S. of Pawnee City, Pawnee County, Nebr. *Sample No.* S58–Neb–67–7–(1 to 8). *Laboratory Nos.* 9177, 9184.	0 to 5	.1	[4] .1	[4] .2	[4] .3	[4] 1.4	63.2	34.8	--------
	5 to 9	.1	.1	[4] .1	[4] .2	[4] .7	56.4	42.6	--------
	9 to 17	.1	.1	[5] .1	[5] .2	[4] .5	52.4	46.8	--------
	17 to 25	.1	[5] .1	[5] .1	[5] .2	[4] .5	58.0	41.1	--------
	25 to 32	.1	[5] .1	[5] .1	[5] .1	[4] .5	59.3	39.9	--------
	32 to 40	.1	[5] .1	[5] .1	[5] .1	[4] .4	61.7	37.6	--------
	40 to 53	.1	.1	.1	.1	[4] .6	65.0	34.4	--------
	53 to 63	.2	1.9	2.5	4.4	2.8	58.6	29.6	--------

[1] Trace of smooth, irregular, light-brown to black concretions, possibly ferromanganese.
[2] Trace.
[3] Trace of smooth, irregular, light-brown to black concretions, possibly ferromanganese; few calcium carbonate concretions.

method (*8*). The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from soil samples treated with concentrated hydrochloric acid. The cation exchange capacity was determined by direct distillation of adsorbed ammonia (*8*). The extractable calcium and magnesium were determined by separating the calcium as calcium oxalate, and the magnesium as magnesium ammonium phosphate (*8*). Extractable sodium and potassium were determined on original extracts with a flame spectrophotometer. The saturation extract was obtained by using methods of the U.S. Salinity Laboratory (*9*).

Soluble sodium and potassium were determined on the saturation extract with a flame spectrophotometer.

Free iron oxide was determined by titration with standard potassium dichromate of an extract obtained by treating the sample with sodium hydrosulfite (*4*).

DESCRIPTIONS OF PROFILES FROM WHICH SAMPLES WERE TAKEN.—The profile of Crete silty clay loam from which the samples for analysis were taken is described in the section "Genesis, Classification, and Morphology of Soils." Following are descriptions of the Pawnee and Wymore profiles from which samples were taken.

Pawnee clay loam—Profile located 0.3 mile west and 350 feet south of the northeast corner of sec. 2, T. 2 N., R 11 E.; about 4 miles north of Pawnee City, Pawnee County, Nebr. Physiography—glacial uplands. Slope—6 percent, facing west.

A1p—0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam; very dark brown (10YR 2/2) when moist; moderate, fine and very fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; abrupt, smooth boundary.

A12—6 to 10 inches, very dark grayish-brown (10YR 3/2) clay loam; very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

AB—10 to 14 inches, dark yellowish-brown (10YR 3/4) clay; dark brown (10YR 3/3) when moist; few, fine, prominent, dark-red mottles; moderate, medium and fine, blocky structure; hard when dry, friable when moist; noncalcareous; gradual, smooth boundary.

B21—14 to 24 inches, dark-brown (10YR 4/3 dry) clay; dark-brown (10YR 3/3) when moist; a few pebbles;

data for selected soils

Laboratory, SCS, Lincoln, Nebr.]

Chemical analysis													
Reaction		Organic carbon	Nitrogen	Electrical conductivity (Ec x 10^3)	Free iron oxide (Fe_2O_3)	Calcium carbonate ($CaCO_3$) equivalent	Cation exchange capacity (NH_4Ac)	Extractable cations (milliequivalents per 100 grams of soil)					Exchangeable sodium
1:1	1:10							Ca	Mg	H	Na	K	
pH	*pH*	*Percent*	*Percent*	*Millimhos per centimeter at 25° C.*	*Percent*	*Percent*							*Percent*
5. 3	5. 8	1. 84	0. 145	----------	----------	----------	22. 4	13. 3	4. 5	------	0. 1	0. 9	----------
5. 5	6. 0	1. 84	. 154	----------	----------	----------	25. 9	16. 3	5. 3	------	. 1	. 8	----------
5. 7	6. 1	1. 54	. 134	----------	----------	----------	30. 0	19. 2	6. 9	------	. 1	. 8	----------
5. 8	6. 4	1. 00	. 075	----------	----------	----------	37. 0	23. 6	8. 9	------	. 2	1. 1	----------
6. 3	6. 8	. 78	. 062	----------	----------	----------	33. 7	23. 4	8. 1	------	. 2	1. 0	----------
6. 7	7. 2	. 54	. 048	----------	----------	----------	32. 4	23. 9	7. 8	------	. 2	1. 0	----------
7. 5	8. 3	. 19	----------	----------	----------	1	29. 2	31. 4	7. 4	------	. 2	. 9	----------
7. 4	8. 0	. 12	----------	----------	----------	----------	28. 7	23. 7	7. 6	------	. 3	. 9	----------
7. 2	7. 7	. 11	----------	----------	----------	1	27. 5	21. 1	7. 8	------	. 4	1. 0	----------
5. 5	------	2. 03	. 165	0. 4	1. 2	----------	18. 8	11. 3	3. 0	6. 5	. 1	. 5	1
5. 5	------	1. 59	. 128	. 3	1. 6	----------	21. 3	13. 7	4. 1	8. 6	. 2	. 3	1
5. 5	------	1. 28	. 108	. 3	1. 7	----------	24. 3	14. 9	4. 7	9. 0	. 3	. 3	1
6. 2	------	. 69	. 057	. 4	2. 2	----------	30. 7	22. 0	6. 9	6. 2	1. 2	. 4	4
7. 2	------	. 47	----------	. 5	2. 6	1	29. 8	23. 5	7. 1	2. 5	1. 7	. 3	5
8. 1	------	. 19	----------	. 7	2. 1	2	27. 6	25. 6	6. 6	0. 8	2. 4	. 3	7
8. 1	------	. 08	----------	. 7	2. 6	2	25. 5	22. 7	6. 1	. 8	3. 0	. 3	10
8. 0	------	. 02	----------	. 7	2. 4	1	23. 2	19. 7	5. 2	. 4	2. 2	. 3	S
5. 6	------	2. 09	. 163	. 3	1. 0	----------	26. 6	17. 2	4. 7	9. 8	. 1	. 8	----------
5. 7	------	1. 84	. 150	. 3	1. 1	----------	31. 7	21. 3	6. 5	9. 0	. 1	. 6	----------
5. 9	------	1. 24	. 095	. 3	1. 2	----------	34. 0	23. 8	7. 3	7. 4	. 2	. 7	----------
6. 1	------	. 63	. 060	. 3	1. 4	----------	32. 2	23. 4	7. 3	6. 2	. 2	. 6	----------
6. 3	------	. 38	----------	. 3	1. 4	----------	30. 2	22. 8	6. 9	4. 5	. 3	. 6	----------
6. 6	------	. 24	----------	. 3	1. 1	1	29. 1	23. 1	6. 9	3. 3	. 4	. 6	----------
6. 8	------	. 15	----------	. 3	. 5	1	27. 2	21. 8	6. 1	2. 9	. 5	. 5	----------
6. 9	------	. 20	----------	. 4	1. 2	1	21. 3	17. 3	4. 4	3. 2	. 5	. 3	----------

