Series 1958, No. 26 Issued May 1963

SOIL SURVEY

Adams County Iowa

OUR SOIL ★ OUR STRENGTH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
IOWA AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Adams County, Iowa, will serve several groups of readers. It will help farmers plan the kind of farming that will improve their soils and provide good yields. It will assist engineers in selecting sites for roads, buildings, ponds, and other structures. Teachers and students can use the report as a reference. Community planning boards will find information that will assist them in planning future development of the area. This report also adds to the soil scientist's fund of knowledge.

Locating and learning about the soils

In the back of the report is a set of aerial photographs that make up a map of Adams County. On these photographs the boundaries of each kind of soil are shown in red. Roads, railroads, streams, houses, cemeteries, and other landmarks make it easy to locate an area. The index to map sheets was drawn to help you find the sheet on the large photographic map that corresponds to the area you are examining.

Within each boundary on the soil map is a symbol. For example, SaC2 is the symbol for Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded. When you have located on the map the farm or other tract in which you are interested, and have noted the soil symbols in this tract, turn to the "Guide to Mapping Units" to find references to the descriptions of these soils and to discussions of management.

Information for different groups

Farmers will be most interested in the sections "Descriptions of Soils" and "Use and Management of Soils," for in these sections each soil in the county is described, management is suggested, and estimates of productivity are made.

Soil scientists and others who want to learn about the origin and composition of the soils in Adams County will be most interested in the sections "Genesis, Morphology, and Classification of Soils" and "Technical Descriptions of Soils."

Bankers who lend money on farms as security and people buying farms can use this report in estimating the value and productivity of a farm.

Engineers will find the section "Engineering Applications" useful in their work, particularly in preliminary planning.

Assessors can use the soil maps, yield tables, and soil descriptions in reappraising land.

Teachers, students, 4-H Clubs, and others can use this report to learn about soils from a general or a detailed standpoint.

* * * * *

Fieldwork for this survey was completed in 1958. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time. This soil survey was made as a part of the technical assistance furnished to the Adams County Soil Conservation District. Other information about the soils in the county, about soil management, and about farm planning can be obtained from the local representative of the Soil Conservation Service and from the County Extension Director.

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Series 1958, No. 26

Issued May, 1963

SOIL SURVEY OF ADAMS COUNTY, IOWA

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

ADAMS COUNTY is in the southwestern part of Iowa (fig. 1). Corning, the county seat and largest town, is about 70 miles southwest of Des Moines, the State capital. The county has an area of about 426 square miles. It is bounded on the north by Cass and Adair Counties, on the west by Montgomery County, on the south by Taylor County, and on the east by Union County.

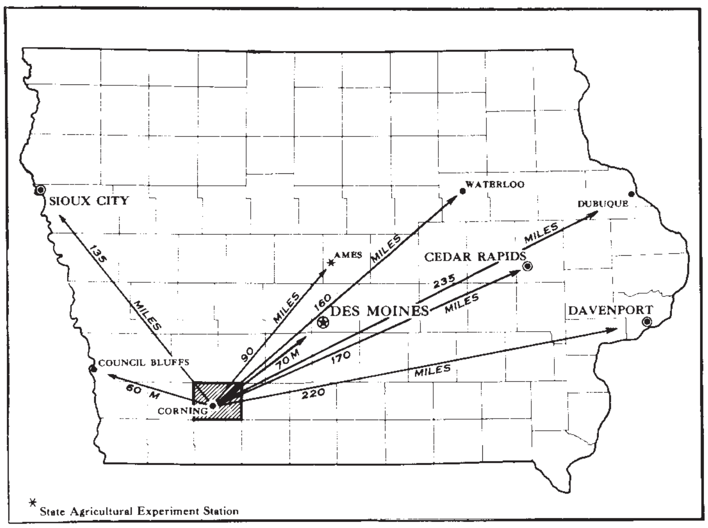

Figure 1.—**Location of Adams County in Iowa.**

Most of the land in the county is in farms, and most of the population is rural. Corn, soybeans, oats, hay, and pasture are the main crops. Corn is the principal grain crop. The hogs and beef cattle raised in the county consume most of the grain and forage grown on the farms. Most of the soils are dark colored and fertile. Many of the soils have developed under a prairie vegetation. The climate is subhumid and continental. Winters are cold, summers are warm, and the growing season is long enough for crops to mature.

How Soils Are Named, Mapped, and Classified

Soil scientists made this survey to learn what kinds of soils are in Adams 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; size and speed of streams; 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 rock material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. 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, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Adair and Shelby, 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 are alike except for 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. Wabash silty clay and Wabash silty clay loam are two soil types in the Wabash 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. In Adams County soil types are divided into phases primarily on the basis of differences in slopes or degrees of erosion because these differences affect management. For example, Sharps-

[1] The soil survey was made and the report prepared under general direction of W. J. B. Boatman, State Soil Scientist, Soil Conservation Service, and F. F. Riecken, Professor of Soils, Iowa Agricultural Experiment Station. The soil survey was made by Raymond I. Dideriksen, Lewis A. Clark, Charles S. Fisher, Elmer H. Harvey, Elton L. King, John R. Nixon, Robert L. Warren, and John R. Worster, Soil Conservation Service; and J. A. Phillips, Iowa Agricultural Experiment Station. D. F. Slusher and S. M. Smith, Soil Conservation Service, helped prepare the report.

burg silty clay loam, 0 to 2 percent slopes, is one of several phases of Sharpsburg silty clay loam, a soil type that ranges from nearly level to moderately steep.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used photos for their base map because they show woodlands, buildings, field borders, trees, and similar detail that greatly help in drawing boundaries accurately. The 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 phase of a soil type. 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 are so intricately mixed, and so small in size, 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, the Colo-Gravity complex in Adams County consists mainly of Colo silty clay loam and Gravity silty clay loam. There are also areas mapped that are practically destroyed by erosion or receive sediments so frequently from flooding 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 Gullied land or Alluvial land, and are called land types rather than soils.

In this report, spot symbols are used on the soil map to designate small areas of wet, sandy, clayey, and severely eroded or gullied 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. The mass of detailed information he had recorded then needed to be presented in different ways for farmers, engineers, and others.

To do this efficiently, the soil scientist had to consult with persons in other fields of work and jointly prepare with them groupings that would be of practical value to different users. Such groupings are the management groups designed primarily for those who want to plan cropping systems; and the classifications used by engineers who build highways or structures to conserve soil and water.

General Soil Map

After study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several patterns of soils, called soil associations. Such a map is the general soil map in figure 2. Each soil 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 greatly among themselves in some properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general soil map does not show the kind of soil at any particular place; it shows patterns, each of which contains several kinds of different soils.

The soil associations are named for the major soil series in them, but as already noted, soils of other series may be present. The major soil series of one soil association may also be present in other associations, but in a different pattern.

The general soil 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.

Adams County is nearly level in some places and is strongly sloping in others. Some areas are upland, and others, along the streams, are bottom land. On the basis of the soils and related features in the landscape, the four soil associations shown in figure 2 have been recognized.

Each soil association in the county is distinctly different from the others. The combinations of the different soils indicate in a general way some of the main problems of soil management, such as erosion, wetness, fertility requirements, and crop suitability. The size of farms, the cropping system, and the amount and kinds of livestock raised are also related to the soils in the associations and vary from one association to another.

Each soil association in the county is discussed in the following pages. The relationship of important soils in the associations to slope, parent material, and native vegetation is shown by three-dimensional drawings (figs. 3 and 4). Important characteristics of soil layers are shown by sketches below the three-dimensional drawings.

1. Macksburg-Winterset association: Nearly level to gently sloping soils

The soils in this association are on broad, nearly level uplands that have gentle side slopes. (See fig. 3, top.) A representative area is located near Stringtown.

The soils in nearly all of this association have formed from loess. Most of them have a thick, dark surface layer that contain much organic matter. Their available moisture-holding capacity is high. Drainage ranges from good to poor, but it can be improved in the poorly drained soils by installing tile lines.

The Macksburg and Winterset soils are the major soils in this soil association, but there is also a fairly large acreage of Sharpsburg soils. The Sperry and Clearfield soils occur in a small total acreage.

The Winterset soils are poorly drained and have a thick, dark surface layer. They are nearly level and, for highest yields, need tile drainage. The Sharpsburg soils are gently sloping and are well drained to moderately well drained. They are not so dark as the Winterset soils and do not have so thick a surface layer. The Macksburg soils are nearly level to gently sloping. They generally lie between areas of Winterset and of Sharpsburg soils and are intermediate in drainage be-

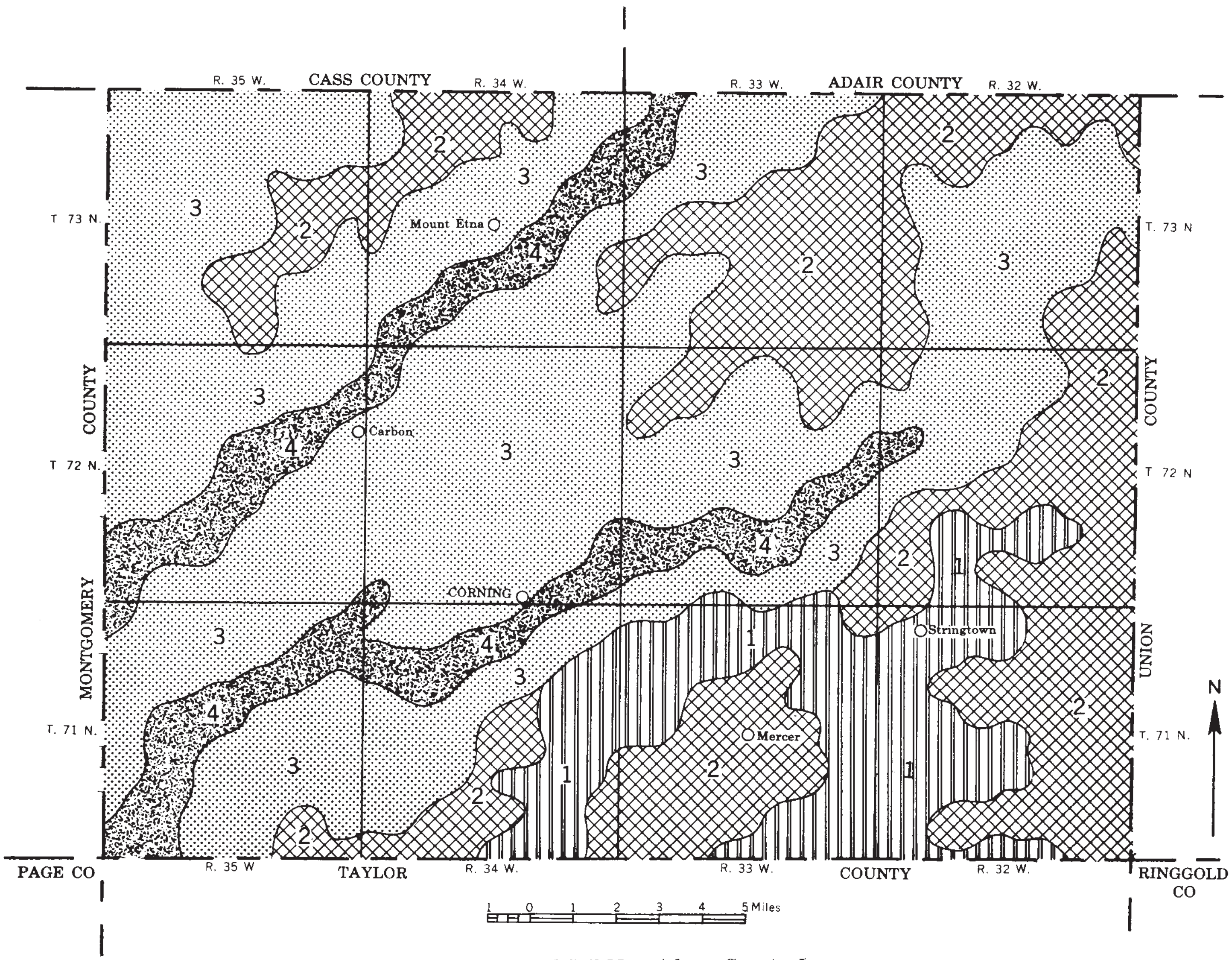

Figure 2.—General Soil Map, Adams County, Iowa.

1. **Macksburg-Winterset association: Nearly level to gently sloping soils.**
2. **Sharpsburg-Adair association: Nearly level to moderately steep soils.**
3. **Shelby-Sharpsburg association: Moderately sloping to steep soils.**
4. **Colo-Wabash-Nodaway association: Nearly level soils.**

tween those soils. The Macksburg soils have a few wet spots, but they need tile drainage in only a few places.

The soils in association 1 are well suited to cultivated crops and are used intensively for row crops (fig. 5). That part of the area used for row crops is greater than the part used in other associations. Corn and soybeans are the main crops, and they yield well. Farmers in this area generally grow grain as a cash crop or follow a diversified system of farming, but much of the grain is fed to livestock. The value of land in this association is high.

The soils in this association are fertile, but nitrogen and phosphate fertilizers are needed if row crops are grown intensively. Most of the soils are slightly acid and require moderate additions of lime.

2. Sharpsburg-Adair association: Nearly level to moderately steep soils

The soils in this association are mainly on nearly level to gently sloping ridgetops and strong to moderately steep side slopes that have many drainageways. (See fig. 3, bottom.) A representative area is near the Williamson store in Colony Township.

The soils of more than half of this association formed from loess on the ridgetops and upper slopes. Glacial till is the parent material on most lower slopes. Except in eroded areas, the surface layer is dark and contains a large amount of organic matter. The soils on the ridgetops and the upper slopes are well drained to moderately well drained, but there is frequently a narrow band of wet, seepy soils near the contact zone of the

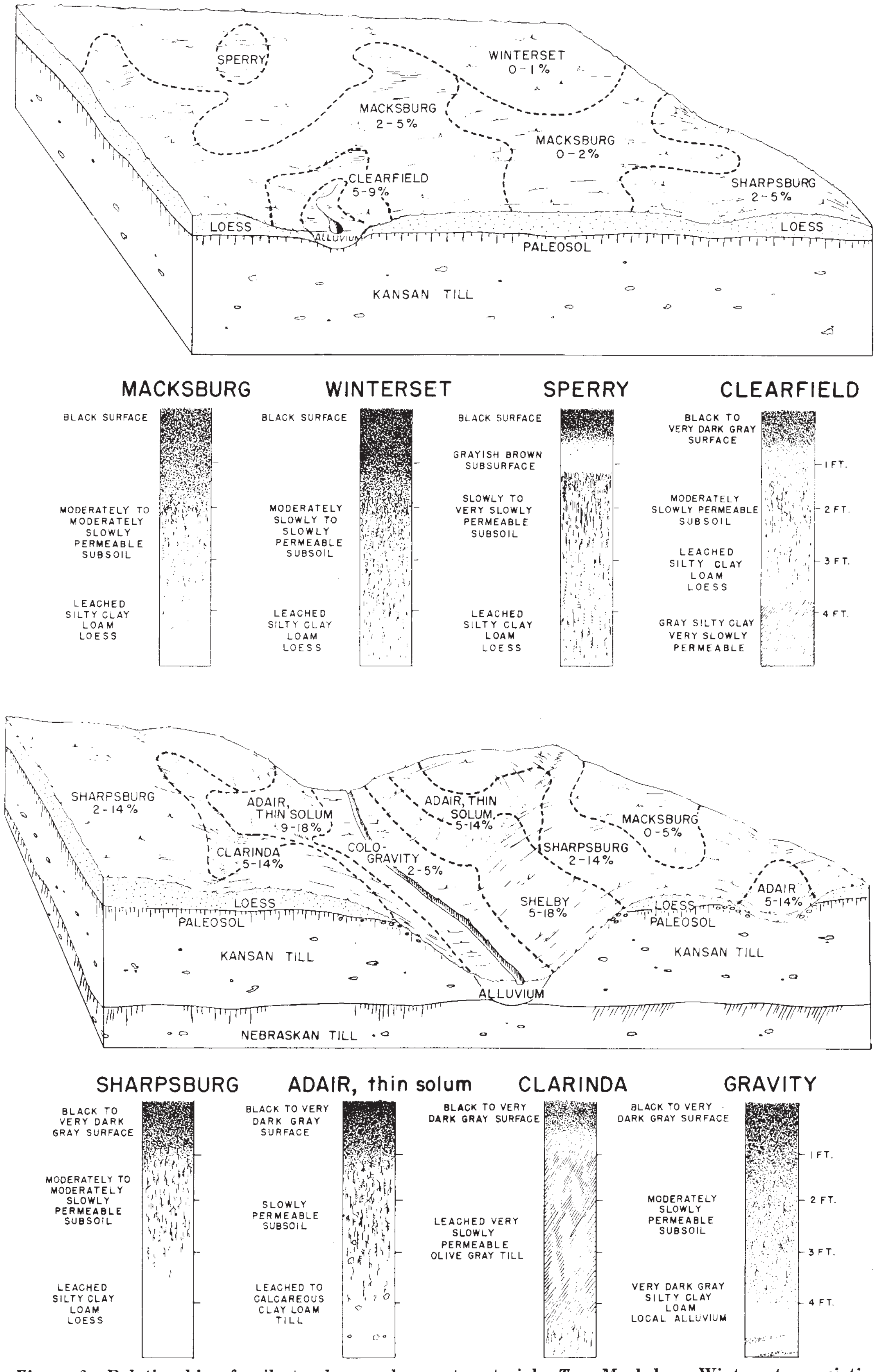

Figure 3.—**Relationship of soils to slope and parent material.** ***Top,*** **Macksburg-Winterset association;** ***bottom,*** **Sharpsburg-Adair association. The native vegetation in these two associations was grasses.**

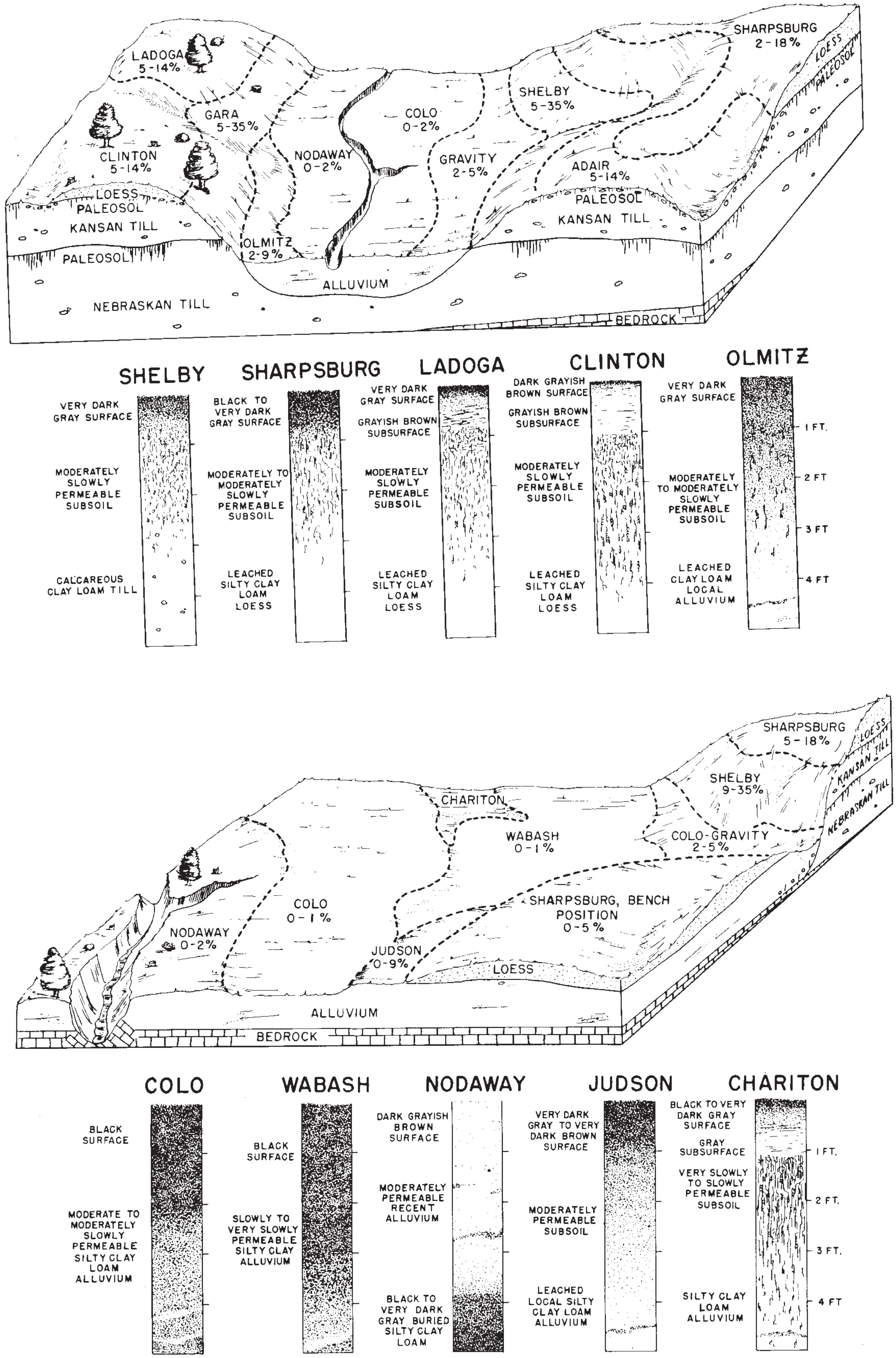

Figure 4.—Relationhip of soils to slope, parent material, and vegetation. *Top,* Shelby-Sharpsburg association; the native vegetation of this association was grasses. *Bottom,* Colo-Wabash-Nodaway association; the native vegetation was trees, where indicated by trees or stumps, and was grasses in other places.

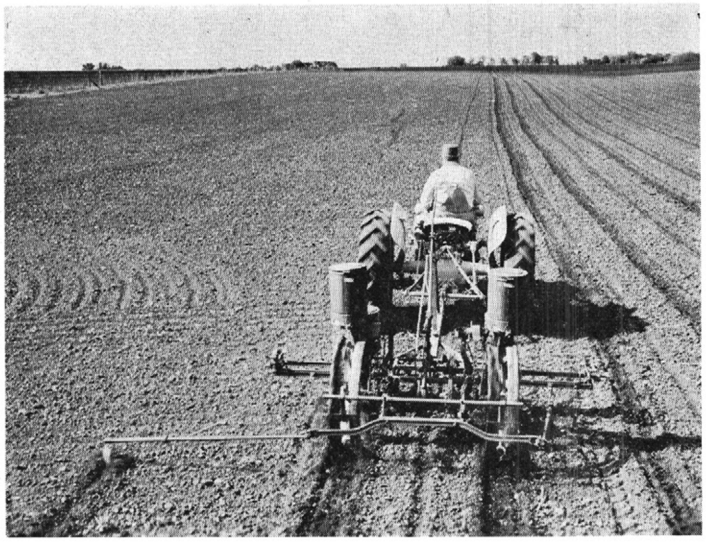

Figure 5.—**Typical field in soil association 1. The soil is Macksburg silty clay loam, 0 to 2 percent slopes, which generally yields about 80 bushels of corn per acre.**

loess and the till. Erosion ranges from slight to severe on the sloping soils, and contour tillage and terracing are required if soil losses are to be reduced.

Sharpsburg and Adair soils are the major soils in this association, but there is also a fairly large acreage of Clarinda soils. The Sharpsburg soils are dark colored, except where eroded, and are well drained to moderately well drained. They formed from loess on upper slopes and ridgetops. Most Sharpsburg soils produce good yields. The Adair and Clarinda soils developed from glacial till and occur downslope from the Sharpsburg soils. The Clarinda soils have a fine-textured subsoil, are poorly drained, and tend to be wet and seepy. They are poorly suited to cultivated crops and produce low yields. The subsoil of the Adair soils is also fine textured, but it is not so fine as that of the Clarinda soils. Adair soils are imperfectly drained to moderately well drained and slightly wet and seepy in some years. The Adair soils produce moderate to low yields.

Most of the soils in this association are suited to cultivated crops, but some strongly sloping or severely eroded soils are better suited to pasture. Crop rotations are followed in most places. Corn is the principal row crop, but the proportion of this association in corn is smaller than that of associations 1 and 4. Yields are generally moderate to high but are lower than those in the Macksburg-Winterset association.

Most of the farming is diversified, and grain and livestock are the main products. Much of the grain is fed to livestock. In this soil association larger farms are required to make economic units than in the Macksburg-Winterset association. The value of farmland is moderately high to high.

Fertility is high in the soils derived from loess and is moderate to low in those derived from till. Additions of nitrogen and phosphate are beneficial for most crops. The soils are slightly acid to moderately acid and need more lime than do the soils in the Macksburg-Winterset association.

3. Shelby-Sharpsburg association: Moderately sloping to steep soils

Narrow rounded ridgetops, long steep side slopes, and narrow valleys are the principal topographic features of the soils in this association (fig. 6). (See fig. 4, top.) A representative area is near Corning in Quincy Township.

The soils of most of this association formed from glacial till, but on ridgetops and upper slopes the soils formed in loess. The surface layer varies in color and thickness and is commonly medium to low in organic matter. The available moisture-holding capacity is adequate to supply the needs of plants. Drainage is good in most places, but there are a few seepy spots on side slopes, and the bottom land is wet in some places. Erosion ranges from slight to severe, and contour tillage and terracing are needed to reduce soil losses.

Shelby and Sharpsburg soils are the major soils in this association. The Sharpsburg soils have formed from loess on upper slopes and ridgetops. Shelby soils formed from glacial till on the lower slopes. The Shelby soils are dark colored in uneroded areas. They are well drained to moderately well drained. Their subsoil is not so fine textured as that of the Adair soils, which are also in this soil association. In a few places near the Middle Nodaway and the East Nodaway Rivers, Gara soils instead of Shelby soils are on the slopes and Ladoga soils instead of Sharpsburg soils are on the ridgetops. The Gara and the Ladoga soils formed under the influence of trees, but the Sharpsburg and the Shelby soils formed under prairie grasses.

The soils in this association are not so well suited to crops as are the soils in the other three associations. Most of this area is used for meadow and permanent pasture, but row crops are grown in rotations on the ridgetops, on upper slopes, and in narrow valleys. The soils derived from loess on ridgetops are generally more productive than those derived from till.

Raising livestock for beef is the main agricultural activity in this association, but the area is also suitable for dairy farming. Most farmers have to buy additional grain to fatten their livestock for market. Larger farms are required to make economic units than are required in the other soil associations. The value of land is low to moderately high.

Figure 6.—**Typical landscape in soil association 3. Shelby soils are dominant.**

Fertilizer should be added to the soils used for crops; it will also increase the yields of pasture. Many of the soils are acid and need additions of lime.

4. Colo-Wabash-Nodaway association: Nearly level soils

Nearly level bottom land is the main topographic feature of this soil association. (See fig. 4, bottom.) A representative area is near Carbon in Douglas Township.

The soils of nearly all of this association formed from alluvium, but on a few high benches the parent material is loess. The soils range from well drained to very poorly drained. Nearly all of the soils are dark colored. Their available moisture-holding capacity is generally good. Flooding is the main hazard in some places, and many areas require tile or surface drainage.

The Colo, Wabash, and Nodaway soils are the major soils in this soil association. The Colo soils are poorly drained, but areas that have outlets can be drained by tile lines. The Wabash soils have a fine-textured subsoil and are poorly drained to very poorly drained, but tile drains do not work very well. In spring, cultivation is generally delayed on Wabash soils because of wetness. The Nodaway soils are moderately well drained to imperfectly drained. They are generally nearer the stream channel than are the Colo and Wabash soils and have better drainage.

Most of the soils in this association are well suited to cultivated crops and are used intensively for corn or soybeans. A few areas that are frequently flooded or are in old stream channels are best suited to permanent pasture. Yields of corn, the principal crop, range from moderate to high. Some grain is sold because all that is grown cannot be used on the farms. Land values are high, and the farms need not be so large as those in the Shelby-Sharpsburg association to make economic units.

These soils are fairly fertile, but they generally need additions of nitrogen and phosphate, especially if they are cropped intensively. The response to fertilizer is generally good. Some soils need additions of lime.

Descriptions of Soils

This section describes each soil in Adams County. For each soil series, there is a general description of the characteristics common to the soils in the series and then a description of each soil in the series. The first individual soil described is representative of the series, and the soils that follow are described by comparing them to the representative soil. This section also includes a brief discussion of the use and management of each soil. Table 1 shows the acreage and proportionate extent of the soils mapped. In table 2, pp. 36 to 41, the major characteristics of each mapping unit are listed. A more detailed description of each soil series is in the section "Technical Descriptions of Soils."

Some readers may not be familiar with terms used in describing soil characteristics, or may not understand the importance of characteristics to the growth of plants. Some of the terms commonly used in soil science are discussed in the following paragraphs. Other terms are defined in the Glossary.

The *color* of the top layer of soil generally indicates the amount of organic matter in the soil. Organic matter is the undecomposed or partly decomposed plant stems, roots, or leaves, and the animal remains in the soil. Dark soils generally contain much organic matter and nitrogen. The color of the subsoil commonly indicates the degree of drainage. A gray and olive, or mottled gray and yellow, subsoil generally is poorly drained. Uniform brown to yellowish-brown colors indicate good drainage. If a soil is poorly drained, generally it is also poorly aerated.

Texture is the coarseness or fineness of the soil and depends on the proportions of sand, silt, and clay. The largest soil particles are sand. Sand grains can be easily seen; they feel gritty beween the fingers. Silt particles are smaller than sand and feel smooth and floury. Clay particles are smallest of all, and their size and shape can be seen only with an electron microscope. Soils that are high in clay feel dense and sticky. The soil scientist judges texture by the feel of the moist soil when it is rubbed between his thumb and forefinger. The texture of many soil samples is checked in the laboratory by mechanical analyses.

Some of the terms for texture are silt loam, loam, clay loam, sandy loam, loamy sand, and clay. Loam contains about 20 percent of the clay-sized particles, 40 percent silt, and about 40 percent sand. Silt loam contains much less sand and more silt. It is about 15 percent clay, 20 percent sand, and at least 50 percent silt. Clay loam contains about equal proportions of sand, silt, and clay. Sandy loam, loamy sand, and sand, in that order, have increasing percentages of sand. Clay (the textural class) contains more than 40 percent clay-size particles.

Texture affects the amount of moisture the soil will hold available to plants, the permeability of the soil, and the ease with which the soil can be cultivated. The silt loams and loams are the most desirable soils for crops. Clay-textured soils restrict the movement of air and water and are difficult to work. Sandy soils hold only a small amount of water available for plants and therefore may be droughty.

Consistence, or the tendency of the soil to crumble or to stick together, indicates whether the soil is easy or difficult to keep open and porous under cultivation. Some of the terms used to describe consistence are loose, very friable, friable, firm, very firm, and extremely firm. These terms are defined in the "Soil Survey Manual" (*23*).[2] Friable and slightly firm consistence are the most desirable. The firmer the soil, the more difficult it is to work. Sandy soils are generally loose.

Native vegetation affects the kinds of soil that develop. If other conditions have been the same, soils that formed under grass are generally darker in color than those that formed under trees. Soils that formed under trees are more acid and have a thinner, darker colored surface layer than those formed in grassland. Some soils have formed under mixed grass-and-tree vegetation and have properties intermediate between soils formed in grassland and those formed in woodland.

[2] Italic numbers in parentheses refer to Literature Cited, p. 95.

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

Soil	Acres	Percent
Adair clay loam, 5 to 9 percent slopes	496	0.2
Adair clay loam, 9 to 14 percent slopes, moderately eroded	931	.3
Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded	5,621	2.1
Adair clay loam, thin solum, 9 to 14 percent slopes	952	.3
Adair clay loam, thin solum, 9 to 14 percent slopes, moderately eroded	15,634	5.7
Adair clay loam, thin solum, 14 to 18 percent slopes, moderately eroded	400	.1
Adair soils, 9 to 14 percent slopes, severely eroded	98	(1)
Adair soils, thin solums, 5 to 9 percent slopes, severely eroded	162	.1
Adair soils, thin solums, 9 to 14 percent slopes, severely eroded	1,108	.4
Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded	240	.1
Adair-Shelby complex, 9 to 14 percent slopes	1,054	.4
Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded	10,341	3.8
Adair-Shelby complex, 9 to 14 percent slopes, severely eroded	864	.3
Adair-Shelby complex, 14 to 18 percent slopes, moderately eroded	4,106	1.5
Adair-Shelby complex, 14 to 18 percent slopes, severely eroded	326	.1
Alluvial land	1,776	.7
Arbor loam, 9 to 14 percent slopes	202	.1
Bremer silty clay loam	637	.2
Chariton silt loam	237	.1
Clarinda silty clay loam, 5 to 9 percent slopes	2,598	1.0
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	2,545	.9
Clarinda silty clay loam, 9 to 14 percent slopes	163	.1
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	1,078	.4
Clarinda soils, 5 to 9 percent slopes, severely eroded	51	(1)
Clarinda soils, 9 to 14 percent slopes, severely eroded	157	.1
Clearfield silty clay loam, 5 to 9 percent slopes	5,291	1.9
Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded	838	.3
Clinton silt loam, 5 to 9 percent slopes, moderately eroded	193	.1
Clinton silt loam, 9 to 14 percent slopes, moderately eroded	187	.1
Colo silty clay loam	9,483	3.5
Colo silty clay loam, channeled	1,723	.6
Colo silty clay loam, overwashed	2,232	.8
Colo-Gravity complex, 2 to 5 percent slopes	36,152	13.3
Gara loam, 5 to 9 percent slopes, moderately eroded	168	.1
Gara loam, 9 to 14 percent slopes	506	.2
Gara loam, 9 to 14 percent slopes, moderately eroded	2,436	.9
Gara loam, 14 to 18 percent slopes	1,479	.5
Gara loam, 14 to 18 percent slopes, moderately eroded	3,998	1.5
Gara loam, 18 to 25 percent slopes	2,348	.9
Gara loam, 25 to 35 percent slopes	136	(1)
Gara soils, 14 to 18 percent slopes, severely eroded	173	.1
Gosport soils, 5 to 14 percent slopes	10	(1)
Gosport soils, 14 to 25 percent slopes	27	(1)
Gosport soils, 25 to 40 percent slopes	21	(1)
Gravity silty clay loam, 2 to 5 percent slopes	4,391	1.6
Gullied land	1,979	.7
Hagener loamy fine sand, 5 to 9 percent slopes, moderately eroded	92	(1)
Hagener loamy fine sand, 9 to 14 percent slopes, moderately eroded	85	(1)
Judson silt loam, 0 to 2 percent slopes	533	0.2
Judson silt loam, 2 to 5 percent slopes	2,687	1.0
Judson silt loam, 5 to 9 percent slopes	68	(1)
Kennebec silt loam	116	(1)
Ladoga silt loam, 2 to 5 percent slopes	689	.3
Ladoga silt loam, 2 to 5 percent slopes, moderately eroded	39	(1)
Ladoga silt loam, 5 to 9 percent slopes	1,167	.4
Ladoga silt loam, 5 to 9 percent slopes, moderately eroded	6,543	2.4
Ladoga silt loam, 9 to 14 percent slopes	481	.2
Ladoga silt loam, 9 to 14 percent slopes, moderately eroded	3,370	1.2
Ladoga silt loam, benches, 0 to 2 percent slopes	50	(1)
Ladoga silt loam, benches, 2 to 5 percent slopes	489	.2
Ladoga soils, 5 to 9 percent slopes, severely eroded	74	(1)
Macksburg silty clay loam, 0 to 2 percent slopes	5,748	2.1
Macksburg silty clay loam, 2 to 5 percent slopes	1,875	.7
Nevin silt loam	1,055	.4
Nodaway silt loam	3,588	1.3
Nodaway silt loam, channeled	145	.1
Olmitz loam, 2 to 5 percent slopes	425	.2
Olmitz loam, 5 to 9 percent slopes	417	.2
Sharpsburg silty clay loam, 0 to 2 percent slopes	374	.1
Sharpsburg silty clay loam, 2 to 5 percent slopes	23,513	8.6
Sharpsburg silty clay loam, 2 to 5 percent slopes, moderately eroded	1,062	.4
Sharpsburg silty clay loam, 5 to 9 percent slopes	7,274	2.7
Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded	39,739	14.6
Sharpsburg silty clay loam, 9 to 14 percent slopes	562	.2
Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded	9,119	3.3
Sharpsburg silty clay loam, 14 to 18 percent slopes	73	(1)
Sharpsburg silty clay loam, benches, 0 to 2 percent slopes	467	.2
Sharpsburg silty clay loam, benches, 2 to 5 percent slopes	1,337	.5
Shelby loam, 5 to 9 percent slopes, moderately eroded	229	.1
Shelby loam, 9 to 14 percent slopes	1,184	.4
Shelby loam, 9 to 14 percent slopes, moderately eroded	10,925	4.0
Shelby loam, 14 to 18 percent slopes	1,531	.6
Shelby loam, 14 to 18 percent slopes, moderately eroded	9,491	3.5
Shelby loam, 18 to 25 percent slopes	967	.4
Shelby loam, 25 to 35 percent slopes	33	(1)
Shelby soils, 9 to 14 percent slopes, severely eroded	842	.3
Shelby soils, 14 to 18 percent slopes, severely eroded	669	.2
Sperry silt loam	33	(1)
Sperry silt loam, benches	36	(1)
Wabash silty clay	675	.2
Wabash silty clay loam	4,867	1.8
Wabash silty clay loam, channeled	14	(1)
Winterset silty clay loam	925	.3
Wiota silt loam, 0 to 2 percent slopes	156	.1
Wiota silt loam, 2 to 5 percent slopes	347	.1
Gravel Pit	20	(1)
Water	892	.3
Total	272,640	100.0

1 Less than 0.1 percent.

Permeability, or the ability of a soil to transmit air and water, can be measured in terms of rate of flow of water. The classes of permeability are very rapid, rapid, moderate, slow, and very slow. Moderate permeability is the most desirable because it permits free movement of air and water through the soil, unless the soil has a high water table.

Soil drainage is described as excessively drained, well drained, moderately well drained, imperfectly drained, poorly drained, very poorly drained, or ponded. The terms refer to the natural drainage class before the soil has been altered by tile drains or ditches. The drainage class of a soil does not change even after the soil is drained and its moisture content is improved. The drainage classes are defined in the "Soil Survey Manual" (*23*). Natural soil drainage is determined by observing the soil colors, by evaluating the permeability, and by observing crop growth.

Adair series

The Adair series consists of imperfectly drained to moderately well drained soils that formed from glacial material on uplands. These soils are generally downslope from the loess-derived Sharpsburg soils and upslope from the till-derived Shelby soils. The slopes range from 5 to 18 percent but are generally 9 to 14 percent. These soils occur throughout the county. Areas of Adair soils less than 1 acre in size that are within areas of other soils are shown on the soil map by the symbol for clay spots.

Adair soils have developed in very thick, fine-textured horizons of soils that formed in an earlier geologic period. These soils were later buried by loess. The Adair soils formed after the buried soils were exposed by geologic erosion. The buried soils were once at the surface of the Kansan drift plain and are believed to have been formed under forest. Since exposure, the vegetation has been of the prairie type. These buried or once buried soils are called paleosols.

Adair clay loam, 5 to 9 percent slopes (AaC).—This soil is on moderate slopes near the ends of extended ridgetops and is generally slightly lower than the surrounding ridges. Because of its position, this soil has a small total acreage and each area generally occupies less than 5 acres.

Representative profile:

0 to 12 inches, black to very dark gray clay loam to gritty silty clay loam; friable.

12 to 48 inches, dark reddish-brown to dark-brown, gritty silty clay or clay with mottles of dark red, olive gray, and strong brown; very firm.

48 to 60 inches, dark yellowish-brown clay loam with coarse mottles of olive gray to gray and dark brown; firm.

The texture of the surface layer ranges from clay loam to gritty silty clay loam. The surface layer is generally 10 to 12 inches thick but is less than 10 inches thick in some places. It overlies a reddish-brown subsoil in most places, but in some places the subsoil is dark brown mottled with reddish colors. Because the subsoil is very firm, clayey, and takes in water slowly, runoff and the hazard of erosion are much greater on this soil than on the Sharpsburg or the Ladoga soils with comparable slopes.

Adair clay loam, 5 to 9 percent slopes, is imperfectly drained. It receives varying amounts of seepage water, but in many places artificial drainage is not needed or is not practical. Because of the very slow permeability, tile drains do not work well in this soil. However, surface wetness can be reduced by a tile interceptor drain installed above this soil in the more permeable Sharpsburg, Ladoga, or Clinton soils upslope. This soil warms up slowly in spring and, because of wetness, must be worked later than most adjoining soils.

This soil is better suited to hay or pasture than it is to row crops. Because it is commonly associated with steeper Shelby soils in pasture, much of this soil is in permanent pasture. Cultivated areas are generally farmed with adjacent more permeable soils. Because yields are low, row crops generally are not planted. If row crops are planted, terrace the soil and till it on the contour. Use rotations that maintain tilth and reduce the loss of soil.

The organic-matter content of this soil is medium to high. Most areas are low in available nitrogen, very low in available phosphorus, and usually are medium in available potassium. This soil is medium acid in most places. Management group 11 (IIIw).

Adair clay loam, 9 to 14 percent slopes, moderately eroded (AaD2).—This soil has a browner and generally thinner surface layer than has Adair clay loam, 5 to 9 percent slopes. The surface layer is 3 to 7 inches thick in most places, but in some places it is as much as 12 inches thick. It is often cloddy and hard when dry.

This soil is in narrow bands on the shoulders of rounded side slopes and in cove positions in areas smaller than 10 acres. At the crest of the rounded slopes, the reddish-brown to dark-brown subsoil is exposed in many places. Plowing, especially on the higher parts of the slopes, generally mixes the subsoil with the surface soil, and additional losses of surface soil soon make this soil unsuitable for cultivation.

In some places this soil receives seepage water from higher lying, loess-derived soils. An interceptor drain will divert this water and allow earlier and easier cultivation. Terracing and contour tillage are needed if this soil is planted to row crops. Row crops should probably not be grown more often than 1 year in 5.

Normally this soil is used for cultivated crops because it occurs with better soils. Yields, however, are low. This soil is better suited to hay and pasture than to row crops.

This soil contains a medium amount of organic matter and is medium acid. It is generally very low in available nitrogen and phosphorus and is medium in available potassium. Pasture seedings respond to fertilizer moderately well. Management group 16 (IVe).

Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded (AcC2).—This soil has a thinner solum than Adair clay loam, 5 to 9 percent slopes. The subsoil is dark brown to dark yellowish brown in most places, but where this soil is associated with Clarinda soils, the subsoil is dark gray to dark yellowish brown. Inclusions of Adair soils, thin solums, 5 to 9 percent slopes, severely eroded, less than 1 acre in size are shown on the soil map by the symbol for severely eroded spots.

This soil is generally on slightly rounded, short side slopes downslope from Clarinda or Sharpsburg soils. It is closely associated with Adair clay loam, 5 to 9 percent slopes, and in some places is in the same kind of position.

This is one of the most extensive soils in the county that formed from till on moderate slopes. In Mercer and Grant townships, it is the dominant till-derived soil on the side slopes.

Representative profile:

0 to 10 inches, very dark gray to dark grayish-brown clay loam to gritty silty clay loam; friable to slightly firm.
10 to 36 inches, dark-brown to dark yellowish-brown, gritty silty clay or clay loam, mottled dark gray, reddish brown, and yellowish brown; very firm to firm.
36 to 48 inches, dark yellowish-brown clay loam; coarse mottles of olive gray, dark brown, and strong brown; firm.

The surface layer is black in virgin areas and is black to very dark grayish brown in cultivated areas. It is generally silty clay loam on uneroded side slopes and clay loam on ridgetops. The thickness of the surface layer ranges from 4 to 15 inches but is 4 to 8 inches in most places.

The surface soil ranges from friable to slightly firm when moist but is often cloddy and hard when dry. Because of the fine-textured subsoil and slow permeability, runoff is rapid and further erosion is likely. The subsoil is exposed in some places on rounded slopes and near drainageways.

This soil is imperfectly drained to moderately well drained and dries out slowly in the spring. A very narrow, wet, seepy band occurs directly above it in some places, and in these places it may be practical to install interceptor drains.

Most of this soil is used for cultivated crops. It is generally in areas large enough to be managed separately from surrounding soils. If row crops are planted, terrace this soil, till on the contour, and use rotations that include meadow one-half of the time. Even then, yields may be only medium.

This soil is commonly very low in available nitrogen and in phosphorus. Available potassium is medium in most places. The soil is medium acid but has lime at a depth of 42 to 56 inches. Management group 7 (IIIe).

Adair clay loam, thin solum, 9 to 14 percent slopes (AcD).—This soil has a thicker and darker surface layer than Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded. The surface layer is black to very dark gray and is as much as 15 inches thick.

This soil is in every township in the county. It occurs on side slopes at the heads of drainageways and on short, rounded shoulders of slopes. This till-derived soil is found downslope from the Sharpsburg or Ladoga soils. In places it is in bands upslope from Shelby soils.

This soil is imperfectly drained to moderately well drained and very erosive. Its use is limited by the slowly permeable, fine-textured subsoil and by the moderate slopes. A narrow, wet band of seepage occurs upslope in many places near the boundary of adjacent loess-derived soils. An interceptor tile drain placed in the loess will reduce wetness.

This soil is not well suited to row crops. Most of it is in pasture along with steeper Shelby soils. It may be used occasionally for a row crop if it is terraced and tilled on the contour.

This soil is usually low in available nitrogen, very low in phosphorus, and medium in available potassium. It contains much organic matter and is medium acid to slightly acid. Management group 15 (IVe).

Adair clay loam, thin solum, 9 to 14 percent slopes, moderately eroded (AcD2).—This strongly sloping soil has a thinner, less strongly developed subsoil than has Adair clay loam, this solum, 5 to 9 percent slopes, moderately eroded. It is the most extensive Adair soil in the county and occurs in every township. It is on short, rounded slopes along drainageways and in coves at the head of drainageways. Areas of Adair soils, thin solums, severely eroded, less than 1 acre in size are included and are shown on the soil map by the symbol for severely eroded spots.

This soil is imperfectly drained to moderately well drained. A narrow, wet seepage band may occur upslope in adjacent loess-derived soils, near the boundary of this soil. An interceptor tile drain installed in the loess will reduce seepage and surface wetness. In years of normal rainfall this soil dries slowly and generally must be worked later in spring than adjacent soils.

Because of the strong slopes and fine-textured subsoil, this soil is susceptible to erosion if it is cultivated. It is best suited to pasture. In many places the surface layer and the subsoil have been mixed by plowing, and the soil clods and hardens when it dries. If only a few more inches of this soil is lost, the soil will be unsuited for cultivation and even pasture will be hard to establish.

Although yields of row crops, especially of corn, are low, this soil is generally planted to crops along with more productive surrounding soils. Terracing, contour tillage, and heavy applications of manure are needed if this soil is cultivated. Hay or pasture is generally a better use.

This soil is generally very low in available nitrogen and phosphorus and is medium in available potassium It is medium to slightly acid, but lime is at a depth of 40 inches in some places. The organic-matter content is generally medium. Management group 15 (IVe).

Adair clay loam, thin solum, 14 to 18 percent slopes, moderately eroded (AcE2).—This steep soil has a thinner, less strongly developed subsoil than has Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded. The surface layer is only 4 to 10 inches thick and varies from loam to clay loam, depending on the degree of erosion. Severely eroded areas less than 1 acre in size are shown on the soil map by the symbol for severely eroded spots.

This soil is on steep, convex side slopes that are generally less than 200 feet long. It is downslope from Sharpsburg and Ladoga soils and upslope from soils along narrow drainageways or on the first bottoms near the major rivers or their tributaries. This soil is in nearly every township in the county. Individual areas are 5 to 20 acres each; the total area in Adams County is only about 400 acres.

Runoff is high because of the strong slopes and the clayey, slowly permeable subsoil. The subsoil is exposed in some places at the crest of rounded slopes or near the drainageways in the hillside. If this soil is cultivated, the subsoil is mixed with the surface soil in many places and tilth is poor. The soil may clod and harden when it dries.

Most of this soil has been cultivated but is now in pasture. The soil is not suited to row crops and is only moderately well suited to pasture. Wetness does not limit this soil if it is used for pasture or hay. If pasture is renovated, oats may be used as a nurse crop.

This soil is generally very low in available nitrogen and phosphorus and is medium in available potassium. Grass seedings respond moderately well to nitrogen and phosphate fertilizers. This soil is medium to slightly acid in most places. Its organic-matter content ranges from medium to low. Management group 19 (VIe).

Adair soils, 9 to 14 percent slopes, severely eroded (AdD3).—These soils are similar to Adair clay loam, 5 to 9 percent slopes, but they are severely eroded and their surface layer is dark grayish-brown loam to clay. The surface layer, however, is clay loam in most places and is generally less than 3 inches thick.

These severely eroded soils are in narrow bands on sidehills at the shoulders of strong slopes. They have a very small total acreage, and individual areas are less than 5 acres in size. Where they occur with better soils, Adair soils may be seeded to hay meadows.

Adair soils receive seepage water from loess-derived soils that are higher on the slopes. It may be practical to reduce wetness of cultivated areas of Adair soils by installing interceptor tile drains. The content of organic matter is very low, and tilth is very poor. The soils often seal after rains so that the penetration of moisture is lessened. As it dries in summer, the surface soil hardens and cracks deeply. Deep gullies are common on sidehills.

These soils are not suited to cultivated crops. They are better suited to hay or pasture, but pasture plants are extremely difficult to establish on bare areas unless heavy applications of manure are used.

These soils are very low in available nitrogen and phosphorus and are medium to low in potassium. Applications of a complete fertilizer will help to establish pasture seedings and to improve production. Management group 20 (VIe).

Adair soils, thin solums, 5 to 9 percent slopes, severely eroded (AmC3).—These severely eroded soils have a surface layer of dark grayish-brown clay to clay loam, less than 4 inches thick. In other respects they are similar to Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded.

These soils are generally on rounded, short, moderate slopes directly below more permeable Sharpsburg or Ladoga soils. In places a narrow, wet, seepy area occurs near the soil boundary. Because these Adairs soils are in areas of less than 5 acres, normally they do not need to be drained. If the surrounding soils are drained, however, the tile line may be extended to intercept seepage water.

When this soil is dry, the surface cracks and becomes cloddy, and when wet, it puddles and seals very easily. This prevents the soils from absorbing normal rainfall and increases sheet erosion. If the vegetation has been destroyed or is poor, gullies soon form. These soils may be used for cultivated crops but should be terraced or tilled on the contour. Yields of row crops, especially corn, are low. Pasture is the best use, but forage yields also are low.

These soils are very low in organic matter and need heavy applications of manure to improve tilth. They are very low in available nitrogen and phosphorus and are medium to low in potassium. Management group 15 (IVe).

Adair soils, thin solums, 9 to 14 percent slopes, severely eroded (AmD3).—These soils have a thinner surface layer than Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded, and a thinner, less strongly developed subsoil. Their clayey subsoil is exposed in many places, and deep gullies have formed. The surface layer is dark grayish-brown clay to clay loam, and the fine-textured subsoil is less than 2 feet thick. Because the subsoil is slowly permeable and slopes are strong, these soils are susceptible to further erosion.

Areas of these soils are normally less than 10 acres. They occur as narrow bands on strong side slopes below the Sharpsburg or Ladoga soils and on rounded slopes between drainageways.

These imperfectly drained to moderately well drained soils are generally wetter than the Sharpsburg soils above them. An interceptor tile drain is seldom used except in places where drainage is installed to improve the soils upslope.

These soils are very low in organic matter and need heavy applications of manure to improve tilth. They are poorly suited to row crops. Oats are generally grown as a nurse crop in areas that are to be reseeded to pasture. Pasture is probably the best use for these soils, but yields of forage are low. Small areas can be used for wildlife food and cover.

These severely eroded soils are very low in available nitrogen and phosphorus and are medium to low in available potassium. They are medium to slightly acid, but lime is about 40 inches below the surface. Management group 20 (VIe).

Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded (ApC2).—This complex consists of very poorly drained to moderately well drained soils that formed from glacial till on uplands. Most areas are imperfectly drained to moderately well drained. The native vegetation was prairie grasses.

The complex occurs throughout the county and is made up of areas of Adair, Shelby, and Clarinda soils that are too small to map separately. Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded, is the dominant soil in the complex. It normally occurs between Clarinda or Adair soils upslope and the Shelby soils of the complex downslope. Crossable drains in side slopes commonly dissect this complex.

The surface layer of these soils is generally very dark grayish brown and is 3 to 9 inches thick. The soils are normally on irregular side slopes and narrow ridgetops. On the shoulder of the side slopes and on the crest of rounded slopes between waterways, the surface layer is thinner than it is elsewhere. Plowing exposes a clay subsoil in some places.

This complex is downslope from the Sharpsburg soils and generally is upslope from the Colo-Gravity complex, which is in drainageways. The Adair soils are the most extensive in the complex, but Clarinda soils may make up as much as 20 percent of some side slopes.

Although these soils may be wet and seepy in places, tile drains are not practical, because the subsoil is fine textured and slowly permeable. Seepage can be reduced by placing interceptor tile drains in the more permeable, loess-derived soils that are upslope. Most wet areas of this complex are less than 1 acre in size. The soils erode easily when cultivated.

This complex generally is in areas of less than 5 acres and is farmed with the adjacent Shelby or Adair soils. Most of the acreage is used in a rotation that includes row crops, but yields are only medium. If they are terraced and tilled on the contour, these soils can be planted to row crops occasionally. They are used for pasture in many places where they are adjacent to steep Shelby soils.

The soils in this complex range from slightly acid to medium acid. They are generally very low in available nitrogen and phosphorus. Available potassium is medium. Corn responds moderately well to applications of fertilizer. Management group 7 (IIIe).

Adair-Shelby complex, 9 to 14 percent slopes (ApD).—This complex has a surface layer that is generally thicker than that in Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded. The surface layer is very dark gray to very dark grayish brown and is 9 to 15 inches thick in some places. The soils in this complex are on strong side slopes and in some places are in bands at the heads of drainageways. They are downslope from loess-derived soils, and generally adjacent to Shelby soils that are on moderately steep side slopes. Crossable drains and some gullies dissect these areas. These soils occur in every township in the county.

In addition to Adair soils and Shelby soils, Clarinda soils are present. The soils in this complex are not generally wet, but at points adjacent to the more permeable Sharpsburg soils, the clayey Clarinda or Adair soils may cause seepage. Interceptor tile drains are normally not used, and areas less than 2 acres in size may be wet enough to delay cultivation or to impair plant growth.

Runoff is high on these soils. If cultivated crops are grown, terrace these soils, till them on the contour, and plan a rotation that provides meadow crops half of the time. Yields generally will be medium. These soils are sometimes farmed with the associated Shelby soils on the side slopes, but many individual areas are 5 to 20 acres and are large enough to be farmed separately.

Where they occur with steep Shelby soils, these soils may be in pasture. Pasture is probably the best use for soils of this complex.

These soils are high in organic matter and are generally in good tilth. They are slightly acid to medium acid. They are medium to low in available nitrogen, are very low in phosphorus, and are usually medium in available potassium. Management group 15 (IVe).

Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded (ApD2).—Except that they are steeper, the soils in this complex are similar to the soils in Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded. They are upslope from the Shelby soils and downslope from the loess-derived Ladoga or Sharpsburg soils. They occur throughout the county in areas as large as 40 acres. Crossable drains and some gullies dissect these soils. Severely eroded areas of less than 1 acre within this complex are shown on the soil map by the symbol for severely eroded spots.

Because they absorb water slowly and are strongly sloping, these soils are very erosive when cultivated. A fine-textured subsoil is exposed in many places on the shoulders of slopes and at the head of small drains. In these areas the subsoil is mixed with the surface soil and tilth is poor; but tilth is good where material has accumulated toward the base of the slopes.

Yields of row crops are low to medium. These soils are probably best suited to pasture. If they are used for cultivated crops, improve tilth and reduce the loss of soil by terracing and contour tillage. Plan rotations that provide meadow crops half of the time.

Wetness is usually not a problem except in areas where Clarinda soils make up about 20 percent of the acreage. When rainfall is above normal, wetness may delay planting and cultivation. Because the moisture content and the soils themselves vary, the growth of crops may not be uniform. Areas of the complex that are mostly in Clarinda soils have more variable plant growth and lower yields than areas that are mostly in Adair soils.

The soils in this complex are generally very low in available nitrogen, very low in phosphorus, and medium in potassium. Manure added to the most severely eroded spots will improve yields. Pasture seedings respond moderately well to fertilizer. These soils need lime, for they are slightly acid to medium acid. Management group 15 (IVe).

Adair-Shelby complex, 9 to 14 percent slopes, severely eroded (ApD3).—The soils in this complex have a thinner, lighter colored surface layer than have the soils in Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded. The surface layer is a dark grayish-brown loam to clay, generally less than 3 inches thick. It is thicker on the lower parts of the slopes where material eroded from the hillsides accumulates. These soils are on severely eroded, rounded slopes between drains on side hills, or are at the head of drainageways. The total acreage in the county is moderate, but individual areas range from 2 to 20 acres in size. The soils in this complex are generally associated with the Sharpsburg soils and with other Shelby soils. They are downslope from the Sharpsburg soils and grade to or occupy the same kinds of position as the Shelby soils. Crossable drains and many gullies dissect this complex.

Because these soils are strongly sloping and are in poor tilth, cultivated areas have rapid runoff and are susceptible to erosion. Where the subsoil is exposed, it hardens and cracks deeply when it dries. Seedbed preparation and other cultivation are difficult because of the poor tilth and low content of organic matter. Wet spots of less than 1 acre occur in some places.

These soils are not suited to row crops. They are better suited to pasture. Oats are used as a nurse crop when pastures are reseeded.

These soils are slightly acid to medium acid in most places. They are very low in available nitrogen and phosphorus. Available potassium is low to medium. Seedings respond well to manure and to commercial fertilizer, especially phosphate. Management group 20 (VIe).

Adair-Shelby complex, 14 to 18 percent slopes, moderately eroded (ApE2).—The surface layer of the soils in this complex varies more in thickness than that in Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded. It is thin on the eroded upper parts of the slope and thicker at the base of the slopes where sediments have accumulated. Slopes are irregular and moderately steep. Materials derived from both Kansan till and Nebraskan till may occur on some of the long slopes.

Clarinda soils are also in this complex. Like the Adair soils, they are at the shoulders of moderately long slopes or at the base of long slopes; they are upslope from the Shelby soils in most places. This complex is in bands that occupy entire side slopes and are in areas as large as 40 acres. Crossable drains and some gullies dissect these soils.

Much of this complex is cultivated. The soils are extremely erosive and are best suited to semipermanent pasture. Plowing mixes the subsoil and remaining surface soil in many places. The Adair and Clarinda soils are usually the first to erode because they are steep and slowly permeable. Tilth varies from place to place, but in most places these soils harden and clod when they dry. The Adair and Clarinda soils puddle in some places because they dry more slowly than the Shelby soils.

Terracing is not suggested. Row crops are not suited to these soils. A nurse crop of oats is planted when pasture is reseeded.

These soils are slightly acid to medium acid. They are usually very low in available nitrogen and phosphorus and are medium in available potassium. Add lime and phosphate to establish seedings. Management group 19 (VIe).

Adair-Shelby complex, 14 to 18 percent slopes, severely eroded (ApE3).—The surface layer of the soils in this complex is thinner and lighter colored than that in Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded. It is dark grayish brown and is less than 3 inches thick.

This complex consists of severely eroded soils on rounded side slopes that are dissected by noncrossable gullies. In some places these soils are upslope from other Shelby soils, in bands at the shoulder of side slopes and around the head of drainageways. The soils generally were derived from Kansan till. They are in areas ranging from 3 to 10 acres in size and are generally farmed with other soils.

Some of the smaller areas are still used for cultivated crops, but these soils are not suited to row crops and are only moderately well suited to pasture. Because they are moderately steep, these soils are extremely erosive and are subject to gullying. Seedbeds are difficult to prepare, especially where the clayey subsoil is exposed.

Available nitrogen and phosphorus are very low and potassium is medium to low in these soils. A good seeding needs additions of lime, phosphate, and manure. Legume-grass seedings respond fairly well to a phosphate fertilizer. Management group 21 (VIIe).

Alluvial land

Alluvial land is a miscellaneous land type consisting of poorly drained to very poorly drained alluvium that was recently deposited by streams on first bottoms. The sediments are coarse and fine and are highly stratified, but a distinct profile has not formed. This land is often flooded.

Alluvial land is on the flood plains of the main rivers and other streams in the county (fig. 7). It is nearly level to slightly undulating. In Adams County the total acreage is large and is in individual areas of 10 to 30 acres.

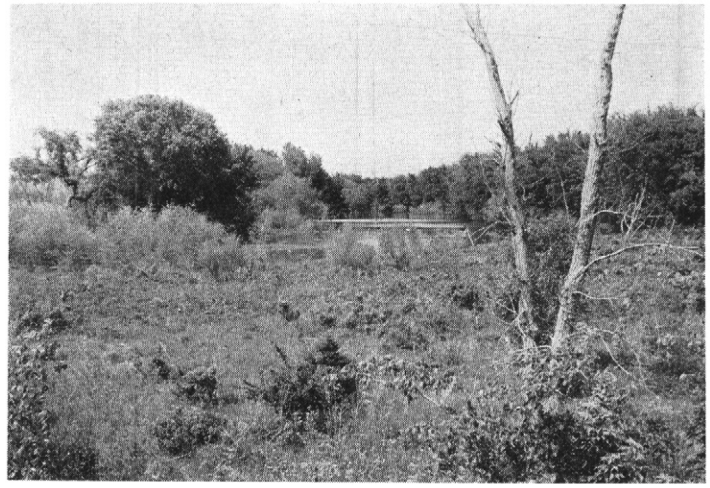

Figure 7.—**Alluvial land on the flood plain along the Middle Nodaway River.**

Alluvial land (Av).—In most places this land has a light-colored silty to sandy surface layer over mixtures of silt, sand, and silty clay. Overflowing streams scour this land or deposit new material on it from year to year. Areas of new deposits that are 30 inches thick or more and are dominantly silt loam are mapped as Nodaway silt loam.

Alluvial land is generally dissected by numerous noncrossable streams and by old bayous that are often filled with water. The undulating slopes are the result of silt and sand accumulating in sand bars. This land is usually wet because of flooding, seepage, and ponded water.

A thick stand of trees grows in many places. Unless the trees are removed and grass is established, this land has little value as pasture. Management group 18 (Vw).

Arbor series

The Arbor series consists of moderately well drained soils on uplands that have received deposits of friable, gritty local alluvium washed from adjacent soils upslope. This alluvium has accumulated as a result of geologic erosion rather than erosion accelerated by cultivation. The subsoil formed in both local alluvium and firm till materials. It is moderately permeable to moderately slowly permeable. The native vegetation was prairie grasses.

Only one Arbor soil is mapped in Adams County, and the total acreage is small. This soil generally occurs as small inclusions in areas of Shelby loam, Gara loam, and soils of the Adair-Shelby complex.

Arbor loam, 9 to 14 percent slopes (AwD).—This soil is on slightly concave to straight slopes along sidehill waterways. It is downslope from the Shelby soils but upslope from the Gravity or Olmitz soils. At the lower parts of the slope, where this soil grades toward the Gravity soils or the Olmitz soils, its profile resembles the profile of Olmitz soils. Upslope the profile is similar to that of uneroded Shelby soils.

This soil has a total acreage of about 200 acres and is in areas of 2 to 10 acres. It is in every township, along major streams and rivers.

Representative profile:

0 to 20 inches, black to very dark gray loam; friable.
20 to 34 inches, very dark grayish-brown to dark-brown clay loam; slightly firm to firm.
34 to 60 inches, dark-brown to dark yellowish-brown clay loam with a few strong-brown and yellowish-brown mottles; firm.

This soil has a dark surface layer, 18 to 24 inches thick. The color of the soil grades gradually from one horizon to the next. The local alluvium in which this soil developed is 18 to 30 inches deep over till. The content of organic matter is high, and tilth is good.

Most of this soil is in areas of less than 5 acres, which are not farmed separately. About half of it is used for cultivated crops. Where this soil occurs with Gravity or Olmitz soils, it is generally farmed with them. Where it is next to steep or moderately steep Shelby soils, it is in pasture.

Arbor loam, 9 to 14 percent slopes, erodes readily if it is cultivated, but in some places it receives deposits of soil at about the same rate that soil is lost through erosion. Runoff from this soil should be controlled to reduce the loss of water and soil. Runoff from higher areas should be diverted to prevent less fertile material from being deposited on this soil. Terraces are difficult to establish, but lower areas can be protected from runoff by diversion terraces. If diversion terraces are constructed and this soil is tilled on the contour, it is suitable for an occasional row crop. Yields of row crops are medium to high if moisture is adequate.

This soil is slightly acid and needs lime. It is medium to low in available nitrogen and phosphorus, and usually medium in available potassium. Row crops that do not follow grass-legume meadow respond moderately well to a fertilizer that contains phosphate and a large amount of nitrogen. Management group 10 (IIIe).

Bremer series

The Bremer series consists of poorly drained soils that formed from dark-colored silty alluvium under prairie grasses. These soils are on broad, flat second bottoms and on nearly level positions that grade to first bottoms. They are sometimes flooded by the small streams that may dissect them before emptying into the major river channels. Although these soils have a medium total acreage in Adams County, generally they are in areas of 20 acres or more.

Only one soil in the Bremer series is mapped in Adams County.

Bremer silty clay loam (0 to 2 percent slopes) (Br).—This soil has a thick, dark-colored surface layer and a lighter colored silty clay to heavy silty clay loam subsoil. The subsoil is 18 to 30 inches thick and contains more clay than the surface layer. This clay seems to be deposits of fine material that were laid down at different times, rather than clay that has moved downward from the surface layer and accumulated.

Representative profile:

0 to 18 inches, black silty clay loam; friable.
18 to 40 inches, very dark gray silty clay with common grayish-brown and yellowish-brown mottles; firm.
40 to 60 inches; olive-gray silty clay loam with many yellowish-brown mottles; firm to slightly firm.

This soil is poorly drained. Because surface runoff is slow and the permeability of the subsoil is moderately slow, artificial drainage is generally necessary. Crops may turn yellow in some small depressions that are wetter than the rest of this soil. Tile drains will work in Bremer silty clay loam, and generally outlets are not difficult to establish.

Nearly all of this soil is used for cultivated crops, and the drained areas produce good yields. It occurs with the Colo soils on bottom lands and is suited to the same kind of rotations as the Colo soils. It is suitable for intensive row cropping.

Although this soil is high in organic matter, tilth may be a problem. Even if drainage is improved, this soil dries out slowly and often must be worked later than adjacent soils to prevent puddling. Slight wind erosion is common, particularly if the soil is plowed in the fall.

Bremer silty clay loam is medium in available nitrogen and phosphorus and is high in available potassium. It is normally slightly acid but ranges from neutral to medium acid. Management group 6 (IIw).

Chariton series

The Chariton series consists of very poorly drained to poorly drained soils that formed from alluvium. Their subsoil is fine textured and very slowly permeable to slowly permeable. These soils are generally on broad first bottoms in flats or depressions that are often flooded by runoff from uplands. Some areas are on poorly defined, low second bottoms. Prairie grasses were the native vegetation.

The Chariton soils are in every township except Lincoln, Colony, and Mercer. They are commonly associated with the Colo and Wabash soils on first bottoms. They are of minor extent in Adams County and are in areas that range from 5 to 20 acres.

Chariton silt loam is the only Chariton soil mapped in Adams County.

Chariton silt loam (0 to 2 percent slopes) (Ca).—This soil has a dark surface layer that is 6 to 12 inches thick and high in organic matter. Beneath the surface layer is a gray, leached subsurface horizon that is underlain abruptly by a thick clay subsoil. The subsoil has formed in fine-textured alluvium.

Representative profile:

0 to 9 inches, black to very dark gray silt loam; friable.
9 to 19 inches, gray silt loam; friable.
19 to 48 inches, black to very dark gray silty clay with few, gray, silt coatings; very firm; gleyed.
48 to 67 inches, gray to dark-gray silty clay loam with common grayish-brown and yellowish-brown mottles; firm.

This soil is wet. Runoff from surrounding soils causes ponding in the depressions, and other areas of this soil are flooded occasionally. Because the subsoil is very slowly to slowly permeable, tile drains do not work well, but excessive surface water can be removed by open ditches.

Even in areas that are artificially drained, this soil is difficult to work and puddles readily. It dries slowly in the spring or after rains, and cultivation is often delayed. Yields of row crops are only medium, and legumes in meadow often winterkill. Wheat and some other grains grow fairly well, but this soil is not well suited to corn. Instead of corn, soybeans can be planted in rotations. Cultivated fields are normally in rotations that include row crops or wheat most of the time.

The larger areas of Chariton silt loam are generally next to the Wabash soils and are suited to the same rotations as those soils. Many small spots are in depressions within or next to the Colo and Nodaway soils, and because of their size and location, are farmed as intensively as the Colo and Nodaway soils. Good management is required to maintain good tilth. This soil is well suited to some pasture plants, and pasture is the best use for undrained areas.

Most of this soil is slightly acid, but some areas are nearly neutral. This soil is usually low in available nitrogen and in phosphorus. It is medium in available potassium. Management group 14 (IIIw).

Clarinda series

The Clarinda series consists of poorly drained to very poorly drained soils that formed from glacial till on uplands. This glacial till is a gray clay that is commonly called gumbotil. Gumbotil was the subsoil of a soil on the nearly level drift plain that remained after the Kansan glacier. Later a deposit of loess covered the gumbotil, but geologic erosion has removed the loess in many places and has exposed the old, buried soil. Clarinda soils are on side slopes where the once buried soil is exposed. These buried or once buried soils are called paleosols. Since exposure the native vegetation has been prairie grasses.

Clarinda soils are downslope from Sharpsburg and Clearfield soils. They have slopes of 5 to 14 percent. These soils occur in every township in the county but are mostly east of the Middle Nodaway River near areas of broad, nearly level uplands. Individual areas are generally less than 20 acres in size. Areas too small to map separately are shown on the soil map by the symbol for clay.

Clarinda silty clay loam, 5 to 9 percent slopes (CcC).—This soil is normally on moderate slopes at the head of drainageways that extend into broad, flat uplands. In some places it is in bands at the shoulders of side slopes below the Sharpsburg or Clearfield soils. (See fig. 3, bottom.) Severe seeps usually occur at the uphill side of these areas where they border the Sharpsburg or Clearfield soils.

Representative profile:

0 to 10 inches, black to very dark gray silty clay loam; friable to slightly firm.

10 to 58 inches, dark grayish-brown to olive-gray heavy silty clay with dark-brown and yellowish-brown mottles; gleyed; very firm when moist and plastic when wet.

58 to 70 inches, gray to dark yellowish-brown clay loam with olive-gray, dark-brown, and yellowish-brown mottles; firm.

This soil has a silty clay loam surface layer, 7 to 12 inches thick, that grades to a very firm, olive-gray subsoil, 4 to 8 feet thick. Because of the very firm clayey subsoil and the moderate slopes, this soil is highly susceptible to erosion. When the soil dries, cracks may appear on the surface and extend deep into the subsoil.

Most of this soil is in pasture. If it is cultivated, it should be protected by terraces, tilled on the contour, and kept in meadow half of the time. It is poorly suited to row crops, especially corn. Pasture is its best use.

Because it is very slowly permeable, this soil stays wet for long periods in spring and after rains in any season. Crops are usually yellow and stunted in growth. By midsummer the yellow may disappear, but crop growth is still poor. Tile drains should not be placed in these soils, but it may be practical to place interceptor tile drains in the adjacent, loess-derived soils upslope to help prevent seepage and reduce the surface wetness.

Undisturbed areas of this soil are normally medium acid, high in organic matter, low in available nitrogen, and very low in available phosphorus. The available potassium is generally medium. Pasture plants respond fairly well to fertilizer, but row crops do not respond so well. Management group 11 (IIIw).

Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded (CcC2).—This soil has a thinner, lighter colored surface layer than has Clarinda silty clay loam, 5 to 9 percent slopes. The surface layer is 3 to 7 inches thick and is very dark gray to very dark grayish brown. The soil is on side slopes within coves at the head of drainageways and may occupy entire short side slopes next to drainageways. It is downslope from the Sharpsburg or Clearfield soils. Areas of this soil generally are less than 20 acres in size.

The grayish clay subsoil may be exposed on the upper part of the slope or on the crown of rounded slopes between drains. In many cultivated fields, the former subsoil is mixed with the surface soil and the soil is difficult to work. This soil is medium to low in organic matter, and when almost dry, the surface soil is cloddy and hard. As the soil continues to dry, cracks appear on the surface and extend deep into the subsoil. Much of this soil is used for cultivated crops, but if erosion continues, yields of row crops will be too low to be profitable. If wetness can be controlled and the soil is protected by terracing and contour tillage, it is suitable for row crops in rotations that include meadow half the time.

Tile drains should not be placed in this soil, but an interceptor tile drain placed in adjacent soils upslope will reduce seepage and surface wetness. Even where a tile drain is installed, the soil remains wet and is difficult to manage. It dries slowly because of the very slow permeability. Row crops, especially corn, are often yellowed.

This soil is medium acid. It is generally very low in available nitrogen and phosphorus and is medium in available potassium. Management group 11 (IIIw).

Clarinda silty clay loam, 9 to 14 percent slopes (CcD).—This soil is similar to Clarinda silty clay loam, 5 to 9 percent slopes. The surface layer is very dark gray to black and grades to a grayish clay subsoil that is 3 to 6 feet thick.

This soil is in narrow bands on the shoulders of strong side slopes and extends around the head of drainageways. It is downslope from the Sharpsburg soils and upslope from Adair soils and Shelby soils. This soil is not extensive and is generally in areas of less than 10 acres.

Water seeps out on this soil near the boundary of adjacent, higher lying Sharpsburg soils. This water has percolated through the Sharpsburg soils. A tile drain placed directly in this soil is not satisfactory, but an interceptor tile drain placed in the Sharpsburg soils will reduce seepage. Even where seepage is reduced, however, this soil dries very slowly.

This soil is very erosive. Runoff is excessive because slopes are strong and the subsoil is very slowly permeable. Crop yields are low even in places where the surface layer is 7 to 12 inches thick. Most of this soil is in pasture. If it is cultivated, it normally is farmed with the other soils on side slopes. If this soil is terraced and tilled on the contour, it is suited to grain grown in a rotation that provides meadow 60 percent of the time. Even under good management, yields of grain are low. Forage yields are not high, but hay or pasture is probably the best use for this soil. Most legumes will not grow well even with good drainage.

This soil contains a large amount of organic matter but needs applications of manure to maintain tilth. It is medium acid and requires lime. The soil is low in available nitrogen, is very low in phosphorus, and is medium in available potassium. Pastures respond fairly well to lime and fertilizer. Management group 16 (IVe).

Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded (CcD2).—This soil has a thinner, lighter colored surface layer than Clarinda silty clay loam, 5 to 9 percent slopes. The surface layer is very dark gray to very dark grayish brown and is 3 to 7 inches thick. The clay subsoil is 3 to 6 feet thick in most places and is very slowly permeable.

This soil is in narrow bands on strong slopes. It is in coves at the head of drainageways and extends to the shoulders of the side slopes. It may also occupy entire side slopes that are less than 150 feet long and are adjacent to drainageways dissecting broad uplands. It is not in continuous bands. This soil is of moderate extent and is mostly in the eastern part of the county. It is generally in areas of less than 10 acres.

Because of the clay subsoil and strong slopes, this soil is extremely erosive and hard to manage. The subsoil may be exposed near high drains in sidehills and at the upper part of slopes. When the surrounding soils on the slopes are ready for cultivation, this soil may still be too wet to work. If cultivated at the same time as the surrounding soils, the soil puddles. By midsummer cracks appear on the surface, and as the soil continues to dry, the cracks extend deep into the clay subsoil. The surface of this soil is very hard and cloddy when dry. It may be practical to place tile drains in the higher lying, adjacent Sharpsburg soils to intercept seepage water, reduce surface wetness, and allow earlier cultivation.

Most of the soil is in cultivated crops, but yields are very low to low. Forage yields are also low, but hay or pasture is probably the best use for these soils. Meadow 3 years out of 5 is suggested, even on fields that are terraced.

This soil is very low in available nitrogen and phosphorus and is medium in available potassium. It needs additions of organic matter and fairly heavy applications of lime, for it is medium acid. Management group 16 (IVe).

Clarinda soils, 5 to 9 percent slopes, severely eroded (CdC3).—These soils have a thinner and lighter colored surface layer than has Clarinda silty clay loam, 5 to 9 percent slopes. The surface layer is dark grayish brown and is less than 3 inches thick. Most of the original surface layer has been removed by erosion.

These soils are on short, moderate side slopes. Their total acreage is very small. They are not suited to cultivated crops and are generally used for hay and pasture. Oats are used as a nurse crop in reseeding pastures.

Wetness and erosion are the main problems. The surface soil dries hard and cracks severely. It puddles readily and absorbs moisture very slowly. Tile drains do not work well when placed in these soils, but it may be practical to place interceptor tile in the more permeable soils upslope to reduce surface wetness. Deep, active gullies have formed, and they should be shaped and planted in grass to prevent further erosion. A short, temporary diversion terrace placed upslope from these areas will help prevent erosion until a seeding is established.

These soils are very low in available nitrogen and phosphorus and are low in available potassium. Legume and grass seedings respond moderately well to heavy applications of manure and phosphate. Lime should also be applied to these soils, as they are medium acid. Management group 20 (VIe).

Clarinda soils, 9 to 14 percent slopes, severely eroded (CdD3)—These soils have a thinner surface layer than has Clarinda silty clay loam, 5 to 9 percent slopes. Most of the original surface soil has been removed by erosion, and the remaining surface soil has been mixed with the former subsoil by plowing. Gullies are common.

These soils are on strong flank slopes in a thin, broken band downslope from the Sharpsburg soils. Most of the acreage is in pasture or is idle. These soils are not extensive in Adams County and are generally in areas of less than 5 acres.

The surface layer of these soils is fine textured and hard to manage. When it dries, wide cracks appear and the surface becomes very hard. Good seedbeds are difficult to prepare. These soils are very slowly permeable, and runoff is rapid. They erode easily if used for cultivated crops. Wetness is a problem, particularly where seepage occurs near adjacent soils upslope.

These soils produce low yields of grain. They are better suited to pasture than to grain, but forage yields are also low. Some areas of these soils could be managed to provide cover and food for wildlife.

To control erosion, work and shape the gullies and seed them in grass. Build a short, temporary diversion terrace above these soils to divert runoff until the seedings are well established. If possible, renovate old pasture without destroying existing vegetation. If areas of these soils are part of a larger pasture area, it may be practical to fence these areas so that the seeding can form a good sod the first year.

Apply manure heavily to improve moisture absorption and reduce erosion. This soil is very low in available nitrogen and phosphorus and is low in available potassium. Apply lime and phosphate, if necessary, to establish grasses. Management group 20 (VIe).

Clearfield series

The soils of the Clearfield series have formed from loess on uplands under prairie vegetation. These soils are imperfectly drained to poorly drained. They have a dark-gray to olive-gray subsoil and a layer of silty clay at a depth of 3 to 6 feet that is very slowly permeable. They are often wet on the surface because they do not absorb the water that seeps from more permeable soils above them.

Most of these soils are east of the Middle Nodaway River in the eastern and southeastern parts of the county. Individual areas are generally less than 30 acres. Small patches of Clearfield soils crop out at the foot of some slopes near waterways and are shown on the soil map by the symbol for wet spots.

Clearfield silty clay loam, 5 to 9 percent slopes (CfC).—This soil lies in coves at the head of waterways. It is on moderate, straight or concave slopes. It is bounded by Sharpsburg and Macksburg soils upslope and by Clarinda soils downslope. (See fig. 3, top.) In Mercer and Grant townships, however, the slopes are more irregular than elsewhere, and small spots of a Clarinda soil may occur within the areas of Clearfield soil about halfway up the slope.

Representative profile:

- 0 to 12 inches, black to very dark gray silty clay loam; friable to slightly firm.
- 12 to 42 inches, dark-gray to olive-gray silty clay loam with dark-brown, strong-brown, and yellowish-brown mottles; slightly firm to firm.
- 42 to 60 inches, gray to olive-gray silty clay loam with olive-brown and strong-brown mottles; firm.
- 60 inches +, gray to dark-gray silty clay; very firm when moist, plastic and sticky when wet.

The surface layer is 8 to 16 inches thick and dries hard and cloddy. The subsoil is dominantly gray and highly mottled.

This soil generally has a perched water table at or near the surface in wet seasons. It is often wet and hard to manage unless it is artificially drained. To obtain the best drainage, proper placement of tile lines is very important in the Clearfield soils. If possible, the tile lines should be placed just above or in contact with the underlying silty clay layer that typically occurs at a depth of 3 to 6 feet. Tile placed in the silty clay layer is not so efficient as tile placed on or just above it.

More than half of this soil is cultivated. If it is artificially drained, it is suited to row crops, but they should not be planted frequently unless the soil is terraced and tilled on the contour. Generally this soil has the same rotation as the adjacent Sharpsburg soils.

Virgin areas of this soil contain a large amount of organic matter, and cultivated areas contain a medium to large amount. None of this soil is seriously eroded, probably because it has not been planted to row crops for many years. Until recently most farmers have left this wet Clearfield soil in native pasture.

This soil is medium to low in available nitrogen, medium in available phosphorus, and high in available potassium. Corn that is not preceded by a legume responds well to fertilizer, especially to nitrogen. This soil is only slightly acid. Management group 12 (IIIw).

Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded (CfC2).—This soil has a thinner, lighter colored surface layer than has Clearfield silty clay loam, 5 to 9 percent slopes. The surface layer is very dark gray to dark grayish brown and is only 3 to 6 inches thick.

This soil is in coves that abruptly break from the broad uplands. The moderate slopes are straight to slightly concave. This soil generally is downslope from the Sharpsburg soils and upslope from Colo-Gravity soils, which are in drainageways. It is often farmed with Sharpsburg soils.

This soil is wet and hard to manage unless it is artificially drained. Tile drains placed above the clayey substratum will reduce seepage if outlets for tile lines are available. Tilth is generally poor because the soil is cloddy and hard when dry.

Most of this soil is in cultivated crops. It is suitable for frequent row cropping but should be terraced and tilled on the contour to prevent loss of soil. The content of organic matter is medium. If rotations include a high percentage of row crops, add organic matter to improve tilth. Yields of crops are medium under good management.

This soil is generally low in available nitrogen and phosphorus but high in available potassium. Corn that is not preceded by a legume responds well to additions of nitrogen. Legumes respond well to phosphate. This soil is slightly acid and requires lime. Management group 12 (IIIw).

Clinton series

In the Clinton series are moderately well drained soils that formed from loess under forest vegetation. This loess is normally 10 to 16 feet thick and covers paleosols that are similar to Adair and Clarinda soils, which developed from Kansan till. When dry, Clinton soils have a prominent, grayish subsurface soil.

These soils are on 5 to 14 percent slopes in the steeply dissected regions along the Middle Nodaway and East Nodaway Rivers in Washington, Jasper, and Nodaway townships. Clinton soils are closely associated with Ladoga soils and are in the same landscape position. They are upslope from the Gara soils, which are on side slopes. In Adams County, the total acreage of soils in the Clinton series is small but individual areas are as large as 60 acres.

Clinton silt loam, 5 to 9 percent slopes, moderately eroded (ClC2).—This soil has a very thin, moderately dark surface soil and a moderately thick, grayish-brown subsurface soil. The surface soil and subsurface soil combined are from 3 to 10 inches thick. The subsoil is dark-brown silty clay loam to light silty clay with a few mottles.

This soil is on narrow, moderately sloping, rounded ridgetops that finger out into irregular, steep uplands (fig. 8). Because of this position, areas of this soil are moderately large. Clinton silt loam, 5 to 9 percent slopes, moderately eroded, is the most extensive Clinton

Figure 8.—**Clinton silt loam, 5 to 9 percent slopes, moderately eroded, on ridgetop; Gara loams on side slopes. The trees are mostly oak.**

soil in Adams County, but the total acreage is small. Some uneroded areas are included.

Representative profile:

0 to 2 inches, very dark grayish-brown to dark grayish-brown silt loam; very friable.
2 to 9 inches, grayish-brown to brown silt loam; light brownish gray when dry; very friable.
9 to 33 inches, dark-brown heavy silty clay loam with mottles of yellowish brown, strong brown, and olive gray; firm.
33 to 42 inches, dark yellowish-brown silty clay loam with olive-gray and strong-brown mottles; slightly firm to firm.