[4] Few, smooth, irregular, dark-brown to black concretions, possibly ferromanganese.
[5] Many, smooth, irregular, dark-brown to black concretions, possibly ferromanganese.

moderate, coarse and medium, blocky structure; the sides of the blocks are slicked at a 45° angle; hard when dry, firm when moist; noncalcareous; gradual, smooth boundary.

B22—24 to 32 inches, dark yellowish-brown (10YR 4/4) clay with a few pebbles; brown (10YR 4/3) when moist; weak, coarse, blocky structure; the sides of the blocks are slicked at a 45° angle; very hard when dry, very firm when moist; noncalcareous; gradual, smooth boundary.

B23—32 to 45 inches, dark yellowish-brown (10YR 4/4) clay; yellowish-brown (10YR 5/6) when moist; many, medium, distinct, weak-red mottles; weak, coarse, blocky structure; very hard when dry, very firm when moist; noncalcareous; gradual, smooth boundary.

B3—45 to 53 inches, mottled 50 percent light olive-brown (2.5Y 5/4) and 50 percent yellowish-brown (10YR 5/8) clay; light olive brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) when moist; weak, medium, blocky structure; very hard when dry, very firm when moist; noncalcareous, except for a few medium-sized, hard concretions; clear, smooth boundary.

C—53 to 63 inches, mottled 75 percent light olive-brown (2.5Y 5/4) and 25 percent yellowish-brown (10YR 5/8) clay; grayish brown (2.5Y 4.5/2) and yellowish brown (10YR 5/6) when moist; seams and concretions of iron and manganese; moderate, medium and coarse, blocky structure; hard when dry, firm when moist; calcareous with a few medium and large, soft concretions.

Wymore silty clay loam—Profile located 1,170 feet west and 580 feet south of the northeast corner of sec. 1, T. 1 N., R. 11 E.; about 1 mile east and 1 mile south of Pawnee City, Pawnee County, Nebr. Physiography—loess-capped glacial till uplands. Slope—4 percent, facing southwest.

A1p—0 to 5 inches, dark-gray (10YR 4/1) silty clay loam; very dark brown (10YR 2/2) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; noncalcareous; abrupt, smooth boundary.

B1—5 to 9 inches, very dark grayish-brown (10YR 3/2) heavy silty clay loam; very dark brown (10YR 2/2) when moist; moderate, very fine, blocky structure with clay films on the aggregate faces; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

B21—9 to 17 inches, dark grayish-brown (10YR 4/2) silty clay; very dark grayish brown (10YR 3/2) when moist; moderate, medium and fine, blocky structure with clay films on the aggregate faces; hard when dry, firm when moist; noncalcareous; clear, smooth boundary.

B22—17 to 25 inches, dark-brown (10YR 4/3) silty clay; dark grayish-brown mottles; moderate, medium and fine, blocky structure with clay films on the aggregate faces; hard when dry, firm when moist; noncalcareous; gradual, smooth boundary.

B23—25 to 32 inches, brown (10YR 5/3) silty clay; dark grayish brown (10YR 4/2) when moist; common, fine, faint, dark yellowish-brown mottles; moderate, medium, blocky structure with clay films on the aggregate faces; hard when dry, firm when moist; noncalcareous; clear, smooth boundary.

B24—32 to 40 inches, mottled 50 percent grayish-brown (2.5Y 5/2) and 50 percent light brownish-gray (2.5Y 6/2) heavy silty clay loam; olive brown (2.5Y 4/4) and grayish brown (2.5Y 5/2) when moist; few, fine, distinct, yellowish-brown mottles and common, fine, distinct, reddish-brown iron and manganese concretions; moderate, medium and fine, blocky structure with patchy clay films on the aggregate faces; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

C—40 to 53 inches, light brownish-gray (2.5Y 6/2) silty clay loam; gray (5Y 5/1) when moist; weak, medium and coarse, blocky structure; few small, pipelike iron concretions; slightly hard when dry, friable when moist; few scattered lime concretions; abrupt, smooth boundary; thin lenses of dark-colored material, probably organic stainings, and concentrations of yellowish-brown iron stains between the C and D horizons.

D—53 to 63 inches, brown (10YR 5/3) silty clay loam; dark brown (7.5YR 4/2) when moist; common, fine, distinct, dark reddish-brown mottles; many fine pores; weak, thin, platy structure; soft when dry, very friable when moist; noncalcareous.

General Nature of the County

This section was prepared mainly for those not familiar with the county. It contains subsections on geology, physiography, relief, and drainage; climate; settlement, organization, and population; agriculture; and other subjects of general interest.

Geology, Physiography, Relief, and Drainage

Gage County lies entirely within the glaciated part of the physiographic province known as the Great Plains. Underlying formations, such as interbedded limestone and shale, indicate that this area was once at the bottom of a sea or an ocean. Subsequently, glaciers moved southeastward across the county and brought large masses of earth material. As the climate changed, the glaciers melted, receded northward, and left these masses of material, known as glacial till. Erosion of this glacial till plain by both wind and water produced the present landscape. Such erosion is referred to as geologic erosion. Water erosion formed uplands, terraces, and bottom lands. The uplands, by far the most extensive of these features, are remnants of the original glacial till plain. The present terraces were once bottom lands that formed when streams were flowing at higher levels than at present. Some old high terraces, those near the Beatrice airport, for example, are now considered uplands. The present bottom lands include only those areas subject to overflow, where soil material is either deposited or removed by floodwaters.

While water deposited mixed alluvium in valleys, the wind deposited silty stone-free loess, mixed in composition but uniform in texture, over most of the landscape. Deposition was heaviest on the smoothest parts of the uplands, where water erosion was least severe. On some slopes, loess did not accumulate or it was removed by water action.

Relief ranges from level to very steep. The most extensive nearly level uplands are in the vicinities of Cortland and Ellis, but several smaller areas are near Virginia, north and south of Odell, north of Filley, and elsewhere over the county on top of major loess-capped divides. Uplands of glacial till and bedrock are gently sloping to steep or very steep. The sloping glacial uplands are most common near Adams, Clatonia, Liberty, and Barneston. The areas of strongest relief are in the bedrock uplands near Krider, Rockford, Wymore, and Blue Springs and elsewhere along the more deeply entrenched streams. The area of strongest relief is southeast of Beatrice. From the top of Iron Mountain—a prominent sandstone outcrop—to the bottom lands of the Big Blue River, the elevation changes several hundred feet within a distance of less than one-half mile. The bottom lands and strips of terraces are nearly level and range in width from a few rods along the smaller streams to 3 miles along the Big Blue and Big Nemaha Rivers.

The highest elevation is near Cortland in the northern part of the county, on top of an upland divide. The lowest elevation is along the Big Blue River south of Barneston where the river crosses the Kansas-Nebraska boundary.

Gentle slopes on the north side of stream valleys and steep to abrupt slopes on the south side are marked features of the uplands. Moreover, this is typical of all major valley sides. Gradients of streams north of the river generally are less steep than those of streams that are south of the river and flow northeastward.

Drainage is chiefly southeastward. Practically all of the county is drained by the Big Blue River, which enters about 8 miles south of the northwestern corner. The Big Nemaha River drains the northeastern corner.

The principal tributaries of the Big Blue River in Gage County are Big Indian, Bear, and Clatonia Creeks. The main tributary of the Big Nemaha River within the county is Hooker Creek. These streams flow constantly, except during unusually prolonged droughts. All are relatively swift, particularly at flood stage. In many places flooding is a serious hazard.

For the most part, the county is well drained. Poor drainage is confined to nearly level areas and terraces, and excessive drainage to areas that are steep or very steep, sandy, shallow, or stony. The channels of some drainageways, particularly of intermittent drains on sloping valley sides, have deepened into gullies since the soils have been broken from sod and cultivated.

Climate[7]

The climate of Gage County is continental and temperate, as is typical for the interior of a large continent in middle latitudes. The principal characteristics of such a climate are rather light or moderate rainfall, hot summers, severe winters, wide variations in temperature and precipitation from year to year, and frequent changes in weather from day to day.

In spite of the variations in temperature and precipitation between winter and summer, the climate is suitable for growing grain, vegetables, and hay crops and for raising livestock. Cool, rainy spring weather is favorable for the rapid growth of winter wheat and spring-planted small grains. Warm days and nights of the long summer are especially favorable for the growth of corn. Long and pleasant autumns, with only occasional periods of rainy weather, give farmers ample time to prepare the soils and seed winter wheat and to harvest the corn crop. Short periods of extremely cold weather in winter are commonly accompanied by snow, which protects winter-grown crops from serious injury. Winter temperatures are usually cold enough to kill many destructive insects.

The normal monthly, seasonal, and annual temperatures and precipitation in the central part of the county, as compiled from records of the United States Weather Bureau station at Beatrice, are shown in table 9.

TABLE 9.—*Temperature and precipitation at Beatrice, Gage County, Nebraska*

[Elevation, 1,235 feet]

Month	Temperature[1]			Precipitation[2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1955)	Wettest year (1951)	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
January	24. 7	68	−24	0. 63	0. 79	0. 47	5. 1
February	27. 8	78	−33	. 93	1. 43	1. 82	6. 2
March	39. 1	91	−14	1. 45	. 47	2. 78	5. 4
April	51. 8	100	10	2. 53	1. 74	3. 96	1. 1
May	61. 6	108	24	3. 87	1. 33	5. 86	. 1
June	71. 9	111	40	4. 41	3. 73	11. 42	0
July	78. 0	117	41	3. 60	1. 04	8. 05	0
August	75. 9	114	40	3. 41	. 76	7. 63	0
September	67. 3	111	24	3. 05	3. 26	4. 01	0
October	54. 7	99	0	1. 93	. 79	1. 69	. 3
November	39. 5	85	−5	1. 25	. 13	. 29	1. 5
December	28. 2	72	−18	. 90	. 49	. 42	4. 7
Year	51. 7	117	−33	27. 96	15. 96	48. 40	24. 4

[1]Average temperature based on a 62-year record, through 1955; highest and lowest temperatures on a 58-year record, through 1952.

[2]Average precipitation based on a 65-year record, through 1955; wettest and driest years based on a 65-year record, in the period 1891–1955; snowfall based on a 47-year record, through 1952.

The following tabulation gives statistical data on the probability that temperatures of 32° or lower will occur in spring after the dates indicated and in fall before the dates indicated.

Probability	*Date for given probability*
Spring:	
1 year in 10 later than	May 11
3 years in 10 later than	May 2
7 years in 10 later than	April 19
9 years in 10 later than	April 9
Fall:	
1 year in 10 earlier than	September 9
3 years in 10 earlier than	October 7
7 years in 10 earlier than	October 19
9 years in 10 earlier than	October 28

Temperature.—Daily weather observations made at Beatrice since 1891 show great variability and severity of the climate. For example, the difference in average temperatures between the coldest and the warmest months is about 54° F. at Beatrice as compared with a difference of only about 10° between the coldest and the warmest months at Eureka, Calif. (a city that has a marine climate and is at nearly the same latitude as Gage County). The difference between the lowest and highest temperatures of record at Beatrice is 150°. At Eureka the difference is only 63°.

The average annual range in temperature at Beatrice is approximately 115°. The widest annual range recorded is 133°. Temperatures of 100° or higher have been recorded between April and September, and temperatures of 0 or lower have been recorded between October and March.

The coldest month on record was January 1940, when the average temperature was 7.8° F. The minimum temperature was below zero on 19 days of that month.

The hottest month on record was July 1934, when the average temperature was 88.4° F. The maximum temperature was 100° or higher on 25 days. A high of 117° was recorded. One night during that month the minimum temperature was 89°.