Some of this soil is still wooded, but the trees have been removed in places and the soil is cultivated or is in pasture. Because this soil generally occurs with steeper soils, in many places it is the only soil in the immediate area that can be cultivated. If it is cultivated, the thin, dark surface soil is mixed with the subsurface layer.

Under cultivation this soil is extremely erosive. The surface soil is very friable and floury and contains little organic matter. The subsoil is moderately slow in permeability.

This soil is suited to row crops grown in a rotation that includes meadow 2 years in 5. If it is planted in row crops, terrace the soil and till it on the contour. Keep it in a meadow crop 3 years if tilth becomes poor. Yields of crops are medium.

This soil is low in available nitrogen and phosphorus and is medium in available potassium. Applications of manure are beneficial. Row crops that have not followed a grass-legume crop respond well to fertilizers. The response of corn is especially good. This soil is strongly acid and requires lime. Management group 8 (IIIe).

Clinton silt loam, 9 to 14 percent slopes, moderately eroded (ClD2).—This soil has a thinner surface soil and subsurface soil than Clinton silt loam, 5 to 9 percent slopes, moderately eroded. Together those layers are only 3 to 6 inches thick.

This soil is at the crest of narrow ridges and is in bands around strong side slopes. It lies upslope from steeper Gara soils. In some places it was partly derived from loess that had blown from the adjacent river valleys. In these places the parent material is of silt loam texture instead of silty clay loam. Many small areas of wind-deposited sand are in or near areas of this soil.

Because it has a friable surface soil, strong slopes, and excessive runoff, this soil is extremely erosive. Plowing exposes subsoil material on the rounded crests in some places. Much of this soil is cultivated, and the rest is in pasture or trees.

This soil is suited to an occasional row crop, but the soil should be terraced and tilled on the contour to reduce erosion. Rotations that include meadow 2 years in every 5 are suitable. An additional year in meadow may be desirable on the more eroded areas. This soil is generally managed the same as adjacent soils on more gentle slopes. Yields of row crops are medium.

This soil is very low in organic matter and needs applications of manure or commercial fertilizer to increase crop yields. It is very low in available nitrogen and is low in available phosphorus, but it is generally medium in available potassium. Most of this soil is strongly acid and responds well to applications of lime. Lime and phosphate are especially needed for seedings. Management group 8 (IIIe).

Colo series

In the Colo series are poorly drained soils on bottom lands. These soils are dominantly black, but they grade to very dark gray or dark gray in their lower layers. They formed in moderately fine textured alluvium.

Colo soils are wet as a result of a high water table and flooding rather than an impermeable subsoil. They are moderate to moderately slow in permeability. Many areas of these soils have been drained and are used for cultivated crops. Areas that are drained and protected from flooding are among the most productive in the county. The native vegetation was water-tolerant prairie grasses. Colo soils are the most extensive soils on bottom land in the county.

Colo silty clay loam (Cm).—This soil is dominant on bottom lands in stream valleys that are less than one-fourth mile wide (fig. 3, bottom). It also occurs on wider bottom lands. In the narrow valleys the soil is flooded frequently and in some places is stratified with medium-textured silts. On the wider, more stable bottoms this soil is adjacent to light-colored Nodaway soils that are parallel to the stream channels (fig. 4, bottom). In many places it lies between the light-colored Nodaway soils and the more clayey Wabash soils. Colo silty clay loam is the most extensive Colo soil in Adams County. It is in large areas in every township. Individual areas range from 20 to 40 acres in size.

Areas of Chariton silt loam less than 1 acre in size are included with this soil and are indicated on the soil map by the symbol for wet spots.

Representative profile:

0 to 22 inches, black to very dark gray silty clay loam; friable to slightly firm.
22 to 42 inches, very dark gray silty clay loam; firm to slightly firm.

Because this soil has poor natural drainage, cultivation is often delayed unless the soil is artificially drained. Tile lines work well, for the subsoil is moderate to moderately slow in permeability. In the narrow drainageways this soil is generally dissected by a running stream that cannot be crossed by farm machinery. Also hindering cultivation are a few old meandering channels and a few very wet depressions less than one-half acre in size.

This soil is flooded occasionally, but most of it is used for cultivated crops. Areas that are flooded more frequently than normal, or are inaccessible, are in pasture.

If it is artificially drained and is protected from overflow, this soil is well suited to row crops. The content of organic matter is high, and tilth is generally good. If tilth becomes poor, plant a meadow crop and allow it to grow for 1 year.

This soil is slightly acid. It is medium in available nitrogen and medium to high in available phosphorus and potassium. Corn that does not follow a legume normally responds well to a nitrogen fertilizer. Management group 5 (IIw).

Colo silty clay loam, channeled (Cn).—This soil is dissected by many meandering channels and in some places is covered with dark-gray, friable silt loam, 3 to 6 inches thick. In other respects it is similar to Colo silty clay loam. The channels are partly filled with clay and silt and generally cannot be crossed with farm machinery. Water stands in old bayous for long periods. Frequent floods bring in silty sediments that accumulate where they are trapped by an undergrowth of young timber.

This soil is idle or is in pasture. Clearing the scrubby timber would make idle areas more suitable for pasture. If flooding could be controlled and the channels worked down, this soil would be suited to cultivated crops. Because areas are normally very small, idle parts of this soil are probably best suited to wildlife food and cover.

This soil is slightly acid and is medium to high in fertility. The content of organic matter is high. Management group 18 (Vw).

Colo silty clay loam, overwashed (Co).—This soil consists of Colo silty clay loam on which a layer of dark-gray silt loam, 16 to 24 inches thick, has been recently deposited. The sediments forming this layer spilled from adjacent rivers or from small secondary drains in the uplands. Most of this soil is on the nearly level flood plains of the East Nodaway and Middle Nodaway Rivers. Some small areas are at the base of upland slopes below Judson or Gravity soils. Areas of this soil are of varied sizes; the total acreage in the county is large.

The soil has a poorly drained subsoil, but the thick surface layer is moderately well drained. Although it is occasionally flooded, it generally is planted to grain crops and is not artificially drained. It can be tiled if tile drainage is needed. The subsoil is moderate to moderately slow in permeability.

Nearly all of this soil is used for cultivated crops. Rotations that provide row crops most of the time may be used, but wetness and flooding may lessen yields. Meadow rather than a green-manure catch crop is used if tilth is poor.

This soil is medium to low in organic matter. It is medium in available nitrogen and is medium to high in phosphorus and potassium. Reaction is slightly acid. Corn that does not follow a legume responds well to a nitrogen fertilizer. Management group 5 (IIw).

Colo-Gravity complex, 2 to 5 percent slopes (CxB).—The soils in this complex are (1) along narrow drainageways (see fig. 3, bottom); (2) in gently sloping to moderately steep areas where the upland soils were derived from loess; and (3) in the rolling to very steep areas where most soils were derived from till (see fig. 4, bottom). Colo silty clay loam and Gravity silty clay loam are the dominant soils in this complex and are described elsewhere in this report.

Along the narrow drainageways, the Colo soils lie adjacent to the streams and in many places have 6 to 18 inches of recently deposited sediment on the surface. These areas are cut by many channels or gullies that cannot be crossed with farm machinery. The Gravity soils are in fairly uniform bands at the base of upland slopes. In the gently sloping to moderately steep areas, this complex includes Judson soils. The largest acreage of this complex is in areas that are generally rolling to very steep. Colo-Gravity complex, 2 to 5 percent slopes, has a large acreage in Adams County.

These soils are imperfectly drained to poorly drained. Diversion terraces can be used to control runoff water from the uplands, and most places can be drained by tile. Grassed waterways are needed in gullied areas.

These soils have many uses. Where they occur in small patches within cultivated fields, they are planted to the same crops as are those fields. If they are in larger areas, they may be cultivated separately. Much of the acreage, however, is in pasture along with other soils. This complex is well suited to pasture if the soils are protected from gullying.

If gullying is prevented and drainage is provided, these soils can be used for rotations in which row crops are grown most of the time. Crop yields are generally high.

These soils are slightly acid in most places. They are medium in available nitrogen and medium to high in phosphorus. Normally they do not need potassium. Response to a nitrogen fertilizer is usually good. Management group 5 (IIw).

Gara series

The Gara series consists of soils that formed from glacial till on uplands under mixed forest and prairie grasses. These soils are moderately well drained. The subsoil is moderately fine to fine textured and of moderately slow to slow permeability.

These soils are in topographic positions that range from the rounded ends of narrow ridgetops to irregular, complex side slopes (see fig. 8). Slopes range from 5 to 40 percent.

Gara soils are in all townships except Mercer and Colony. They occur on slopes along large streams and rivers in the county and have a large total acreage.

Gara loam, 5 to 9 percent slopes, moderately eroded (GaC2).—This soil formed from Kansan till that has been exposed by geologic erosion. It is on narrow, rounded ridgetops in areas generally less than 10 acres. It lies below Ladoga soils and above steeper Gara soils.

Representative profile:

0 to 4 inches, dark-gray to dark grayish-brown loam; friable to slightly firm.
4 to 6 inches, dark grayish-brown loam; gray when dry; friable.
6 to 30 inches, dark-brown heavy clay loam to light clay with yellowish-brown and strong-brown mottles; firm to very firm.
30 to 60 inches, dark yellowish-brown to yellowish-brown clay loam with olive-gray and dark-brown mottles; firm.

The surface soil is 2 to 4 inches thick and is underlain by a very thin, leached subsurface soil. These layers are mixed where they have been plowed. The surface soil combined with the subsurface soil ranges from 3 to 10 inches in thickness.

Most of this soil has been partly cleared of its native oak, elm, and hickory. The few remaining wooded areas are uneroded. It may not be practical to cultivate some parts of this soil that are adjacent to soils on steep, irregular side slopes.

Because of the strong slopes and the firm subsoil, runoff is rapid and further erosion is likely. This soil is suited to cultivated crops if it is terraced and tilled on the contour. It is normally farmed with adjacent soils. On terraces a rotation that includes meadow 2 years in 5 is suitable. Add manure or other organic matter to maintain tilth and increase yields. These amendments are needed in large amounts in the channels that occur on terraces. Crop yields are medium.

This soil is well suited to pasture, and where it occurs with other soils on slopes of more than 15 percent, pasture is probably the best use.

This soil is medium acid in most places and needs large amounts of lime. It is low in available nitrogen and phosphorus and is medium to low in available potassium. The response of row crops to fertilizer is moderate. Pasture plants respond very well to phosphate. Management group 7 (IIIe).

Gara loam, 9 to 14 percent slopes (GaD).—This soil has a thicker surface soil and a more distinct subsurface soil than has Gara loam, 5 to 9 percent slopes, moderately eroded. The surface soil is very dark gray, friable loam, 4 to 6 inches thick. This soil normally is in bands on rounded, strong side slopes. It is downslope from the Ladoga soils and upslope from the Colo-Gravity soils that are along small drainageways. The total acreage in the county is medium, and individual areas are as much as 100 acres or more.

Most cleared areas are in pasture. In many places this soil occurs with steeper soils that are not suited to cultivated crops. Runoff is very high because slopes are strong and the subsoil is moderately slow to slow in permeability. If it is used for cultivated crops, terrace the soil and till it on the contour to control erosion. If this soil is terraced, a rotation that includes meadow for 2 years in 4 is suitable. Yields are generally low to medium. Hay or pasture is an alternate use.

This soil produces excellent pasture. Seedings respond very well to additions of lime and of phosphate fertilizer. The soil is medium acid and is low in available nitrogen and phosphorus. It is medium to low in available potassium. The content of organic matter is medium in virgin areas. Management group 15 (IVe).

Gara loam, 9 to 14 percent slopes, moderately eroded (GaD2).—This soil is more sloping than Gara loam, 5 to 9 percent slopes, moderately eroded. It includes a few severely eroded areas. Severely eroded spots less than 1 acre in size are shown on the soil map by a spot symbol. Less than 3 inches of the original surface soil remains in some places. The texture of the surface soil ranges from loam to clay loam.

This soil is in long bands on strong, rounded side slopes. It is downslope from the Ladoga soils and upslope from the Colo-Gravity soils that are along drainageways. Some individual areas are large.

Runoff is rapid because this soil is moderately steep and permeability is moderately slow to slow. Erosion has exposed the subsoil on rounded slopes and along drains high in the sidehills. Gullies that cannot be crossed with farm machinery have formed in a few areas.

This soil contains a small amount of organic matter. Its surface soil is cloddy and hard when dry. In plowed fields the very thin, light-colored, leached subsurface layer is mixed with the surface layer.

This soil is poorly suited to row crops, but other crops planted in a rotation that includes meadow for 2 years in 4 are suitable if the soil is terraced and is tilled on the contour. To help improve tilth, add large amounts of manure. As a rule, it is best to plant a row crop only when pasture is renovated. Yields of row crops are low.

This soil produces good pasture. For best results, apply lime and phosphate. This soil is medium acid, is very low in available nitrogen, and is low in available phosphorus. Available potassium is medium to low. Management group 15 (IVe).

Gara loam, 14 to 18 percent slopes (GaE).—This soil was derived from Nebraskan till as well as from Kansan till, and it has a very dark gray, friable surface soil, 4 to 6 inches thick. In other respects it is similar to Gara loam, 5 to 9 percent slopes, moderately eroded.

This soil is on moderately steep, rounded slopes downslope from the Ladoga or Clinton soils and upslope from the Colo-Gravity soils that are along drainageways. Where it is adjacent to the valleys of major streams, this soil grades to the Olmitz or to the Gravity soils in many places. It has a large total acreage and is in large individual areas.

Most of this soil is in pasture or is wooded. Many areas are still in oak, elm, and hickory. These areas probably would be of value as woodland if they were managed well. Cleared areas are suited to pasture. If trees are removed to prepare this soil for pasture, the pasture should be seeded as soon as possible after the trees are removed because runoff is rapid and may cause erosion. Lime and a complete fertilizer may be added at the time of seeding.

This soil is medium in content of organic matter. It is low in available nitrogen and phosphorus, and is medium to low in available potassium. Management group 19 (VIe).

Gara loam, 14 to 18 percent slopes, moderately eroded (GaE2).—This steep soil contains more clay in the surface soil than Gara loam, 5 to 9 percent slopes, moderately eroded. The surface soil is slightly firm and ranges from loam to clay loam. It is low in organic matter and generally is poor in tilth. This soil was derived from Kansan or Nebraskan till but mostly from Kansan till. It is the most extensive Gara soil in the county.

Runoff is very rapid, for this soil is on long, moderately steep slopes that are dissected by many small drains. Many areas are in cultivated crops. This soil is not suited to row crops and is probably best suited to permanent pasture. It produces good pasture when managed properly.

This soil is very low in available nitrogen and is low in phosphorus. It is medium to low in available potassium. Additions of manure and fertilizer will help establish seedings. Lime is needed, for this soil is medium acid. Management group 19 (VIe).

Gara loam, 18 to 25 percent slopes (GaF).—This soil has a darker, more friable surface soil than Gara loam, 5 to 9 percent slopes, moderately eroded. A leached, grayish subsurface layer is generally present. The subsoil is 18 to 20 inches thick.

This soil formed from Kansan till or Nebraskan till that has been exposed on steep slopes. The long slopes are generally irregular and complex. This soil is downslope from the Clinton or the Ladoga soils and is upslope from the Colo-Gravity soils along drainageways. The total acreage in Adams County is large, but most individual areas are less than 20 acres. This soil has rapid runoff and is extremely erosive. A few areas where the vegetation has been destroyed are severely eroded. The content of organic matter is medium to low.

Some areas of this soil have been partly cleared of timber and are in pasture, but this pasture does not provide much grazing. Although it is difficult to renovate pasture, depleted pasture should be renovated without destroying the existing grass. The use of equipment may be dangerous because of the steep slopes and the gullies. Oak, elm, and hickory trees cover most of the acreage. This soil could be used as woodland if it were properly managed. Management group 21 (VIIe).

Gara loam, 25 to 35 percent slopes (GaG).—This very steep soil has a thinner subsoil than Gara loam, 5 to 9 percent slopes, moderately eroded. The subsoil is 18 to 20 inches thick. The surface layer is very dark and in most places is underlain by a leached, grayish subsurface layer.

This soil is on abrupt, very steep side slopes. It is downslope from the Clinton soils or from less steep Gara soils and is upslope from the Colo-Gravity soils along drainageways. The extent of this soil is less than 150 acres in Adams County. Individual areas may be as large as 20 acres but in most places are less.

This soil is in trees, mostly elm, oak, and hickory. Some areas are used for very limited grazing, but it is usually not practical to clear the soil and seed pasture. This soil is best suited as woodland. Management group 21 (VIIe).

Gara soils, 14 to 18 percent slopes, severely eroded (GbE3).—These soils differ from Gara loam, 5 to 9 percent slopes, moderately eroded, in that most of the original surface soil has been removed by erosion. The remaining surface soil is dark grayish-brown to brown clay to clay loam. These soils generally were derived from Kansan till.

These soils are in narrow, broken bands at the shoulders of rounded, moderately steep side slopes. They are downslope from the Ladoga soils and upslope from the uneroded Gara soils or the Colo-Gravity soils. In Adams County the total acreage of these soils is small; individual areas are less than 10 acres.

These soils are very erosive. Runoff is rapid because of the strong slopes, the very thin surface layer, moderately slow to slow permeability, and the sparse vegetation. Though they are suited to pasture, these soils cannot support much grazing. Overgrazing has caused erosion, and deep gullies have formed. Many areas should be reshaped and the gullies filled before seedings are established. No more vegetation should be destroyed than is necessary to smooth the gullied spots. New seedings respond well to heavy additions of manure, lime, and phosphate. A seeded pasture should be protected from grazing until the plants are well established. Areas of these soils could be used for wildlife if they are not needed for pasture. Management group 21 (VIIe).

Gosport series

The Gosport series consists of moderately well drained soils on uplands. These soils formed from weathered shale. A thin layer of loess or loess and till occurs over the shale in many places. The natural vegetation was of the forest and prairie types. These soils have a distinct, fine-textured, very slowly permeable subsoil.

These soils are on side slopes in areas that are strongly dissected by geologic erosion. Slopes range from 5 to 40 percent. The Gosport soils occur mainly in Douglas Township and tend to parallel the Middle Nodaway River. Individual areas range from 2 to 20 acres, and the total area in the county is about 60 acres.

Gosport soils, 5 to 14 percent slopes (GpD).—These soils have formed from a thin layer of loess or loess and till over shale that is generally exposed on the side slopes and on the nose of slopes. They are commonly associated with the Ladoga, Clinton, Gara, and Shelby soils. They are downslope from the Ladoga and Clinton soils and occur with the Gara and Shelby soils. Gosport soils, 5 to 14 percent slopes, are inextensive in Adams County and occur in areas of 2 to 5 acres.

Representative profile:

0 to 5 inches, dark-gray silt loam; friable.
5 to 8 inches, brown silt loam; friable.
8 to 26 inches, strong-brown, reddish-gray, or gray silty clay; very firm.
26 to 60 inches, yellowish-brown, olive-brown, or dark-red silty clay; very firm.

Gosport soils, 5 to 14 percent slopes, have a surface layer that is 3 to 12 inches thick and is underlain by a very firm, clay subsoil.

These soils are extremely erosive because they are strongly sloping and very slowly permeable in the subsoil. Although most of the acreage is in woodland or pasture, vegetation is so sparse that it gives little protection against erosion. These soils are not suited to row crops and are only moderately well suited to pasture. When necessary, pasture should be renovated without destroying the existing cover.

These soils are strongly acid. In reestablishing a pasture add lime and a complete fertilizer before seeding. Most of these soils are very low in available nitrogen, phosphorus, and potassium. The response to fertilizer is moderate to low. Management group 19 (VIe).

Gosport soils, 14 to 25 percent slopes (GpF).—These steep soils have profiles similar to those of Gosport soils, 5 to 14 percent slopes. They are on moderately steep to steep, abrupt slopes, generally near the nose of slopes that project toward the river valleys. Individual areas are 2 to 12 acres in size. These soils are surrounded by the Gara soils and are downslope from the Clinton and Ladoga soils.

Runoff is extremely rapid and has caused moderate to severe sheet and gully erosion. Some of the gullies cannot be crossed with farm machinery. These soils are in pasture or are idle. Though they are poorly suited to it, they may be used for pasture along with Gara soils. Thin stands of oak, elm, and hickory grow on the idle areas. These soils could be used for wildlife.

These soils are strongly acid and are very low in available plant nutrients. Because response to fertilizer is poor, the soils are seldom fertilized or limed. Management group 21 (VIIe).

Gosport soils, 25 to 40 percent slopes (GpG).—These soils have a surface layer that is 3 to 8 inches thick, which is thinner than that of Gosport soils, 5 to 14 percent slopes. They occur in escarpmentlike positions that face the valley of the Middle Nodaway River. These soils are downslope from the Clinton soils and grade to the Gara soils on adjacent slopes. Because areas are very small, they occupy only parts of side slopes.

The dominant native vegetation on these soils was moderately thick stands of oak, elm, and hickory. Most areas have been cut over, and the growth is scrubby. These soils are very poorly suited to pasture. They are best suited as woodland or for wildlife food and cover. Management group 21 (VIIe).

Gravity series

In the Gravity series are generally imperfectly drained soils that formed in moderately fine textured local alluvium. These soils are dark colored throughout their profile and show only weak differences in color and texture between layers. Some areas of Gravity soils in Adams County are poorly drained.

Gravity soils are on gently sloping alluvial fans or foot slopes. Generally they lie between the uplands and the first or second bottoms, parallel to the base of slopes and around the mouth of narrow drainageways.

These soils occur in every township in the county. They are commonly near strongly sloping areas that are dissected by moderately wide stream valleys. The total acreage is large in Adams County, and separate areas range from 5 to 30 acres or more.

Gravity silty clay loam, 2 to 5 percent slopes (GrB).—This soil formed from dark-colored sediments washed from the adjacent soils on uplands. It is on gently sloping, straight to slightly concave foot slopes downslope from the Shelby and Gara soils and fans out to the Colo soils on bottom lands.

Representative profile:

0 to 20 inches, black to very dark gray, gritty silty clay loam; slightly firm.

20 to 40 inches, very dark gray to very dark grayish-brown, gritty silty clay loam with few dark-brown mottles; firm to slightly firm.

40 inches +, very dark gray, gritty silty clay loam with common dark-brown and dark grayish-brown mottles; firm to slightly firm.

The dark surface layer is 20 to 24 inches thick and ranges from clay loam to silty clay loam. In most places the top part of the surface layer is a layer of very dark gray, deposited sediment, 8 to 12 inches thick.

Most of this soil has slopes of 3 percent or less. Erosion is not a serious hazard. The subsoil is of moderately slow permeability and normally absorbs most of the rainfall. This soil is often wet, for it receives excessive runoff and some seepage from adjacent uplands. The seepage is a result of an impervious layer that is upslope from these soils, but it can be prevented by tile drainage. If the uplands above this soil are terraced, artificial drainage may not be needed. Diversion terraces are often built in this soil to divert runoff that comes from the uplands.

This soil is often farmed with the Colo and Wabash soils of the first bottoms. If it is drained and well managed, it is suitable for rotations that include row crops 75 percent of the time. Yields are medium to high. Tilth may become poor after frequent row cropping but meadow grown for 1 year will improve the tilth.

This soil is high in organic matter. It is medium in available nitrogen and medium to high in available phosphorus and potassium. It needs lime, for it is slightly acid. Management group 5 (IIw).

Gullied land

Gullied land is a miscellaneous land type consisting of imperfectly drained to poorly drained soils that are severely gullied in many places. These soils occur along narrow drainageways where they formed in dark-colored, moderately fine textured alluvium. Slopes range from 2 to 5 percent. This land type occurs throughout the county, but most of it is in soil association 3.

Gullied land (Gu).—This land is similar to Colo-Gravity complex, 2 to 5 percent slopes, except that the surface soil has been removed by erosion and many deep, active gullies have formed in about half the area. Added to the problem of erosion is the problem of wetness. In most places, however, tile drainage is not needed, because the water absorbed by the soils percolates to the deep, narrow drainageways.

All this land is in pasture or is idle. It could be used to furnish food and cover for wildlife. Individual areas are generally less than 10 acres in size. Management group 21 (VIIe).

Hagener series

In the Hagener series are excessively drained soils that developed from local sands deposited on uplands by the wind. These soils are very droughty; they are very rapidly permeable and hold little moisture. They have a moderately dark surface soil that contains little organic matter. The native vegetation was of the prairie type.

These soils are in narrow bands at the crest of ridges and on side slopes. The sand from which these soils formed often crops out in fairly thick horizontal layers, between a layer of loess above and loess or till below. The sand was blown from the flood plain of the Middle Nodaway and East Nodaway Rivers. Nearly all areas of these soils in Adams County are in small spots high on the slopes east of these rivers. Slopes range from 5 to 14 percent.

The Hagener soils are in every township except Mercer and Lincoln, but the total acreage in Adams County is very small. Individual areas are 2 to 10 acres in size.

Hagener loamy fine sand, 5 to 9 percent slopes, moderately eroded (HaC2).—This sandy soil is very droughty. It occurs in horizontal bands where the thick layers of sand crop out on rounded slopes. It is surrounded by Sharpsburg soils. This is the most extensive Hagener soil in Adams County.

Representative profile:

0 to 6 inches, very dark grayish-brown loamy fine sand; friable.

6 to 15 inches, dark grayish-brown loamy fine sand; friable to loose.

15 to 48 inches +, yellowish-brown loamy sand; loose.

This soil has a moderately dark surface layer, 3 to 7 inches thick. In some places where it is thickest, the surface layer is fine sandy loam. The subsoil grades to loamy sand parent material at a depth of 12 to 20 inches.

In years of normal rainfall this soil does not hold enough moisture to supply the needs of a crop all summer. It is subject to both wind and water erosion. Because it occurs in small areas in large fields of better soils, most of this soil is cultivated. It is fairly well suited to cultivated crops, but even with good management, yields are low. To control water erosion, construct terraces upslope in the Sharpsburg soils and till this soil on the contour.

To help reduce wind erosion, leave crop residue on the surface or keep this soil in hay or pasture. Apply manure if it is needed to establish seedings.

This soil is slightly acid to medium acid. It is very low in available nitrogen and phosphorus, and it is low in potassium. Management group 17 (IVs).

Hagener loamy fine sand, 9 to 14 percent slopes, moderately eroded (HaD2).—This sandy, very droughty soil is similar to Hagener loamy fine sand, 5 to 9 percent slopes, moderately eroded. In some places it is surrounded by the Sharpsburg or the Ladoga soils. In other places it is adjacent to and downslope from Sharpsburg soils and separates those soils from Gara or Shelby soils, which lie further down the slope.

About half of this soil is used in crop rotations together with the better soils that surround it. Areas of this soil in fields with better soils are generally not large enough to fence and manage separately. Yields are low. This soil is suited to hay, late season pasture, or wildlife food and cover. Permanent vegtation is probably the best use.

This soil should be protected from wind and water erosion. If it is cultivated, leave crop residue on the surface to reduce wind and water erosion.

This soil is slightly acid to medium acid. It is very low in available nitrogen and phosphorus, and it is low in potassium. Management group 19 (VIe).

Judson series

The soils of the Judson series are well drained to moderately well drained and moderately permeable. They have formed from local alluvium that washed from adjacent loess-covered uplands. The native vegetation was of the prairie type.

These soils are on low, straight to slightly concave, gentle to strong foot slopes (see fig. 4, bottom). In this position they are generally in bands between the Sharpsburg soils upslope and soils on first and second bottoms. They also occur in nearly level areas where upland drains empty onto the bottom lands.

These soils are of minor extent and are in every township in the county. Individual areas range from 5 to 20 acres in size. Judson soils are very productive.

Judson silt loam, 0 to 2 percent slopes (JuA).—This soil is on nearly level fans that formed where upland drains empty onto bottom lands. It is generally downslope from steeper Judson soils and above soils on bottom lands. A dark buried soil is at a depth of 30 inches in some places but does not occur in other places.

Areas of these soils are normally less than 10 acres in size.

Representative profile:

0 to 30 inches, very dark brown to very dark gray silt loam; friable.
30 to 44 inches, very dark grayish-brown to dark-brown silty clay loam; slightly firm to friable.
44 to 58 inches, dark-brown silty clay loam with a few yellowish-brown mottles; slightly firm.

This soil has a dark surface layer, 18 to 30 inches thick, that absorbs moisture readily. Runoff water from the uplands deposits silt on the surface and is more of a problem than surface water. Newly emerged crops may be buried by silt after a heavy rain. A diversion terrace built upslope from this soil will divert water and reduce the deposits of silt. On the whole, this soil is excellent for cultivated crops.

Nearly all of this soil is used for cultivated crops. It is very well suited to row crops and produces high yields. Because areas of this soil are small, they are generally farmed with adjoining soils on the bottoms or terraces. Rotations that include row crops 75 percent of the time may be used. If crop residues are plowed under, the present good tilth can be maintained under intensive cropping.

This soil is high in organic matter. It generally requires lime, for it is slightly acid in most places. It is medium in available nitrogen and phosphorus. Available potassium is high. Corn that does not follow a legume responds well to a nitrogen fertilizer. Management group 2 (I).

Judson silt loam, 2 to 5 percent slopes (JuB).—This soil is similar to Judson silt loam, 0 to 2 percent slopes. It lies in gently sloping fans parallel to the base of strongly sloping, loess-covered uplands. It is mostly associated with the Sharpsburg soils on uplands that extend toward the wide stream valleys. It grades downslope toward and adjoins the loess-covered soils on benches, alluvial terraces, or first bottoms.

This is the most extensive Judson silt loam in the county, and its total acreage is large. Areas are 2 to 20 acres in size.

This soil is slightly erosive, but the amount of soil material washed away almost equals the deposits received in runoff. Small waterways that can be crossed by farm machinery occur in some places. Terraces on the cultivated Sharpsburg soils upslope generally protect this soil from deposition and runoff water and harmful sediments. If the uplands are not completely terraced, a diversion terrace near the junction of this soil and soils at the base of the upland slopes will carry away excess runoff from the uplands.

Where it is tilled on the contour, this soil is suitable for intensive row cropping. It generally is farmed with the soils on terraces or bottoms rather than with the more sloping soils on uplands. Crop yields are usually high.

Most of this soil is high in organic matter and slightly acid. It is medium in available nitrogen and phosphorus but is high in potassium. Corn that does not follow a legume will respond well to a nitrogen fertilizer. Management group 4 (IIe).

Judson silt loam, 5 to 9 percent slopes (JuC).—This soil has a slightly thinner surface layer than Judson silt loam, 0 to 2 percent slopes.

This soil occupies the foot slopes below the Sharpsburg or Ladoga soils. The slopes are straight to slightly concave and lie next to small waterways on side hills. Areas of this soil are generally very small.

Most of this soil is cultivated, generally with the Sharpsburg or Ladoga soils on the surrounding slopes. If it is terraced and tilled on the contour, it can be used for row crops frequently. Rotations that include meadow 1 year in 4 are suitable if the soil is terraced. This soil is well suited to cultivated crops and produces good yields.

Most of this soil is medium in available nitrogen and phosphorus. It is high in available potassium. It is slightly acid and is high in organic matter. Tilth is generally good. Management group 9 (IIIe).

Kennebec series

The Kennebec series consists of moderately well drained to imperfectly drained soils on first bottoms. These soils have formed in silty alluvium under prairie grasses, but a few trees occur in some places. They are dominantly black to very dark gray throughout their profile. Permeability is moderate to moderately slow.

Kennebec silt loam (0 to 2 percent slopes) (Kb).—This soil is on nearly level to flat areas along meandering streams. It lies within the curve of many of the river bends and in this position may be next to the river channel. Individual areas are 3 to 10 acres in size. This soil occurs in nearly every township in the county, generally with the Colo and Nodaway soils, but the total acreage is small.

The surface layer of this soil is silt loam, about 18 inches thick. It is high in organic matter and is underlain by silty clay loam at a depth of 30 to 48 inches. Where the silty clay loam is shallowest, this soil is slightly wetter than where the silty clay loam is deeper.

Representative profile:

0 to 18 inches, black silt loam; friable.
18 to 36 inches, black to very dark gray silt loam; friable.
36 to 54 inches, very dark brown to very dark gray silty clay loam; firm.

Because this soil is in areas that are too small to farm separately, it is farmed with soils on adjacent bottom lands. Rotations that include row crops on 75 percent or more of the acreage are suitable.

Occasional flooding and possibly a temporary perched water table may cause wetness in years when rainfall is above normal, but this soil is usually not wet enough to require tile drainage.

This soil is slightly acid. If it is limed and fertilized, it is extremely productive. Yields of row crops are normally high. This soil is medium in available nitrogen and phosphorus and is high in available potassium. Tilth is usually very good. Management group 2 (I).

Ladoga series

The Ladoga series consists of soils that developed from loess under a mixed forest and grass vegetation. These soils are moderately well drained, and the permeability of their subsoil is moderately slow.

Most areas of these soils in this county are on uplands on slopes of 2 to 14 percent, but a few are on loess-covered benches. Ladoga soils are most common along the major rivers in the areas that have been strongly dissected by geologic erosion. These soils occur in every township except Mercer and Colony, and their total area in the county is very large.

The loess from which these Ladoga soils formed is normally 10 to 16 feet thick. Beneath the upland loess in Kansan till is a paleosol similar to that in the Adair or Clarinda soils.

Ladoga silt loam, 2 to 5 percent slopes (LaB).—This soil is on gently sloping, rounded, moderately wide ridgetops. It is generally surrounded by moderately sloping Ladoga soils. Most areas in Adams County are less than 20 acres in size.

Representative profile:

0 to 6 inches, very dark gray silt loam; friable.
6 to 9 inches, dark grayish-brown to grayish-brown silt loam; gray when dry; friable.
9 to 34 inches, dark grayish-brown to dark-brown silty clay loam; firm.
34 to 44 inches, dark-brown silty clay loam with grayish-brown, yellowish-brown, and olive-gray mottles; slightly firm.

This soil has a dark surface layer, 6 to 9 inches thick, over a very thin but perceptible layer that becomes quite gray when it dries. The subsoil is silty clay loam to light silty clay, which is 24 to 30 inches thick and faintly mottled.

This soil erodes readily. The silty surface soil contains only a medium amount of organic matter and is not well granulated. Loss of soil may be severe under cultivation. If it is planted to row crops frequently, till this soil on the contour and, if necessary, terrace it. Plan a cropping system that includes meadow 1 year in 5. Add organic matter to improve tilth. Under good management yields are high.

Most of this soil is farmed with the surrounding Ladoga soils. More than half of the acreage is used for crop rotations.

This soil is medium acid and requires lime. Most of it is low in available nitrogen. It is medium to low in available phosphorus and high in potassium. Management group 3 (IIe).

Ladoga silt loam, 2 to 5 percent slopes, moderately eroded (LaB2).—The surface layer of this soil is browner than that in Ladoga silt loam, 2 to 5 percent slopes. The subsurface soil has been mixed with the plow layer in most places.

This soil is on moderately wide, gently sloping ridgetops in the townships that are adjacent to the valleys of major streams. The total acreage is very small in Adams County, and individual areas range from 5 to 10 acres.

The surface soil is friable and contains a small amount of organic matter. Water runs off rapidly and causes erosion in cultivated fields that are not tilled on the contour. With good management this soil can be used for row crops in rotations that include meadow 1 year in 5. Terraces will help to prevent runoff water from reaching the more strongly sloping sidehills. This soil is farmed with Ladoga soils on moderately sloping ridges. All of it is used for rotation crops.

This soil is medium acid and requires additions of lime before legumes are seeded. It is generally low in available nitrogen and medium to low in phosphorus. Available potassium is high. The response to nitrogen and phosphate fertilizer is good. Yields are generally high under good management. Management group 3 (IIe).

Ladoga silt loam, 5 to 9 percent slopes (LaC).—This soil has a profile similar to that of Ladoga silt loam, 2 to 5 percent slopes. It is on moderately sloping, rounded ridge crests and narrow divides. The narrow divides extend toward broader, less steep divides. Near the broad divides this soil is generally associated with the Sharpsburg soils. Below it on most of the steeper lower slopes are Gara soils. Some areas of Ladoga silt loam, 5 to 9 percent slopes, are very large. This is the third most extensive soil of the Ladoga series.

Most of the acreage is in pasture. Areas in rotation crops are generally farmed separately from other soils on side slopes. This soil is very erosive because of the rapid runoff. It is moderately well suited to row crops, and yields are often high. Rotations that include meadow 1 year in 4 are suitable if the soil is terraced and tilled on the contour.

This soil contains a medium amount of organic matter. It is medium acid and requires lime. It is low in available nitrogen, medium to low in available phosphorus, and high in potassium. The response to nitrogen and phosphate fertilizers is good. Management group 9 (IIIe).

Ladoga silt loam, 5 to 9 percent slopes, moderately eroded (LaC2).—The surface layer of this soil is thinner and browner than that in Ladoga silt loam, 2 to 5 percent slopes. In many places, the grayish subsurface soil has been mixed with the surface soil by tillage and the plow layer is noticeably lighter colored when dry.

This soil is in almost continuous bands on narrow, rounded ridgetops upslope from the till-derived soils. It is the most extensive Ladoga soil in the county. Some individual areas are more than 100 acres in size.

This soil is very erosive. The thin surface layer is low in organic matter and poorly granulated. After rains, the surface tends to crust. Plowing may expose the subsoil at the edge of slope shoulders and at the head of waterways in sidehills.

Nearly all of this soil is used in crop rotations. If it is terraced and tilled on the contour, it can be planted to row crops frequently, but the rotations should include meadow 1 year in 4. An extra year of meadow generally improves soil tilth, and applications of manure are also beneficial. Yields are high under good management.

This soil needs lime, for it is medium acid. It is low in available nitrogen, medium to low in available phosphorus, and high in potassium. The response to nitrogen and phosphate fertilizers is very good. Management group 9 (IIIe).

Ladoga silt loam, 9 to 14 percent slopes (LaD).—Steeper slopes and a slightly thinner subsoil distinguish this soil from Ladoga silt loam, 2 to 5 percent slopes. The subsoil is about 20 inches thick. This soil occurs in broken bands on strong side slopes above the Gara soils and below other Ladoga soils. Within or near areas of this soil there may be areas of Hagener loamy fine sand, 9 to 14 percent slopes, moderately eroded. Small spots of Hagener soil are shown on the soil map by the symbol for sand.

Most of this soil is in small pastures; the rest is woodland. It is generally associated with steep to very steep Gara soils, which are not suited to cultivated crops. If it is cultivated, this soil is farmed with soils higher up on the slopes.

This soil is very erosive because it is strongly sloping and poorly granulated. Since the surface soil is only moderately thick, the loss of soil should be reduced. This soil can be planted to a row crop occasionally if fields are tilled on the contour and terraced. Yields of crops are medium. A very good use is pasture, but the pasture should be renovated for highest yields.

This soil is medium acid. It is generally low in available nitrogen, medium to low in phosphorus, and high in potassium. The response to nitrogen and phosphate fertilizer is usually good. Management group 10 (IIIe).

Ladoga silt loam, 9 to 14 percent slopes, moderately eroded (LaD2).—The surface soil of this soil is thinner and lighter colored than that in Ladoga silt loam, 2 to 5 percent slopes. In most places the subsurface layer has been mixed with the surface layer by plowing. Some of the loess parent material may have come from adjacent river valleys. Small areas of Hagener loamy fine sand, 9 to 14 percent slopes, moderately eroded, are within or near areas of this soil in some places.

This soil is in bands on strong side slopes downslope from other Ladoga soils. It entirely occupies many side slopes that grade to first or second bottoms. In Adams County, individual areas may be as much as 30 acres, and the total acreage is large.

Runoff is very rapid on this soil. The thin surface soil, which contains little organic matter, is very erosive. On the rounded slopes between waterways in the sidehills, the subsoil is exposed and in some places has been mixed with the surface layer by plowing. After rains the surface soil tends to seal and crust.

Because this soil occurs with better soils, most of it is used with those soils in crop rotations. The rotations should include meadow 2 years in 5, and the fields should be terraced and tilled on the contour for row crops. To improve tilth, apply manure and, if necessary, allow the meadow to grow an additional year. Crop yields are medium.

This soil is medium acid and needs lime. It is generally very low in available nitrogen, is medium to low in phosphorus, and is high in potassium. It responds well to applications of nitrogen and phosphate. Management group 10 (IIIe).

Ladoga soils, 5 to 9 percent slopes, severely eroded (LdC3).—These soils have a thinner surface layer that is of more varied texture than that in Ladoga silt loam, 2 to 5 percent slopes. The surface layer is brown to dark-brown silty clay loam in most places and is less than 3 inches thick. When these soils are dry, cracks are more numerous and deeper than they are in the less eroded Ladoga soils.

These soils are on rounded divides of moderate slope. They generally are in narrow, broken bands immediately downslope from the more nearly level divides. In Adams County, the total acreage is less than 80 acres and most areas are less than 10 acres. Areas less than 1 acre in size that occur in other soils are shown on the soil map by the symbol for severely eroded spots.

Because of poor tilth and moderate slopes, water runs off these soils rapidly. The soils are very low in organic matter. An exposed, firm subsoil makes plowing difficult. Nearly all of the acreage is cultivated along with the better Ladoga soils. Ladoga soils, 5 to 9 percent slopes, severely eroded, should be in a rotation that includes meadow for 1 year more than is customary on the better soils. The rotation on terraces should provide meadow 2 years in 5. Yields of crops are medium. Applications of manure will help to improve tilth.

These soils are medium acid. They are very low in available nitrogen and, in most places, are low in phosphorus and high in available potassium. Applications of lime and phosphate are needed to establish seedings.

The response to nitrogen and phosphate fertilizers is fairly good. Management group 8 (IIIe).

Ladoga silt loam, benches, 0 to 2 percent slopes (LbA).—This soil has a very dark gray to dark grayish-brown surface soil instead of a very dark gray one like that in Ladoga silt loam, 2 to 5 percent slopes. It is on nearly level, moderately wide, loess-covered benches that extend into the valleys of the Middle Nodaway and East Nodaway Rivers. The loess is 15 feet or more thick in most places and is underlain by alluvium.