The average date of the last freezing temperature (32°) in spring is April 26, and that of the first in fall is October 13. Freezing temperatures have occurred as late as May and as early as September. The average freeze-free period of 170 days is ample for the maturing and harvesting of all crops commonly grown.

The average grazing period is from May 1 to October 30.

Precipitation.—The average annual precipitation is 27.96 inches. Approximately 80 percent of this falls from April through September. This is favorable for the production of all field crops and pasture grasses commonly grown.

Tables 10 and 11 show the 10 driest years and the 10 wettest years of record at Beatrice, Nebr.

Table 12 shows the wettest and driest months of record at Beatrice and the years in which they occurred. It also shows the maximum 24-hour precipitation ever recorded in each month and the year in which it occurred.

Deviations from the average are often extreme, as may be seen by comparing the driest year, 1955, which had 15.96 inches, and the wettest year, 1951, which had 48.40 inches. The wet and dry periods vary in length and in frequency of occurrence. Monthly precipitation also varies considerably from the average.

Tables 10 and 11 show an extreme variation from a low of 11.28 inches during the warm season of 1934 to a high of 40.93 inches in that of 1951. The average amount of precipitation for this season is 21.46 inches. Table 10 shows that four of the driest years were in the 1930's

[7] Prepared by W. R. STEVENS, U.S. Weather Bureau, State climatologist for Nebraska.

TABLE 10.—*Amount of precipitation during 10 driest years on record at Beatrice, Nebr.*

Months	Years									
	1894	1895	1910	1924	1934	1936	1937	1939	1955	1956
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
January	0.32	(1)	1.05	0.96	0.20	1.34	1.54	0.57	0.79	0.64
February	1.33	1.05	.20	.61	.64	.68	.16	1.06	1.43	.56
March	.90	.52	(1)	2.73	.36	.06	2.62	2.70	.47	.10
April	1.31	1.55	.05	2.62	.22	1.68	1.74	2.35	1.74	1.05
May	1.43	2.59	4.35	1.22	2.18	3.60	2.72	1.07	1.33	2.83
June	7.28	3.48	1.96	3.89	2.84	2.93	3.01	4.74	3.73	5.98
July	1.39	3.04	1.69	4.04	.02	.24	3.70	1.04	1.04	3.99
August	0	3.79	3.57	1.37	1.17	1.83	.85	4.32	.76	1.43
September	3.03	1.09	3.88	.89	4.85	4.17	2.84	.22	3.26	.77
October	2.49	0	.80	.15	1.56	.60	1.94	1.21	.79	1.56
November	0	1.25	.13	.57	3.39	.05	.07	0	.13	.84
December	.90	.10	.90	1.83	.54	.93	.14	1.01	.49	.08
Total	20.38	18.46	18.58	20.88	17.97	18.11	21.33	20.29	15.96	19.83
Amount for April-September	[2] 14.44	[3] 15.54	[4] 15.50	[5] 14.03	[6] 11.28	[7] 14.45	[8] 14.86	[9] 13.74	[10] 11.86	[11] 16.05

[1] Trace.
[2] 71 percent of total.
[3] 84 percent of total.
[4] 83 percent of total.
[5] 67 percent of total.
[6] 63 percent of total.
[7] 80 percent of total.
[8] 70 percent of total.
[9] 68 percent of total.
[10] 74 percent of total.
[11] 81 percent of total.

TABLE 11.—*Amount of precipitation during 10 wettest years on record at Beatrice, Nebr.*

Months	Years									
	1896	1902	1903	1908	1941	1944	1949	1951	1954	1958
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
January	0.40	1.10	0.10	0.30	1.58	1.02	3.03	0.47	0.03	1.22
February	.40	.14	1.16	2.07	.88	1.74	.73	1.82	2.02	2.37
March	1.30	.61	.97	.42	.75	2.23	1.60	2.78	.47	1.86
April	2.08	.87	3.50	2.53	2.42	5.00	1.84	3.96	2.02	1.73
May	10.30	5.68	12.11	8.33	1.06	2.47	6.24	5.86	5.63	4.26
June	5.27	10.17	2.84	13.25	11.49	8.86	7.04	11.42	6.00	2.44
July	7.52	7.35	1.79	3.77	1.04	2.71	5.32	8.05	1.42	10.88
August	8.43	3.97	6.25	4.04	2.32	7.31	5.72	7.63	15.44	3.07
September	2.01	5.13	5.17	.21	11.61	1.53	4.94	4.01	1.28	8.35
October	2.68	2.59	3.32	2.56	4.43	1.92	1.57	1.69	4.53	(1)
November	1.26	1.90	1.67	.57	1.32	2.65	.06	.29	.04	1.25
December	.48	.85	.05	.30	2.89	.70	.46	.42	.44	.05
Total	42.13	40.36	38.93	38.35	41.79	38.14	38.55	48.40	39.32	37.48
Amount for April–September	[2] 35.61	[3] 33.17	[4] 31.66	[2] 32.13	[5] 29.94	[6] 27.88	[4] 31.10	[7] 40.93	[4] 31.79	[3] 30.73

[1] Trace.
[2] 84 percent of total.
[3] 82 percent of total.
[4] 81 percent of total.
[5] 72 percent of total.
[6] 73 percent of total.
[7] 85 percent of total.

and two were in the 1950's. Table 11 shows that four of the wettest years of record occurred in the 11-year period, 1941–51.

In summer, the rainfall often takes the form of heavy thundershowers. Torrential rains are rare. Droughts are almost unknown in May and June, but short periods of dry weather sometimes occur in the latter part of July and in August. Crops properly tended are seldom affected by lack of moisture, except locally on some of the most clayey and severely eroded soils during unusually long droughts. Hail may damage crops over small areas in some years. The damage generally is local and does not reduce the total yield for the county to any great extent.