This soil is associated with moderately sloping to strongly sloping Ladoga soils that are upslope from it and farther from the rivers. Gently sloping or moderately sloping Ladoga soils generally extend from this soil toward the first bottoms. The total acreage of this soil is very small and is distributed in only a few townships that parallel the Middle Nodaway and East Nodaway Rivers. This soil is important, agriculturally, however, because row crops can be planted frequently. Individual areas range from 3 to 10 acres in size.

The surface layer is friable, but it may form a crust when drying. It is medium in organic-matter content. This soil is well suited to row crops, and yields are generally high. If crop residues are returned to the soil and heavy applications of fertilizers are used, this soil is suitable for intensive row cropping. If tilth becomes poor, keep the soil in meadow for 1 year.

This soil is medium acid and requires lime. It is generally low in available nitrogen, medium to low in available phosphorus, and high in available potassium. The response of corn to nitrogen and phosphate is good. Some areas may need a complete fertilizer. Management group 1 (I).

Ladoga silt loam, benches, 2 to 5 percent slopes (LbB).—This soil generally has a browner, lighter colored surface layer than has Ladoga silt loam, 2 to 5 percent slopes. It is on the gently sloping, moderately high, loess-covered benches that finger out into the river bottoms. It also occupies some moderately wide benches that break abruptly from the strongly sloping Ladoga soils upslope. It generally adjoins moderately sloping Ladoga soils downslope. The loess in which the soil formed is 15 feet or more thick and is underlain by alluvium.

A large part of this soil is cultivated. Though the surface soil is friable, it is poorly granulated and is susceptible to erosion. Terraces are difficult to establish, however, because of the irregular soil pattern. Rotations that include meadow 1 year in 5 are suitable if this soil is tilled on the contour. Crop yields are usually high.

Most of this soil needs lime, for it is generally medium acid. In many places it is low in available nitrogen, medium to low in phosphorus, and high in available potassium.

The response of crops to nitrogen and phosphate fertilizers is usually good. In some places this soil may need a complete fertilizer for best yields. Management group 3 (IIe).

Macksburg series

The soils of the Macksburg series have developed in uplands on nearly level to gently sloping, broad divides. (See figure 3.) These soils were formed from loess under prairie grasses. They are imperfectly drained and have a prominent, thick, dark surface horizon. The permeability of the subsoil is moderately slow to moderate.

The loess from which these soils formed is 10 to 16 feet thick. Beneath the loess is Kansan till in which paleosols similar to those in Clarinda soils are present.

These soils are most common in the southeastern part of the county, especially in general soil area 1, but they are in every township east of the Middle Nodaway River. Many areas are more than 100 acres in size, and their total acreage is large.

Within areas of Macksburg soils are small areas of the very poorly drained Sperry soils. These small areas are shown on the soil map by the symbol for wet spots.

Macksburg silty clay loam, 0 to 2 percent slopes (MaA).—This imperfectly drained soil has formed from moderately fine textured loess on nearly level uplands that have not been dissected by drainageways. It generally surrounds the poorly drained Winterset and the very poorly drained Sperry soils. This soil is closely associated with Sharpsburg soils that are on rounded slopes and narrow divides.

Representative profile:

0 to 20 inches, black silty clay loam; friable.
20 to 42 inches, very dark grayish-brown silty clay loam mottled with grayish brown and olive gray; firm to slightly firm.
42 to 59 inches, olive-gray silty clay loam mottled with yellowish brown; slightly firm.

The surface layer of this soil ranges from 16 to 20 inches in thickness and is underlain by a very dark brown layer that has grayish mottles. Although the subsoil absorbs moisture somewhat slowly, tile lines are generally not needed. The wet spots within this soil, however, may be artificially drained. Because it is slow to warm up in the spring, this soil may have to be worked later than adjacent Sharpsburg soils.

Nearly all of this soil is used for cultivated crops. It is one of the most productive soils in the county, and many areas are large enough to farm separately. Row crops can be grown almost continuously. Maintain tilth and fertility by plowing under all crop residues, and if necessary, replace meadow in the rotation with a green-manure crop.

This soil is high in organic matter and is generally in good tilth. In most places it is well granulated. It is generally medium to low in available nitrogen, medium in available phosphorus, and high in available potassium. If row crops are planted frequently, nitrogen and phosphate fertilizers are needed. The response is very good. This soil is slightly acid and requires additions of lime. Management group 1 (I).

Macksburg silty clay loam, 2 to 5 percent slopes (MaB).—This soil is similar to Macksburg silty clay loam, 0 to 2 percent slopes. It is at the head of drains in gently sloping, large, bowl-shaped areas that break from the upland flats. It is dissected by many drainageways that can be crossed with farm machinery. This soil is imperfectly drained, but its use is not seriously limited by wetness. However, tile is needed in some of the drainageways. Erosion is a slight problem if row crops are planted.

This soil is very well suited to frequent row cropping. It is used mostly for cultivated crops. Rotations that include meadow only 1 year in 5 are suitable if tillage is on the contour. Crop yields are usually very high.

This soil is high in organic matter and is generally in good tilth. If the small drains are worked when wet the surface may become puddled. This soil is medium to low in available nitrogen, medium in available phosphorus, and high in available potassium. Most crops respond very well to nitrogen and phosphate fertilizers. This soil is slightly acid and requires additions of lime. Management group 3 (IIe).

Nevin series

The soils of the Nevin series have formed from silty alluvium. They are imperfectly drained and have a firm subsoil that is moderate to moderately slow in permeability. The native vegetation was dominantly of the prairie type.

These soils are on second bottoms in the wide valleys of rivers. Slopes range from 0 to 2 percent. Many areas are bounded by abrupt escarpments that may drop several feet to first bottoms.

These soils are of moderate extent in Adams County and only occur in the townships that are dissected by the East Nodaway and Middle Nodaway Rivers.

Nevin silt loam (0 to 2 percent slopes) (Nn).—This soil has a dark silt loam surface layer, 12 to 18 inches thick, that is underlain by moderately well developed silty clay loam subsoil. Part of the clay in the subsoil was brought down from upper layers, but some is probably a part of the original alluvium. The subsoil is distinctly mottled.

This soil is on nearly level, moderately broad second bottoms that are slightly higher than the adjacent first bottoms. Because of this position, flooding from the rivers is not likely, but areas adjacent to foot slopes may receive runoff that brings in deposits of soil material.

This soil is slightly downslope from the Wiota soils and a little higher than the Bremer soils and the Colo and Wabash soils on first bottoms.

Individual areas are from 5 to 20 acres in size.

Representative profile:

0 to 16 inches, black silt loam; friable.

16 to 42 inches, very dark gray to dark grayish-brown silty clay loam mottled with dark brown, grayish brown, and yellowish brown; gleyed; slightly firm to firm.

42 to 60 inches, dark grayish-brown to grayish-brown silty clay loam mottled with yellowish brown; firm to slightly firm.

This soil is imperfectly drained but normally does not need tiling. The rainfall is generally absorbed and does not cause excessive runoff, but protection is needed in some places. This protection can be provided by constructing diversion terraces at the base of upland slopes.

All of this soil is in cultivated crops. It is very well suited to row crops and produces high yields if it is protected from runoff. It is suitable for intensive row cropping if fertilizer is applied regularly and disease and insects are controlled. A green-manure crop every 4 or 5 years normally helps to maintain tilth.

This soil is slightly acid and may need lime for best yields. It is generally medium to low in available nitrogen and is medium in available phosphorus. The available potassium is usually high. If row crops are planted frequently, additions of nitrogen and phosphate are required. Management group 1 (I).

Nodaway series

The Nodaway series consists of moderately well drained to imperfectly drained soils that have formed on first bottoms from light-colored silty alluvium. These soils are moderately permeable. Vegetation has not influenced soil formation. Nodaway soils are likely to be flooded in periods of high rainfall and to receive deposits of medium-textured material.

Slopes range from 0 to 2 percent and are more undulating than those of some other soils in the county on bottom land. The undulating slopes are often remnants of old meandering streams. In some places a large permanent stream dissects areas of Nodaway soils or runs parallel to the boundary. (See fig. 4, bottom.)

These soils generally occur on wide stream bottoms with the Colo soils. They occupy large areas in the county.

Nodaway silt loam (0 to 2 percent slopes) (No).—This soil is friable and shows little development in the profile. In some areas a dark buried soil may be present below a depth of 36 inches. In areas that receive only small amounts of deposits, the color of the surface layer is darker than in the less stable areas and may grade toward dark gray. The subsoil is not highly mottled in most places, but the degree and color of mottling varies with the frequency of overflow. Permeability is moderate in the subsoil.

This soil is on nearly level first bottoms. Where large stream channels have been straightened, some areas are slightly undulating. Areas that were once old bayous are farmed in these areas.

This is the most extensive Nodaway soil in the county. Individual areas are 10 to 50 acres in size.

Representative profile:

0 to 20 inches, dark grayish-brown silt loam; friable.

20 to 54 inches, brown to very dark grayish-brown stratified silt loam with few yellowish-brown mottles; friable.

Nodaway silt loam is very well suited to cultivated crops. Most of it is cultivated, but occasional flooding is a hazard. Pasture and woodland are flooded more frequently than cultivated fields because the pasture or woodland is generally next to the main river channel. Instead of artificial drainage, protection from overflow is needed.

This soil is suitable for intensive row cropping. Tilth is usually not a problem, though the content of organic matter is low. This is a very responsive soil; it warms up quickly and can be worked earlier in spring than the dark-colored soils on bottom lands. Except after damaging floods, crop yields are generally high.

This soil normally does not need lime. It is low in available nitrogen, is medium in available phosphorus, and is high in available potassium. Apply a nitrogen fertilizer for highest corn yields. Management group 2 (I).

Nodaway silt loam, channeled (Nw).—This soil contains lenses of coarse silt to loamy sand and is more stratified than Nodaway silt loam. It is also more mottled. It occupies undulating first bottoms next to the stream channels and is dissected by many meandering streams and oxbows. The channels cannot be crossed with farm machinery and in many places are filled with water and clayey sediments.

Because it is frequently flooded, this soil is not suited to cultivated crops. Nearly all of it is in scattered young trees and in pasture. It can be farmed if it is cleared, protected from floods, and old channels are filled. However, its best use is probably for pasture or for wildlife habitats. This soil is well suited to pasture, but floods may damage legumes seeded in pastures or smother them with sediments.

Lime is not needed. Unless flooding is prevented, fertilizer is not usually beneficial. Management group 18 (Vw).

Olmitz series

The Olmitz series consists of well drained to moderately well drained, gritty soils on uplands. These soils have formed from loamy materials that washed from the adjoining slopes. They are moderate to moderately slow in permeability. The native vegetation was of the prairie type.

These soils occupy many slightly concave foot slopes of 2 to 9 percent between the soils on the bottom lands and the steeper till-derived soils on hillsides. They are not, however, in a continuous band. Olmitz soils are also on alluvial fans. Areas range from 3 to 30 acres in size. These soils are present in every township in the county, and the total acreage is moderate.

Olmitz loam, 2 to 5 percent slopes (OmB).—This soil generally is on gently sloping alluvial fans at or near the mouth of upland drainageways. It is nearly uniform in texture throughout the profile. The variations in texture that do occur probably result from deposits of sediments varying in texture rather than from profile development.

Representative profile:

0 to 24 inches, very dark gray loam; friable.
24 to 38 inches, very dark grayish-brown clay loam with few yellowish-brown mottles; friable to slightly firm.
38 to 56 inches, very dark grayish-brown clay loam with few dark-brown mottles; friable to slightly firm.

The thick surface layer of this soil ranges from loam to light clay loam. It is black to very dark gray, depending on the amount and kind of sediments that have been recently deposited. In most areas these sediments are moderately dark colored and are in a layer 6 to 18 inches thick. This soil is closely associated with Shelby and other till-derived soils that are upslope, and it grades downslope to soils on first and second bottoms.

Olmitz loam on alluvial fans receives runoff and overwash from the uplands. This water is carried away in small drains that form. A terrace constructed upslope will divert runoff, prevent the drains from deepening, and reduce the hazard of sheet erosion.

Many areas of this soil are cultivated, generally with the soils on adjoining bottom lands. Because it is somewhat erosive, this soil should be tilled on the contour. Normally, however, it receives new sediment about as fast as it loses soil through erosion. If it is tilled on the contour, this soil is suitable for intensive row cropping. Average yields are normally high. Tilth is usually good.

This soil contains a medium amount of organic matter. It needs additions of lime and, if corn is grown frequently, a nitrogen fertilizer. In most places it is medium in available nitrogen and phosphorus but generally contains an adequate amount of available potassium. Management group 4 (IIe).

Olmitz loam, 5 to 9 percent slopes (OmC).—This soil has a profile similar to that of Olmitz loam, 2 to 5 percent slopes. It is on moderately sloping foot slopes that are concave to nearly straight. It lies below the steeper Shelby and other till-derived soils, and next to the gently sloping soils, which are near the major streams. In some places it grades to the Colo-Gravity soils downslope, especially in the strongly dissected areas that parallel the drainageways emptying into the river valleys.

This soil receives soil material in deposits, and loses soil through erosion. Excessive runoff from the uplands sometimes forms rills or small gullies. In some places the gullies are large enough to hinder farm operations. Most of this soil can be protected from excessive surface water by diversion terraces built near the base of the steeper slopes, but in some places the diversions cannot be built in an effective location.

Some of this soil is used in crop rotations, generally with the soils that lie downslope. Under contour tillage a rotation that includes meadow 1 year in 4 is suitable. A diversion may also be required. Yields of crops are usually high. Some small areas of this soil are in pasture that is not near cropland. Because these areas are less than 10 acres in size, they are likely to remain in pasture. The pasture can be renovated to raise its carrying capacity.

This soil is medium in organic matter and is slightly acid. For best yields it should be limed. It is medium in available nitrogen and phosphorus and is generally high in available potassium. Management group 9 (IIIe).

Sharpsburg series

The soils of the Sharpsburg series have formed from loess and are well drained to moderately well drained. Permeability is moderate to moderately slow. The native vegetation was prairie grasses. Sharpsburg soils in the eastern part of the county contain slightly more clay in the subsoil than those in the western part.

The position of these soils ranges from sites on nearly level uplands to those occupying entire side slopes and high benches. (See figs. 3 and 4.) Slopes range from 0 to 18 percent. Sharpsburg soils are the most extensive in the county and are generally in very large individual areas.

The loess from which the Sharpsburg soils on uplands developed is normally 10 to 16 feet thick in nearly level areas and is underlain by paleosols. These paleosols are similar to Adair and Clarinda soils, which developed in Kansan till. The loess is thinner on the more sloping areas.

Sharpsburg silty clay loam, 0 to 2 percent slopes (SaA).—This soil is generally east of the Middle Nodaway River. It is on moderately wide, nearly level uplands. The uplands are slightly rounded instead of flat and are bordered by steeper Sharpsburg soils. Areas of this soil are from 5 to 20 acres in size, but the total acreage in Adams County is small.

Representative profile:

0 to 15 inches, black to very dark gray silty clay loam; friable.

15 to 36 inches, dark-brown silty clay loam with few yellowish-brown and grayish-brown mottles; slightly firm to friable.
36 to 48 inches, yellowish-brown silty clay loam with common olive-gray mottles; slightly firm. This horizon may grade to olive-gray silty clay loam at 42 to 54 inches.

This soil has a dark surface layer, 10 to 16 inches thick. Although the surface layer and the subsoil are silty clay loam, the subsoil contains more clay than the surface layer. Olive-gray mottles may begin at a depth of 30 inches in some places.

This soil has few limitations, but it needs good management. Tilth is generally good and can be maintained if crop residues are returned to the soil. This soil is well suited to intensive row cropping. Yields are among the highest in the county.

This soil is slightly acid in most places and needs additions of lime. It is medium to low in available nitrogen, medium in available phosphorus, and usually high in available potassium. The soil requires additions of nitrogen and phosphate if it is cultivated intensively to row crops. Management group 1 (I).

Sharpsburg silty clay loam, 2 to 5 percent slopes (SaB).—This soil has a profile similar to that of Sharpsburg silty clay loam, 0 to 2 percent slopes. It is one of the most extensive soils in the Sharpsburg series. Some areas are more than 100 acres in size. This soil is on gently sloping ridgetops and in many places is in continuous bands on ridge crests that extend downslope from Macksburg or other soils on broad upland flats. In many places this soil is the boundary of small watersheds.

It is somewhat erosive. The small drainageways that form can be crossed by farm machinery. Small areas of Macksburg soils occurring near these drains are included.

This soil should be tilled on the contour if it is planted to row crops. In some places terraces are needed to prevent runoff from reaching the steeper slopes. Plan rotations that include meadow 1 year in 5. Yields of crops are generally high.

This soil is high in organic matter and generally is in good tilth. It is normally slightly acid. Most areas are medium to low in available nitrogen, medium in available phosphorus, and high in available potassium. Most crops respond well to nitrogen and phosphate fertilizers. Management group 3 (IIe).

Sharpsburg silty clay loam, 2 to 5 percent slopes, moderately eroded (SaB2).—This soil has a thinner, lighter colored surface layer than Sharpsburg silty clay loam, 0 to 2 percent slopes. The surface layer is very dark grayish brown and is 4 to 10 inches thick. In most places the subsoil is immediately below the plow layer but is not mixed with it.

This soil occurs on ridgetops of varied width. In many places it is surrounded by moderately sloping Sharpsburg soils on lower slopes. Areas of this soil are normally 5 to 15 acres, but the total acreage is large.

Runoff is generally high because this soil is sloping and its surface layer is compacted in most places. Much of the original surface soil has been lost through erosion. This soil dries out cloddy and hard and needs to be improved in tilth. If the soil is tilled on the contour, rotations that include meadow 1 year in 5 are suitable. Apply manure to improve soil granulation and thus to help hold soil losses to a minimum. If this soil is managed well, yields are high.

Available nitrogen is low, available phosphorus is medium, but available potassium is sufficient to supply the needs of plants. Crops respond well to additions of lime, nitrogen, and phosphate. Management group 3 (IIe).

Sharpsburg silty clay loam, 5 to 9 percent slopes (SaC).—This soil is similar in profile to Sharpsburg silty clay loam, 0 to 2 percent slopes. The total acreage is extensive in the county, and some individual areas are large. This soil is in every township, generally below the Sharpsburg soils on gentle slopes and above till-derived soils. In parts of the eastern tier of townships, especially in Mercer, it may entirely occupy the moderate convex side slopes.

This soil includes some small areas of Clearfield silty clay loam, 5 to 9 percent slopes. These included areas are shown on the soil map by the symbol for wet spots.

This soil erodes readily if it is cultivated, because water runs off in large amounts. Most of it is in pasture, possibly because it occurs with soils that are less desirable for cultivated crops. This soil is well suited to row crops, but it should be terraced and tilled on the contour. Rotations that include meadow 1 year in 4 are suitable on terraces. This soil is farmed separately or with better soils on gentle slopes. Crop yields are usually high under good management.

This soil is high in organic matter. It has a well-granulated, friable surface layer. It is slightly acid, is medium to low in available nitrogen, and is medium in available phosphorus. Additions of lime and nitrogen are needed if this soil is used for cultivated crops. Phosphate is required in some places for maximum yields. It generally does not need potash. Management group 9 (IIIe).

Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded (SaC2).—The very dark grayish-brown surface layer of this soil is 4 to 10 inches thick. It is thinner and lighter colored than the surface soil in Sharpsburg silty clay loam, 0 to 2 percent slopes. Less than 3 inches of the original soil remains in a few small areas. These small areas that are less than 1 acre in size are shown on the soil map by the symbol for severely eroded spots.

This is the most extensive soil in Adams County, and it occurs in every township. It occupies narrow divides and crests in continuous bands that are upslope from the till-derived soils. It is adjacent to and below the more gently sloping Sharpsburg soils, generally in places where the divides widen. In areas adjacent to the valleys of major streams it is closely associated with the Ladoga soils.

This soil is generally in poor tilth. The surface soil is cloddy and hard when it dries. Water runs off excessively because the soil is moderately sloping and absorbs moisture slowly. The subsoil may be exposed on the surface at the shoulder of slopes or near drains in sidehills.

Nearly all of this soil is farmed in crop rotations. It is moderately well suited to row crops and normally produces high yields. If row crops are planted, however, this soil needs to be terraced and tilled on the contour.

This soil contains a medium amount of organic matter. It can be worked more easily if manure or other organic matter is added. It is slightly acid and needs additions of lime. This soil is low in available nitrogen and is medium to low in available phosphorus. It generally contains enough potassium to supply the needs of plants. Crops respond well to nitrogen and phosphate fertilizers. Management group 9 (IIIe).

Sharpsburg silty clay loam, 9 to 14 percent slopes (SaD).—The surface layer of this soil ranges from 8 to 12 inches in thickness, and the subsoil is slightly less thick than that of Sharpsburg silty clay loam, 0 to 2 percent slopes. In the northwestern part of the county, the parent material in some places is a silt loam instead of a silty clay loam.

This soil occurs to a limited extent in every township in the county. Most of it is near the valleys of major streams. Small areas of Hagener loamy fine sand are included with or are associated with this soil, especially in areas east of the Middle Nodaway and East Nodaway Rivers. The included Hagener soils are shown on the map by a symbol for sands.

This soil is on narrow, strong side slopes that probably have been protected from extensive geologic erosion. In other places it entirely occupies side slopes that are mantled with loess and grade toward first or second bottoms. Less sloping Sharpsburg soils are upslope from this soil, and till-derived soils are downslope from it. The total acreage is moderate in Adams County, and individual areas range from 5 to 40 acres or more.

Most of this soil is in pasture. If it is needed for cultivated crops, it should be protected from erosion by terraces. With terraces and contour tillage, rotations that include meadow 2 years in 5 are suitable. Because it is in small, irregularly shaped areas, this soil is generally farmed with the adjoining soils on the side slopes. However, it is better suited to cultivated crops than are other soils on slopes of 9 to 14 percent. Yields of row crops are medium.

This soil contains much organic matter and is generally in good tilth. It is slightly acid and needs additions of lime. The available nitrogen is medium to low, available phosphorus is medium, and available potassium is high. The response to added nitrogen is good. Management group 10 (IIIe).

Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded (SaD2).—The surface soil is thinner than that in Sharpsburg silty clay loam, 0 to 2 percent slopes. It is very dark grayish brown and is 3 to 7 inches thick. In some areas less than 3 inches of the original surface layer remains. These places are shown on the soil map by the symbol for severely eroded spots. Material from the former subsoil is mixed into the plow layer in some places. The subsoil is generally only 12 to 18 inches thick and is not so fine textured as that in Sharpsburg soils on more gentle slopes. The parent material ranges from a heavy silt loam to a silty clay loam, especially in Lincoln Township and in townships bordering the Nodaway Rivers.

In Adams County this soil is more common in the northwestern part. In some places it is in narrow bands between the till-derived soils and less steep Sharpsburg soils. It is upslope from the till-derived soils and downslope from the less steep Sharpsburg soils. In other places it covers entire side slopes that extend to the major stream bottoms. It is in areas ranging from 5 to 60 acres in size. The total acreage in Adams County is large.

Although it contains a medium amount of organic matter, this soil sometimes dries out hard and cloddy. The subsoil is exposed in many places at the crest of rounded ridges and near the upper reaches of crossable drains.

This soil is very erosive because it is strongly sloping and generally is in poor tilth. It is suited to row crops, however, and is one of the better soils on 9 to 14 percent slopes. Nearly all of this soil is used in crop rotations. To maintain good tilth, terrace the soil, till it on the contour, and add manure. Plan rotations that include meadow 2 years in 5. Yields of crops are medium under good management.

This soil is slightly acid and generally needs additions of lime. It is low in available nitrogen, is medium to low in available phosphorus, but contains an adequate amount of potassium. Nitrogen and phosphate fertilizers are needed for corn that does not follow a legume. Management group 10 (IIIe).

Sharpsburg silty clay loam, 14 to 18 percent slopes (SaE).—This soil has a thinner and lighter colored surface layer than has Sharpsburg silty clay loam, 0 to 2 percent slopes. The surface layer is dark grayish-brown silty clay loam and is 7 to 12 inches thick in most places. The subsoil is 12 to 18 inches thick and is moderately permeable.

This soil is in narrow bands in bowl-shaped areas at the upper parts of drainageways and is on the shoulders of moderately steep slopes. It is directly downslope from other Sharpsburg soils and upslope from till-derived soils.

The total acreage in Adams County is about 75 acres. Areas range from 3 to 30 acres in size, but the smaller areas are most common.

This extremely erosive soil is poorly suited to cultivated crops. It should be kept in meadow 3 years in 5, even where terraced. Most of it is in pasture. Under good management, it has a moderately high carrying capacity. Most pasture, however, should be renovated and seeded to better suited grasses and legumes. A row crop is generally grown on the contour for 1 year after the pasture is plowed for renovation.

This soil is slightly acid and needs additions of lime. It is medium to low in available nitrogen and medium in available phosphorus. Available potassium is generally high. Management group 15 (IVe).

Sharpsburg silty clay loam, benches, 0 to 2 percent slopes (SbA).—This soil has a profile similar to that of Sharpsburg silty clay loam, 0 to 2 percent slopes, but normally olive-gray mottles occur at a depth of 30 inches or more. It is on high to moderately high benches that extend into the valleys of the Middle Nodaway and East Nodaway Rivers. Generally, it is partly surrounded by more sloping Sharpsburg soils. In many places this soil extends from the Judson soils on low foot slopes to soil on the first bottoms. Areas of this soil range from 5 to 20 acres in size, and the total area in Adams County is small.

The loess parent material is 15 feet or more thick and is underlain by alluvial material. This soil can be planted to row crops intensively if it is managed well. Though row crops can be grown almost continuously, plow under all crop residue, and seed and plow under a green-manure crop when it is needed to improve tilth.

This soil is slightly acid. It is medium to low in available nitrogen and medium in phosphorus. The response to nitrogen and phosphate fertilizers is good. This soil contains enough potassium to supply the needs of plants. Management group 1 (I).

Sharpsburg silty clay loam, benches, 2 to 5 percent slopes (SbB).—This soil is similar to Sharpsburg silty clay loam, 0 to 2 percent slopes, but olive-gray mottles occur at a greater depth. It occupies gently sloping, moderately high benches. These benches extend into valleys of the Middle Nodaway and East Nodaway Rivers. This soil is in the townships that parallel those rivers. It covers the entire bench in some places. Generally, however, it is in bands below Sharpsburg silty clay loam, benches, 0 to 2 percent slopes, and it extends to first bottoms. Areas range from 10 to 40 acres in size.

The loess parent material is 15 feet or more thick and is underlain by alluvium. All of this soil is used for crops grown in rotations. It is well suited to row crops and under good management produces high yields. This soil is somewhat erosive and should be tilled on the contour or terraced. Terracing may be difficult and impractical because of the complex soil pattern. Rotations that include meadow 1 year in 5 are suitable if erosion is controlled by contour tillage. This soil is medium to low in available nitrogen and is medium in phosphorus. It is usually high in available potassium. It needs nitrogen and phosphate fertilizers if row crops are planted frequently. Management group 3 (IIe).

Shelby series

This series consists of well drained to moderately well drained, gently sloping to steep soils that have formed on uplands from glacial till. (See fig. 3, bottom, and fig. 4, top and bottom.) These soils have a prominent, yellowish-brown subsoil. They are moderately slow in permeability and are calcareous at a depth of 30 to 60 inches. The native vegetation was of the prairie type with a few trees in places. Small areas of Adair soils occur with Shelby soils in some places.

Shelby soils are very extensive in Adams County. They occur in large areas in every township.

Shelby loam, 5 to 9 percent slopes, moderately eroded (ShC2).—This soil has formed from Kansan till. It is generally on narrow, rounded, moderately sloping divides. It also occurs at the base of foot slopes as isolated knolls that have been partly separated from the uplands by geologic erosion.

This soil is associated with Sharpsburg or Adair soils, which lie upslope.

Downslope it adjoins steeper Shelby soils. In some places it extends directly to the narrow drainageways. This soil is in areas ranging from 3 to 10 acres in size, and the total acreage in Adams County is small.

Representative profile:

0 to 8 inches, very dark gray loam; slightly firm.
8 to 27 inches, dark yellowish-brown clay loam with a few dark-brown mottles; firm.
27 to 40 inches, dark yellowish-brown clay loam with common olive-gray mottles; firm.

The dark-colored surface layer ranges from 4 to 8 inches in thickness and from loam to clay loam in texture. The subsoil is firm clay loam and is generally 18 to 24 inches thick.

This soil is very erosive. Runoff is excessive because of the somewhat poor tilth and the moderate slopes. If it is used for row crops, this soil should be terraced and tilled on the contour. Terracing, however, may be difficult because of the complex soil pattern.

Some of this soil is in permanent pasture. It is well suited to pasture and has a high carrying capacity. In the few areas that can be cultivated, rotations that include meadow 1 year in 4 are suitable if the fields are terraced. Crop yields are medium.

This soil is likely to puddle if it is worked when wet, and the surface layer may dry out cloddy and hard. In eroded spots the subsoil and surface layer are mixed by plowing. Applications of manure may be used to improve tilth and to increase the absorption of moisture on these eroded areas.

In most areas, this soil is slightly acid, but the parent material contains lime at a depth of 30 to 60 inches or more. Generally, this soil is low in available nitrogen and phosphorus. It is medium in available potassium. Management group 9 (IIIe).

Shelby loam, 9 to 14 percent slopes (ShD).—The surface layer of this soil is 9 to 12 inches thick. It is thicker and more friable than the surface layer of Shelby loam, 5 to 9 percent slopes, moderately eroded, and is dominantly loam. It grades, however, to silty clay loam near the loess soils upslope.

Shelby loam, 9 to 14 percent slopes, formed from Kansan till. It generally bands the lower slopes at the head of drainageways and extends to the strong side slopes. In some places it is in strongly dissected areas at the end of ridges. It is similar to the adjoining steep Shelby soils and is downslope from the Adair and Clarinda soils. Individual areas are about 20 acres in size. This soil is in every township in the county.

Because of the strong slopes and slowly permeable subsoil, water runs off excessively. This soil is very erosive if cultivated. If row crops are planted, terrace the soil and till it on the contour. Rotations that include meadow 2 years in 5 are suitable on terraced fields. Yields of crops are usually medium. Much of this soil is in permanent pasture, and some of it probably will remain so because it is managed with other soils poorly suited to cultivation. Pasture on this soil is excellent after it is renovated.

The tilth of this soil is generally very good. The content of organic matter is high. Lime is required in most areas, although an adequate amount is present at a depth below 60 inches. The amount of available nitrogen and phosphorus is medium to low, and the available potassium is medium. Management group 10 (IIIe).

Shelby loam, 9 to 14 percent slopes, moderately eroded (ShD2).—This soil is similar to Shelby loam, 5 to 9 percent slopes, moderately eroded. The surface layer is very dark grayish-brown loam to clay loam that is slightly firm and becomes crusty when it dries.

This soil formed from Kansan till on moderate, rounded slopes, generally in areas that are strongly dis-

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sected. It is in bands that in many places completely encircle the sidehills. It is directly downslope from Sharpsburg, Ladoga, Adair, or Clarinda soils. This soil occurs throughout Adams County in areas as much as 100 acres in size and is the most extensive Shelby soil in the county.

If it is cultivated, this soil erodes readily. The yellowish-brown firm subsoil is exposed near some drains in sidehills and near areas of Sharpsburg and Ladoga soils that are upslope. Additional losses of the surface soil will reduce crop yields.

This soil is moderately well suited to row crops and is generally used in crop rotations. Rotations that include meadow 2 years in 5 are suitable if the soil is terraced and tilled on the contour. Yields are medium if management is good.

Although lime occurs at a depth of 40 inches or more, this soil is slightly acid. It is generally low in available nitrogen and phosphorus and is medium in potassium. It responds well to nitrogen and phosphate fertilizers. Applications of manure improve tilth and fertility. Management group 10 (IIIe).

Shelby loam, 14 to 18 percent slopes (ShE).—The profile of this soil is similar to that of Shelby loam, 5 to 9 percent slopes, moderately eroded. It formed from Kansan till or from Nebraskan till. The surface layer is friable loam, but near the base of some long, uniform slopes, it has been covered by 8 to 12 inches of local alluvium that washed down from the upper part of the slope.

This is one of the dominant till-derived soils on moderately steep slopes in the county. It occurs in every township, but most of it is near the valleys of large streams. It covers entire side slopes between the Sharpsburg soils, which lie upslope, and the Colo-Gravity soils, which lie downslope.

Water runs off excessively, and this soil erodes readily if cultivated. Nearly all of it is in semipermanent pasture. It is well suited to pasture and has good carrying capacity in renovated meadows that are managed well. This soil generally is not terraced, but if terraces are built, rotations that include meadow 3 years in 5 are suitable. Yields of row crops are low.

This soil is slightly acid. Depth to lime ranges from 30 to 60 inches. The available nitrogen and phosphorus are medium to low, and available potassium is medium. Management group 15 (IVe).

Shelby loam, 14 to 18 percent slopes, moderately eroded (ShE2).—This soil is similar to Shelby loam, 5 to 9 percent slopes, moderately eroded. The very dark grayish-brown surface layer is slightly firm and is more than 8 inches thick at the base of some slopes where sediment has accumulated. This soil has formed from Kansan till or from Nebraskan till. The depth to parent material is about 30 inches.

This soil is on slightly irregular, convex slopes and in many places covers entire side slopes. It generally is between soils derived from loess and soils in drainageways. The loess-derived soils are upslope, and the soils in drainageways are downslope. This soil has a large total acreage and occurs in every township.

Water runs off excessively and causes a severe erosion hazard if the soil is cultivated. Tilth is generally poor, because the yellowish-brown subsoil is exposed in many areas. Terraces are generally not used. If this soil is terraced, however, rotations that include meadow 3 years in 5 are suitable. This soil is probably better suited to hay or pasture than to row crops. Yields of row crops are generally low. However, 1 year of a row crop planted on the contour may be desirable when pasture is renovated.

Most of this soil is slightly acid, but lime generally is abundant below 30 inches. The available nitrogen and phosphorus are low, and available potassium is medium. Management group 15 (IVe).

Shelby loam, 18 to 25 percent slopes (ShF).—The surface layer of this soil is thicker than that of Shelby loam, 5 to 9 percent slopes, moderately eroded, and it ranges from very dark gray to very dark grayish brown. The thickness of the surface layer generally ranges from 3 to 9 inches. Near drainageways, however, at the lower parts of slopes, the surface layer is as much as 12 inches thick.

This soil is on steep slopes that form an irregular and complex pattern. Both Kansan and Nebraskan till are exposed in many places. This soil is also on short, abrupt side slopes next to the valleys of large streams. The total acreage is moderate in Adams County, and separate areas may be as much as 50 acres.

Nearly all of this soil is in permanent pasture, and there are some scattered areas of woodland. The soil is extremely erosive and is not suited to cultivated crops. It is moderately well suited to pasture. Although renovation of pasture is desirable, the use of farm equipment may be dangerous on this steep land. If pasture can be renovated, seed oats as a nurse crop. Control grazing to prevent the loss of cover and subsequent erosion.

This soil is generally low in available nitrogen and medium to low in available phosphorus. It is medium in available potassium. Oats and pasture seedings respond well to fertilizer. Lime may not be needed as this soil generally has an adequate amount at a depth of about 36 inches. Management group 19 (VIe).

Shelby loam, 25 to 35 percent slopes (ShG).—Thickness of the surface layer is more variable in this soil than in Shelby loam, 5 to 9 percent slopes, moderately eroded. The surface layer is very dark gray to very dark grayish brown and is 3 to 9 inches thick. The parent material in some areas is Kansan till and in others is Nebraskan till.

This soil occurs only on the strongly dissected side slopes parallel to the Middle Nodaway and East Nodaway Rivers. Runoff is extremely high on these very steep, irregular slopes. The total acreage of this soil in Adams County is very small. Included with this soil are areas of Colo-Gravity complex, 2 to 5 percent slopes, gullied, that are too small to map separately.

This soil is extremely erosive. It is suited only to limited grazing and to wildlife. It is mainly in pasture and scattered stands of trees. Because slopes are steep, pasture is difficult to renovate. Management group 21 (VIIe).

Shelby soils, 9 to 14 percent slopes, severely eroded (SoD3).—These soils are somewhat similar to Shelby loam, 5 to 9 percent slopes, moderately eroded, but most of their original surface soil has been removed by erosion. The surface layer is dark grayish-brown, firm clay loam. The thin, compact surface layer cracks when it dries, and it is dissected by many crossable and noncrossable gullies.

These soils may occur as a series of eroded spots between drainageways in strong side slopes. They also are in thin, narrow bands at the shoulder of side slopes immediately downslope from the Sharpsburg and Ladoga soils. The total acreage in this county is moderate, and individual areas range from 5 to 40 acres in size. Areas less than 1 acre are shown on the soil map by the symbol for severely eroded spots.

Because they are on strong slopes and absorb moisture slowly, these soils are extremely erosive. They puddle easily and seal quickly after rains. Although about half of their total area is in cultivated crops, these soils are poorly suited to row crops. Rotations that include meadow 3 years in 5 are suitable in terraced fields.

Pasture is a more suitable use than row crops, but except in fairly large areas, these soils may continue to be used for row crops along with better soils. The smaller areas could be used to provide food and cover for wildlife.

These soils are low in organic matter. They are very low in available nitrogen and phosphorus and are low to medium in potassium. They need manure and a complete fertilizer to improve in tilth and fertility. Although lime is abundant at a depth of 36 inches and below, the upper part of these soils is slightly acid. Management group 15 (IVe).

Shelby soils, 14 to 18 percent slopes, severely eroded (SoE3).—These soils have a thinner surface layer than Shelby loam, 5 to 9 percent slopes, moderately eroded. All except about 3 inches of the original surface layer has been removed by erosion. The present surface layer is firm and dark grayish brown. In most places it is clay loam, but texture varies according to how much of the original surface layer has washed away.

These soils are generally in poor tilth, and they puddle readily if they are worked when wet. The surface layer is hard and cracked when dry. Some areas are dissected by a few noncrossable drainageways. Areas less than 1 acre in size that occur within other soils are shown on the soil map by the symbol for severely eroded spots.

These soils are in every township in the county, but most areas are less than 20 acres in size. Their total acreage is moderate. They are on the shoulders of moderately steep side slopes. They sometimes occur on irregular sidehills in a series of sharply rounded slopes. The slopes are moderately long, and some of them extend over both Kansan and Nebraskan till.

These soils are suited only to pasture. If it is practical to renovate the pasture, fill in gullies and plant a grass-legume mixture along with a nurse crop. Apply manure and fertilizers that contain nitrogen and phosphate to get a quick growth and cover. The available potassium is low to medium. Lime may not be needed. Management group 19 (VIe).

Sperry series

The soils of the Sperry series are very poorly drained and slowly to very slowly permeable. They have formed from loess. These soils have a prominent, light-colored subsurface horizon that is underlain abruptly by a silty clay subsoil. The natural vegetation was grass and sedges tolerant of excess water. Areas of Sperry soils are 3 to 20 acres in size, but the total area in Adams County is less than 70 acres.

These soils are in slight depressions on broad, nearly flat uplands (see fig. 3, top). They are associated with the Macksburg and Winterset soils.

Sperry silt loam (0 to 2 percent slopes) (Sp).—This soil is in small depressions that are surrounded by Winterset and Macksburg soils on the broad divides of uplands (see fig. 3, top). Most of it is in the southeastern part of the county in soil association 1. It has formed in loess.

Representative profile:

0 to 9 inches, black silt loam; friable.
9 to 17 inches, grayish-brown silt loam; friable.
17 to 40 inches, black to very dark gray silty clay with few gray mottles; very firm.
40 to 58 inches, dark-gray silty clay loam with yellowish-brown and dark-brown mottles; firm.

The dark surface layer of this soil is 6 to 12 inches thick. A distinct subsurface layer 4 to 10 inches thick has formed. The distinct development of layers has been caused by excess water that carries organic matter and clay from the upper layers to the subsoil. The subsoil is very plastic and sticky when wet.

Runoff from adjoining soils collects and forms ponds in the depressions, for this soil does not have natural outlets to drain surface water. Because the subsoil contains a large amount of clay, tile lines are not suitable for drainage. Shallow, effectively located ditches, however, will remove excess water and improve drainage.

This soil puddles if it is worked when wet. In some places plowing mixes the grayish subsurface layer with the surface soil. Drained areas of this soil are cultivated with the associated Macksburg and Winterset soils. These areas, however, are small and generally are troublesome. Crops planted in undrained spots are usually drowned, but row crops can be grown frequently if wetness is reduced. In periods when rainfall is more than normal, crops may turn yellow and be stunted. Average yields of row crops are medium.

This soil is slightly acid to medium acid and needs additions of lime. It is generally low in available nitrogen and phosphorus and is medium in available potassium. Management group 14 (IIIw).

Sperry silt loam, benches (0 to 2 percent slopes) (St).—This soil has a profile similar to the one described for Sperry silt loam. It is on moderately high benches in the coves of drainageways and is associated with Sharpsburg soils in similar positions. In this county Sperry silt loam, benches, occurs only along the East Nodaway and Middle Nodaway Rivers.

This soil requires artificial drainage. Because the subsoil is clayey, open ditches work better than tile. Areas are small, and most of them are cropped in the same way as the surrounding soils. Row crops can be grown frequently if the soil is drained. Plants may turn yellow and be stunted because aeration is poor and moisture is excessive. Yields of row crops are medium.

This soil is slightly acid to medium acid. The available nitrogen and phosphorus are generally low, and available potassium is medium. Management group 14 (IIIw).

Wabash series

This series consists of poorly drained to very poorly drained soils that have formed from alluvium on bottom lands. The dark surface soil is silty clay loam to clay. The subsoil is fine textured and very slowly permeable.

Wabash soils are among the most extensive soils that occur on the wide first bottoms. Some areas of these soils are dissected by river channels, but most areas are adjacent to the foot slopes, and are fairly distant from rivers. (See fig. 4, bottom.)

These soils are likely to be flooded in areas near river channels that have not been straightened. A perched water table and a very slowly permeable subsoil make them wet.

Wabash silty clay (0 to 2 percent slopes) (Wa).—This soil has formed in low areas where floodwater often stands long enough to allow the clay in it to settle. Most areas of this soil are on nearly level bottom lands adjoining the foot slopes. It is also in the old bayous that have received deposits in the past but are now a considerable distance from the stream channel.

This soil is in townships that border the valleys of large rivers. Individual areas range from 5 to 30 acres in size, and the total area in Adams County is moderate.