TABLE 12.—*Wettest and driest months, and maximum 24-hour precipitation for each month, as recorded at Beatrice, Nebr.*

Months	Driest		Wettest		24-hour maximum	
	Precipitation	Year	Precipitation	Year	Precipitation	Year
	In.		*In.*		*In.*	
January	(1)	[2] 1889	3. 03	1949	1. 13	1937
February	0	1904	2. 53	1911	1. 93	1954
March	(1)	1910	4. 20	1897	2. 60	1897
April	0. 05	1910	6. 54	1897	2. 85	1903
May	1. 06	1941	12. 11	1903	3. 32	1913
June	. 69	1933	13. 25	1908	5. 05	1941
July	. 02	1934	11. 56	1911	11. 05	1911
August	0	1894	15. 44	1954	3. 97	1895
September	. 21	1908	11. 61	1941	4. 81	1941
October	0	[3] 1952	6. 11	1891	5. 30	1891
November	0	[4] 1939	6. 80	1909	2. 55	1930
December	(1)	1929	4. 76	1913	1. 74	1941

[1] Trace.
[2] Also 1892, 1893, and 1895.
[3] Also 1895.
[4] Also 1894 and 1914.

The greatest and the least precipitation expected each month have been calculated from records kept since 1891. Once in 10 years the monthly precipitation is likely to be less than the amount given in the first column, and greater than the amount in the second column.

Month	*1 year in 10 equal to or less than*	*1 year in 10 equal to or more than*
January	0. 06	1. 54
February	. 19	2. 02
March	. 42	2. 79
April	. 87	4. 96
May	1. 73	6. 98
June	1. 86	8. 86
July	1. 04	7. 40
August	1. 10	6. 53
September	. 89	5. 17
October	. 34	3. 98
November	. 04	2. 97
December	. 08	1. 83
Annual	20. 29	38. 55

Snowfalls occur mainly in January, February, and March. The average annual snowfall is about 24 inches. Individual snowfalls range from a trace to a foot or more but generally amount to a few inches. Strong winds often accompany snowfall and cause considerable drifting along side roads and fence rows. Blizzards accompanied by cold temperatures do occur but are generally of short duration and not severe.

Wind and humidity.—From about October 1 to April 1, the prevailing wind is from the northwest. The rest of the year, it is from the south. Strong winds are common, especially in spring and early summer. Tornadoes are rare, but they do occur, and some are devastating.

The relative humidity is fairly regular. The average is about 70 percent. During most years, from 120 to 160 days are clear, and many of the rest are only partly cloudy.

Settlement, Organization, and Population

The first permanent settlement in Gage County was made in 1855, in the southeastern part of the county. The bottom lands along Plum Creek were settled first. Here, fuel and water were plentiful and easily obtained. Settlement of the uplands was rapid as the population increased.

The county was established by the Territorial Legislature in 1855. It was organized in 1857, with Beatrice as the county seat. The eight northern townships were added in 1864, from what was then part of Clay County.

Much of the land was settled under the Pre-emption Act of 1841, whereby a settler who would stake out 160 acres of land and make his home on it could purchase the land for $1.25 an acre. Some land was acquired with land warrants issued to war veterans. The first settlers were squatters who staked out claims and lived on the land until it was surveyed and title could be obtained from the government. The first homestead in the United States, entered under the Homestead Act of 1862 by Daniel Freeman on January 1, 1863, was near Beatrice. Under the Homestead Act, a settler could acquire title to 160 acres of land by living on it for 5 years and paying a nominal fee. In 1939, the Federal Government bought this original homestead from the Freeman heirs for a National Park.

Most of the early settlers came from Missouri, Iowa, Illinois, and other midwestern states. Subsequently, immigrants came direct from Europe, chiefly from Germany, Bohemia, Holland, and Wales. People of German descent live mainly in the northern part of the county; those of Bohemian descent, mostly in the southwestern and extreme northwestern parts and in the eastern part near the town of Virginia. Dutch dominate in the northeastern part around Adams. The Welsh are mostly south of Wymore.

Beatrice and Wymore are the principal towns. Beatrice is centrally located and has approximately 12,132 inhabitants. Wymore is in the south-central part of the county and has a population of about 1,975. Other small towns in the county are Adams, Cortland, Clatonia, Pickrell, Filley, Virginia, Liberty, Barneston, Odell, and Blue Springs. All are important local retail centers. Hoag, Rockford, Holmesville, Krider, and Lanham are small villages. Each has a grain elevator and a general store.

The 1960 census showed the population to be 26,818, half urban and half rural. The rural population averages about 16.2 persons a square mile. Except near Beatrice and other towns and villages, it is rather evenly distributed. The population of the county has increased steadily since settlement began. The greatest increase in recent years has been in and near Beatrice. Farm population has declined slightly in recent years.

Community Facilities

Nearly every town in the county has a public high school. There are two high schools in Beatrice. Many of the rural school districts have been consolidated. Churches of various faiths are well distributed over the county. Each town, except for the smallest ones, has a weekly or daily newspaper. Rural mail routes reach all sections of the county. A radio station at Beatrice serves all of the county and the adjoining territory. The Beatrice State Home is a state-owned institution for the feebleminded.

There are about 578 miles of rural electric lines in the county. Natural gas is available in nearly all of the towns.

The Big Blue River and many artificial lakes and ponds scattered throughout the county provide recreation, chiefly boating and fishing. No natural lakes or large hunting areas exist.

Industry

The economy of the county depends mainly on agriculture and on related marketing. Beatrice, Wymore, and other towns are important distribution centers for farm produce and supplies.

Beatrice is one of the leading wholesale-retail shopping centers in southeastern Nebraska. Numerous metal and woodworking plants and other small industrial plants are located in Beatrice. There are feed and flour mills, a poultry-processing plant, a concrete-mixing plant, and a brick and tile company. Two gas companies have booster-pump stations nearby. Other industries are scattered throughout the county.

Limestone rock quarries in the southern part of the county supply crushed stone that is used in concrete structures and for surfacing roads. The largest quarries are near Wymore and Barneston. Much of the rock from these quarries is rather soft and is suitable for agricultural lime. For local use in constructing roads and concrete structures, good-quality sand and gravel is obtained in places along the Big Blue River and from pockets of outwash in the uplands.

Water Supply

Good, but moderately hard, well water, in amounts sufficient for household and livestock needs, is available in most parts of the county at a depth of 20 to 100 feet. Throughout the uplands, well water is obtained from lenses and buried channels of sand and gravel. Where bedrock is near the surface, the supply of well water is limited but springs are more numerous.

In limited areas, the supply of water from the buried channels of sand and gravel is sufficient for irrigation. Most such areas are on the bottom lands of the Big Blue River and on tablelands west and north of Beatrice and near Wymore and Blue Springs.

The Big Blue River, the Big Nemaha River, and other perennial streams provide a limited amount of water for irrigating crops and for watering livestock. The smaller intermittent streams dry up late in summer when the need for water for livestock is greatest. Artificial lakes and ponds are used to store water for livestock, and a few are used to store irrigation water.

Transportation and Markets

Railroads and State and Federal highways cross the county in all directions and furnish good connections with outside markets. No part of the county is more than a few miles from a shipping point. Nearly all towns are on paved, oiled, or gravel-surfaced roads. Many of the minor roads on section lines are of earth construction but are well maintained. Air transportation is available at Beatrice.

Market facilities are excellent. In large part, the dairy products, poultry, and meat are marketed locally. Produce not marketed locally is shipped by truck or rail to outside markets, chiefly to Omaha and Lincoln, Nebr., and to St. Joseph, Mo.

Agriculture

The county has been chiefly agricultural ever since it was settled. At first, corn, potatoes, and other crops were grown for home use. Flax was grown as a cash crop.

As transportation facilities opened new markets, farmers increased their production of cash crops. Acreages of corn and winter wheat increased. Oats and alfalfa and other new types and varieties of grain and feed crops were grown. Farming became more diversified. Many farmers sold cattle and hogs for additional income. Tractors and other new machinery were added. The oats acreage declined as the tractor replaced the horse as a source of farm power.

Today, most farms are family sized. Mechanization enables one man to farm more land; thus, the size of the farm has increased to about 246 acres. Corn, wheat, oats, alfalfa, and grain sorghum are grown on the largest acreages. Much of the feed grain and hay is fed to cattle and hogs. The cash grain-livestock farmer grows grain and hay in the summer and fattens cattle and hogs in the winter. Some of the cash-grain farmers work off the farm during the winter.

Grain and feed crops, livestock, and poultry are the main sources of revenue on most farms.

Crops

Cultivated crops were grown on 334,411 acres in the county in 1959. The main crops are corn, wheat, oats, sorghum, alfalfa, clover, and bromegrass. Barley, rye, sudangrass, and soybeans are minor crops. The acreage of principal crops in stated years is shown in table 13.

TABLE 13.—*Acreage of principal crops in stated years*

Crop	1939	1949	1959
	Acres	*Acres*	*Acres*
Corn for all purposes	136, 621	147, 971	130, 158
Wheat harvested	118, 459	112, 219	76, 799
Oats harvested	41, 999	34, 756	24, 758
Sorghum for all purposes except sirup	19, 322	2, 805	54, 967
Alfalfa and alfalfa mixtures cut for hay	14, 393	34, 195	37, 279
Clover, timothy, and mixtures of clover and grasses cut for hay	1, 383	801	727
Wild hay cut	11, 394	9, 885	6, 589

Livestock

Livestock has always been a major source of income in Gage County. Table 14 shows the number of livestock in stated years. According to the census of agriculture, 125,854 acres in the county was used for pasture in 1959, and wild hay was cut from 6,589 acres.

TABLE 14.—*Number of livestock on farms in stated years*

Livestock	1940	1950	1959
	Number	*Number*	*Number*
Cattle and calves	[1] 33, 499	48, 554	59, 810
Hogs and pigs	[2] 26, 449	55, 884	67, 652
Horses and mules	[1] 11, 219	3, 656	604
Sheep and lambs	[3] 5, 975	3, 471	4, 801
Chickens	[2] 314, 424	[2] 329, 034	[2] 381, 375

[1] Over 3 months old. [2] Over 4 months old. [3] Over 6 months old.

Status of farms

In 1959 there were 539,124 acres in farms. There were 2,192 farms averaging 246 acres in size. Of these, 598 farms were cash grain; 31 were poultry; 165 were dairy; 641 were livestock farms other than poultry or dairy; 436 were general farms; and 321 were miscellaneous and unclassified.

Full owners operated 775 farms; part owners, 526; managers, 2; and tenants, 889. There were 70 cash tenants, 565 share-cash, 125 crop-share, 50 livestock-share, and 79 other and unspecified.

Cattle were raised on 1,890 farms; milk cows, on 1,288 farms; hogs, on 1,377; sheep, on 99; and chickens, on 1,581.

Corn was harvested on 1,801 farms; wheat, on 1,810; oats, on 1,184; and sorghum, on 1,370. Alfalfa was cut on 1,687 farms; clover, on 62; and wild hay, on 616.

In 1959 there were telephones on 1,941 farms; home freezers on 1,163; milking machines on 491; and power-operated elevators, conveyors, or blowers on 1,225 farms.

Literature Cited

(1) AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS.
1955. STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING. Ed. 7, 2 v., illus.

(2) DYKSTERHUIS, E. J.
1949. CONDITION AND MANAGEMENT OF RANGELAND BASED ON QUANTITATIVE ECOLOGY. Jour. Range Management 2: 104–115.

(3) ———
1958. RANGE CONSERVATION AS BASED ON SITES AND CONDITION CLASSES. Jour. Soil and Water Cons., 13: 151–155.

(4) KILMER, V. J.
1960. THE ESTIMATION OF FREE IRON OXIDES IN SOILS. Soil Sci. Soc. Amer. Proc. 24 (5): 420–421.

(5) KILMER, V. J., and ALEXANDER, L. T.
1949. METHODS OF MAKING MECHANICAL ANALYSES OF SOILS. Soil Sci. 68: 15–24.

(6) KILMER, V. J., and MULLINS, J. F.
1954. IMPROVED STIRRING AND PIPETTING APPARATUS FOR MECHANICAL ANALYSIS OF SOILS. Soil Sci. 77: 437–441.

(7) OLMSTEAD, L. B., ALEXANDER, L. T., and MIDDLETON, H. E.
1930. A PIPETTE METHOD OF MECHANICAL ANALYSIS OF SOILS BASED ON IMPROVED DISPERSION PROCEDURE. U.S. Dept. Agr. Tech. Bul. 170, 22 pp., illus.

(8) PEECH, MICHAEL, and ALEXANDER, L. T.
1947. METHODS OF SOIL ANALYSIS FOR SOIL-FERTILITY INVESTIGATIONS. U.S. Dept. Agr. Cir. 757, 25 pp.

(9) UNITED STATES DEPARTMENT OF AGRICULTURE.
1954. DIAGNOSIS AND IMPROVEMENT OF SALINE AND ALKALI SOILS. U.S. Dept. Agr. Handb. No. 60, 160 pp., illus.