Representative profile:

0 to 16 inches, black silty clay; gleyed; firm.
16 to 48 inches, very dark gray silty clay; gleyed; very firm.

This poorly drained to very poorly drained soil is silty clay or clay throughout the profile. When it dries, it becomes extremely hard. Many cracks form and extend from the surface into the subsoil. The soil will then absorb rainfall at a moderate rate until it is saturated and the cracks seal. After the cracks seal, the surface soil is slowly permeable and the subsoil is very slowly permeable.

This soil ponds after heavy rains. Excess water usually delays field operations in spring and in fall. Flooding from the overflow of streams, however, is only occasional.

Excess water can be reduced by a system of open ditches and shallow surface drains. Tile drains will not work, because the subsoil is very slowly permeable.

The black surface layer is high in organic matter but generally is very poor in tilth. Aeration is poor. Seedbeds are very difficult to prepare because the soil puddles easily. If it is drained, this soil can be planted to row crops frequently. Legumes, however, are not well suited because they usually winterkill. Crops are sometimes lost when rainfall is more than average. Yields are medium to low.

About half of this clayey soil is cultivated with the Wabash silty clay loam and Colo silty clay loam. The rest is in pasture. Using this soil for wildlife food and cover should be considered because it is somewhat limited for use as cropland.

This soil is neutral to slightly acid and generally does not require lime. Fertility is generally high, partly because the soil has been cultivated for only a short time and only small amounts of nutrients have been taken from the soil by plants. This soil is medium in available nitrogen, and medium to high in phosphorus and potassium. Management group 13 (IIIw).

Wabash silty clay loam (0 to 2 percent slopes) (Wb).—This soil is on nearly level first bottoms in wide to moderately wide valleys of streams. It extends parallel to river channels in many places and occurs along with the Colo soils. This soil is in areas of 50 acres or more and is one of the most extensive soils on the bottom lands in Adams County.

Representative profile:

0 to 20 inches, black silty clay loam; slightly firm.
20 to 54 inches, black to very dark gray silty clay; gleyed; firm to very firm.

The dark silty clay loam surface layer ranges from 18 to 24 inches in thickness. It is underlain by a fine-textured, very slowly permeable subsoil. This soil is generally in better tilth than Wabash silty clay, but it also puddles if it is worked when wet. It is limited in use because of poor drainage and occasional floods. If it is cultivated, it should be drained by open ditches. Because the subsoil is very slowly permeable, tile drains do not work very well. Bedding systems, which raise the level of the cultivated soil, have been established in some places to improve drainage.

This soil is generally farmed with soils that are better suited to cultivated crops. Fields that are artificially drained can be planted to row crops frequently, but yields are only medium. Crops often mature slowly, and harvests are frequently delayed. Without artificial drainage, this soil is best suited to pasture.

Wabash silty clay loam is generally slightly acid. It is medium in available nitrogen, and medium to high in available phosphorus and potassium. Management group 13 (IIIw).

Wabash silty clay loam, channeled (Wc).—This soil is similar to Wabash silty clay loam, except that some areas have received 3 to 6 inches of sediment recently. It is flooded more often than other Wabash soils. It generally occurs in small areas where old meandering streams have been straightened. It is dissected by many noncrossable side streams that empty into the main channel. The old bayous are ponded after rains. The total area of this soil in Adams County is very small.

If it is cleared of grass and scattered trees, this soil is best suited to pasture. It is not suited to crops in its present condition. Wooded areas must be cleared and old channels must be filled or made crossable before crops can be planted. Unless it is drained, this soil is best suited to pasture or wildlife.

Most of this soil is highly fertile and slightly acid, but lime is not used on unimproved areas. Management group 18 (Vw).

Winterset series

These are poorly drained soils derived from loess. The dark, thick surface layer is silty clay loam, and the subsoil is grayish silty clay to heavy silty clay loam. The natural vegetation consisted of prairie grasses that are tolerant of excess moisture.

These soils are on broad upland flats and nearly level ridges. (See fig. 3, top.) They are surrounded by the Macksburg soils and are most extensive in soil association 1.

Small areas of Sperry soils less than 1 acre in size are included within areas of Winterset soils and are indicated on the soil map by the symbol for wet spots.

Winterset silty clay loam (0 to 2 percent slopes) (Wr).—The dark surface layer of this soil is 18 to 24 inches thick and contains much organic matter. It is generally well granulated, but it puddles if it is cultivated too soon after rains.

Areas of Winterset silty clay loam are 10 to 40 acres in size. The total acreage is moderate.

Representative profile:

0 to 20 inches, black silty clay loam; friable.
20 to 42 inches, very dark grayish-brown to dark-gray silty clay with yellowish-brown and olive-gray mottles; gleyed; firm.
42 to 54 inches, olive-gray silty clay loam with yellowish-brown mottles; slightly firm.

Because surface drainage is poor and the subsoil is slow to moderately slow in permeability, there are some problems in managing this productive soil. With careful management, however, this soil can be farmed without artificial drainage. Some areas can be tiled, but suitable outlets may be so far away that they present a problem.

This soil is farmed along with the surrounding Macksburg soils that are well suited to row crops. If excess moisture is reduced, Winterset silty clay loam is suited to intensive row cropping. Yields are high but are somewhat lower than on the Macksburg soils. This soil dries more slowly after rains or floods than do Macksburg soils and warms more slowly in spring. Crops mature more slowly.

This soil is medium acid to slightly acid. Most crops respond well to applications of lime. The available nitrogen and phosphorus are medium. Available potassium is adequate. Management group 6 (IIw).

Wiota series

The soils of the Wiota series have formed from medium-textured alluvium on second bottoms within the wide valleys of the Middle Nodaway and East Nodaway Rivers. These soils are well drained and are moderate to moderately slow in permeability. The native vegetation was prairie grasses. Although the total acreage is moderate, these soils are important because they are very productive.

Wiota silt loam, 0 to 2 percent slopes (WtA).—This soil is on nearly level second bottoms that lie slightly above the flood plains of rivers. It occurs closely with Bremer and Nevin soils and is slightly higher on the landscape than those soils. In some areas it is completely surrounded by Colo and other soils on first bottoms. Individual areas are 3 to 10 acres in size.

Representative profile:

0 to 16 inches, black silt loam; friable.
16 to 38 inches, very dark grayish-brown to dark-brown silty clay loam; friable to slightly firm.
38 to 60 inches, dark-brown to dark yellowish-brown silty clay loam with a few grayish-brown and yellowish-brown mottles; slightly firm.

The dark surface layer of this soil is 12 to 18 inches thick. It is high in organic matter and is generally in very good tilth. This soil holds a large amount of moisture available for plants. It is well granulated and friable. Sand begins at a depth of about 10 feet in some areas.

All of this soil is cultivated. It is suited to intensive row cropping, for it has no serious limitations. When rainfall is more than average, some areas are slightly wet because surface runoff is slow. This soil warms quickly in the spring and responds well to fertilizer. Yields of crops are among the highest in the county. If it is planted to row crops frequently, this soil requires good management of crop residue and regular applications of fertilizer.

This soil is slightly acid and needs small additions of lime. It generally is medium to low in available nitrogen, medium in available phosphorus, and high in available potassium. Management group 1 (I).

Wiota silt loam, 2 to 5 percent slopes (WtB).—This soil is similar to Wiota silt loam, 0 to 2 percent slopes. Underlying strata of sand or sandy alluvial material are present at a depth of 6 to 10 feet in some places, but crops are not damaged by lack of moisture.

This soil is on gently sloping second bottoms that are parallel to the river. Most areas are upslope from the Nevin soils and slope toward the Colo soils on first bottoms. Some areas are completely surrounded by Colo or Wabash soils. Individual areas are from 2 to 10 acres in size.

This soil is well suited to row crops. Although sheet erosion is commonly caused by runoff from rainfall, this soil is generally not terraced, for it is in an irregular pattern. Rotations that include meadow 1 year in 5 are suitable if the soil is tilled on the contour. Yields of row crops are high under good management.

This soil is slightly acid. It is medium to low in available nitrogen, medium in available phosphorus, and high in potassium. It responds well to nitrogen fertilizer. Management group 3 (IIe).

TABLE 2.—*Major characteristics*

Map symbol	Soil type or phase	Position	Parent material	Native vegetation	Organic-matter content	Natural drainage
AaC	Adair clay loam, 5 to 9 percent slopes.	Upland	Glacial till	Prairie	Medium to high.	Imperfect
AaD2	Adair clay loam, 9 to 14 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium	Imperfect
AdD3	Adair soils, 9 to 14 percent slopes, severely eroded.	Upland	Glacial till	Prairie	Very low	Imperfect
AcC2	Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium	Imperfect to moderately good.
AcD	Adair clay loam, thin solum, 9 to 14 percent slopes.	Upland	Glacial till	Prairie	High	Imperfect to moderately good.
AcD2	Adair clay loam, thin solum, 9 to 14 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium	Imperfect to moderately good.
AcE2	Adair clay loam, thin solum, 14 to 18 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium to low.	Imperfect to moderately good.
AmC3	Adair soils, thin solums, 5 to 9 percent slopes, severely eroded.	Upland	Glacial till	Prairie	Very low	Imperfect to moderately good.
AmD3	Adair soils, thin solums, 9 to 14 percent slopes, severely eroded.	Upland	Glacial till	Prairie	Very low	Imperfect to moderately good.
ApC2	Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium	Moderately good to very poor.
ApD	Adair-Shelby complex, 9 to 14 percent slopes.	Upland	Glacial till	Prairie	High	Moderately good to very poor.
ApD2	Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium	Moderately good to very poor.
ApD3	Adair-Shelby complex, 9 to 14 percent slopes, severely eroded.	Upland	Glacial till	Prairie	Low	Imperfect to moderately good.
ApE2	Adair-Shelby complex, 14 to 18 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium	Imperfect to moderately good.
ApE3	Adair-Shelby complex, 14 to 18 percent slopes, severely eroded.	Upland	Glacial till	Prairie	Low	Imperfect to moderately good.
Av	Alluvial land	Bottom land	Recent alluvium	Shrubs and young trees.	Low	Poor to very poor
AwD	Arbor loam, 9 to 14 percent slopes	Upland	Local alluvium over glacial till.	Prairie	High	Moderately good
Br	Bremer silty clay loam	Second bottoms	Alluvium	Wet prairie	High	Poor
Ca	Chariton silt loam	First bottoms and low second bottoms.	Alluvium	Wet prairie	High	Very poor to poor
CcC	Clarinda silty clay loam, 5 to 9 percent slopes.	Upland	Glacial till	Prairie	High	Poor to very poor
CcC2	Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium to low.	Poor to very poor
CcD	Clarinda silty clay loam, 9 to 14 percent slopes.	Upland	Glacial till	Prairie	High	Poor to very poor
CcD2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium to low.	Poor to very poor
CdC3	Clarinda soils, 5 to 9 percent slopes, severely eroded.	Upland	Glacial till	Prairie	Low	Poor to very poor
CdD3	Clarinda soils, 9 to 14 percent slopes, severely eroded.	Upland	Glacial till	Prairie	Low	Poor to very poor
CfC	Clearfield silty clay loam, 5 to 9 percent slopes.	Upland	Loess	Prairie	Medium to high.	Imperfect to poor
CfC2	Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded.	Upland	Loess	Prairie	Medium	Imperfect to poor
ClC2	Clinton silt loam, 5 to 9 percent slopes, moderately eroded.	Upland	Loess	Forest	Very low	Moderately good
ClD2	Clinton silt loam, 9 to 14 percent slopes, moderately eroded.	Upland	Loess	Forest	Very low	Moderately good
Cm	Colo silty clay loam	First bottoms	Alluvium	Wet prairie	High	Poor
Cn	Colo silty clay loam, channeled	First bottoms	Alluvium	Wet prairie	High	Poor
Co	Colo silty clay loam, overwashed	First bottoms	Alluvium	Wet prairie	Medium to low.	Poor
CxB	Colo-Gravity complex, 2 to 5 percent slopes.	Foot slopes and narrow drainageways.	Alluvium and local alluvium.	Wet prairie	High	Imperfect to poor

See footnote at end of table.

of the mapping units

Surface soil		Subsoil			Reaction
Consistence	Color	Texture [1]	Consistence	Permeability	
Friable	Dark	Fine	Very firm	Very slow	Medium acid.
Slightly firm to friable.	Dark	Fine	Very firm	Very slow	Medium acid.
Firm to slightly firm	Moderately dark	Fine	Very firm	Very slow	Medium acid.
Slightly firm to friable.	Dark	Fine to moderately fine.	Very firm to firm	Slow	Medium acid.
Friable	Dark	Fine to moderately fine.	Very firm to firm	Slow	Medium acid to slightly acid.
Slightly firm to friable.	Dark	Fine to moderately fine.	Very firm to firm	Slow	Medium acid to slightly acid.
Slightly firm	Dark	Fine to moderately fine.	Very firm to firm	Slow	Medium acid to slightly acid.
Slightly firm to firm	Moderately dark	Fine to moderately fine.	Very firm to firm	Slow	Medium acid.
Slightly firm to firm	Moderately dark	Fine to moderately fine.	Very firm to firm	Slow	Medium acid to slighty acid.
Slightly firm to friable.	Dark	Fine to moderately fine.	Very firm to firm	Very slow to moderately slow.	Medium acid to slightly acid.
Friable	Dark	Fine to moderately fine.	Very firm to firm	Very slow to moderately slow.	Medium acid to slightly acid.
Slightly firm to friable.	Dark	Fine to moderately fine.	Very firm to firm	Very slow to moderately slow.	Medium acid to slightly acid.
Slightly firm to firm	Moderately dark	Fine to moderately fine.	Very firm to firm	Very slow to moderately slow.	Medium acid to slightly acid.
Slightly firm to friable.	Dark	Fine to moderately fine.	Very firm to firm	Very slow to moderately slow.	Medium acid to slightly acid.
Slightly firm to firm	Moderately dark	Fine to moderately fine.	Very firm to firm	Very slow to moderately slow.	Medium acid to slightly acid.
Friable to slightly firm.	Usually light	Coarse to fine	Loose to slightly firm	Moderate to slow	Neutral to slightly acid.
Friable	Dark	Moderately fine	Slightly firm to firm	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Fine	Firm	Moderately slow	Slightly acid.
Friable	Dark	Fine	Very firm	Very slow to slow	Slightly acid.
Friable	Dark	Fine	Very firm	Very slow	Medium acid.
Slightly firm	Dark	Fine	Very firm	Very slow	Medium acid.
Friable	Dark	Fine	Very firm	Very slow	Medium acid.
Slightly firm	Dark	Fine	Very firm	Very slow	Medium acid.
Firm	Moderately dark	Fine	Very firm	Very slow	Medium acid.
Firm	Moderately dark	Fine	Very firm	Very slow	Medium acid.
Friable to slightly firm.	Dark	Moderately fine	Slightly firm to firm	Moderately slow	Slightly acid.
Slightly firm	Dark	Moderately fine	Slightly firm to firm	Moderately slow	Slightly acid.
Very friable	Moderately dark	Moderately fine to fine.	Firm	Moderately slow	Strongly acid.
Friable	Moderately dark	Moderately fine to fine.	Firm	Moderately slow	Strongly acid.
Friable to slightly firm.	Dark	Moderately fine	Firm to slightly firm	Moderate to moderately slow.	Slightly acid.
Friable to slightly firm.	Moderately dark	Moderately fine	Firm to slightly firm	Moderate to moderately slow.	Slightly acid.
Friable	Moderately dark to light.	Moderately fine	Firm to slightly firm	Moderate to moderately slow.	Slightly acid.
Friable to slightly firm.	Dark	Moderately fine	Slightly firm to firm	Moderate to moderately slow.	Slightly acid.

TABLE 2.—*Major characteristics*

Map symbol	Soil type or phase	Position	Parent material	Native vegetation	Organic-matter content	Natural drainage
GaC2	Gara loam, 5 to 9 percent slopes, moderately eroded.	Upland	Glacial till	Forest and prairie.	Medium to low.	Moderately good
GaD	Gara loam, 9 to 14 percent slopes	Upland	Glacial till	Forest and prairie.	Medium	Moderately good
GaD2	Gara loam, 9 to 14 percent slopes, moderately eroded.	Upland	Glacial till	Forest and prairie.	Low	Moderately good
GaE	Gara loam, 14 to 18 percent slopes	Upland	Glacial till	Forest and prairie.	Medium	Moderately good
GaE2	Gara loam, 14 to 18 percent slopes, moderately eroded.	Upland	Glacial till	Forest and prairie.	Low	Moderately good
GaF	Gara loam, 18 to 25 percent slopes	Upland	Glacial till	Forest and prairie.	Medium to low.	Moderately good
GaG	Gara loam, 25 to 35 percent slopes	Upland	Glacial till	Forest and prairie.	Low	Moderately good
GbE3	Gara soils, 14 to 18 percent slopes, severely eroded.	Upland	Glacial till	Forest and prairie.	Very low	Moderately good
GpD	Gosport soils, 5 to 14 percent slopes	Upland	Thin loess or loess–till over shale.	Forest and prairie.	Low	Moderately good
GpF	Gosport soils, 14 to 25 percent slopes	Upland	Thin loess or loess–till over shale.	Forest and prairie.	Low	Moderately good
GpG	Gosport soils, 25 to 40 percent slopes	Upland	Thin loess or loess–till over shale.	Forest and prairie.	Low	Moderately good
GrB	Gravity silty clay loam, 2 to 5 percent slopes.	Foot slopes or alluvial fans.	Local alluvium	Prairie	High	Imperfect to poor.
Gu	Gullied land	Foot slopes and narrow drainageways.	Alluvium and local alluvium.	Wet prairie	High	Imperfect to poor
HaC2	Hagener loamy fine sand, 5 to 9 percent slopes, moderately eroded.	Upland	Eolian sands	Prairie	Very low	Excessive
HaD2	Hagener loamy fine sand, 9 to 14 percent slopes, moderately eroded.	Upland	Eolian sands	Prairie	Very low	Excessive
JuA	Judson silt loam, 0 to 2 percent slopes.	Foot slopes or alluvial fans.	Local alluvium	Prairie	High	Good to moderately good.
JuB	Judson silt loam, 2 to 5 percent slopes.	Foot slopes or alluvial fans.	Local alluvium	Prairie	High	Good to moderately good.
JuC	Judson silt loam, 5 to 9 percent slopes.	Foot slopes or alluvial fans.	Local alluvium	Prairie	High	Good to moderately good.
Kb	Kennebec silt loam	First bottoms	Alluvium	Prairie	High	Moderately good to imperfect.
LaB	Ladoga silt loam, 2 to 5 percent slopes.	Upland	Loess	Forest and prairie.	Medium	Moderately good
LaB2	Ladoga silt loam, 2 to 5 percent slopes, moderately eroded.	Upland	Loess	Forest and prairie.	Low	Moderately good
LaC	Ladoga silt loam, 5 to 9 percent slopes.	Upland	Loess	Forest and prairie	Medium	Moderately good
LaC2	Ladoga silt loam, 5 to 9 percent slopes, moderately eroded.	Upland	Loess	Forest and prairie.	Low	Moderately good
LaD	Ladoga silt loam, 9 to 14 percent slopes.	Upland	Loess	Forest and prairie.	Medium	Moderately good
LaD2	Ladoga silt loam, 9 to 14 percent slopes, moderately eroded.	Upland	Loess	Forest and prairie.	Low	Moderately good
LdC3	Ladoga soils, 5 to 9 percent slopes, severely eroded.	Upland	Loess	Forest and prairie.	Very low	Moderately good
LbA	Ladoga silt loam, benches, 0 to 2 percent slopes.	Bench position	Loess	Forest and prairie.	Medium	Moderately good
LbB	Ladoga silt loam, benches, 2 to 5 percent slopes.	Bench position	Loess	Forest and prairie.	Medium	Moderately good
MaA	Macksburg silty clay loam, 0 to 2 percent slopes.	Upland	Loess	Prairie	High	Imperfect
MaB	Macksburg silty clay loam, 2 to 5 percent slopes.	Upland	Loess	Prairie	High	Imperfect
Nn	Nevin silt loam	Second bottoms	Alluvium	Prairie	High	Imperfect
No	Nodaway silt loam	First bottoms	Alluvium	Young trees and prairie.	Low	Moderately good to imperfect.

See footnotes at end of table.

of the mapping units—Continued

Surface soil		Subsoil			Reaction
Consistence	Color	Texture [1]	Consistence	Permeability	
Friable to slightly firm.	Moderately dark	Moderately fine	Firm to very firm	Moderately slow to slow.	Medium acid.
Friable	Dark	Moderately fine	Firm to very firm	Moderately slow to slow.	Medium acid.
Slightly firm	Moderately dark	Moderately fine	Firm to very firm	Moderately slow to slow.	Medium acid.
Friable	Dark	Moderately fine	Firm to very firm	Moderately slow to slow.	Medium acid.
Slightly firm	Moderately dark	Moderately fine	Firm to very firm	Moderately slow to slow.	Medium acid.
Friable	Dark	Moderately fine	Firm to very firm	Moderately slow to slow.	Medium acid.
Friable	Dark	Moderately fine	Firm to very firm	Moderately slow to slow.	Medium acid.
Firm	Moderately dark	Fine	Firm to very firm	Moderately slow to slow.	Medium acid.
Friable to slightly firm.	Moderately dark	Fine	Very firm	Very slow	Strongly acid.
Friable to slightly firm.	Moderately dark	Fine	Very firm	Very slow	Strongly acid.
Friable to slightly firm.	Moderately dark	Fine	Very firm	Very slow	Strongly acid.
Slightly firm to friable.	Dark	Moderately fine	Firm to slightly firm	Moderately slow	Slightly acid.
Friable to slightly firm.	Dark	Moderately fine	Slightly firm to firm	Moderate to moderately slow.	Slightly acid.
Friable to loose	Moderately dark	Coarse	Loose	Very rapid	Slightly acid to medium acid.
Friable to loose	Moderately dark	Coarse	Loose	Very rapid	Slightly acid to medium acid.
Friable	Dark	Moderately fine	Friable to slightly firm.	Moderate	Slightly acid.
Friable	Dark	Moderately fine	Friable to slightly firm.	Moderate	Slightly acid.
Friable	Dark	Moderately fine	Friable to slightly firm.	Moderate	Slightly acid.
Friable	Dark	Medium to moderately fine.	Friable to slightly firm.	Moderate to moderately slow.	Slightly acid.
Friable to very friable.	Dark	Moderately fine to fine.	Firm	Moderately slow	Medium acid.
Friable	Moderately dark	Moderately fine to fine.	Firm	Moderately slow	Medium acid.
Friable to very friable.	Dark	Moderately fine to fine.	Firm	Moderately slow	Medium acid.
Friable	Moderately dark	Moderately fine to fine.	Firm	Moderately slow	Medium acid.
Friable to very friable.	Dark	Moderately fine to fine.	Firm	Moderately slow	Medium acid.
Friable	Moderately dark	Moderately fine to fine.	Firm	Moderately slow	Medium acid.
Slightly firm	Moderately dark	Moderately fine to fine.	Firm	Moderately slow	Medium acid.
Friable to very friable.	Dark to moderately dark.	Moderately fine to fine.	Firm	Moderately slow	Medium acid.
Friable to very friable.	Dark to moderately dark.	Moderately fine to fine.	Firm	Moderately slow	Medium acid.
Friable	Dark	Moderately fine to fine.	Slightly firm	Moderately slow to moderate.	Slightly acid.
Friable	Dark	Moderately fine to fine.	Slightly firm	Moderately slow to moderate.	Slightly acid.
Friable	Dark	Moderately fine	Firm to slightly firm	Moderate to moderately slow.	Slightly acid.
Friable	Light	Medium	Friable	Moderate	Slightly acid to neutral.

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TABLE 2.—*Major characteristics*

Map symbol	Soil type or phase	Position	Parent material	Native vegetation	Organic-matter content	Natural drainage
Nw	Nodaway silt loam, channeled	First bottoms	Alluvium	Young trees and prairie.	Low	Moderately good to imperfect.
OmB	Olmitz loam, 2 to 5 percent slopes	Foot slopes or alluvial fans.	Local alluvium	Prairie	Medium	Good to moderately good.
OmC	Olmitz loam, 5 to 9 percent slopes	Foot slopes or alluvial fans.	Local alluvium	Prairie	Medium	Good to moderately good.
SaA	Sharpsburg silty clay loam, 0 to 2 percent slopes.	Upland	Loess	Prairie	High	Good to moderately good.
SaB	Sharpsburg silty clay loam, 2 to 5 percent slopes.	Upland	Loess	Prairie	High	Good to moderately good.
SaB2	Sharpsburg silty clay loam, 2 to 5 percent slopes, moderately eroded.	Upland	Loess	Prairie	Medium	Good to moderately good.
SaC	Sharpsburg silty clay loam, 5 to 9 percent slopes.	Upland	Loess	Prairie	High	Good to moderately good.
SaC2	Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded.	Upland	Loess	Prairie	Medium	Good to moderately good.
SaD	Sharpsburg silty clay loam, 9 to 14 percent slopes.	Upland	Loess	Prairie	High	Good to moderately good.
SaD2	Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded.	Upland	Loess	Prairie	Medium	Good to moderately good.
SaE	Sharpsburg silty clay loam, 14 to 18 percent slopes.	Upland	Loess	Prairie	High	Good to moderately good.
SbA	Sharpsburg silty clay loam, benches, 0 to 2 percent slopes.	Bench position	Loess	Prairie	High	Good to moderately good.
SbB	Sharpsburg silty clay loam, benches, 2 to 5 percent slopes.	Bench position	Loess	Prairie	High	Good to moderately good.
ShC2	Shelby loam, 5 to 9 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium	Good to moderately good.
ShD	Shelby loam, 9 to 14 percent slopes	Upland	Glacial till	Prairie	High	Good to moderately good.
ShD2	Shelby loam, 9 to 14 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium	Good to moderately good.
ShE	Shelby loam, 14 to 18 percent slopes	Upland	Glacial till	Prairie	High	Good to moderately good.
ShE2	Shelby loam, 14 to 18 percent slopes, moderately eroded.	Upland	Glacial till	Prairie	Medium	Good to moderately good.
ShF	Shelby loam, 18 to 25 percent slopes	Upland	Glacial till	Prairie	High to medium.	Good to moderately good.
ShG	Shelby loam, 25 to 35 percent slopes	Upland	Glacial till	Prairie	High to medium.	Good to moderately good.
SoD3	Shelby soils, 9 to 14 percent slopes, severely eroded.	Upland	Glacial till	Prairie	Low	Good to moderately good.
SoE3	Shelby soils, 14 to 18 percent slopes, severely eroded.	Upland	Glacial till	Prairie	Low	Good to moderately good.
Sp	Sperry silt loam	Upland	Loess	Sedges and swamp grasses.	High	Very poor
St	Sperry silt loam, benches	Upland	Loess	Sedges and swamp grasses.	High	Very poor
Wa	Wabash silty clay	First bottoms	Alluvium	Wet prairie	High	Poor to very poor
Wb	Wabash silty clay loam	First bottoms	Alluvium	Wet prairie	High	Poor
Wc	Wabash silty clay loam, channeled	First bottoms	Alluvium	Wet prairie	High	Poor
Wr	Winterset silty clay loam	Upland	Loess	Prairie	High	Poor
WtA	Wiota silt loam, 0 to 2 percent slopes	Second bottoms	Alluvium	Prairie	High	Good
WtB	Wiota silt loam, 2 to 5 percent slopes	Second bottoms	Alluvium	Prairie	High	Good

[1] General terms are used for textural classes as follows: Coarse—sand and loamy sand; medium—loam and silt loam; moderately fine—clay loam and silty clay loam; fine—silty clay and clay.

of the mapping units—Continued

Surface soil		Subsoil			Reaction
Consistence	Color	Texture [1]	Consistence	Permeability	
Friable	Light	Medium	Friable	Moderate	Slightly acid to neutral.
Friable	Dark	Moderately fine	Friable to slightly firm.	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Moderately fine	Friable to slightly firm.	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Moderately fine	Friable to slightly firm.	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Moderately fine	Slightly firm	Moderate to moderately slow.	Slightly acid.
Slightly firm to friable.	Dark	Moderately fine	Slightly firm	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Moderately fine	Slightly firm	Moderate to moderately slow.	Slightly acid.
Slightly firm to friable.	Dark	Moderately fine	Slightly firm	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Moderately fine	Slightly firm to friable.	Moderate to moderately slow.	Slightly acid.
Slightly firm to friable.	Dark	Moderately fine	Slightly firm to friable.	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Moderately fine	Slightly firm to friable.	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Moderately fine	Slightly firm to friable.	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Moderately fine	Slightly firm to friable.	Moderate to moderately slow.	Slightly acid.
Slightly firm	Dark	Moderately fine	Firm	Moderately slow	Slightly acid
Friable	Dark	Moderately fine	Firm	Moderately slow	Slightly acid.
Slightly firm	Dark	Moderately fine	Firm	Moderately slow	Slightly acid.
Friable	Dark	Moderately fine	Firm	Moderately slow	Slightly acid.
Slightly firm	Dark	Moderately fine	Firm	Moderately slow	Slightly acid.
Friable	Dark	Moderately fine	Firm	Moderately slow	Slightly acid.
Friable	Dark	Moderately fine	Firm	Moderately slow	Slightly acid.
Firm	Moderately dark	Moderately fine	Firm	Moderately slow	Slightly acid.
Firm	Moderately dark	Moderately fine	Firm	Moderately slow	Slightly acid.
Friable	Dark	Fine	Very firm	Slow to very slow	Slightly acid to medium acid.
Friable	Dark	Fine	Very firm	Slow to very slow	Slightly acid to medium acid.
Firm	Dark	Fine	Very firm	Very slow	Slightly acid to neutral.
Slightly firm	Dark	Fine	Very firm to firm	Very slow	Slightly acid.
Slightly firm	Dark	Fine	Very firm to firm	Very slow	Slightly acid.
Friable	Dark	Fine to moderately fine	Firm	Moderately slow to slow.	Medium acid to slightly acid.
Friable	Dark	Moderately fine	Slightly firm	Moderate to moderately slow.	Slightly acid.
Friable	Dark	Moderately fine	Slightly firm	Moderate to moderately slow.	Slightly acid.

Use and Management of Soils

This section discusses characteristics that affect the management of soils, describes general practices of management, gives estimates of soil productivity, and tells something about making a farm plan. It also describes the system of capability classification used by the Soil Conservation Service and discusses the management of groups of soils, or capability units.

Soil Characteristics

Farmers must know their soils if they are to make a successful plan for controlling erosion, improving the soil, selecting crops, and maintaining good yields. The suitability of a soil for certain plants and the management needed depends on drainage, permeability, texture, slope, content of organic matter, and other soil characteristics. These characteristics have been defined in the section "Descriptions of Soils". The characteristics of each soil have also been described in that section. The effect of soil characteristics on plant growth and soil management is discussed generally in the following paragraphs.

Drainage is generally indicated by the color and mottling of the subsoil. Besides knowing the drainage class, which is stated in each soil description, it is important to know how often and how long the soil is saturated, the permeability of the major horizons, and the capacity of the soil to hold water available to plants.

Permeability, or the ability of soil to transmit air and water, should also be considered, for it affects the growth of plants. Fine-textured, compact soils are generally slowly permeable and absorb moisture slowly. Water ponds on the surface or runs off rapidly, depending on the slope. This runoff causes erosion, especially if the soil is cultivated. If soils need artificial drainage, farmers must know the permeability of their soils before deciding the kind of drainage system to install.

Texture, or the proportions of sand, silt, and clay in a soil, affects the amount of water the soil will hold, its permeability, and the ease with which the soil can be cultivated and penetrated by plant roots. Texture is considered in determining the kind of drainage system to install and the choice of crops. Very fine-textured soils do not absorb moisture rapidly and are difficult to work. Coarse soils do not hold much water available for plants.

Slope affects runoff and determines the need for controlling erosion. The rate of runoff and the hazard of erosion increase as the degree of slope increases. Slopes of more than 2 percent are normally subject to erosion when they are cultivated. Erosion losses are greater in places where there is no plant cover. Steep slopes limit the use of farm machinery and generally have thinner stands of row crops than mild slopes.

The *content of organic matter* is important to the growth of plants. It is normally related to the color of the soil. Ordinarily, the darker the color, the higher the organic-matter content. A high organic-matter content, in turn, indicates a high level of nitrogen. Sandy soils usually contain less organic matter than soils of the same color that are less sandy. Light-colored soils generally need more nitrogen fertilizer than do dark-colored soils.

General Practices of Management

Farmers should select management practices that are suited to their soils. This subsection discusses some of the main practices of management. More specific suggestions for groups of soils are given in the subsection "Management Groups," and suggestions for individual soils are given in the section "Descriptions of Soils."

Artificial drainage

Wet soils do not produce high yields of corn, soybeans, alfalfa, or small grains. These plants, especially corn and alfalfa, must root deeply if they are to grow well. Their roots are shallow in wet soils and do not take in the nutrients that are available deeper in the soil. Planting and cultivation are often delayed on wet soils, and weeds are difficult to control.

Poorly drained soils need tile lines or open ditches to carry away the excess water. If outlets for the drains are available, tile drains work well in soils that are moderate or moderately slow in permeability. Open ditches, or surface drains, should be used if the soils are very slowly permeable, because tile drains do not carry off water effectively.

Control of erosion

Erosion increases costs and reduces yields. It takes away soil that contains more organic matter and plant nutrients than does the soil left behind. In areas that receive the eroded material, crops may be buried and drainage ditches and ponds may be filled.

Water erosion can be controlled by tilling fields on the contour, building terraces, and stripcropping; by planting meadow crops; and by installing diversion terraces. In sloping cultivated fields water erosion can be controlled most effectively by building terraces and tilling the fields on the contour. Terraces break the slope and control the flow of water to an outlet. This reduces runoff and allows moisture to penetrate the soil. Terraces do not improve soil fertility, but they do save surface soil, lime, and soil nutrients that might otherwise be removed through erosion.

Grassed waterways also help to control erosion, for waterway channels not protected by vegetation are soon gullied. Grassed waterways of sufficient width carry water off the fields with a minimum loss of soil. The grass slows the flowing water and traps the soil, thus preventing gullying. If the waterways are shaped, farm machinery can cross them. The grass in these small areas can be used for hay or seed.

Soil that is planted to row crops is more susceptible to erosion than soil in pasture; but areas in pasture or trees may become eroded if the vegetation is sparse. To protect pasture and woodland, plant the proper kind of grasses or trees, fertilize, and control grazing.

Liming and fertilizing

The need for lime and fertilizer varies among soils and depends on the kind of soil, the past management, the crops grown, and the fertility level of the soils. In this report the suggestions for improving the fertility of soils are only general, for the needs of soils change and new fertilizers are continually developed. The best way to determine what a soil needs is to test samples of it. The county extension director or a representative of the Soil Conservation Service will gladly give you information about testing soils and about fertilizers.

The soil map, which shows the boundaries of the soils, is a good guide for selecting areas to sample. At least one sample should be taken from every 10 acres.

Iowa State University tested 1,737 samples of soil from Adams County for acidity and for available nitrogen, phosphorus, and potassium. The results of the tests for nitrogen, phosphorus, and potassium are summarized in table 3. Table 4 lists the general level of nitrogen, phosphorus, and potassium for each soil in the county. The requirements for lime are summarized in the next paragraph.

Lime.—Many areas of soil in Adams County are acid to some degree and need additions of lime. This need for lime, as indicated by tests of the 1,737 soil samples, is listed according to percentage of samples as follows:

Percent	*Tons of lime needed per acre*
24	None
32	1.5 to 2
29	2.5 to 3
15	3.5 to 4

On almost all fields additions of lime are needed if good yields of alfalfa or other legumes are to be obtained.

TABLE 3.—*Results of soil tests to determine available nitrogen, phosphorus, and potassium* [1]

[1,737 samples tested]

Element	Percentage of samples testing—			
	High	Medium	Low	Very low
Nitrogen	4	26	65	5
Phosphorus	11	25	51	13
Potassium	81	18	1	0

[1] Tests made at the Iowa State University Soil Testing Laboratory. The results for phosphorus and potassium are from all samples tested before July 1, 1954. The results for nitrogen are from all samples tested during 1953 and 1954.

Nitrogen.—The summary of soil tests in table 3 shows that 65 percent of the samples tested were low and 5 percent were very low in available nitrogen. Corn that does not follow a good legume or grass-legume meadow normally responds well to nitrogen fertilizer that is applied as a side dressing or is plowed down. On Shelby, Adair, and other soils derived from till, corn generally requires phosphate as well as nitrogen. Bromegrass, bluegrass, and other meadow crops grown without a legume also respond well to nitrogen fertilizer. Yields of oats and other crops can be improved by adding a nitrogen fertilizer, but it is important to maintain the proper balance between phosphate and nitrogen.

Average levels of nitrogen in the soils of Adams County are given in table 4. These estimates indicate, in a general way, the level of available nitrogen in each soil. The amount to apply, however, depends on cropping history, expected yields, and crops to be grown.

Phosphate.—Table 3 shows that 51 percent of the samples tested were low in available phosphorus and that 13 percent were very low. Legumes need a large amount of phosphorus. Generally the Sharpsburg, Macksburg, and other soils derived from loess contain more available phosphorus than do soils derived from till. On soils derived from loess, as a rule, enough phosphate for corn can be applied to hills or rows at planting time. However, soils derived from till and planted to corn need phosphate applied to the hills and rows at planting time and also need phosphate disked or plowed into the soil in fall and spring.

Small grains require additions of phosphate, especially if they are grown with a legume that will be used as meadow after the small grain is harvested. Small grains seeded on soils derived from till need larger additions of phosphate than do small grains on soils derived from loess.

In an oat-legume seeding the proper balance must be maintained between the applications of nitrogen and phosphate to prevent lodging of the oats or excessive growth of the legume. Too much nitrogen may cause the oats to lodge. Too much phosphate may increase the growth of legumes so much that the oats will be difficult to harvest because of the green material. The fertilizer for the oat-legume crop can be disked in ahead of planting, can be drilled in at planting time, or can be topdressed before the oats are 6 inches high.

Potash.—Available potassium was high in 81 percent of the samples tested (table 3). The soils formed in till are generally lower in available potassium than those formed in loess. Some potash, applied in the hills or rows of corn at planting time, is needed on all the soils in the county. It is especially needed on the poorly drained Winterset and Bremer soils, though tests show a high level of potassium in those soils. Other additions of potash fertilizer are seldom needed on the soils in Adams County.

Crop rotations

A suitable cropping system is part of good soil management. A rotation suitable for a farmer who has adequate capital and is raising a large amount of livestock may not be suitable for a farmer having little capital and raising a small amount of livestock. Sloping, erosive soils need rotations different from those needed on level soils that are not erosive.

Suggested crop rotations or other land uses, with accompanying practices for erosion control, are given in the subsection "Management Groups" and in table 4. Suitable rotations combined with other good practices, help to obtain maximum yields for each soil, to reduce erosion losses, and to maintain a satisfactory level of organic matter. Add fertilizer according to needs shown by soil tests, however, to obtain maximum yields of crops in any rotation.

In planning a crop rotation for a farm or a field, consider the kinds of soils and their capabilities, the erosion control and fertilization required, and the amount of feed and pasture needed for livestock. Then compare the expected yields with the cost.