(10) WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS.
1953. THE UNIFIED SOIL CLASSIFICATION SYSTEM. Tech. Memo. 3–357, v. 3.

Glossary

Aggregate (soil structure). Many fine particles held in a single mass or cluster, such as a clod, a crumb, a block, or a prism.

Alkaline soil. Any soil that is alkaline (above pH 7.3) in reaction. Soils made alkaline by calcium carbonate alone are called calcareous and rarely have pH values above 8.5.

Alluvial soils. An azonal group of soils that consist of transported and relatively recently deposited material and are characterized by a weak modification, or no modification, of the the original material by soil-forming processes.

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Brunizems. A zonal group of soils that have an acid, thick, very dark brown to black A horizon rich in organic matter; a brown B horizon that may or may not be mottled; and lighter colored parent material at a depth of 2 to 5 feet. These soils formed under tall grasses in a relatively humid, temperate climate.

Calcareous soil. A soil that contains enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Chernozems. A zonal group of soils that have a deep, dark-colored to nearly black A horizon rich in organic matter; a brown transitional B horizon that may contain more clay than the A horizon; and a light-colored C horizon with an accumulation of lime at a depth of 1½ to 4 feet. These soils formed under tall grasses or a mixture of tall and short grasses in a subhumid, temperate to cool-temperate climate.

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

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

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; will not hold together in a mass.

Friable. When moist, crushes easily under gentle to moderate 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.

Very firm. When moist, crushes under strong pressure; barely crushable between thumb and forefinger.

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; tends to stretch somewhat and pull apart, rather than 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 and brittle; little affected by moistening.

Flood plain. Nearly level land, consisting of stream sediment, that borders a stream and is subject to flooding unless protected artificially.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. The relative position of the several soil horizons in a typical soil profile and their nomenclature are as follows:

A0 Organic debris, partly decomposed or matted.
A1 A dark-colored horizon having a fairly high content of organic matter mixed with mineral matter.
A2 A light-colored horizon, often representing the zone of maximum leaching where podzolized; absent in wet, dark-colored soils.
A3 Transitional to B horizon but more like A than B; sometimes absent.
B1 Transitional to B horizon but more like B than A; sometimes absent.
B2 A usually darker colored horizon that often represents the zone of maximum illuviation where podzolized.
B3 Transitional to C horizon.
C Slightly weathered parent material; absent in some soils.
D Underlying substratum.

The A horizons make up a zone of eluviation, or leached zone. The B horizons make up a zone of illuviation, in which clay and other materials have accumulated. The A and B horizons, taken together, are called the solum, or true soil.

Humic Gley soils. An intrazonal group of poorly or very poorly drained soils that have a thick, black A horizon high in content of organic matter, over a gray or mottled B or C horizon. These soils formed under marsh plants or swamp forest in a subhumid and temperate to warm-temperate climate.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Lithosols. An azonal group of soils having no clearly expressed soil morphology and consisting of a freshly and imperfectly weathered mass of rock fragments. These soils occur mainly on steep slopes.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles.

Mature soil. Any soil that has well-developed soil horizons having characteristics produced by the natural processes of soil formation and in equilibrium with its present environment.

Morphology, soil. The makeup of the soil, including the texture, structure, consistence, color, and other physical, chemical, mineralogical, and biological properties of the various horizons that make up the soil profile.

Mottles. Contrasting color patches that vary in number and size. Descriptive terms are as follows:
Abundance. Few, common, and many.
Contrast. Faint, distinct, and prominent.
Size. Fine, medium, and coarse.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation 10YR 3/4 is a color with the hue of 10YR, a value of 3, and a chroma of 4.

Normal erosion. The erosion that takes place on the land surface in its natural environment, undisturbed by human activity. Synonym: Geologic erosion.

Normal soil. A soil having a profile in equilibrium with its environment; developed under good but not excessive drainage from parent material of mixed mineral, physical, and chemical composition. Its characteristics show the full effects of the forces of climate and living matter.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which the soil has formed; horizon C in the soil profile.

Permeability, soil. The quality that enables water or air to move through the soil. Terms used to describe permeability are—*very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Planosols. An intrazonal group of soils having an eluviated surface horizon underlain by a B horizon more strongly illuviated, cemented, or compacted than that of associated normal soils. These soils formed in nearly level upland areas under grass or forest vegetation in a humid or subhumid climate.

Reaction, soil. The degree of acidity or alkalinity of a soil expressed in pH values or in words, as follows:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Regosol. An azonal group of soils that lack definite genetic horizons and are developing from deep, unconsolidated or soft, rocky deposits.

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff, or seepage flow from ground water.

Sand. Individual rock or mineral fragments that range in diameter from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Solonetz soils. An intrazonal group of soils having a friable surface horizon of variable thickness that is underlain by dark-colored, hard soil material, ordinarily of columnar structure. These soils are ordinarily highly alkaline. They formed under grass or shrub vegetation, mainly in a subhumid or semiarid climate.

Solum. The upper part of the soil profile, above the parent material, in which the processes of soil formation are active. The solum in a mature soil includes the A and B horizons. Generally, the characteristics of the soil in these horizons are unlike those of the underlying parent material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stratified. Composed of, or arranged in, strata, or layers, such as stratified alluvium. The term is confined to geological material. Layers that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. 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 (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering without any regular cleavage, as in many claypans and hardpans).

Substratum. Any layer beneath the solum, or true soil; the C or D horizon.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace, geological. An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. Stream terraces are frequently called *second bottoms,* as contrasted to *flood plains,* and are seldom subject to overflow.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of fine particles, are as follows: Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by adding the words *coarse*, *fine*, or *very fine* to the name of the textural class. (See also, Clay, Sand, Silt.)

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Weathering. All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents. These changes result in more or less complete disintegration and decomposition of the rock.

GUIDE TO MAPPING UNITS

[See table 1, p. 5, for approximate acreage and proportionate extent of soils; table 2, p. 33, for estimated average acre yields; table 3, p. 39, for tree-planting sites and suitable species; and table 4, p. 42, table 5, p. 46, and table 6, facing p. 52, for engineering properties of soils]

Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page	Range site Name	Range site Page
AdB2	Adair clay loam, 3 to 5 percent slopes, eroded	5	IIIe-2	27	Clayey	35
AdC2	Adair clay loam, 5 to 8 percent slopes, eroded	5	IIIe-2	27	Clayey	35
AdD2	Adair clay loam, 8 to 12 percent slopes, eroded	6	IVe-2	29	Clayey	35
APC3	Adair and Pawnee soils, 5 to 8 percent slopes, severely eroded	6	IVe-2	29	Clayey	35
APD3	Adair and Pawnee soils, 8 to 12 percent slopes, severely eroded	6	VIe-2	31	Clayey	35
BLg	Rough broken land	18	VIIe-1	33	Thin Clayey	37
Bt	Butler silty clay loam	7	IIIw-2	29	Clayey	35
Cm	Cass loam	7	I-1	25	Overflow	36
CrA	Crete silty clay loam, 0 to 3 percent slopes	8	IIs-2	27	Clayey	35
CrB	Crete silty clay loam, 3 to 5 percent slopes	9	IIIe-2	27	Clayey	35
CrB2	Crete silty clay loam, 3 to 5 percent slopes, eroded	9	IIIe-2	27	Clayey	35
Ct	Colo silty clay loam	8	IIw-4	26	Subirrigated	36
E	Exline soils	9	VIs-1	32	(Unclassified)	----
Fm	Fillmore silt loam	10	IIIw-2	29	Overflow	36
GeB2	Geary silty clay loam, 3 to 5 percent slopes, eroded	10	IIe-1	25	Clayey	35
GeC2	Geary silty clay loam, 5 to 8 percent slopes, eroded	10	IIIe-1	27	Clayey	35
GeD3	Geary soils, 5 to 12 percent slopes, severely eroded	10	IVe-8	30	Clayey	35
Hb	Hobbs silt loam, seldom flooded	12	I-1	25	Overflow	36
2Hb	Hobbs silt loam, occasionally flooded	12	IIw-3	26	Overflow	36
Hv	Hedville stony loam	11	VIs-4	32	Shallow Nonlimy	36
JfB	Judson fine sandy loam, 3 to 5 percent slopes	12	IIe-3	26	Silty	36
JuA	Judson silt loam, 1 to 3 percent slopes	12	I-1	25	Silty	36
JuB	Judson silt loam, 3 to 5 percent slopes	12	IIe-1	25	Silty	36
LcC	Lancaster loam, 3 to 8 percent slopes	13	IIIe-1	27	Silty	36
LcD	Lancaster loam, 8 to 12 percent slopes	13	IVe-1	29	Silty	36
Lg	Lanham clay loam	14	VIe-2	31	Clayey	35
LwD	Labette silty clay loam, 5 to 12 percent slopes	13	IVe-1	29	Clayey	35
MC3	Morrill soils, 5 to 8 percent slopes, severely eroded	16	IVe-8	30	Silty	36
ME3	Morrill soils, 8 to 18 percent slopes, severely eroded	16	VIe-8	31	Silty	36
MrB2	Morrill loam, 3 to 5 percent slopes, eroded	14	IIe-1	25	Silty	36
MrC2	Morrill loam, 5 to 8 percent slopes, eroded	14	IIIe-1	27	Silty	36
MrD2	Morrill loam, 8 to 12 percent slopes, eroded	14	IIIe-1	27	Silty	36
MrE2	Morrill loam, 12 to 18 percent slopes, eroded	15	IVe-1	29	Silty	36
Mu	Muir silt loam	16	I-1	25	Silty	36
MxC	Morrill complex, 5 to 8 percent slopes	15	IIIe-3	28	Silty	36
MxD	Morrill complex, 8 to 12 percent slopes	15	IVe-3	30	Silty	36
MxE	Morrill complex, 12 to 18 percent slopes	15	VIe-3	31	Silty	36
MxC3	Morrill complex, 5 to 8 percent slopes, severely eroded	15	IVe-3	30	Silty	36
MxD3	Morrill complex, 8 to 18 percent slopes, severely eroded	16	VIe-3	31	Silty	36
PwB2	Pawnee clay loam, 3 to 5 percent slopes, eroded	17	IIIe-2	27	Clayey	35
PwC2	Pawnee clay loam, 5 to 8 percent slopes, eroded	17	IIIe-2	27	Clayey	35
PwD2	Pawnee clay loam, 8 to 12 percent slopes, eroded	18	IVe-2	29	Clayey	35
Rt	Rokeby silty clay loam	18	IIs-2	27	Clayey	35
Rv	Rough stony land	18	VIIs-3	33	Thin Breaks	36
SBB2	Shelby and Burchard clay loams, 3 to 5 percent slopes, eroded	19	IIe-1	25	Clayey	35
SBC2	Shelby and Burchard clay loams, 5 to 8 percent slopes, eroded	19	IIIe-1	27	Clayey	35
SBD2	Shelby and Burchard clay loams, 8 to 12 percent slopes, eroded	19	IIIe-1	27	Clayey	35
SBD3	Shelby and Burchard soils, 8 to 12 percent slopes, severely eroded	19	IVe-8	30	Clayey	35
SBE2	Shelby and Burchard clay loams, 12 to 18 percent slopes, eroded	19	IVe-1	29	Clayey	35
Sn	Sogn complex	20	VIs-4	32	Shallow Limy	36
StE	Steinauer clay loam, 12 to 25 percent slopes	20	VIe-9	31	Thin Clayey	37
StE3	Steinauer soils, 12 to 18 percent slopes, severely eroded	20	VIe-8	31	Thin Clayey	37
Sy	Alluvial land	6	VIw-1	32	Wet Land	37
Wa	Wabash silty clay	21	IIIw-1	28	Subirrigated	36
WtA	Wymore silty clay loam, 0 to 3 percent slopes	21	IIs-2	27	Clayey	35
WtB	Wymore silty clay loam, 3 to 5 percent slopes	21	IIIe-2	27	Clayey	35
WtB2	Wymore silty clay loam, 3 to 5 percent slopes, eroded	21	IIIe-2	27	Clayey	35
WtC2	Wymore silty clay loam, 5 to 8 percent slopes, eroded	21	IIIe-2	27	Clayey	35
WtC3	Wymore soils, 5 to 8 percent slopes, severely eroded	22	IVe-2	29	Clayey	35
WtD3	Wymore soils, 8 to 12 percent slopes, severely eroded	22	VIe-2	31	Clayey	35

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