TABLE 4.—*Management and*

[Dashed lines indicate that crop is not suited

Map symbol	Soil	Management group [1]	Nutrient level			Management problems
			Nitrogen	Phosphorus	Potassium	
AaC	Adair clay loam, 5 to 9 percent slopes.	11 (IIIw)	Low	Very low	Medium	Wetness and erosion
AaD2	Adair clay loam, 9 to 14 percent slopes, moderately eroded.	16 (IVe)	Very low	Very low	Medium	Wetness and erosion
AcC2	Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded.	7 (IIIe)	Very low	Very low	Medium	Sheet erosion and slight wetness.
AcD	Adair clay loam, thin solum, 9 to 14 percent slopes.	15 (IVe)	Low	Very low	Medium	Sheet erosion and slight wetness.
AcD2	Adair clay loam, thin solum, 9 to 14 percent slopes, moderately eroded.	15 (IVe)	Very low	Very low	Medium	Sheet erosion and slight wetness.
AcE2	Adair clay loam, thin solum, 14 to 18 percent slopes, moderately eroded.	19 (VIe)	Very low	Very low	Medium	Sheet erosion
AdD3	Adair soils, 9 to 14 percent slopes, severely eroded.	20 (VIe)	Very low	Very low	Medium to low.	Sheet erosion, gullies, wetness, and poor tilth.
AmC3	Adair soils, thin solums, 5 to 9 percent slopes, severely eroded.	15 (IVe)	Very low	Very low	Medium to low.	Sheet erosion, gullies, poor tilth, and slight wetness.
AmD3	Adair soils, thin solums, 9 to 14 percent slopes, severely eroded.	20 (VIe)	Very low	Very low	Medium to low.	Sheet erosion, gullies, poor tilth, and slight wetness.
ApC2	Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded.	7 (IIIe)	Very low	Very low	Medium	Sheet erosion and slight wetness.
ApD	Adair-Shelby complex, 9 to 14 percent slopes.	15 (IVe)	Low	Very low	Medium	Sheet erosion and slight wetness.
ApD2	Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded.	15 (IVe)	Very low	Very low	Medium	Sheet erosion and slight wetness.
ApD3	Adair-Shelby complex, 9 to 14 percent slopes, severely eroded.	20 (VIe)	Very low	Very low	Medium to low.	Sheet erosion, gullies, poor tilth, and slight wetness.
ApE2	Adair-Shelby complex, 14 to 18 percent slopes, moderately eroded.	19 (VIe)	Very low	Very low	Medium	Sheet erosion
ApE3	Adair-Shelby complex, 14 to 18 percent slopes, severely eroded.	21 (VIIe)	Very low	Very low	Medium to low.	Sheet erosion and gullies
Av	Alluvial land	18 (Vw)	Variable	Variable	Variable	Frequent overflow and wetness.
AwD	Arbor loam, 9 to 14 percent slopes	10 (IIIe)	Medium to low.	Medium to low.	Medium	Sheet erosion
Br	Bremer silty clay loam	6 (IIw)	Medium	Medium	High	Wetness
Ca	Chariton silt loam	14 (IIIw)	Low	Low	Medium	Wetness and ponding
CcC	Clarinda silty clay loam, 5 to 9 percent slopes.	11 (IIIw)	Low	Very low	Medium	Wetness and erosion
CcC2	Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded.	11 (IIIw)	Very low	Very low	Medium	Wetness and erosion
CcD	Clarinda silty clay loam, 9 to 14 percent slopes.	16 (IVe)	Low	Very low	Medium	Wetness and sheet erosion
CcD2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded.	16 (IVe)	Very low	Very low	Medium	Wetness and sheet erosion
CdC3	Clarinda soils, 5 to 9 percent slopes, severely eroded.	20 (VIe)	Very low	Very low	Low	Wetness, sheet erosion, gullies, and poor tilth.
CdD3	Clarinda soils, 9 to 14 percent slopes, severely eroded.	20 (VIe)	Very low	Very low	Low	Wetness, sheet erosion, gullies, and poor tilth.
CfC	Clearfield silty clay loam, 5 to 9 percent slopes.	12 (IIIw)	Medium to low.	Medium	High	Wetness and sheet erosion
CfC2	Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded.	12 (IIIw)	Low	Low	High	Wetness and sheet erosion
ClC2	Clinton silt loam, 5 to 9 percent slopes, moderately eroded.	8 (IIIe)	Low	Low	Medium	Sheet erosion
ClD2	Clinton silt loam, 9 to 14 percent slopes, moderately eroded.	8 (IIIe)	Very low	Low	Medium	Sheet erosion

[1] Roman numeral and small letter in parentheses indicate capability class and subclass.

yield data for soils

to soil or is not generally grown on it]

Crop rotations and other uses	Expected yields under a high level of management [2]			
	Corn	Soybeans	Oats	Hay or pasture
	Bu. per acre	*Bu. per acre*	*Bu. per acre*	*Tons per acre*
Contour tillage: 1 year of a row crop, 1 year of a small grain, 4 years of meadow. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	38	15	28	2. 0
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 3 years of meadow.	28	----------	22	1. 0
Contour tillage: 1 year of a row crop, 1 year of a small grain, 3 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	47	18	32	2. 5
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	43	----------	30	2. 2
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	38	----------	28	2. 0
Permanent pasture	----------	----------	----------	1. 4
Control gullies and seed for permanent pasture	----------	----------	----------	. 3
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	30	----------	20	1. 2
Permanent pasture	----------	----------	----------	. 8
Contour tillage: 1 year of a row crop, 1 year of a small grain, 3 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	51	20	34	2. 6
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	47	----------	32	2. 4
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	42	----------	30	2. 2
Permanent pasture	----------	----------	----------	1. 2
Permanent pasture	----------	----------	----------	1. 6
Permanent pasture, woodland, wildlife habitats	----------	----------	----------	. 8
Permanent pasture, woodland, wildlife habitats	----------	----------	----------	1. 5
Hay or pasture. *Terraces or diversion terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	58	----------	38	2. 7
Drained by tile or ditches: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	75	29	46	2. 8
Drained by ditches: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 2 years of row crops, 1 year of a small grain seeded with a legume for green manure.	50	24	30	1. 8
Contour tillage: 1 year of a row crop, 1 year of a small grain, 4 years of meadow. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	34	14	26	1. 8
Contour tillage: 1 year of a row crop, 1 year of a small grain, 4 years of meadow. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	29	12	24	1. 3
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 3 years of meadow.	29	----------	22	1. 2
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 3 years of meadow.	24	----------	20	. 8
Permanent pasture	----------	----------	----------	. 4
Permanent pasture	----------	----------	----------	. 2
Contour tillage and interceptor tile: 1 year of a row crop, 1 year of a small grain, 2 years of meadow. *Terraces and interceptor tile:* 2 years of row crops, 1 year of a small grain, 1 year of meadow.	64	23	40	2. 6
Contour tillage and interceptor tile: 1 year of a row crop, 1 year of a small grain, 2 years of meadow. *Terraces and interceptor tile:* 2 years of row crops, 1 year of a small grain, 1 year of meadow.	60	22	38	2. 5
Contour tillage: 1 year of a row crop, 1 year of a small grain, 3 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	56	21	38	2. 7
Hay or pasture. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	49	----------	35	2. 5

[2] See text for what is meant by a high level of management and for the basis on which yields were estimated.

TABLE 4.—*Management and*

Map symbol	Soil	Management group [1]	Nutrient level			Management problems
			Nitrogen	Phosphorus	Potassium	
Cm	Colo silty clay loam	5 (IIw)	Medium	Medium to high.	Medium to high.	Wetness and occasional flooding.
Cn	Colo silty clay loam, channeled	18 (Vw)	Medium	Medium to high.	Medium to high.	Wetness, channeling, and frequent flooding.
Co	Colo silty clay loam, overwashed	5 (IIw)	Medium	Medium to high.	Medium to high.	Wetness and occasional flooding.
CxB	Colo-Gravity complex, 2 to 5 percent slopes.	5 (IIw)	Medium	Medium to high.	Medium to high.	Wetness and gullies
GaC2	Gara loam, 5 to 9 percent slopes, moderately eroded.	7 (IIIe)	Low	Low	Medium to low.	Sheet erosion
GaD	Gara loam, 9 to 14 percent slopes	15 (IVe)	Low	Low	Medium to low.	Sheet erosion
GaD2	Gara loam, 9 to 14 percent slopes, moderately eroded.	15 (IVe)	Very low	Low	Medium to low.	Sheet erosion
GaE	Gara loam, 14 to 18 percent slopes	19 (VIe)	Low	Low	Medium to low.	Sheet erosion
GaE2	Gara loam, 14 to 18 percent slopes, moderately eroded.	19 (VIe)	Very low	Low	Medium to low.	Sheet erosion
GaF	Gara loam, 18 to 25 percent slopes	21 (VIIe)	Low	Low	Medium to low.	Sheet erosion
GaG	Gara loam, 25 to 35 percent slopes	21 (VIIe)	Low	Low	Medium to low.	Sheet erosion
GbE3	Gara soils, 14 to 18 percent slopes, severely eroded.	21 (VIIe)	Very low	Very low	Medium to low.	Sheet erosion, gullies, and poor tilth.
GpD	Gosport soils, 5 to 14 percent slopes	19 (VIe)	Very low	Very low	Very low	Sheet erosion
GpF	Gosport soils, 14 to 25 percent slopes	21 (VIIe)	Very low	Very low	Very low	Sheet erosion and gullies
GpG	Gosport soils, 25 to 40 percent slopes.	21 (VIIe)	Very low	Very low	Very low	Sheet erosion
GrB	Gravity silty clay loam, 2 to 5 percent slopes.	5 (IIw)	Medium	Medium to high.	Medium to high.	Wetness and overwash.
Gu	Gullied land	21 (VIIe)	Variable	Variable	Variable	Gullies and slight wetness.
HaC2	Hagener loamy fine sand, 5 to 9 percent slopes, moderately eroded.	17 (IVs)	Very low	Very low	Low	Droughtiness, wind erosion, and sheet erosion.
HaD2	Hagener loamy fine sand, 9 to 14 percent slopes, moderately eroded.	19 (VIe)	Very low	Very low	Low	Droughtiness, wind erosion, and sheet erosion.
JuA	Judson silt loam, 0 to 2 percent slopes.	2 (I)	Medium	Medium	High	Overwash and deposition
JuB	Judson silt loam, 2 to 5 percent slopes.	4 (IIe)	Medium	Medium	High	Overwash and erosion.
JuC	Judson silt loam, 5 to 9 percent slopes.	9 (IIIe)	Medium	Medium	High	Sheet erosion
Kb	Kennebec silt loam	2 (I)	Medium	Medium	High	Slight hazard of flooding
LaB	Ladoga silt loam, 2 to 5 percent slopes.	3 (IIe)	Low	Medium to low.	High	Sheet erosion
LaB2	Ladoga silt loam, 2 to 5 percent slopes, moderately eroded.	3 (IIe)	Low	Medium to low.	High	Sheet erosion
LaC	Ladoga silt loam, 5 to 9 percent slopes.	9 (IIIe)	Low	Medium to low.	High	Sheet erosion
LaC2	Ladoga silt loam, 5 to 9 percent slopes, moderately eroded.	9 (IIIe)	Low	Medium to low.	High	Sheet erosion
LaD	Ladoga silt loam, 9 to 14 percent slopes.	10 (IIIe)	Low	Medium to low.	High	Sheet erosion
LaD2	Ladoga silt loam, 9 to 14 percent slopes, moderately eroded.	10 (IIIe)	Very low	Medium to low.	High	Sheet erosion
LbA	Ladoga silt loam, benches, 0 to 2 percent slopes.	1 (I)	Low	Medium to low.	High	None
LbB	Ladoga silt loam, benches, 2 to 5 percent slopes.	3 (IIe)	Low	Medium to low.	High	Sheet erosion
LdC3	Ladoga soils, 5 to 9 percent slopes, severely eroded.	8 (IIIe)	Very low	Low	High	Sheet erosion and poor tilth.
MaA	Macksburg silty clay loam, 0 to 2 percent slopes.	1 (I)	Medium to low.	Medium	High	None

yield data for soils—Continued

Crop rotations and other uses	Expected yields under a high level of management [2]			
	Corn	Soybeans	Oats	Hay or pasture
	Bu. per acre	*Bu. per acre*	*Bu. per acre*	*Tons per acre*
Drained by tile and protected from overflow: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	67	27	45	2. 8
Permanent pasture, woodland, wildlife habitats				2. 0
Drained by tile and protected from overflow: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	68	27	45	2. 9
Diversion terraces, tile drains, and grassed waterways: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	60	24	40	2. 6
Contour tillage: 1 year of a row crop, 1 year of a small grain, 3 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	45	17	31	2. 5
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	41		29	2. 1
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 2 years of meadow.	35		26	1. 9
Permanent pasture				1. 5
Permanent pasture				1. 3
Permanent pasture, woodland, wildlife habitats				1. 0
Permanent pasture, woodland, wildlife habitats				. 5
Permanent pasture, woodland, wildlife habitats				. 7
Permanent pasture				1. 0
Permanent pasture, woodland, wildlife habitats				. 5
Permanent pasture, woodland, wildlife habitats				. 5
Diversion terraces and tile: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	65	26	43	2. 8
Permanent pasture, woodland, and wildlife habitats. Control gullies before seeding pasture.				. 5
Hay or pasture. *Contour and mulch tillage:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	30		20	1. 0
Permanent pasture, wildlife habitats				. 6
Diversion terraces: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	72	29	48	3. 1
Diversion terraces or contour tillage: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	71	28	46	3. 0
Contour tillage: 1 year of a row crop, 1 year of a small grain, 2 years of meadow. *Contour tillage and diversion terraces:* 2 years of row crops, 1 year of a small grain, 1 year of meadow.	70	26	44	2. 9
Protected from floods: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	69	27	45	2. 9
2 years of row crops, 1 year of a small grain, 2 years of meadow. *Contour tillage or terraces:* 3 years of row crops, 1 year of a small grain, 1 year of meadow.	68	26	44	2. 9
2 years of row crops, 1 year of a small grain, 2 years of meadow. *Contour tillage or terraces:* 3 years of row crops, 1 year of a small grain, 1 year of meadow.	65	25	42	2. 9
Contour tillage: 1 year of a row crop, 1 year of a small grain, 2 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 1 year of meadow.	63	23	42	2. 8
Contour tillage: 1 year of a row crop, 1 year of a small grain, 2 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 1 year of meadow.	60	22	40	2. 8
Hay or pasture. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	58		39	2. 7
Hay or pasture. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	53		37	2. 6
3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	72	26	44	3. 0
2 years of row crops, 1 year of a small grain, 2 years of meadow. *Contour tillage:* 3 years of row crops, 1 year of a small grain, 1 year of meadow.	68	25	44	2. 9
Contour tillage: 1 year of a row crop, 1 year of a small grain, 3 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	50		35	2. 5
3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	80	30	50	3. 2

TABLE 4.—*Management and*

Map symbol	Soil	Management group [1]	Nutrient level			Management problems
			Nitrogen	Phosphorus	Potassium	
MaB	Macksburg silty clay loam, 2 to 5 percent slopes.	3 (IIe)	Medium to low.	Medium	High	Sheet erosion
Nn	Nevin silt loam	1 (I)	Medium to low.	Medium	High	Slight wetness
No	Nodaway silt loam	2 (I)	Low	Medium	High	Occasional flooding
Nw	Nodaway silt loam, channeled	18 (Vw)	Low	Medium	High	Wetness, channeling, and frequent flooding.
OmB	Olmitz loam, 2 to 5 percent slopes	4 (IIe)	Medium	Medium	High	Overwash and sheet erosion
OmC	Olmitz loam, 5 to 9 percent slopes	9 (IIIe)	Medium	Medium	High	Sheet erosion
SaA	Sharpsburg silty clay loam, 0 to 2 percent slopes.	1 (I)	Medium to low.	Medium	High	None
SaB	Sharpsburg silty clay loam, 2 to 5 percent slopes.	3 (IIe)	Medium to low.	Medium	High	Sheet erosion
SaB2	Sharpsburg silty clay loam, 2 to 5 percent slopes, moderately eroded.	3 (IIe)	Low	Medium	High	Sheet erosion
SaC	Sharpsburg silty clay loam, 5 to 9 percent slopes.	9 (IIIe)	Medium to low.	Medium	High	Sheet erosion
SaC2	Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded.	9 (IIIe)	Low	Medium to low.	High	Sheet erosion
SaD	Sharpsburg silty clay loam, 9 to 14 percent slopes.	10 (IIIe)	Medium to low.	Medium	High	Sheet erosion
SaD2	Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded.	10 (IIIe)	Low	Medium to low.	High	Sheet erosion
SaE	Sharpsburg silty clay loam, 14 to 18 percent slopes.	15 (IVe)	Medium to low.	Medium	High	Sheet erosion
SbA	Sharpsburg silty clay loam, benches, 0 to 2 percent slopes.	1 (I)	Medium to low.	Medium	High	None
SbB	Sharpsburg silty clay loam, benches, 2 to 5 percent slopes.	3 (IIe)	Medium to low.	Medium	High	Sheet erosion
ShC2	Shelby loam, 5 to 9 percent slopes, moderately eroded.	9 (IIIe)	Low	Low	Medium	Sheet erosion
ShD	Shelby loam, 9 to 14 percent slopes	10 (IIIe)	Medium to low.	Medium to low.	Medium	Sheet erosion
ShD2	Shelby loam, 9 to 14 percent slopes, moderately eroded.	10 (IIIe)	Low	Low	Medium	Sheet erosion
ShE	Shelby loam, 14 to 18 percent slopes	15 (IVe)	Medium to low.	Medium to low.	Medium	Sheet erosion
ShE2	Shelby loam, 14 to 18 percent slopes, moderately eroded.	15 (IVe)	Low	Low	Medium	Sheet erosion
ShF	Shelby loam, 18 to 25 percent slopes	19 (VIe)	Low	Medium to low.	Medium	Sheet erosion
ShG	Shelby loam, 25 to 35 percent slopes	21 (VIIe)	Low	Medium to low.	Medium	Sheet erosion
SoD3	Shelby soils, 9 to 14 percent slopes, severely eroded.	15 (IVe)	Very low	Very low	Medium to low.	Sheet erosion, gullies, and poor tilth.
SoE3	Shelby soils, 14 to 18 percent slopes, severely eroded.	19 (VIe)	Very low	Very low	Medium to low.	Sheet erosion and gullies
Sp	Sperry silt loam	14 (IIIw)	Low	Low	Medium	Wetness and ponding
St	Sperry silt loam, benches	14 (IIIw)	Low	Low	Medium	Wetness and ponding
Wa	Wabash silty clay	13 (IIIw)	Medium	Medium to high.	Medium to high.	Occasional flooding and wetness.
Wb	Wabash silty clay loam	13 (IIIw)	Medium	Medium to high.	Medium to high.	Occasional flooding and wetness.
Wc	Wabash silty clay loam, channeled	18 (Vw)	Medium	Medium to high.	Medium to high.	Frequent flooding, wetness, and channeling.
Wr	Winterset silty clay loam	6 (IIw)	Medium	Medium	High	Wetness
WtA	Wiota silt loam, 0 to 2 percent slopes	1(I)	Medium to low.	Medium	High	None
WtB	Wiota silt loam, 2 to 5 percent slopes	3 (IIe)	Medium to low.	Medium	High	Sheet erosion

yield data for soils—Continued

Crop rotations and other uses	Expected yields under a high level of management [2]			
	Corn	Soybeans	Oats	Hay or pasture
	Bu. per acre	*Bu. per acre*	*Bu. per acre*	*Tons per acre*
2 years of row crops, 1 year of a small grain, 2 years of meadow. *Contour tillage:* 3 years of row crops, 1 year of a small grain, 1 year of meadow.	78	30	49	3. 1
3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	78	29	49	3. 0
Protected from floods: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	70	28	46	3. 0
Permanent pasture, woodland, wildlife habitats				2. 0
Diversion terraces and contour tillage: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of a row crop, 1 year of a small grain seeded with a legume for green manure.	68	27	44	3. 0
Contour tillage: 1 year of a row crop, 1 year of a small grain, 2 years of meadow. *Contour tillage and diversion terraces:* 2 years of row crops, 1 year of a small grain, 1 year of meadow.	66	25	42	2. 9
3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	76	28	46	3. 0
2 years of row crops, 1 year of a small grain, 2 years of meadow. *Contour tillage or terraces:* 3 years of row crops, 1 year of a small grain, 1 year of meadow.	73	27	46	3. 0
2 years of row crops, 1 year of a small grain, 2 years of meadow. *Contour tillage:* 3 years of row crops, 1 year of a small grain, 1 year of meadow.	70	25	45	2. 9
Contour tillage: 1 year of a row crop, 1 year of a small grain, 2 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 1 year of meadow.	70	25	44	2. 9
Contour tillage: 1 year of a row crop, 1 year of a small grain, 2 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 1 year of meadow.	67	24	42	2. 8
Hay or pasture. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	62		40	2. 7
Hay or pasture *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	60		38	2. 6
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 3 years of meadow.	48		34	2. 5
3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	76	28	46	3. 0
2 years of row crops, 1 year of a small grain, 2 years of meadow. *Contour tillage or terraces:* 3 years of row crops, 1 year of a small grain, 1 year of meadow.	73	27	46	3. 0
Contour tillage: 1 year of a row crop, 1 year of a small grain, 2 years of meadow. *Terraces:* 2 years of row crops, 1 year of a small grain, 1 year of meadow.	57	22	39	2. 8
Hay or pasture. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	53		38	2. 6
Hay or pasture. *Terraces:* 2 years of row crops, 1 year of a small grain, 2 years of meadow.	49		36	2. 5
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 3 years of meadow.	40		30	2. 3
Hay or pasture. *Terraces:* 1 year of row crop, 1 year of a small grain, 3 years of meadow.	36		28	2. 0
Permanent pasture				1. 2
Permanent pasture, woodland, wildlife habitats				. 6
Hay or pasture. *Terraces:* 1 year of a row crop, 1 year of a small grain, 3 years of meadow.	34		24	1. 9
Permanent pasture				1. 5
Drained by ditches: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 2 years of row crops, 1 year of a small grain seeded with a legume for green manure.	50	24	30	1. 8
Drained by ditches: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 2 years of row crops, 1 year of a small grain seeded with a legume for green manure.	50	24	30	1. 8
Protected from overflow and drained by ditches: 2 years of row crops, 1 year of wheat; or 2 years of row crops, 1 year of a small grain seeded with a legume for green manure.	45	22	30	1. 6
Protected from overflow and drained by ditches: 2 years of row crops, 1 year of wheat; or 2 years of row crops, 1 year of a small grain seeded with a legume for green manure.	55	25	35	2. 0
Permanent pasture, woodland, wildlife habitats				1. 5
Drained by tile: 3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	77	29	47	2. 9
3 years of row crops, 1 year of a small grain, 1 year of meadow; or 3 years of row crops, 1 year of a small grain seeded with a legume for green manure.	78	29	49	3. 1
2 years of row crops, 1 year of a small grain, 2 years of meadow: *Contour tillage:* 3 years of row crops, 1 year of a small grain, 1 year of meadow.	75	27	47	3. 0

Soil Productivity

An estimate of expected yields should be made before the cropping system is planned for a soil. Table 4 lists expected acre yields of the principal crops on each soil in the county if the soil has been managed well for at least 10 years. Good management provides the following practices:

1. Controlling erosion.
2. Planting rates for corn that will produce—
   (a) 14,000 to 16,000 plants per acre on soils having estimated yields of more than 65 bushels per acre.
   (b) 12,000 to 14,000 plants per acre on soils having estimated yields of 50 to 65 bushels per acre.
   (c) 10,000 to 12,000 plants per acre on soils having estimated yields of less than 50 bushels per acre.
3. Applying fertilizer and lime in the kinds and amounts indicated by soil tests so that the soil reaches levels of fertilization and reaction approaching those suggested by the testing laboratory of Iowa State University.
4. Using cropping systems suggested in the subsection "Management Groups" and in table 4.
5. Draining wet soils adequately by tile or surface drains.
6. Using suitable varieties of crops.
7. Controlling weeds, plant diseases, and insects effectively.
8. Cultivating and harvesting at the proper time.
9. Controlling floods.
10. Planting alfalfa or bromegrass for hay on suitable soils and, in three cuttings the first year, obtaining yields listed in table 4.

The average yields in table 4 are considered to be fairly reliable appraisals of what can be harvested if normal methods of good management are followed. They are based on research data from experimental farms, on the experience of farmers, on the judgment of soil scientists, and on the opinion of the agronomy staff at Iowa State University. Yields fluctuate from year to year. A few farmers who use the best techniques and management known today may exceed the estimated yields by as much as 10 to 15 percent. The averages may be changed in the future by the introduction of new crop varieties, by better fertilization practices, or by other improved methods.

Making a Farm Plan

After identifying the soils, noting good management practices, and studying the special needs of his soil, a farmer may want to work out a more efficient program of land use and soil management. The county extension director and a representative of the Soil Conservation Service will assist in making a farm plan.

Some fields, especially those in rolling areas, contain two or more soils that are suited to different crops and, consequently, need different management. If the area of one soil is very small, it may have to be farmed the same as the rest of the field. On some farms one rotation is suitable for the entire farm, but the special practices, such as contouring, draining, or fertilizing, are different for different soils. On many farms, soil areas are so large that two or more rotations may be used at the same time, or field boundaries may be rearranged so that soils needing similar management are kept together.

Ordinarily, more than one good field arrangement and cropping system can be worked out for any farm. More than one cropping system may be needed on some farms. For example, on a farm having undulating land, rolling land, and some bottom land, two different rotations may be needed if the farm is to be managed to best advantage.

In making a farm plan, consider carefully the characteristics of the soils, rotation of crops, erosion control and drainage, need for fertilizer and lime, expected crop yields, and the capability of the soils as defined in the capability classification used by the Soil Conservation Service.

If a farm plan is to have any value it must be put into operation. The order in which desirable changes should be made depends on the individual farm. If drainage is a problem, perhaps that is the place to start. If alfalfa and brome meadows are to be established, the lime requirements should be checked in advance. Fields that are in meadow are easier to rearrange than fields in row crops. Terraces can be conveniently constructed on meadow that will be plowed for corn. If a meadow is to be tilled on the contour and planted to corn, leave strips of sod on the headlands and in places where machinery will be turned to help keep these areas safe from erosion.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable the soils 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, subclass, and unit. Eight capability classes are in the broadest grouping and 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. Adams County has no soils in class VIII.

The subclasses indicate major kinds of limitations within the class. 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 close-growing plant cover is maintained; *w* means that water in or on the soil will interfere 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 only in 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, which are 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 response to management. The capability unit is a convenient grouping of soils for many statements about their management. In this report capability units are called management groups and are numbered consecutively from 1 to 21.

Soils are classified in capability classes, capability subclasses, and management groups according to the degree and kind of their permanent limitations, but without consideration of major landforming and reclamation that would change the slope, depth, or other characteristics of the soil.

The seven classes, the subclasses, and the management groups in Adams County are described in the list that follows.

Class I.—Soils that have few limitations that restrict their use.
- Management group 1.—Nearly level, well-drained to imperfectly drained soils on benches and uplands.
- Management group 2.—Well-drained to imperfectly drained soils on bottom lands or low foot slopes.

Class II.—Soils that have some limitations that reduce choice of plants or require moderate conservation practices.
- Subclass IIe.—Soils subject to moderate erosion if they are not protected.
  - Management group 3.—Gently sloping, well-drained to imperfectly drained soils.
  - Management group 4.—Gently sloping, well drained to moderately well drained soils on low foot slopes or alluvial fans.
- Subclass IIw.—Soils that are moderately limited by wetness if they are not protected.
  - Management group 5.—Nearly level, imperfectly drained to poorly drained soils on first bottom lands and low foot slopes.
  - Management group 6.—Nearly level, poorly drained soils on uplands or second bottoms.

Class III.—Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IIIe.—Soils that can be cultivated safely if protected from erosion.
  - Management group 7.—Moderately sloping, till-derived soils that are imperfectly drained to moderately well drained.
  - Management group 8.—Moderately sloping to strongly sloping, loess-derived soils that are moderately well drained.
  - Management group 9.—Moderately sloping soils that are well drained to moderately well drained.
  - Management group 10.—Strongly sloping soils that are well drained to moderately well drained.
- Subclass IIIw.—Soils that are severely limited because of wetness.
  - Management group 11.—Fine-textured, moderately sloping soils that are imperfectly drained to poorly drained.
  - Management group 12.—Imperfectly drained to poorly drained, loess-derived soils on moderate slopes.
  - Management group 13.—Poorly drained to very poorly drained soils on bottom lands.
  - Management group 14.—Poorly drained to very poorly drained soils, generally in depressions.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.
- Subclass IVe.—Soils that can be cultivated safely only if appropriate conservation practices are followed.
  - Management group 15.—Moderately sloping to moderately steep soils.
  - Management group 16.—Strongly sloping soils that have a fine-textured subsoil.
- Subclass IVs.—Soils limited by low moisture-holding capacity.
  - Management group 17.—Sandy soils that are very droughty and erosive.

Class V.—Soils that have little or no erosion hazard but have other limitations, impractical to remove, that limit their use largely to pasture, woodland, or wildlife.
- Subclass Vw.—Soils that are not suitable for cultivation without protection from overflow.
  - Management group 18.—Soils on bottom land likely to be flooded frequently.

Class VI.—Soils that have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture, woodland, or wildlife.
- Subclass VIe.—Soils that erode readily but, under careful management, are fairly well suited to trees or pasture.
  - Management group 19.—Strongly sloping to steep soils.
  - Management group 20.—Severely eroded soils on moderate to strong slopes.

Class VII.—Soils that have very severe limitations that make them unsuitable for cultivated crops and that restrict their use largely to pasture, woodland, or wildlife.
- Subclass VIIe.—Soils subject to severe sheet and gully erosion.
  - Management group 21.—Moderately steep, steep, very steep, or gullied soils.

Management Groups

In the following pages the soils of the county are placed in their respective management groups. The soils in each group are described generally, and use and management of the group are discussed. The Roman numeral and the small letter following the number of the management group denotes the capability class and subclass of soils in the group.

MANAGEMENT GROUP 1 (I)

Nearly level, well-drained to imperfectly drained soils on benches and uplands

Ladoga silt loam, benches, 0 to 2 percent slopes.
Macksburg silty clay loam, 0 to 2 percent slopes.
Nevin silt loam.
Sharpsburg silty clay loam, 0 to 2 percent slopes.
Sharpsburg silty clay loam, benches, 0 to 2 percent slopes.
Wiota silt loam, 0 to 2 percent slopes.

These soils have a surface layer of dark to moderately dark silt loam to silty clay loam. They are easily worked and are easy to keep in good tilth. These soils have moderate to moderately slow permeability. They readily absorb most of the rain when it falls in normal amounts, and they hold much of this moisture available for plants. Aeration is generally good. The soils warm up quickly in spring, and they can be worked soon after rains.

The content of organic matter is medium to high. The reaction is medium acid to slightly acid. These soils are medium to low in available nitrogen and in phosphorus but are high in potassium.

Use and suitability.—These soils are well suited to cultivated crops. Though they are nearly level and have little or no runoff, they have good to only slightly restricted internal drainage and are seldom wet. Erosion is not a problem.

Nearly all of the acreage is used for cultivated crops. Individual areas are generally large and can be farmed separately. These soils are planted to corn, soybeans, grain sorghum, small grains, hay, and pasture. Corn is the main crop, but large acreages of soybeans are common. If row crops are grown continuously, weeds, insects, and soil tilth or fertility may become a problem.

This group consists of the most productive soils in the county. Yields are high.

Management.—Corn grown successively for 3 years and followed by a crop of oats and of green manure is suitable for these soils. Also suitable is a 5-year rotation consisting of 3 years of corn, 1 year of a small grain, and 1 year of meadow. If tilth is poor, the 5-year rotation is suggested. Soybeans or grain sorghum can be substituted for corn in the rotation.

These soils generally need lime for highest yields. Corn that does not follow a legume responds well to nitrogen and phosphate fertilizer. Small grains respond well to additions of phosphate. Applications of potash on hills or in rows may be needed for maximum yields of corn. For best results, the amount of lime and the kinds and amounts of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 2 (I)

Well-drained to imperfectly drained soils on bottom lands or low foot slopes

Judson silt loam, 0 to 2 percent slopes.
Kennebec silt loam.
Nodaway silt loam.

These soils have a friable silt loam surface layer and a friable to slightly firm subsoil. The subsoil is moderate to moderately slow in permeability, and the soil profile is well to moderately well aerated throughout.

Most of the rainfall absorbed by these soils is available for plants. The soils generally can be farmed somewhat sooner than can associated soils on bottom lands.

These soils are usually medium to low in available nitrogen, medium in available phosphorus, and high in potassium. They are slightly acid to neutral.

Use and suitability.—These soils are very well suited to cultivated crops. In normal years runoff or overflow is usually not a serious hazard, but in periods of high rainfall the soils are flooded infrequently. They sometimes receive runoff and sediment from sloping uplands, and occasionally a seeding may be lost. These soils usually are not wet, for they absorb rainfall and runoff readily. They are sloping enough to prevent ponding. Erosion is not a problem.

Most of the acreage is used for cultivated crops. The soils are in areas large enough to be farmed separately but generally are farmed with adjacent wetter soils of the bottom lands.

These soils are very well suited to corn, soybeans, grain sorghum, and oats, and to hay or pasture. Corn is the main crop, and yields are high. These are among the most productive soils in the county.

Management.—A rotation that provides 3 years of corn followed by oats planted with a green-manure crop is suitable. Also suitable is a 5-year rotation that has 3 years of corn, 1 year of oats, and 1 year of meadow. Soybeans or grain sorghum can be substituted for corn in these rotations.

These soils need to be protected from floods in some years. The Judson soil can be protected from runoff by diversion terraces. In some places old bayous can be filled and stream channels straightened to reduce the hazard of overflow on the Nodaway soil and the Kennebec soil.

All the soils in this group respond well to fertilizer. Corn that does not follow a legume needs nitrogen and, in smaller amounts, phosphate. A legume seeding responds well to phosphate. These soils generally do not need potash. They may need lime. For best results, the amount of lime and the kinds and amounts of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 3 (IIe)

Gently sloping, well-drained to imperfectly drained soils

Ladoga silt loam, 2 to 5 percent slopes.
Ladoga silt loam, 2 to 5 percent slopes, moderately eroded.
Ladoga silt loam, benches, 2 to 5 percent slopes.
Macksburg silty clay loam, 2 to 5 percent slopes.
Sharpsburg silty clay loam, 2 to 5 percent slopes.
Sharpsburg silty clay loam, 2 to 5 percent slopes, moderately eroded.
Sharpsburg silty clay loam, benches, 2 to 5 percent slopes.
Wiota silt loam, 2 to 5 percent slopes.

These soils have a dark to moderately dark surface layer of silt loam to silty clay loam. The permeability of the subsoil is moderate to moderately slow. The soils absorb much of the rainfall and hold it available for plants. Tilth is generally good. Except for the imperfectly drained Macksburg soil, these soils are well aerated.

The content of organic matter is high to medium. Reaction is slightly acid to medium acid. These soils are low in available nitrogen and in phosphorus and are high in potassium.

Use and suitability.—These soils are well suited to cultivated crops but are subject to some sheet erosion because of slope.

Individual areas of these soils are generally large, and many of them are farmed separately from the adjoining soils. Nearly all of the acreage is used for cultivated crops. These soils are well suited to row crops if erosion is controlled. Corn is the main crop, but soybeans, grain sorghum, oats, and hay or pasture also grow well. Average yields are high.

Management.—If these soils are tilled on the contour, a rotation of 3 years of corn, 1 years of oats, and 1 year of meadow is suitable. In fields not tilled on the contour, a rotation of corn for 2 years, oats for 1 year, and meadow for 2 years is suitable. Soybeans or grain sorghum may be substituted for corn in the rotation. To prevent runoff onto adjacent soils, terraces and contour tillage are used in some areas. On some of the benches, however, contour tillage may be more practical than terracing because of the irregular soil pattern.

Most of the soils in the group stay in good tilth if all crop residues are returned to them, but the moderately eroded Ladoga soil and Sharpsburg soil need additions of manure.

These soils respond well to additions of fertilizer. Corn that does not follow a legume usually needs nitrogen. Corn and legumes respond well to phosphate. The moderately eroded soils generally need more nitrogen than the other soils of this group. Additions of potash are generally not required, but lime should be applied for continued high yields. For best results, the amount of lime and the kinds and amounts of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 4 (IIe)

Gently sloping, well drained to moderately well drained soils on low foot slopes or alluvial fans

Judson silt loam, 2 to 5 percent slopes.
Olmitz loam, 2 to 5 percent slopes.

These soils have a very thick, dark, friable surface soil of silt loam to loam. The subsoil is friable to slightly firm clay loam to silty clay loam. Permeability is moderate to moderately slow, and aeration is satisfactory.

These soils absorb much of the rain that falls and hold this water available for plants. The soils warm up quickly in the spring and can be worked as soon as the adjoining soils.

The content of organic matter is medium. The reaction normally is medium acid to slightly acid. These soils are generally medium in available nitrogen and phosphorus but are high in potassium.

Use and suitability.—These soils are well suited to cultivated crops, but some areas are used for pasture along with other soils in pasture.

Surface runoff causes slight sheet erosion, but because they are on foot slopes, these soils receive about as much soil material in runoff from the slopes above as is lost through erosion. The deposits, however, are less fertile and generally are lower in organic matter than the original soil. Occasionally the deposits cover new seedings and make it necessary to replant. Wetness is not generally a problem.

Areas of these soils vary considerably in size, but most of them are small. They are often farmed with the associated soils in management groups 9 and 10.

Corn is well suited and is the main crop, but soybeans, grain sorghum, oats, and hay or pasture also grow well. Soybeans are often planted instead of corn in fields large enough to be farmed separately or in areas that are farmed with the adjoining bottom lands. Grain sorghum is not grown extensively.

Yields of crops are high, but the average is lower than on soils in management group 1.

Management.—A rotation that consists of 3 years of corn and 1 year of oats planted with a green-manure crop is suitable if diversion terraces are built and contour tillage is used. An alternate rotation is corn for 3 years, oats for 1 year, and meadow for 1 year. Soybeans or grain sorghum can be substituted for corn in the rotations. Tilth is not a problem if all crop residues are returned to the soil.

Diversion terraces intercept runoff water from the uplands. These diversions also carry away sediment brought from the upland areas and thereby reduce the hazard of smothering new seedings. Most of the fields downslope from the diversions can be tilled on the contour.

These soils respond very well to fertilizer. Corn that does not follow a legume usually needs nitrogen. Small grain and legumes respond very well to applications of phosphate. Potash is normally not needed. This group of soils usually requires additions of lime for maximum yields. For best results, the amount of lime and the amounts and kinds of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 5 (IIw)

Nearly level, imperfectly drained to poorly drained soils on first bottom lands and low foot slopes

Colo silty clay loam.
Colo silty clay loam, overwashed.
Colo-Gravity complex, 2 to 5 percent slopes.
Gravity silty clay loam, 2 to 5 percent slopes.

These soils have a friable to slightly firm, silty clay loam surface soil. Except in Colo silty clay loam, overwashed, the surface soil is dark colored and very thick. The dark-colored silty clay loam subsoil is firm to slightly firm and is moderate to moderately slow in permeability.

These soils are excessively wet because of a high water table, flooding, or both. The movement of water and air in them is slightly restricted. They dry out somewhat slowly in spring and must be worked later after rains than soils of management groups 1 through 4. Tilth is generally good if wetness is controlled, but the soils puddle if they are worked when wet. These soils hold a large supply of water available for plants.

Except for Colo silty clay loam, overwashed, these soils are high in organic matter. All the soils are slightly acid. They are generally medium in available nitrogen and medium to high in available potassium.

Use and suitability.—These soils are well suited to cultivated crops but require artificial drainage. Much of the acreage has been drained with tile and is intensively farmed. If they adjoin steep soils, the Colo-Gravity soils and other soils in this unit are not planted to crops in most places. Most areas of these soils are large enough to be managed separately, but the Colo-Gravity soils in small drainageways are often farmed with the adjacent soils on uplands.

Because the soils of this group are flooded occasionally, they are damaged by sediments and by excess water. Sheet erosion or wind erosion is not a hazard, but at times an active gully or a stream channel forms. Before entering a major stream or river channel, water from runoff collects on these soils and drains across them.

Corn and soybeans are suited to these soils and are the main crops. Also suitable are grain sorghums, small grains, and hay or pasture. Yields are medium to high. Legumes may be drowned out by high rainfall. Yields are increased and the soils are easier to manage if drainage is improved, but these soils are farmed in many places without drainage or protection from overflow.

Management.—A rotation that provides 3 years of corn and 1 year of oats seeded with a green-manure crop is suitable. An alternative rotation is 3 years of corn, 1 year of oats, and 1 year of meadow. In these rotations, wheat may be substituted for corn. If tilth is poor, the rotation that includes meadow is more suitable. All crop residues should be returned to the soil to maintain the content of organic matter and to improve tilth.

The soils of this group generally are drained by tile. Outlets can be established in most areas. Grass waterways are generally used in the drainageways to remove excess surface water. To divert runoff from some areas of these soils, diversion terraces are built at the base of upland slopes. Some fields are plowed in the fall, especially if wetness delays planting in spring.

These soils need additions of fertilizer and lime for continued high yields under frequent row cropping. Corn not preceded by a legume generally requires nitrogen. Small grains and legumes respond well to applications of phosphate. Potash is needed in only small amounts, if at all. For best results, the amount of lime and the kinds and amounts of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 6 (IIw)

Nearly level, poorly drained soils on uplands or second bottoms

Bremer silty clay loam.
Winterset silty clay loam.

These soils have a very thick, friable surface soil of dark-colored silt loam to silty clay loam. The subsoil is moderately slow to slow in permeability and absorbs moisture slowly. These soils are poorly drained because surface runoff is slow and the water table is high at times. They are slower to warm up in the spring than the soils in management group 1, and they dry out more slowly after rains.

The soils in management group 6 normally are in good tilth, but they puddle if worked when wet and dry out cloddy and hard. They hold large amounts of moisture available for plants.

These soils are high in organic matter. They are medium to slightly acid. They are normally medium in available nitrogen and phosphorus and high in potassium.

Use and suitability.—If they are drained, these soils are well suited to cultivated crops. They are not subject to sheet erosion, and wind erosion is not severe.

In years of high rainfall, the slow runoff and restricted drainage may delay planting and cause crops to mature late. Though most of the acreage is in cultivated crops, many fields without tile drains are farmed. Crops are generally not lost if artificial drainage is not provided, but average yields are low. Though they are in areas large enough to be farmed separately, these soils are mostly cultivated with better drained soils.

Crops normally grown in the county do well on these soils if excess water is controlled. Corn, soybeans, wheat, grain sorghum, oats, and hay or pasture are suitable. Corn and soybeans are the main row crops. Wheat is often planted on the Bremer soils.

Average yields are moderate under natural drainage, but if drainage is improved, yields are high.

Management.—A rotation that provides 3 years of corn and 1 year of oats seeded with a green-manure crop is suitable. Artificial drainage is needed for fields using this rotation. Also suitable is a rotation that provides 3 years of corn, 1 year of oats, and 1 year of meadow. Rotations that include meadow improve tilth. All crop residues should be returned to the soil to maintain organic matter.

Tile drains work well in these soils, but tiling is costly because of the distance to outlets in most places. Shallow ditches may be dug to improve surface drainage or in areas where installing tile outlets is costly.

If row crops are planted frequently, apply fertilizer for continued high yields. Apply nitrogen for corn that does not follow a legume. Corn, small grain, and legumes respond well to phosphate. Potash is generally not needed or is needed in only small amounts.

These soils require some lime, especially for legumes. The amount of lime and the amounts and kinds of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 7 (IIIe)

Moderately sloping, till-derived soils that are imperfectly drained to moderately well drained

Adair clay loam, thin solum, 5 to 9 percent slopes, moderately eroded.
Adair-Shelby complex, 5 to 9 percent slopes, moderately eroded.
Gara loam, 5 to 9 percent slopes, moderately eroded.

These soils have a moderately dark to dark surface soil that is friable to slightly firm. The subsoil is clayey, and water moves downward slowly. Aeration is seasonally poor. Although the soils of this group dry out slowly in the spring and must be worked later after rains than other soils, erosion is more of a problem than wetness. Narrow seepage bands occur where the Adair soils border the loess-derived soils that are upslope. However, in years when rainfall is normal, wetness generally is not a serious problem.

These soils have a high available moisture-holding capacity. Tilth is generally satisfactory, but the soils puddle if they are worked when wet, and they dry out cloddy and hard.

They are slightly acid to medium acid. Available nitrogen and phosphorus are low to very low, and available potassium is medium.

Use and suitability.—These soils are not well suited to cultivated crops. They are subject to sheet and gully erosion because they are on moderate slopes and take in water slowly. Further erosion should be prevented because these soils are difficult to manage if the original surface soil is gone. They are often plowed in fall, and workability is improved by freezing and thawing. This practice increases the susceptibility to erosion but makes it possible to work the soils earlier in the spring.

Most areas of these soils are large and are often farmed separately from adjacent soils that are better suited to cultivation. A few of the areas are in permanent pasture and this is the best use where these soils occur with soils in management group 19. A large part of the acreage is regularly planted to cultivated crops.

Corn, grain sorghum, oats, hay, and pasture are suitable crops. Soybeans are seldom planted. Corn is not well suited but is commonly grown in a rotation. Average yields are moderate.

Management.—A suitable rotation with terraces is 2 years of corn, 1 year of oats, and 2 years of meadow. If only contour tillage is used, a rotation of corn for 1 year, oats for 1 year, and meadow for 3 years is suitable. All of these soils are suited to hay or pasture.

If they are used for row crops, these soils should be tilled on the contour or terraced to prevent excessive loss of soil and water. Because of the irregular slopes, terraces may be somewhat difficult to establish in the Adair-Shelby soils.

Where subsoil material is exposed in the terrace channels, add topsoil and manure. Interceptor tile drains are often needed in Adair soils to control seepage and should be placed upslope from and parallel to the seep line.

These soils require fertilizer to produce good yields. Oats respond well to applications of nitrogen and phosphate. More vigorous meadow stands can be obtained by adding lime and phosphate. Corn that does not follow a meadow crop responds well to nitrogen and phosphate. For best results, the amount of lime and the amounts and kinds of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 8 (IIIe)

Moderately sloping to strongly sloping, loess-derived soils that are moderately well drained

Clinton silt loam, 5 to 9 percent slopes, moderately eroded.
Clinton silt loam, 9 to 14 percent slopes, moderately eroded.
Ladoga soils, 5 to 9 percent slopes, severely eroded.

These soils are moderately dark colored. The subsoil is firm silty clay loam to silty clay and is moderately slow in permeability. These soils absorb water more slowly than do the soils in management group 9. They are well aerated.

The Clinton soils are easy to work, but the severely eroded Ladoga soils are difficult to work and to prepare in seedbeds. All of these soils are susceptible to serious sheet erosion. Partly because of the poorly granulated surface soil, runoff is high. The surface soil tends to crust after rains, but the soils in this group hold large amounts of moisture available for plants. They warm up quickly in the spring and can be worked soon after rains.

These soils are very low in organic matter. They are medium acid. Available nitrogen is low to very low, available phosphorus is low, and available potassium is medium to high.

Use and suitability.—The use of these soils is seriously limited by erosion, but the soils are moderately well suited to cultivated crops if erosion is controlled. About half of the acreage is in cultivated crops along with the better soils of management groups 9 and 10. Corn is the main row crop. These soils are suited to corn, grain sorghum, oats, hay, and pasture. Soybeans generally are not grown. Yields are medium.

Some areas of these soils are not used for cultivated crops because they are surrounded by areas of other soils that are suited to only pasture or trees. The soils of this group produce good yields of forage crops. Individual areas are generally large enough to be managed separately.

Management.—A suitable rotation on terraces is 2 years of corn, 1 year of oats, and 2 years of meadow. Because slopes are irregular in some places, terraces are more difficult to build on these soils than on soils in management group 9 or 10. If the soils are not terraced, they should be used for semipermanent hay or pasture and corn should be planted only once in 5 to 8 years. Manure should be added to the severely eroded Ladoga soils if they are planted to row crops.

Fertilizers are required to sustain good yields. Corn requires additions of phosphate, and if it does not follow a legume, it also requires nitrogen. Some potassium may also be needed. Apply nitrogen and phosphate for maximum yields of oats. These soils often need large additions of lime where legumes are to be seeded. For best results the amount of lime and the kinds and amounts of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 9 (IIIe)

Moderately sloping soils that are well drained to moderately well drained

Judson silt loam, 5 to 9 percent slopes.
Ladoga silt loam, 5 to 9 percent slopes.
Ladoga silt loam, 5 to 9 percent slopes, moderately eroded.
Olmitz loam, 5 to 9 percent slopes.
Sharpsburg silty clay loam, 5 to 9 percent slopes.
Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded.
Shelby loam, 5 to 9 percent slopes, moderately eroded.

These soils have a moderately dark to dark surface soil that is normally friable and easy to work. The subsoil is slightly firm to firm and in most places is silty clay loam or silty clay. The soils of this group absorb water at a moderate to moderately slow rate and hold large amounts available for plants. Air and water move well in these soils, and wetness is not a problem.

The content of organic matter is medium. Most areas are slightly acid. Available nitrogen and phosphorus are low to medium. Except in the Shelby soil, available potassium is high.

Use and suitability.—These soils are moderately well suited to cultivated crops, but runoff is rapid and the soils are susceptible to sheet erosion.

Except for the Judson and Olmitz soils, the soils of this group are in large areas and generally are used for cultivated crops. Some areas of the Olmitz soil are seeded to pasture because they occur adjacent to soils suited only to pasture.

Corn is the main crop on these soils, but soybeans, grain sorghum, oats, hay, and pasture are also suited. Average yields are usually high.

Management.—If these soils are terraced, they can be managed in a rotation consisting of 2 years of corn, 1 year of oats, and 1 year of meadow. If the soils are not terraced but are tilled on the contour, the rotation should consist of 1 year of corn, 1 year of oats, and 2 years of meadow. Soybeans or grain sorghum can be substituted for corn in the rotation.

All the soils in this group except the Judson and the Olmitz can be protected from erosion by conventional terraces. Diversion terraces will help to protect the Judson and Olmitz soils, and in most places the diversions are built in these soils or in the soils upslope.

The content of organic matter is not difficult to maintain if suitable rotations are used and erosion is held to a minimum. The moderately eroded soils may need additions of manure to improve tilth.

Corn and seedings of oats and legumes require a phosphate fertilizer. Corn that does not follow a legume requires a nitrogen fertilizer. These soils respond well to amendments. The amounts of lime and the kinds and amounts of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 10 (IIIe)

Strongly sloping soils that are well drained to moderately well drained

Arbor loam, 9 to 14 percent slopes.
Ladoga silt loam, 9 to 14 percent slopes.
Ladoga silt loam, 9 to 14 percent slopes, moderately eroded.
Sharpsburg silty clay loam, 9 to 14 percent slopes.
Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded.
Shelby loam, 9 to 14 percent slopes.
Shelby loam, 9 to 14 percent slopes, moderately eroded.

These soils have a dark or moderately dark surface soil that generally is friable. The subsoil is clay loam to silty clay loam and is moderate to moderately slow in permeability. Moisture and air move easily in these soils, and wetness is not a hazard. The soils of this group are easy to work. They warm up quickly in the spring and can be cultivated fairly soon after rains. They hold large amounts of water that plants can use.

These soils are medium to low in available nitrogen and phosphorus and are medium to high in potassium. They are slightly acid to medium acid.

Use and suitability.—These soils are moderately well suited to cultivated crops, but erosion is a serious hazard. If row crops are planted, they should be planted on the contour or on terraces.

Except for the Arbor soil, these soils occur in large areas and are used mainly for cultivated crops. These areas can be farmed separately, but some are farmed with soils in management group 9. Permanent pasture or scattered stands of trees are on some areas of the uneroded soils, especially the Ladoga soil. These soils may be in pasture in places surrounded by steep or severely eroded soils.

Corn is the main row crop, but grain sorghum, oats, hay, and pasture are also suited. Average yields are medium. Soybeans generally are not grown.

Management.—If they are terraced, these soils can be managed in a rotation that provides 2 years of corn or grain sorghum, 1 year of oats, and 2 years of meadow. If the soils are not terraced, they can be seeded for hay or pasture. Before a depleted pasture or hay meadow is reseeded, these soils usually are plowed on the contour and planted to a row crop.

Terraces normally are not difficult to build on these soils. The part of the Arbor soil at the base of slopes can be protected by diversion terraces.

The soils of this group should be fertilized to obtain good yields. All corn needs a phosphate fertilizer, and corn that does not follow a legume generally needs additions of nitrogen. Oats may require some nitrogen and large amounts of phosphate. Legumes need additions of phosphate and lime. These soils require lime in varied amounts. The amounts of lime and the kinds and amounts of fertilizer needed should be determined by soil tests.

MANAGEMENT GROUP 11 (IIIw)

Fine-textured, moderately sloping soils that are imperfectly drained to poorly drained

Adair clay loam, 5 to 9 percent slopes.
Clarinda silty clay loam, 5 to 9 percent slopes.
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded.

These soils have a dark, friable to slightly firm surface soil. The fine-textured subsoil is very firm, compact, and plastic when wet. Water is absorbed and moves through the soils very slowly. Aeration is poor. Cultivation is usually delayed in spring by wetness. Because of a narrow, wet, seepy band at the upper border in some places, parts of these soils may be extremely wet until midsummer. These soils are cold and are slow to warm up in the spring. Tilth generally is good, but it is easily destroyed by working the soils when they are wet. Deep cracks can be seen in many places when these soils dry out in the summer.

Available nitrogen and phosphorus are very low to low, and available potassium is medium. These soils are medium acid.

Use and suitability.—These soils are suited to cultivated crops, but yields are low. Wetness is the main hazard, but the soils are also susceptible to future erosion because they are saturated quickly when it rains and runoff is rapid. Most areas are too small to farm separately and are in permanent pasture, but some areas are cultivated with the soils of management group 7 or 16.

These soils are not well suited to corn or other row crops. Corn often turns yellow and is stunted. Rooting is shallow. These soils should be used for hay and pasture except where they occur in small areas within fields suited to cultivated crops.

Management.—If these soils must be used for row crops, control erosion by terracing and reduce surface wetness by diversion terraces or by drains. Because the subsoil is a clay, the soils in this group are not well suited to terracing unless the exposed subsoil is redressed with topsoil or large amounts of manure. If terraces are built, use a rotation that provides 1 year of corn, 1 year of oats, and 2 years of meadow. Hay or pasture is an alternative use. Planting a crop of corn before reseeding pasture may be desirable. These soils are difficult to manage, for they are much wetter than the surrounding soils.

The very slowly permeable subsoil prohibits tile drainage in these soils, but interceptor tile can be placed upslope in adjacent soils. Also, terraces, including diversion terraces, constructed above these soils will protect them from erosion.

These soils are sometimes plowed in the fall so that fieldwork can be started sooner in the spring. Freezing and thawing seems to improve the structure of the surface soil and make the soils easier to work.

Even if they are fertilized, these soils produce low yields. Row crops and small grains may require additions of nitrogen, phosphorus, and potassium. Most areas require large amounts of lime. These soils should be tested to determine the amounts of lime and the kinds and amounts of fertilizer needed.

MANAGEMENT GROUP 12 (IIIw)

Inperfectly drained to poorly drained, loess-derived soils on moderate slopes

Clearfield silty clay loam, 5 to 9 percent slopes.
Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded.

These soils have a dark, friable to slightly firm surface soil. The subsoil is slightly firm to firm and is highly mottled. The upper part of these soils is moderately permeable, but a layer of very slowly permeable clay begins at 3 to 6 feet from the surface. This clay layer causes a high water table at times and much seepage in periods of normal or high rainfall.

The soils in this group hold a large amount of water available for plants. They are poorly aerated unless they are artificially drained. Ordinarily, these soils must be worked later than soils in management group 9 that are nearby. They are generally poor in tilth. If they are worked when wet, they puddle easily and dry out cloddy and hard.

The content of organic matter ranges from medium in the eroded soil to high in some parts of the uneroded soil. These soils are medium to low in available nitrogen and phosphorus but are high in available potassium. They are neutral to slightly acid.

Use and suitability.—If they are artificially drained, these soils are moderately well suited to cultivated crops. Wetness is a severe limitation. Unless the soils are drained, excess water restricts crop growth and delays fieldwork for several weeks. Most drained areas of these soils are farmed with soils in management group 9.

Corn is the main crop, but grain sorghum, soybeans, small grain, hay, and pasture also are suited. Large acreages of soybeans are not planted, though yields of this crop are good. Wheat is sometimes seeded in fields ordinarily planted to row crops. If these soils are not drained, they are best suited to hay and pasture. Legumes do not grow well when rainfall is above normal. Yields are usually high in drained fields.

Management.—On fields that have been terraced and tiled, a suitable rotation is 2 years of corn, 1 year of oats, and 1 year of meadow. In fields that are tiled and are tilled on the contour but not terraced, 1 year of corn, 1 year of oats, and 2 years of meadow is suitable. Grain sorghum or soybeans can be substituted for corn in both of these rotations.

Laying tile is not difficult, and outlets for the tile are easy to establish. Terraces can be laid out fairly uniformly. A single terrace can protect an entire short side slope in some places. The tilth of these soils generally improves after drainage has been provided.

These soils respond well to fertilizer, especially if row crops are planted frequently. Row crops that do not follow a legume generally need additions of nitrogn. Oats and meadows respond to a phosphate fertilizer. The soils may require liming. They should be tested to determine the amounts of lime and the kinds and amounts of fertilizer they need.

MANAGEMENT GROUP 13 (IIIw)

Poorly drained to very poorly drained soils on bottom lands

Wabash silty clay loam.
Wabash silty clay.

These soils have a dark, slightly firm to firm surface soil and a dark, very firm to firm subsoil. The subsoil is silty clay in most places. These soils absorb rainfall slowly, but hold large amounts of water available for plants. They are poorly aerated. They warm up slowly in spring and must be worked later after normal rains than soils in management groups 2 or 5. A high water table may be present. Runoff is very slow.

These soils are difficult to work and puddle easily even if they are drained. The surface soil becomes cloddy and hard when it dries, and it cracks deeply in midsummer.

These soils are fertile and are medium acid to neutral. They generally contain a medium amount of available nitrogen and a medium to high amount of available phosphorus and potassium.

Use and suitability.—If they are drained, these soils are moderately well suited to cultivated crops. Areas that are not drained are suited to pasture.

The use of these soils is severely limited by excess water. The water table is high at times. In addition, floodwater is received from adjacent streams and runoff from uplands. The growth of roots is restricted by wetness and by poor aeration.

Most areas of these soils are large and can be farmed separately. Drained fields are used for corn, soybeans, grain sorghum, and wheat. The grain sorghum is commonly used for forage. Sometimes the corn and grain sorghum do not mature before the first freezing temperature. Alfalfa does not grow well unless good surface drainage is provided and the soils are protected from flooding. Yields of row crops are medium, and yields of wheat are medium to high.

Management.—These soils can be planted to row crops frequently. They are suitable for a rotation that provides 2 years of row crops and 1 year of oats planted with a green-manure crop. However, good yields depend on artificial drainage. Ditches that are properly graded remove excess water, but tile drainage does not work in these fine-textured soils. Protection from runoff and flooding is difficult. These soils are usually plowed in fall so that workability is improved by freezing and thawing. Planting is often delayed even when these soils are plowed in fall, but it is delayed more if they are plowed in spring.

If they are planted to row crops frequently, these soils need additions of nitrogen and phosphate. They generally need small amounts of lime. For best results, the amounts of lime and kinds and amounts of fertilizer to be applied should be determined by soil tests.

MANAGEMENT GROUP 14 (IIIw)

Poorly drained to very poorly drained soils, generally in depressions

Chariton silt loam.
Sperry silt loam.
Sperry silt loam, benches.

These soils have a dark, friable surface soil that is underlain by a leached subsurface layer. The subsoil is very firm, mottled silty clay that is slowly to very slowly permeable.

Because they are generally in depressions that collect water, these soils are often ponded. The water table is high at times, but it recedes somewhat in the summer. The movement of air and water in the soils is restricted, but the available water-holding capacity is high.

The soils of this group generally are in good tilth unless they are worked when wet. If they are artificially drained, they can be worked at about the same time as are nearby soils in management groups 5 and 6.

These soils contain a moderate to high amount of organic matter. They are slightly acid to medium acid. The available nitrogen and phosphorus are low, and the available potassium is medium.

Use and suitability.—These soils are only moderately well suited to cultivated crops. They are not susceptible to erosion.

The use of these soils is limited mostly by wetness. Water may stand on the surface because internal drainage is very slow. Without drainage, the best use is permanent vegetation, but row crops can be grown if drainage is provided. Most of the acreage is drained and is farmed with drier surrounding soils.

Many areas of these soils are small, troublesome wet spots. Tile drainage generally does not work in these soils, but drainage by ditches is possible. Diversion terraces above Sperry silt loam, benches, will divert some water and reduce wetness.

Corn, soybeans, grain sorghum, small grain, hay, and pasture are grown on these soils. Alfalfa and similar legumes frequently drown out or winterkill. Yields of most crops are medium.

Management.—If these soils are drained, a suitable rotation is 2 years of corn followed by 1 year of oats with a green-manure crop. Also suitable is 3 years of corn, 1 year of oats, and 1 year of meadow. These soils occur in small areas that are usually cropped the same as the adjacent soils in management groups 1, 5, and 6. If tilth becomes poor, additional organic matter may be needed.

Additional plant nutrients are needed when these soils are used frequently for row crops. The response to fertilizers is usually moderate. Corn that does not follow a legume generally needs added nitrogen. Both corn and legumes need a phosphate fertilizer. Small amounts of potassium may be needed. These soils require additions of lime, especially for legumes. The amounts of lime and the kinds and amounts of fertilizer applied should be determined by soil tests.

MANAGEMENT GROUP 15 (IVe)

Moderately sloping to moderately steep soils

Adair clay loam, thin solum, 9 to 14 percent slopes.
Adair clay loam, thin solum, 9 to 14 percent slopes, moderately eroded.
Adair soils, thin solums, 5 to 9 percent slopes, severely eroded.
Adair-Shelby complex, 9 to 14 percent slopes.
Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded.
Gara loam, 9 to 14 percent slopes.
Gara loam, 9 to 14 percent slopes, moderately eroded.
Sharpsburg silty clay loam, 14 to 18 percent slopes.
Shelby loam, 14 to 18 percent slopes.
Shelby loam, 14 to 18 percent slopes, moderately eroded.
Shelby soils, 9 to 14 percent slopes, severely eroded.

The surface layer of these soils is of varied color, consistence, and texture, but it is generally a dark, friable to slightly firm, clay loam or loam. The subsoil is moderately fine textured and is slow to moderately slow in permeability. The movement of air and water within the soils is fairly good, and wetness is seldom a problem, except in seepage spots on the upper slopes of the Adair soils and soils in the Adair-Shelby complex. These soils have good available moisture-holding capacity. Tilth is good in the uneroded soils but may be somewhat poor in the eroded soils.

These soils are slightly acid to medium acid. Most of them are low to very low in available nitrogen and are medium in available potassium. Sharpsburg soils are high in available potassium.

Use and suitability.—These soils are poorly suited to cultivated crops. They probably should be used for hay or pasture. They are often planted to corn for 1 year when pasture is renovated. They are moderately sloping to moderately steep and are susceptible to severe sheet erosion. Gullies are common on the severely eroded soils. Runoff is rapid.

These soils are in areas large enough to manage separately. Most of the moderately eroded to severely eroded areas have been farmed, but now many of these are used only for pasture.

Alfalfa mixed with bromegrass is suitable for semipermanent hay or pasture. Birdsfoot trefoil and bluegrass are suitable for permanent pasture. Corn, grain sorghum, or oats are also grown on these soils, but yields are low.

Management.—Semipermanent hay or pasture is a good use for these soils. If good stands of alfalfa or alfalfa mixed with bromegrass are established, the fields should not be plowed until the stands become poor. If these soils are tilled on the contour, a suitable rotation is 1 year of corn followed by small grain and 4 to 8 years of meadow. Birdsfoot trefoil and bluegrass live longer and are productive longer than alfalfa.

If they are terraced, these soils are suited to row crops. However, good terraces are difficult to build in many places because slopes are irregular and are dissected by sidehill drainageways. A rotation of corn for 1 year, oats for 1 year, and meadow for 2 years is suitable on terraced, strongly sloping soils. On terraced, moderately steep soils, plant corn only 1 year in 5.

Apply manure and fertilizer to fields used for row crops. Mixtures of legumes and grasses respond well to a phosphate fertilizer and to lime. Yields can be increased by topdressing with phosphate. Pastures that are mainly in grass respond well to nitrogen and phosphate. The amounts of lime and the kinds and amounts of fertilizer should be determined by soil tests.

MANAGEMENT GROUP 16 (IVe)

Strongly sloping soils that have a fine-textured subsoil

Adair clay loam, 9 to 14 percent slopes, moderately eroded.
Clarinda silty clay loam, 9 to 14 percent slopes.
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded.

These strongly sloping soils are imperfectly drained to very poorly drained. They are wet and seepy in spring. Aeration is poor. The surface soil is dark colored, and the subsoil is fine textured and very firm. These soils are very slowly permeable to water. Cultivated areas are very susceptible to erosion because the intake of water is slow and runoff is high.

These soils are medium acid. In most places they are low to very low in available nitrogen and phosphorus and are medium in available potassium.

Use and suitability.—The soils in this group are best suited to hay or pasture. They are poorly suited to row crops but can be planted to a row crop occasionally if tile drains are installed upslope in the loess-derived soils. The tile lines should be placed slightly above or in contact with the fine-textured subsoil.

Narrow bands and other small areas of these soils are within large fields that are used for cultivated crops. These small areas should be left in permanent vegetation until the crop in a large field is harvested. Then they can be seeded to pasture along with the rest of the field. Erosion must be controlled in these small areas, because seeding and establishing a stand is difficult if the subsoil is exposed.

These soils are generally too wet for alfalfa, but in some of the drier places alfalfa mixed with bromegrass grows fairly well. Birdsfoot trefoil is more tolerant of excess moisture than alfalfa. Birdsfoot trefoil mixed with bluegrass can be seeded to pasture that is to be grazed for a long time. Another suitable pasture mixture is bluegrass mixed with white clover or alsike clover.

Corn, grain sorghum, or small grains are also grown on these soils, but yields are low. Row crops are often slow to mature and may be damaged by early freezing temperatures.

Management.—If a mixture of alfalfa and bromegrass is established, these soils should not be plowed until stands become poor. A suitable rotation is 1 year of corn planted on the contour, a small grain, and then 4 to 8 years of alfalfa-bromegrass meadow. Birdsfoot trefoil and bluegrass live longer and are productive longer than alfalfa. If these soils are terraced, a rotation of corn for 1 year, oats for 1 year, and meadow for 3 years is suitable. Yields of grain, however, are low.

Terraces are not desirable on these soils, because the fine-textured subsoil will be exposed in the terrace channels. The terraces should be built in the soils above or below these soils. If it is necessary to terrace the soils in this group, spread manure or topsoil in the terrace channels.

Excess water can be reduced by placing interceptor tile drains in the more permeable soil upslope. If a tile drain is placed directly in the Adair or the Clarinda soils, it does not work well because these soils are very slow in permeability.

Fertilizer and lime are normally required on these soils for all crops. Row crops respond poorly to fertilizer, however, and yields are low. Lime and phosphate are needed for legume seedings. The amounts to apply should be determined by soil tests.

MANAGEMENT GROUP 17 (IVs)

Sandy soils that are very droughty and erosive

Hagener loamy fine sand, 5 to 9 percent slopes, moderately eroded, is the only soil in this management group. It has a moderately dark surface soil and a subsoil of friable to loose loamy fine sand. The subsoil is very rapidly permeable.

This soil is very droughty. It readily absorbs rainfall but holds little moisture available for plants. It warms up quickly in the spring and can be worked soon after rains. Workability is good.

This soil contains very little organic matter. It is medium acid to slightly acid. The available potassium normally is low, and the available nitrogen and phosphorus are very low.

Use and suitability.—Use is limited because this sandy soil is droughty and is susceptible to wind erosion and sheet erosion. Blowing sand sometimes damages new seedings on this soil or on soils nearby. Crop residues left on the surface reduce wind erosion.

This soil generally is used for cultivated crops because it occurs in small spots within larger fields of cultivated soils that are in management group 10. Corn, grain sorghum, oats, hay, and pasture are the main crops. Yields of corn are low because sufficient moisture is lacking. Soybeans are seldom grown. Moderate yields of forage and grain are obtained from grain sorghum. Yields of oats, hay, and pasture are moderate. A few areas are in hay and pasture.

Management.—If this soil is tilled on the contour, a rotation that provides 2 years of corn or grain sorghum, 1 year of oats, and 2 years of meadow is suitable. Terraces generally are not built on this sandy, unstable soil, but it can be protected by terraces built upslope in the Sharpsburg or Ladoga soils. This soil can be kept in alfalfa and bromegrass instead of rotation crops.

This soil is so well aerated that it is not practical to try to build up the content of organic matter. But crop residues should be left on the surface to reduce wind erosion. This soil needs additions of fertilizer, but because it is droughty and produces low yields, adding large amounts of fertilizer seldom pays. Legume seedings need additions of lime, phosphate, and potash. For best results, the amounts of lime and kinds and amounts of fertilizer applied should be determined by soil tests.

MANAGEMENT GROUP 18 (Vw)

Soils on bottom lands likely to be flooded frequently

Alluvial land.
Colo silty clay loam, channeled.
Nodaway silt loam, channeled.
Wabash silty clay loam, channeled.

These soils are varied in most all properties. Recent deposits from overflowing streams cover most of the surface.

Except for the Wabash soil, these soils absorb water at a moderately slow rate. The Wabash soil absorbs water very slowly. Because they are flooded frequently and have a high water table, these soils may not be well aerated. They are high in available moisture.

The content of organic matter ranges from high to very low. The amounts of plant nutrients vary. Reaction is slightly acid to neutral.

Use and suitability.—These soils are unsuited to cultivated crops and are only moderately well suited to pasture. The main limitations are the presence of stream channels and frequent flooding. The stream channels are nearly always flooded in periods of high rainfall.

Many individual areas of these soils are large and are used differently than surrounding soils. Nearly all areas are in pasture and scattered stands of young timber. Some of these areas are used for wildlife. Only a small acreage is cultivated. By relocating fences and clearing trees, however, additional areas could be made suitable for cultivated crops. If flooding can be controlled and old bayous or channels straightened and filled, other areas could be made productive.

Management.—Permanent pasture is the most suitable use for these soils, but the carrying capacity is low. The woodland is of little value because most of the trees are small. Cleared fields are normally used for crops rather than pasture. Many areas can be managed to increase wildlife. Old bayous that are not drained hold water for a long time and are suitable habitats for wildlife.

Fertilizer and lime generally are not used on the parts of these soils that are in unimproved pasture.

MANAGEMENT GROUP 19 (VIe)

Strongly sloping to steep soils

Adair clay loam, thin solum, 14 to 18 percent slopes, moderately eroded.
Adair-Shelby complex, 14 to 18 percent slopes, moderately eroded.
Gara loam, 14 to 18 percent slopes.
Gara loam, 14 to 18 percent slopes, moderately eroded.
Gosport soils, 5 to 14 percent slopes.
Hagener loamy fine sand, 9 to 14 percent slopes, moderately eroded.
Shelby loam, 18 to 25 percent slopes.
Shelby soils, 14 to 18 percent slopes, severely eroded.

These soils have a moderately dark to dark surface soil. Except for the Hagener soil, which absorbs water very rapidly, these soils absorb water moderately slowly to very slowly.

All of the soils except the Hagener soil hold much water available for plants. Runoff is rapid because slopes are strong or steep. These soils contain only a medium to a very small amount of plant nutrients. They are slightly acid to strongly acid.

Use and suitability.—These soils are not suited to cultivated crops but are moderately well suited to pasture. They are extremely erosive. The Hagener soil is droughty.

These soils usually occur in fairly large areas and, except for the Hagener soil, can be used separately from surrounding soils. Most areas are in pasture, but some areas, especially those of the Gara soils, are in scattered timber. The timber generally is of poor quality and of little value. Much of this woodland is grazed. The carrying capacity of unimproved pasture is moderate to low. These soils also can be used for permanent pasture.

Management.—Though most of the acreage of permanent pasture is in bluegrass, higher yields can be obtained by seeding mixtures of alfalfa and bromegrass or birdsfoot trefoil and bluegrass. In Iowa, where grazing trials were carried out for a long period, the beef produced on improved or renovated pasture has averaged two and one-half times as much as that on unimproved pasture.

Reseeding pastures to more productive legumes and grasses generally requires some tillage to weaken or destroy existing plants and to prepare a seedbed. Though some slopes are steep, farm machinery can be operated safely in most places. Oats are generally grown as a cover crop when pastures are renovated. The oats can be clipped or can be grazed lightly the first year.

In addition to reseeding, pasture is improved by fertilization. A pasture that does not contain legumes responds to nitrogen. All pasture responds to phosphate fertilizers. Pastures of alfalfa, birdsfoot trefoil, or other legumes need additions of phosphate and lime. The amounts of lime and kinds and amounts of fertilizer should be determined by soil tests.

Other practices that improve pasture are proper grazing, controlling undesirable vegetation, liming, and fertilizing or a combination of these practices.

MANAGEMENT GROUP 20 (VIe)

Severely eroded soils on moderate to strong slopes

Adair soils, 9 to 14 percent slopes, severely eroded.
Adair soils, thin solums, 9 to 14 percent slopes, severely eroded.
Adair-Shelby complex, 9 to 14 percent slopes, severely eroded.
Clarinda soils, 5 to 9 percent slopes, severely eroded.
Clarinda soils, 9 to 14 percent slopes, severely eroded.

These severely eroded soils have a clay loam to silty clay surface layer. The subsoil is slowly to very slowly permeable. The available moisture-holding capacity is good, but runoff is rapid. Gullies are common.

These soils are in poor tilth and are very difficult to work and to manage. The surface tends to seal during rains, and runoff is increased. The soils dry out hard and cloddy. In the spring most of these soils are seepy in many places, especially near the border of the loess-derived soils upslope. The soils of the Adair-Shelby complex are generally less seepy.

These soils are low to very low in organic matter and are medium acid to slightly acid. They are normally very low in available nitrogen and phosphorus and are low to medium in available potassium.

Use and suitability.—These soils are unsuited to cultivated crops. Erosion is the dominant hazard, but excess moisture is also a problem in most places. Good seedbeds are difficult to prepare. These soils are better suited to hay or pasture than to grain.

Interceptor tile placed upslope from these soils in more permeable loess-derived soils reduces excess moisture. Yields of crops, however, are so low that installing tile may not be economical. Terraces can be built to control erosion, but yields are not high.

Alfalfa is not well suited to these soils, but it can be grown on the drier areas. Suitable pasture plants are bluegrass mixed with alsike clover or white clover. Birdsfoot trefoil is also suited. Corn, soybeans, or grain sorghum produce low yields.

Management.—These soils should be kept in permanent vegetation. Small areas within fields planted to cultivated crops should be seeded down and left idle or should be used for pasture if the cultivated crops are grazed. Small areas of these soils within large fields of better soils that are used mainly for hay or pasture can be seeded to pasture and grazed along with the rest of the field.

Seedings often fail because these soils are wet and in poor tilth. Gullies should be filled before seeding, and lime and fertilizers should be applied. Heavy applications of manure improve tilth and help prevent erosion. Grazing should be controlled until seedings are well established. If a seeded pasture is grazed when it is very wet, the trampling of cattle damages seedings.

MANAGEMENT GROUP 21 (VIIe)

Moderately steep, steep, very steep, or gullied soils

Adair-Shelby complex, 14 to 18 percent slopes, severely eroded.
Gara loam, 18 to 25 percent slopes.
Gara loam, 25 to 35 percent slopes.
Gara soils, 14 to 18 percent slopes, severely eroded.
Gosport soils, 14 to 25 percent slopes.
Gosport soils, 25 to 40 percent slopes.
Gullied land.
Shelby loam, 25 to 35 percent slopes.

These soils have severe limitations caused by their steep slope, severe erosion, or gullies. Their capacity to hold water available for plants is high, but water runs off rapidly and only a small amount enters the soils. Aeration may be somewhat restricted in the Gara, Gosport, and Adair-Shelby soils.

All of these soils except Gullied land are low in fertility. Gullied land is generally variable in fertility and is slightly acid to strongly acid.

Use and suitability.—These soils are not suited to cultivation, and they are poorly suited to pasture. They are extremely erosive, and many areas are very dry in midsummer. They can be used as woodland and as wildlife habitats.

Except for the Gosport soils, the soils in this group are in moderately large to large areas and can be used separately from the surrounding soils. Many areas are in permanent pasture, some are in trees, and a few are used for wildlife habitats.

Management.—Because of the trees, noncrossable gullies, or steep slopes, pasture is difficult to renovate. Ordinary farm machinery is difficult and often dangerous to use on the steep, irregular slopes. On the milder slopes, farm machinery can be used and pasture is easier to renovate.

Mixtures of alfalfa and bromegrass or of birdsfoot trefoil and bluegrass are suitable for permanent pasture. Some tillage is generally required to disturb the existing plants when pasture is improved by reseeding it to more productive grasses. Oats can be grown as a cover crop. They can be clipped or grazed lightly the first year. The carrying capacity of pasture is low, and grazing should be controlled.

Areas now in trees should be protected from grazing; other areas can be planted to suitable trees. Specialists at the local office of the Soil Conservation Service or the forester assigned to the area by the State Conservation Commission will be glad to help you plan tree planting and other woodland management.

Agriculture

This section discusses farms and farm tenure, crops, livestock, and other subjects related to the agriculture of Adams County. Unless otherwise stated, the data given are from the U.S. Census of Agriculture.

Farms and Farm Tenure

According to the U.S. Census of Agriculture, the total land in farms in Adams County amounted to 260,160 acres in 1959. There were 1,233 farms in the county, and the average-sized farm was 211 acres. Full owners operated 35.9 percent of the land in farms, part owners operated 29.0 percent, and 35.1 percent was rented by farm operators.

Types and Sizes of Farms

In 1959 there were 778 livestock farms, 125 cash grain farms, 80 general farms, 210 miscellaneous and unclassified farms, 35 dairy farms, and 5 poultry farms in Adams County. Dairy farms increased in number between the years 1950 and 1959, but all other types of farms decreased in number during that period.

Farms were classified by size in the 1959 census as follows:

Size of farms (acres)	*Number*
Under 10	35
10 to 49	98
50 to 99	141
100 to 179	318
180 to 259	306
260 to 499	278
500 to 999	55
1,000 or more	2
	1,233

The trend seems to be toward larger farms in Adams County. The number of farms larger than 260 acres increased between 1950 and 1959, but in that period the number of farms smaller than 260 acres decreased.

Crops and Pasture

In Adams County most of the cropland is used for grain, which is fed to livestock on the farms where it is grown. The acreage in soybeans decreased more than two-thirds between 1939 and 1954, but between 1954 and 1959 the acreage of soybeans increased to about two-thirds of the acreage in 1939. The acreage in hay has more than doubled since 1939. Table 5 lists the acreage of principal crops grown in Adams County in 1939, 1949, 1954, and 1959.

Corn is the most extensive grain crop. It is planted in powerchecked or in drilled rows and is cultivated with rowcrop tractors. Only hybrid corn is planted. Varieties that mature in 110 to 120 days are most common. The crop is cultivated one to three times a year, depending on the weather, on the kinds and quantity of weeds, and on the need of special cultivation. Most farmers use mechanical pickers to harvest the corn.

Soybeans, the most important cash grain crop in Adams County, was the fourth most extensive crop in 1959. Soybeans are drill-planted in May in about the same way that corn is planted. The rows are cultivated with a corn cultivator, and the crop is harvested with combines. The soybeans are hauled to elevators and then are shipped to markets in Iowa and Missouri.

Oats is the second largest grain crop. Most of it is fed to livestock on the farms. The acreage in oats was about the same in 1954 as it was in 1949, but by 1959 it decreased almost one-third. In the past few years many different varieties of oats have been introduced. The seed is planted the latter part of March or early in April so that the crop will mature before it is damaged by summer heat. The crop is harvested early in July.

Wheat, rye, and barley are grown, but the total acreage in Adams County is small. The acreage in wheat decreased from 10,220 acres in 1949 to 1,552 in 1959, a decrease of almost 85 percent.

TABLE 5.—*Acreage of principal crops in Adams County in 1939, 1949, 1954, and 1959*

Crops	1939	1949	1954	1959
	Acres	*Acres*	*Acres*	*Acres*
Corn for all purposes	65, 156	72, 111	63, 633	62, 635
Oats threshed or combined	22, 910	38, 920	38, 937	26, 670
Soybeans for all purposes	10, 884	2, 268	3, 269	7, 292
Spring and winter wheat threshed or combined	4, 864	10, 220	1, 043	1, 552
Hay, all	14, 390	20, 710	35, 231	34, 384
Clover and timothy, and mixtures	6, 473	12, 286	26, 450	18, 499
Alfalfa and alfalfa mixtures	5, 567	5, 879	7, 264	15, 130
Small grains	1, 610	1, 329	883	298
Other hay cut	740	1, 216	634	457
Timothy seed harvested	(1)	1, 333	382	815
Red clover seed harvested	(1)	1, 722	1, 826	1, 826

1 Not reported.

Most of the hay and other forage crops are fed to livestock on the farm. A mixture of clover and timothy is the most common hay crop. This mixture doubled in acreage between 1949 and 1954 but decreased considerably between 1954 and 1959. Also grown for hay are soybeans, small grains, alfalfa, and alfalfa mixed with grasses. Alfalfa is generally mixed with bromegrass or orchardgrass and is planted in a rotation with row crops to conserve and improve the soil. Three cuttings of hay are usually made each year. In 1959 the acreage in alfalfa and alfalfa mixtures was three times as large as it was in 1949. Soybean hay, small-grain hay, and other forage crops generally are fed to livestock as supplemental feed.

The largest areas in pasture in the county are along the Middle Nodaway and East Nodaway Rivers and their tributaries, but pasture occurs throughout the county. Much of the pasture vegetation is unimproved Kentucky bluegrass and is on the uplands. Improved pasture is dominantly a legume-grass mixture of alfalfa or red clover and bromegrass or orchardgrass. Some pasture in Kentucky bluegrass is improved by adding birdsfoot trefoil.

Livestock and Livestock Products

Raising cattle has been important since Adams County was first settled. Most of the dairy cattle are raised on farms in the nearly level to gently rolling areas where they are fed the hay and grazed on the pasture that are grown in rotation with row crops. The principal breeds of dairy cows are Holstein and Guernsey. Dairy products are marketed through local creameries.

A creamery, the second largest in the State, has been in operation at Corning for 27 years. This creamery makes butter, ice cream, nonfat dried milk, and buttermilk. More than 4 million pounds of butter are produced annually, and most of this is shipped to New York City. All the ice cream is sold locally, and the dried milk is shipped to bakeries and meat-packing plants.

The beef cattle are mostly Hereford, Aberdeen Angus, Shorthorn, and mixed breeds. Several herds in Adams County are purebred. The beef cattle are trucked to nearby packing centers.

Hogs are raised throughout the county but are most common on farms in the nearly level areas. The principal breeds are Duroc-Jersey, Hampshire, Poland China, and Chester White. Several herds are purebred, but most of the hogs produced for market are crossbreeds. Hogs and beef cattle are shipped to the same markets.

There were 3,580 lambs born in 1954, or only about one-fourth the number born in 1939. The number of grain-fed sheep and lambs sold in 1945 was 3,276, but this number fell to 2,390 in 1954. Flocks of 50 sheep or more are on farms throughout the county. The principal breeds are Hampshire and Western, and some of the flocks are purebred Hampshires.

Except for the poultry, the livestock is usually trucked to packing plants at Omaha, Nebraska, or to centers in Iowa and Missouri.

Poultry is also important in Adams County, but the number of laying hens has decreased since 1945. Besides chickens, some turkeys, ducks, and geese are raised.

According to local sources, the principal kinds of livestock raised in Adams County and sold in 1955 were as follows:

Kinds of livestock	*Number*
Grain-fed cattle sold	8, 622
Grain-fed sheep and lambs sold	2, 390
Calves born	15, 912
Lambs born	3, 580
Sows farrowing, fall	6, 869
Sows farrowing, spring	10, 003
Cows and heifers 2 years old and over:	
Milk cows	4, 873
Beef cows	12, 069
Hens and pullets of laying age	149, 319
Poultry raised:	
Chickens	190, 045
Turkeys	745

General Nature of the Area

This section has been written for those not familiar with Adams County. It discusses native vegetation, climate, early settlement, and other subjects of general interest. Preceding this section is the section "Agriculture," and following is the section "Geology, Landforms, and Drainage."

Native Vegetation

Adams County lies within the vast region of prairie vegetation that extends from western Indiana into Nebraska. Luxuriant, tall native grasses covered most of the county when it was settled (*29*). Big bluestem (*Andropogon gerardi*) was the dominant grass. Little bluestem (*A. scoparius*) grew on the better drained parts of the uplands, and side-oats grama (*Bouteloua curtipendula*) grew on drier parts. On droughty south-facing slopes and in other areas of drier soils were sand dropseed (*Sporobolus cryptandrus*), porcupinegrass (*Stipa spartea*), junegrass (*Koeleria cristata*), prairie cordgrass (*Spartina pectinata*), and prairie three-awn (*Aristida oligantha*). In lower, more poorly drained areas, sedge (*Carex*), common reed (*Phragmites communis*), common cattail (*Typha latifolia*), and boggrass were dominant and there were a few clumps of willow (*Salix*) and alder (*Alnus rugosa*).

Trees grew mostly in narrow belts on bottom lands and on uplands along streams. Most of the trees now on bottom lands and on the lower slopes of valleys are cottonwood (*Populus deltoides*), soft maple (*Acer saccharinum*), black walnut (*Juglans nigra*), American elm (*Ulmus americana*), and American linden (*Tilia americana*). In steeper areas are oaks, particularly red oak (*Quercus rubra*) and bur oak (*Q. macrocarpa*), and boxelder (*Acer negundo*), shagbark hickory (*Carya ovata*), and an undergrowth of American filbert (*Corylus americana*).

Few undisturbed areas remain in native vegetation on the better drained soils in Adams County. Only a little prairie sod remains that has not been turned under, and it has been changed in some way. Bluestem, a tall prairie grass, has been practically eliminated by grazing in the few native pastures that remain. The bluestem has been replaced by bluegrass.

All native timber has been cutover. Trees must now compete with livestock because all wooded areas are in pasture.

Climate [3]

The climate of Adams County is continental. Summers are warm and the winters are cold, but periods of intense cold or of prolonged heat are rare. Changes in weather, however, are frequent and rapid, and sometimes are pronounced or violent. These changes occur mainly because Adams County is near two major storm tracks. Storms from the northwest follow one of these storm tracks, and storms from the southwest follow the other.

Though changes in weather are frequent, the climate of the county as a whole does not vary much. The climate at Corning is representative of most of the county and is summarized in table 6.

Temperatures and precipitation may vary considerably from one local area to another. On calm, clear nights, valleys and other lowlands may be several degrees colder than the uplands. Showers, which are mostly in summer, vary considerably in amount and intensity within short distances. However, the amount of rainfall in a season is about the same in all parts of Adams County.

Summer rainfall comes mostly in showers and thunderstorms, occasionally accompanied by high winds and hail. Tornadoes can be expected about once in 5 years and usually occur in May and June during the afternoon.

The largest amount of rainfall recorded in a day at Corning was on August 27, 1903, when 8.02 inches fell. This caused the East Nodaway River to rise to the highest crest ever recorded. Among the worst floods in recent years were those in June 1947 and in May 1950. The rivers in Adams County overflow frequently late in spring and in summer.

About once in 2 years, rain can be expected to fall at an intensity of at least 1.60 inches in 1 hour and at least 2.90 inches in 24 hours. About once in 50 years, the rainfall intensity can be expected to be at least 2.95 inches in 1 hour and at least 7.25 inches in 24 hours.

Approximately three-fourths of the annual precipitation in Adams County falls during the growing season, or from April through September. The wettest month is normally June, which has an average rainfall of 4.20 inches. Except in early stages, growing corn needs at least 1 inch of rain per week. The chance of 1 inch or more of rain per week is about 1 in 3 during May, is slightly more than 1 in 2 during June, and is less than 1 in 4 during the last 2 weeks of July. During August and September the chance of 1 inch of rain per week is little more than 1 in 3.

The average snowfall in winter is about 21 inches, but snowfall varies greatly from winter to winter. Occasionally, a single blizzard accounts for half of the snowfall that normally falls in a winter.

The heaviest snowfall recorded in the past 24 years was 16 inches on January 1 and 2 in 1942. The most snow recorded in a single winter was in 1911–12, when 68.5 inches of snow fell. On March 14, 1912, the depth of snow was 29 inches, the deepest recorded. Following the coldest January on record, 52 inches of snow fell during February and March in 1912. In contrast, only 1.5 inches of snow fell during the winter of 1921–22.

Extended dry periods during the growing season are most likely during the latter part of July and early in fall. About 1 year in 3, two consecutive rainless weeks are likely during the growing season. Three consecutive weeks without rain are likely about 1 year in 8.

Although rainfall varies greatly from year to year, some periods of years are drier than others. During most of the 1930's and in the first half of the 1950's, the average rainfall at Corning was considerably less than the average for the period of 1898 through 1938. It was a great deal less than the average in a 68-year period.

The climatic data at Corning show wide ranges of temperature that are characteristic of continental climate.

[3] This subsection was written by P. J. WAITE, State climatologist, U. S. Weather Bureau.

TABLE 6.—*Summary of temperature and precipitation*

[Based on a 30-year record, from 1929 through 1958;

Month	Temperature in °F.							Mean heating degree-days [1]	Precipitation in inches	
	Means			Extremes					Mean	Greatest daily
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year			
Years of record	*28-30*	*28-30*	*28-30*	*30*		*30*		*8*	*28-30*	*28-30*
January	32. 7	13. 1	22. 9	66	1944	−32	1930	1, 313	0. 84	0. 95
February	37. 7	17. 1	27. 4	79	1930	−25	1936	1, 023	0. 78	1. 84
March	47. 7	26. 5	37. 1	85	1945	−22	1948	923	1. 52	2. 19
April	62. 5	38. 9	50. 7	92	1930	8	1936	452	2. 64	2. 30
May	72. 3	50. 3	61. 3	103	1934	27	1944	159	3. 97	4. 11
June	82. 1	59. 9	71. 0	106	1936	36	1934	29	4. 20	5. 05
July	88. 8	64. 9	76. 9	115	1936	44	1930	2	2. 80	2. 15
August	85. 8	62. 9	74. 4	112	1936	38	1950	7	3. 75	2. 80
September	78. 4	54. 0	66. 2	104	1939	24	1942	74	3. 37	3. 23
October	67. 6	43. 0	55. 3	93	1953	15	1949	318	1. 96	2. 57
November	49. 2	28. 6	38. 9	80	1938	−8	1937	787	1. 49	2. 50
December	37. 1	18. 7	27. 9	70	1946	−15	1932	1, 144	0. 64	1. 24
Year	61. 8	39. 8	50. 8	115	1936	−32	1930	6, 231	[3] 27. 96	5. 05

[1] Degree-days based on 65° F. The heating degree-days for a day are determined by subtracting the average daily temperature from 65. These daily values are totaled to obtain the number of degree-days in a month. To determine the mean degree-days for January in an 8-year period, total the degree-days for each January in that period and divide by 8.

[2] Trace.

[3] The mean annual precipitation for a 68-year period was 30.68 inches.

There has been a range of −32° F. to 115° recorded at least 4 times in 68 years. The average monthly variation is from 22.9° in January to 76.9° in July. Temperatures above 90°, which is too hot for the best growth of most plants, occur an average of 34 days annually. The temperature falls to zero or below on an average of 12 days in a winter. The average period without freezing temperature is 163 days, or between May 2 and October 12.

Water Supply

In most rural areas wells supply drinking water and water for household uses. These wells are dug or drilled 25 to 200 feet deep and are equipped with electric or hand pumps. They are normally deep enough to furnish ample water, but the shallow wells generally go dry during droughts. A few families use cisterns to supplement their water supply, and some get water from springs. Ponds on a few farms supply water for livestock.

The only town in the county with a municipal water supply is Corning, which obtains its water from two artificial lakes northeast of the town. During droughts water from deep wells supplements that from the lakes. Other towns in the county obtain most of their water from wells.

Population

According to the 1960 Census of Population, there were 7,468 people in Adams County. All of this population was classed rural. The 1960 census reports that Corning, the county seat, has a population of 2,041; Prescott, 311; Nodaway, 204; and Carbon, 162. Fewer people live in Adams County than in any other county in Iowa.

Transportation

The main line of the Chicago, Burlington, and Quincy Railroad passes through the southern half of Adams County in an east-west direction. The county is also served by truck and bus lines. U.S. Highway No. 34 crosses the county in an east-west direction. This highway, six State highways, and many paved secondary roads form a net that adequately covers the county. Few farms are more than a mile from an all-weather road that connects them with market and trading centers.

Farm, Home, and Community Facilities

The farms in Adams County generally have a substantial farmhouse, barn, corncrib, and other buildings. The cropland is enclosed by fences, mostly of woven wire. Efficient, modern farm equipment is used, and most farms have electricity, running water, a telephone, a television set, and an automobile. In 1959 there were 1,292 automobiles and 603 trucks in Adams County.

Churches, grade schools, and high schools serve the county. School buses transport the children to and from most of the high schools. Rural mail reaches all populated places in the county. A new county hospital at Corning takes care of the medical needs of the people.

at Corning Station, Adams County, Iowa

elevation at Corning, 1,230 feet]

Year	Precipitation in inches—Continued					Mean number of days with—				
	Snow and sleet					Precipitation of 0.10 inch or more	Maximum temperature of—		Minimum temperature of—	
	Mean	Maximum monthly	Year	Greatest daily	Year		90° and above	32° and below	32° and below	0° and below
	30	*30*		*30*		*26–28*	*28–29*	*28–30*	*28–30*	*28–30*
1944	6. 7	24. 0	1936	16. 0	1942	3	0	15	30	6
1955	4. 3	14. 8	1942	10. 0	1945	2	0	9	26	3
1946	3. 8	10. 7	1941	8. 0	1948	4	0	4	23	0
1946	0. 3	3. 5	1957	2. 9	1957	6	0	0	9	0
1950	([2])	([2])	1950	([2])	1950	6	1	0	1	0
1941	0. 0	0. 0	----------	0. 0	----------	7	5	0	0	0
1958	0. 0	0. 0	----------	0. 0	----------	5	14	0	0	0
1951	0. 0	0. 0	----------	0. 0	----------	6	10	0	0	0
1941	([2])	([2])	1949	([2])	1949	5	4	0	0	0
1935	([2])	1. 0	1932	1. 0	1932	4	0	0	5	0
1929	2. 4	8. 0	1932	5. 0	1934	3	0	3	19	0
1941	3. 8	13. 0	1940	5. 0	1940+	2	0	10	28	3
1941	21. 3	24. 0	1936	16. 0	1942	53	34	41	141	12

Early History

Adams County was legally organized in April 1853, and was named after John Quincy Adams (*22*). Although it was called the Heart of the Blue Grass District, Adams County was one of the last counties in Iowa to be settled. It was far from major streams or great wagon trails.

The first settler in Adams County was Elijah Walters, a Kentuckian who moved first to Missouri and, in 1846, to Iowa. The Walters family settled about 2 miles south of the present site of Quincy and at first lived on game, nuts, acorns, and the corn meal brought from Missouri. In 1849 the family moved to the present site of Carbon, and Walters erected a grist mill for grinding corn. Later he built a sawmill.

Quincy was laid out in March 1853, and became the county seat. A weekly mail service was started in 1855 between parts of the county and Osceola in Clark County. Two years later Corning was surveyed and established. In 1869 a railroad was built through the town, and 3 years later the county seat was moved from Quincy to Corning.

The Icarian Colony played an important part in the early development of Adams County. This colony was established in 1853 when a group of French socialists settled about 3 miles east of Corning. The colony added to the culture of the county by bringing in languages, music and art, as well as useful material things. Lilacs, asparagus, and rhubarb were introduced by members of the Icarian colony. The first electric telephone in the State was used in the colony to connect the teacher's home and the schoolhouse.

Restlessness and dissatisfaction caused the colony to dissolve. About 1876 the colony was divided into Old Colony and New Colony because the different factions could not agree on the way affairs should be conducted. Later the young people became dissatisfied because they wanted an advanced education and modern clothes. The colony broke up in 1895.

Geology, Landforms, and Drainage

The geology, landforms, and drainage of Adams County are discussed because a knowledge of these subjects is helpful in understanding the soils of the county.

Geology

There are seven kinds of geologic materials that occur as deposits or exposures in Adams County. The relationships of these deposits are shown in table 7. The deposits, in order of their influence on the soils of the county, are loess, glacial till, alluvium, eolian sands, shale, sandstone, and limestone.

TABLE 7.—*Geologic deposits in Adams County*

System and glacial stage	Interglacial stage or period of soil development	Principal materials deposited in Adams County
	Recent	([1]).
Pleistocene:		
Wisconsin	Late Wisconsin	([1]).
	Early Wisconsin	Loess, eolian sand.
Illinoian	Sangamon	([1]).
	Yarmouth	([1]).
Kansan		Till.
Nebraskan	Aftonian	Till.
Upper Cretaceous (Dakota series).		Sandstone, shale, limestone.
Pennsylvanian (Virgil series).		Shale, limestone.

[1] Alluvium or other geologic materials may have been deposited but no major deposit occurred that covered the entire county.

Loess is silty, wind-deposited material that mantles the upland divides and many of the side slopes throughout the county. It is believed to have been blown mainly from the flood plain of the Missouri River along the western side of Iowa (*3*). The loess was deposited from 24,500 to 14,000 years ago during the Wisconsin glacial period (*15*). Hutton (*3*), in a traverse from Monona County to Wayne County, found that the loess was about 115 feet thick on the upland divides near the Missouri River, and that it thinned gradually to a thickness of about 8 feet in Wayne County. This traverse passes through Adair County, which borders Adams County on the northeast.

The thickness of the loess on the nearly level divides in Adams County has been observed to be 12 to 16 feet (*21*). Loess varies from west to east in thickness and texture (*3*), but the variation is not great in Adams County. Ruhe (*10*) has also studied the relationship of the loess to topography in western Iowa.

Two glaciers have deposited material in Adams County—the Nebraskan and later the Kansan. The Nebraskan glacier left a deposit of calcareous glacial till that is a mixture of sand, silt, clay, boulders, and other rocks. This glacial till is 100 feet or more thick in the eastern part of the county, but it is very thin in the western part (*31*). It was exposed to weathering and soil formation during the Aftonian interglacial age.

The Kansan glacier deposited calcareous till of clay loam texture that is similar to that left by the Nebraskan glacier but contains slightly fewer rocks and boulders. According to Wood (*31*), the Kansan till ranges in thickness from 100 to 150 feet in the eastern part of the county to only a few feet in Douglas Township. Both Kansan and Nebraskan tills were observed during this survey on some slopes in parts of the county. A soil formed on the Kansan till during the Yarmouth and Sangamon interglacial ages and was later covered by the loess.

Alluvium, or material deposited by running water, is also an important geologic deposit in Adams County. The river valleys that formed during glacial periods have a high percentage of sand and gravel on their floor. These coarse materials are overlain by silts and clays that have eroded mostly from the loess and glacial deposits. The modern surface of the alluvium is younger than the Wisconsin loess and probably dates from Late Wisconsin to Recent age.

Eolian, or wind-deposited sands are on some slopes along the east side of the Middle Nodaway and East Nodaway Rivers and their tributaries and were probably blown from the flood plains of those rivers. The sands are therefore somewhat coarser in texture than the silty loess that is believed to have been blown from the flood plain of the Missouri River.

Most of the shale, sandstone, and limestone deposits are covered by the more recent glacial till or loess. A few outcrops, however, are near the major streams, especially along the main stem of the Middle Nodaway River and its branches and along Williams Creek in Lincoln and Douglas Townships. The only exposures of limestone appear in the river beds of the Middle Nodaway and East Nodaway Rivers.

The exposures of sandstone in Adams County are dominantly of the Dakota series in the Cretaceous system (*31*). A deposit of sandstone occurs on the east side of a roadcut about one-half mile north of the southwestern corner of section 16 in Douglas Township.

The exposures of shale are of the Soldier Creek or Cedar Vale series in the Pennsylvanian period. One of the largest exposures in Adams County is 0.4 mile east of the southwestern corner of section 16 in Douglas Township.

Landforms

Adams County is an upland plain that slopes slightly toward the southwest. It is moderately altered by natural erosion and well-defined valley fills. The watershed divides throughout the county are at about the same elevation (*31*). The highest elevation is near Nevinville in the northeastern corner of the county, and the lowest is near Nodaway in the southwestern corner.

Wood (*31*) outlined areas in the northern part of Mercer and the western part of Grant Townships that appear to be remnants of the old glacial plain. These areas have not been subjected to the cutting and filling forces of geologic erosion. The remainder of the plain has been dissected by geologic erosion, and slopes and valleys have formed below the original plain.

The landscape of Adams County is characteristic of that found in the southern half of Iowa. A landscape similar to that in Adams County has been studied in detail by Ruhe (*11*) in Adair County. Ruhe observed that the slopes along the axis of the interfluves are broken at two or three places by distinct changes in gradient. Each interfluve has a sequence of stepped levels that rise from the valley shoulders to the upland divide. Ruhe concluded that this sequence of levels is the result of multicyclic erosion of a glacial till landscape that has been further complicated by a mantle of loess.

The overall effect of normal geologic erosion is emphasized by the appearance of the landscape at the head of drains compared to that at the mouth of the resulting stream. As the stream trenches lower and valleys widen, the slopes that are exposed on the uplands are longer and steeper and the divides decrease in width.

Drainage

The runoff water from Adams County (*8*) flows to the Missouri River. The principal drainage systems in Adams County are shown in figure 9.

The Middle Nodaway and East Nodaway Rivers and their tributaries are the largest drainage systems in the county. The channels of these rivers originally meandered in some places but, between about 1920 and 1930, were partly straightened to reduce flooding. The Middle Nodaway River begins in the northwestern part of Adair County and enters the northern part of Adams County in Carl Township. The valley floor is about 1 mile wide at Carbon. The East Nodaway River enters Adams County in Colony Township and flows from northeast to southwest. The branches of the Hundred and Two River drain most of Jasper and Mercer Townships and have only small flood plains. The Platte River originates in Union County and is about 11 miles long before entering Adams County in Union Township.

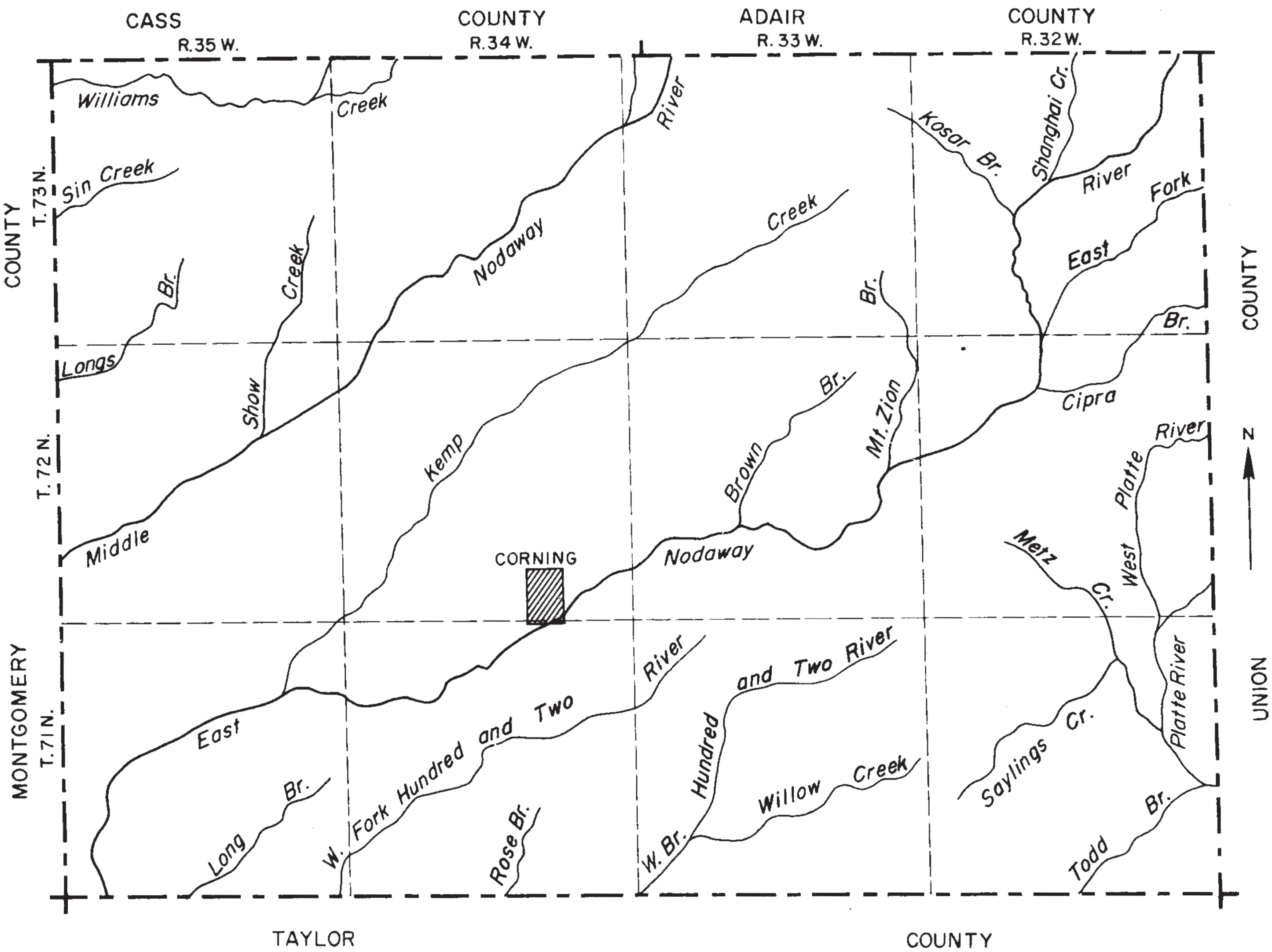

Figure 9.—**Principal drainage systems in Adams County.**

It flows in a southerly direction through Union and Grant Townships before reentering Union County.

Genesis, Morphology, and Classification of Soils

This section has been prepared principally for persons interested in soil science so that they may obtain a better understanding of how the soils in Adams County were formed and how they are classified.

Factors of Soil Formation

Soil is a function of climate, living organisms, parent materials, topography, and time. The effects of these five factors at any one place determine the nature of the soil at that place. All the factors come into play in the genesis of every soil. The relative importance of each factor differs from place to place; sometimes one is more important and sometimes another. In extreme cases one factor may dominate the formation of the soil and fix most of its properties, as is common where the parent material is pure quartz sand. Little can happen to quartz sand, and the soils derived from it generally have faint horizons. Even in quartz sand, however, distinct profiles can be formed under certain kinds of vegetation if the topography is low and flat and the water table is high. Thus, the present character of every soil depends on how the five major factors combined in their effects during the formation of the soil. Man also may affect soil formation by activities that disturb and change the soil.

Climate

The climate of Adams County is continental. It is subhumid and has a wide range in temperature. The soils in the county are thought to have developed for the last 5,000 years under the kind of climate existing today. The climate from about 5,000 to 16,000 years ago, however, is thought to have been cooler and more moist (*15*).

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Nearly uniform climate prevails throughout Adams County. Major differences between the soils in the county were not caused by differences in the recent climate. The soils that formed in arid to semiarid climate normally are less well developed than the soils in Adams County, and where carbonates occur, they have not been leached. In the southeastern part of the United States and in other warm, humid areas, the soils are more highly leached than those in Adams County and are more strongly developed.

Living organisms

Vegetation and micro-organisms greatly influenced the development of soils in Adams County, the micro-organisms by helping the decay of organic matter. The native vegetation of Adams County was mainly big and little bluestem at the time of settlement, but a few areas along the major streams were in trees. Ruhe and Scholtes (*15*) report that for the last 5,000 years the environment in Iowa was conducive to prairie vegetation. From 5,000 to 16,000 years ago, however, the cooler, more moist climate that existed was more favorable to forest. The effect of this earlier period of forest vegetation is not reflected in the morphology of the Sharpsburg and other dark-colored soils that have formed more recently under prairie vegetation.

The Sharpsburg soils are typical of soils developed under prairie vegetation in Adams County. The prairie grasses have thick, fibrous roots that penetrate the soil to a depth of 12 to 15 inches. As a result of this vegetation, the Sharpsburg soils have developed a thick, dark-colored A_1 horizon that contains a relatively high amount of organic matter. In contrast, the Clinton and other soils that developed under forest normally have an A horizon that is thinner and not so dark colored. The Ladoga soils have properties intermediate between those of soils formed entirely under prairie vegetation and soils formed entirely under forest. It is believed that the Ladoga soils were first formed under prairie vegetation and later were occupied by trees.

The Sharpsburg, Ladoga, and Clinton soils are members of a *biosequence*, or a group of soils formed from the same parent materials and under comparable environment except for the native vegetation. The native vegetation has caused the main differences in morphology among the soils in the group. The biosequential relations of somewhat similar soils have been studied in some detail by White and Riecken (*30*).

Parent materials

In Adams County the soils formed from loess, glacial till, alluvium, eolian sand, and shale.

Loess is the most extensive parent material in Adams County. It consists of accumulated particles of silt and lesser amounts of clay that have been deposited by wind. Unweathered loess is silt loam to light silty clay loam in texture. The mineral composition is heterogeneous (*7*), and mineral plant nutrients are abundant. It is assumed that the loess was calcareous when it was deposited. The Sharpsburg, Macksburg, Winterset, Sperry, Clearfield, Clinton, and Ladoga soils have developed in loess. These soils can be distinguished from many other soils by the absence of sand-sized particles in the profile. They can be distinguished from each other by comparing characteristics that are the result of soil-forming factors other than parent material. The characteristics of the Sharpsburg and Winterset soils in southwestern Iowa have been studied in detail by Hutton (*3*, *4*), by Ulrich (*25*, *26*), and have been described in the Soil Survey of Taylor County, Iowa (*18*).

Glacial till is the second most extensive parent material in Adams County. Most of this glacial till is Kansan. The unweathered glacial till is a firm, calcareous clay loam. It contains pebbles, boulders, and sand, as well as silt and clay. The till is a heterogeneous mixture and shows little evidence of sorting or stratification. The mineral composition of its components is also heterogeneous (*7*) and is similar to that of the particles in unweathered loess.

Soils were developed on the Kansan till plain during the Yarmouth and Sangamon interglacial ages. (See table 7.) This was before the loess was deposited. On the nearly level areas the soils were strongly weathered. Their subsoil was a gray clay and is called *gumbotil* (*6*, *31*). The only primary minerals remaining in these strongly weathered soils are those most resistant to weathering. This gumbotil is several feet thick and is very slowly permeable. It formed during the Yarmouth and Sangamon interglacial stages. The soils that formed in the more sloping parts of the Kansan till plain were less strongly weathered, more reddish colored, and not so thick as the soils that formed on level areas. The soils in these sloping areas formed during the Sangamon interglacial stage and in most places contains a layer of pebbles or a stone line (*12*) in the upper part.

The soils formed during Yarmouth and Sangamon ages were covered by loess during the Wisconsin age (*31*). They are called *paleosols*. Studies of buried soils have been made by several people (*9*, *15*, *17*, *19*, *20*). In his study, Simonson (*19*) concluded that the buried soils had been altered by bases that leached from the overlying materials and resaturated the buried soils.

Geologic erosion has removed the loess from many slopes and has exposed strongly weathered paleosols. In some places the paleosols have been beveled or truncated so that only the lower part of the strongly weathered soil remains. In other places erosion has removed all of the paleosol and has exposed till that is only slightly weathered at the surface.

The parent material of soils derived recently from till ranges from relatively unweathered till to strongly weathered paleosols. The unweathered till is in places where geologic erosion has been most active. The Clarinda soils have developed where the most strongly weathered, gray paleosols crop out. The Adair soils have formed where the less strongly weathered, reddish paleosols crop out. Shelby and Gara soils have formed in unweathered or only slightly weathered Kansan till that has had the overlying paleosols removed by geologic erosion.

Figure 10 shows how some of the soils in the county are related to parent material and geomorphic surfaces. The two cross sections are of areas on the soil map at the locations given below each cross section.

In the top cross section (A) from left to right, the traverse A′B′ shows the mapping units (1) in thick loess, (2) in thin loess over the Yarmouth-Sangamon paleosol, (3) directly on the Yarmouth-Sangamon paleosol, (4) in

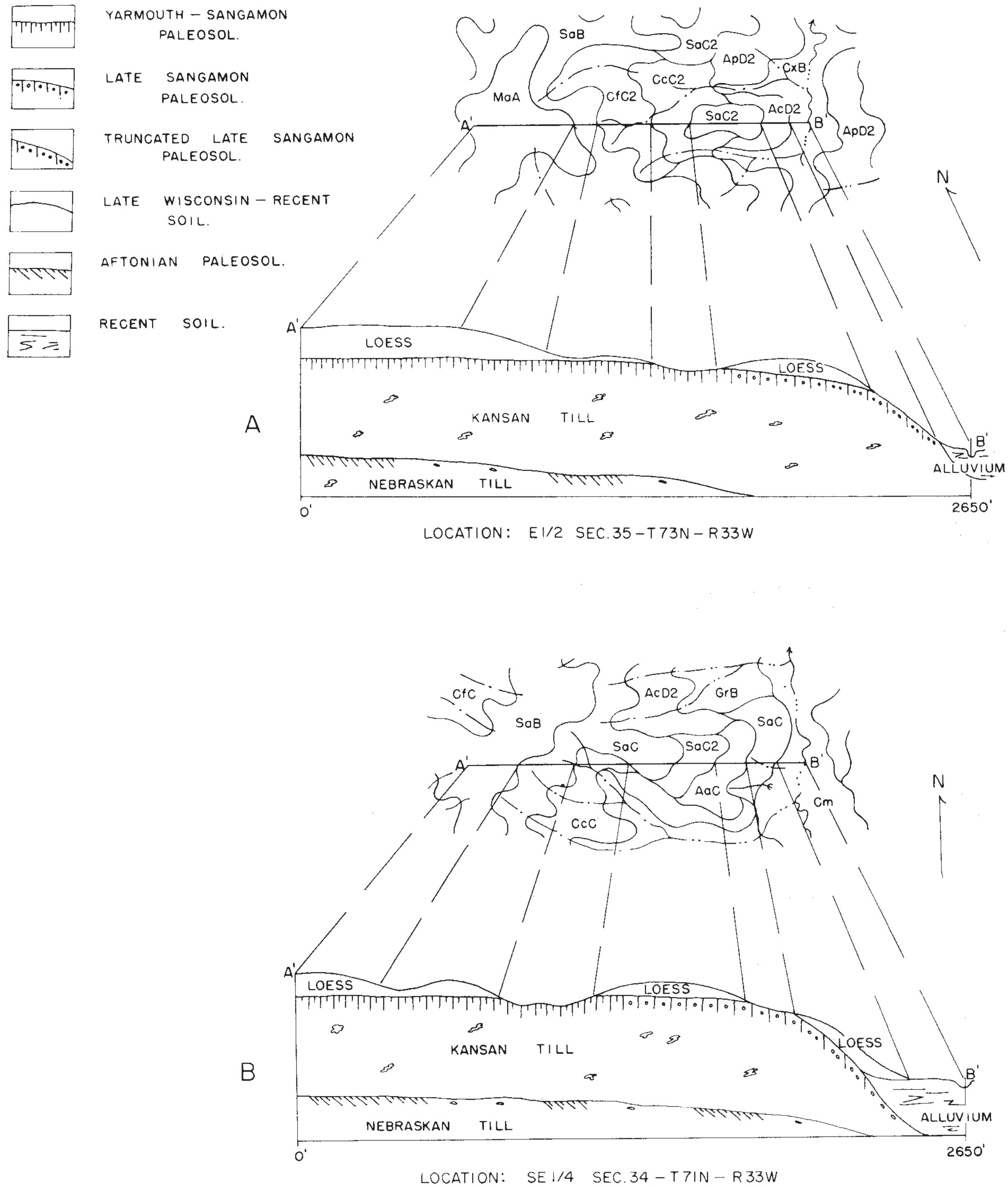

***Figure 10.*—Relation of underlying formations to mapping units in two areas of Adams County.**

Symbol	*Soil*
AaC	**Adair clay loam, 5 to 9 percent slopes.**
AcD2	**Adair clay loam, thin solum, 9 to 14 percent slopes, moderately eroded.**
ApD2	**Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded.**
CcC	**Clarinda silty clay loam, 5 to 9 percent slopes.**
CcC2	**Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded.**
CfC	**Clearfield silty clay loam, 5 to 9 percent slopes.**
CfC2	**Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded.**
Cm	**Colo silty clay loam.**
CxB	**Colo-Gravity complex, 2 to 5 percent slopes.**
GrB	**Gravity silty clay loam, 2 to 5 percent slopes.**
MaA	**Macksburg silty clay loam, 0 to 2 percent slopes.**
SaB	**Sharpsburg silty clay loam, 2 to 5 percent slopes.**
SaC	**Sharpsburg silty clay loam, 5 to 9 percent slopes.**
SaC2	**Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded.**

thick loess, (5) directly on the truncated Sangamon paleosol, and (6) in recent alluvium.

In the bottom cross section (B) from left to right, the traverse A′B′ shows the mapping units (1) in thick loess, (2) directly on the Yarmouth-Sangamon paleosol, (3) in thick loess, (4) directly on the Late Sangamon paleosol, (5) in thick loess, and (6) in recent alluvium.

Alluvium is the third most extensive parent material in Adams County. The texture of the alluvium normally ranges from silt loam to silty clay. Some of the alluvial material has been transported only short distances and is called local alluvium. This alluvium retains many characteristics of the soils in the areas from which it has eroded. The Judson soils, for example, generally occur at the foot of slopes directly below loess-derived soils. Through the profile, Judson soils are silt loam to silty clay loam, or the same texture as are the loess-derived soils. The Olmitz soils also have formed from local alluvium but are downslope from the till-derived soils. Olmitz soils contain more sand in the profile than Judson soils because the alluvial parent material came from sandier soils.

The Nodaway, Kennebec, Colo, and Wabash soils have formed in alluvium consisting of local sediments that washed from nearby uplands and intermixed with sediments that washed from longer distances. The Bremer, Wiota, and Nevin soils are above the level of the present flood plain and presumably have developed in older alluvium than have the Colo, Kennebec, and Wabash soils. The Nodaway soils have developed in alluvium that has been partly deposited since the county was settled.

Eolian sand is an inextensive parent material in Adams County. Because it consists largely of quartz, which is very resistant to weathering, the eolian sand has not been altered appreciably since it was deposited. Hagener soils are the only soils in Adams County developed in eolian sand. These soils can be distinguished from other soils by their high content of sand and their low content of clay.

Shale is the main parent material of Gosport soils. The shale examined in this county did not contain carbonate of lime. Shale parent material can be distinguished from the loess by its high content of clay and, when moist, by its soapy feel. Unlike till, this shale does not contain coarse sand and gravel.

Topography

Topography affects the rate of surface runoff, the height of the water table, and the degree of erosion. The Sperry, Winterset, Macksburg, and Sharpsburg soils have formed from the same kind of parent material, under similar vegetation, but at different topographic positions. The Sperry soils are very poorly drained and occur in low places where water accumulates. The Sharpsburg soils are well drained to moderately well drained and occur on slopes that cause some of the water to run off. Water on soils percolates to lower depths or evaporates. The water that percolates through the soils removes clay from the A horizon, and much of this clay accumulates in the B horizon. The Sperry soils in depressions have accumulated more clay in the B horizon than the Sharpsburg soils on sloping topography because more water percolates through the profile. The content of clay in the B horizon generally is greater in gently sloping or level soils than in steep soils. This content is progressively greater from Sharpsburg soils to Macksburg to Winterset to Sperry soils. The clay content of Winterset and Sharpsburg soils has been reported in detail by Ulrich (*25*, *26*) and Hutton (*3*, *4*).

Topography is often related to the color of the B horizon by affecting drainage and aeration. Restricted drainage causes gray or mottled colors in the subsoil, but under good drainage the subsoil is generally brown. The browner colors of well-drained soils are the result of oxidation and distribution of compounds containing iron. The Sperry soils are in depressions and have a grayish B horizon, whereas the Sharpsburg soils are on slopes and have a brownish B horizon.

Slope affects runoff, which in turn affects the amount of moisture available for plants. The lack of available moisture may have restricted the growth of plants on some of the steeper Shelby and Sharpsburg soils. This possibly accounts for the lower content of organic matter and the thinner A horizon in the Shelby and Sharpsburg soils than in the Winterset soils.

Time

Time is required for climate and living organisms to affect the parent material of soils. The soils of Adams County range from extremely young to very old. The Nodaway soils are young. They have formed in alluvial material, some of which was deposited after the county was settled. The Clarinda soils are very old and formed from till that weathered for perhaps 450,000 years during the Yarmouth and Sangamon interglacial ages (*6*). This material was covered by loess during the Early Wisconsin age (*15*). More recently the material has been exposed to weathering again when the loess was removed by erosion. As a result of the long periods of weathering, the Clarinda soils have a fine-textured B horizon, 3 to 8 feet thick.

Adair soils have a history of formation similar to that of the Clarinda soils, but the Adair soils probably weathered for only 115,000 years before they were covered by the loess. Further weathering has taken place since the loess was removed. The Adair soils are also old but are younger than the Clarinda soils. The B horizon of Adair soil is 2 to 3½ feet thick and is moderately fine to fine in texture.

Like the Adair and Clarinda soils, the Shelby soils have formed in glacial till. Shelby soils, however, have weathered only during Late Wisconsin and Recent times, or for a period of 14,500 years or less. The B horizon of the Shelby soils is 1½ to 2½ feet thick and is moderately fine in texture.

The radiocarbon technique (*16*) for determining the age of carbonaceous material found in loess and till has been useful in dating soils formed partly in Wisconsin age. According to Ruhe and Scholtes (*15*), Early Wisconsin is the age of the upper part of the Wisconsin loess on the uneroded uplands. The Macksburg, Winterset, and Sperry soils have formed in this loess since Early Wisconsin age. The Sharpsburg soils are on slopes, and geologic erosion continues to expose fresh parent material. The Sharpsburg soils, therefore, range in age from Early Wisconsin to Recent.

The alluvium from which the Colo, Wabash, and Kennebec soils have formed was deposited after the loess was deposited. These soils, therefore, are not older than 14,500 years and are probably much younger. Studies indicate that, in areas of loess, the basal fill in gullies is only 6,800 years old (*14*).

Godfrey and Riecken (*2*) studied the phosphorus distribution in some genetically related soils derived from loess in southwestern Iowa. They assumed that the time of weathering was the main variable affecting the formation of the soils studied. They found that the total phosphorus in the soil profile decreased as the development of the profile increased. A Winterset soil that was sampled in Union County contained less phosphorus than a Minden soil that was sampled in Shelby County. The Winterset soil, however, contained more phosphorus than a Haig soil that was sampled in Decatur County.

Man

The greatest effect that man has had on the formation of soils has been his activity that aided accelerated erosion. In addition, when man drained the soils, the effects of climate may have been decreased or the effects of topography may have been altered. The effect of organisms was reduced when native vegetation was destroyed. Also, man adds lime and fertilizer to the soil and changes its chemical composition.

Morphology and Classification

The major horizons of different soils in Adams County differ in kind, number, thickness, and distinctness. The Winterset and the Sperry soils have different kinds of horizons. Winterset soils have A_1, B, and C horizons whereas Sperry soils have A_1, A_2, B, and C horizons. Clearfield soils have four major horizons—A, B, C, and D—whereas the Nodaway soils have only A and C horizons. Clarinda soils have a B horizon 3 to 8 feet thick whereas the B horizon of Shelby is only 1½ to 2½ feet thick.

Distinctness, or the degree that horizons are expressed, ranges from faint to prominent in Adams County. Sperry soils have prominent A_1 and A_2 horizons and a strongly developed B horizon. The horizons in Sharpsburg soils grade gradually from one to another and are only moderately developed.

The principal characteristics of soils in Adams County are described in the section "Technical Descriptions of Soils." These characteristics are color, texture, structure, consistence, reaction, and content of organic matter. On the basis of these characteristics, the 25 soil series in Adams County have been grouped in table 8 into the higher categories of great soil groups, suborders, and orders (*24*, *27*).

Zonal order

In Adams County 17 soil series are in the zonal order. Zonal soils have well-developed soil characteristics that reflect the influence of climate and vegetation, which are the active forces of soil genesis (*27*). They do not have one characteristic that completely outweighs another, and in a profile the horizons are in an A, B, and C arrangement.

TABLE 8.—*Classification of the soil series by higher categories*

Order and suborder	Great soil group	Series
Zonal:		
1. Dark-colored soils of subhumid grasslands.	Brunizems (Prairie).	Adair. Arbor. Clearfield.[1] Gravity.[1] Hagener.[2] Judson.[3] Kennebec.[3] Macksburg. Nevin. Olmitz. Sharpsburg. Shelby. Wiota.
2. Light-colored podzolized soils of timbered regions.	Gray-Brown Podzolic soils.	Clinton. Gara.[4] Gosport.[5] Ladoga.[4]
Intrazonal:		
1. Hydromorphic soils in seepy areas and on flats.	Humic Gley (Wiesenboden).	Bremer. Clarinda. Colo.[3] Wabash. Winterset.
	Planosols	Chariton. Sperry.
Azonal	Alluvial soil	Nodaway.

[1] Intergrade to Humic Gley (Wiesenboden).
[2] Intergrade to Regosol.
[3] Intergrade to Alluvial soils.
[4] Intergrade to Brunizem.
[5] Intergrade to Lithosol.

Two suborders of zonal soils are in Adams County: (1) Dark-colored soils of subhumid grasslands and (2) light-colored podzolized soils of timbered regions.

The Brunizem (Prairie) great soil group (*21*, *22*) is in suborder 1. In Adams County it consists of 13 soil series. The soils in five of the series have some physical properties similar to those of soils in other great soil groups, and the series are intergrades to those groups.

Brunizems of the central concept in Adams County have a black to very dark grayish-brown A_1 horizon, 10 to 18 inches thick, that is friable and medium to moderately fine textured. The B horizon is 15 to 30 inches thick and is commonly dark brown to dark grayish brown with a few yellowish-brown to strong-brown mottles. It is moderately fine textured and slightly firm to firm. The C horizon is leached in some places. It is yellowish brown mottled with strong brown to olive gray, moderately fine textured, and slightly firm to firm. Sharpsburg and Wiota soils represent the central concept of the Brunizems.

The Gray-Brown Podzolic great soil group is in suborder 2. In Adams County it consists of four soil series. The Clinton soils are the only true Gray-Brown Podzolic soils in the county. The soils in the other three series grade toward Brunizems or Lithosols because of soil characteristics that result mainly from the effects of vegetation or relief. White and Riecken

(*30*) discuss some soils in suborder 2 that have a morphology similar to those soils. Gray-Brown Podzolic soils of the central concept have a light to moderately dark, medium-textured, friable A_1 horizon that is 2 to 4 inches thick. A prominent, leached A_2 horizon is present. It is grayish brown, medium textured, friable, and 4 to 7 inches thick. The B horizon is dark brown to dark grayish brown with a few yellowish-brown and olive-gray mottles. It is firm and moderately fine to fine textured. The C horizon is leached. It is dark yellowish brown with a few olive-gray mottles and is moderately fine textured and slightly firm.

Intrazonal order

In Adams County are seven soil series in the intrazonal order. Intrazonal soils have fairly well developed soil characteristics that reflect the dominating effect of some local factor of relief or parent material over the normal effect of climate and vegetation.

In Adams County the local factor of relief has influenced the morphology of the soils in all series in the intrazonal order except one. The nearly level to depressional relief has accelerated the effect of wetness. Chariton, Sperry, Winterset, and Bremer are typical intrazonal soils. The Clarinda and Wabash soils show the dominating influence of parent material. These soils have developed in clay materials. Because of their topographic position and their relations with other soils, Clarinda and Wabash soils are wet. The intrazonal soils in Adams County are in suborder 1, which consists of hydromorphic soils in seepy areas and on flats.

The two great soil groups in Adams County in suborder 1 are Humic Gley (Wiesenboden) and Planosol. Of the five series in the Humic Gley group the Colo series grades toward the Alluvial soils great soil group.

A typical Humic Gley soil in Adams County has a dark, moderately fine textured, friable to slightly firm A horizon, 18 to 24 inches thick. The B horizon is a very dark grayish brown to very dark gray commonly mottled with dark brown and dark yellowish brown. It is moderately fine to fine textured and firm to very firm. The C horizon is olive gray abundantly mottled with dark yellowish brown to dark brown. It is moderately fine textured and slightly firm to firm. Winterset soils are representative of the Humic Gley great soil group.

Soils in the Chariton and Sperry series are hydromorphic and are in the Planosol great soil group. A Planosol of the central concept has a dark, medium-textured, friable A_1 horizon, 6 to 12 inches thick. The A_2 horizon is grayish brown, medium textured, friable, and is 6 to 12 inches thick. The B horizon is a very dark gray to dark gray and is commonly mottled with grayish brown and dark brown. It is fine textured and firm to very firm. The C horizon is gray to olive gray and is abundantly mottled with dark yellowish brown. It is moderately fine textured and slightly firm to firm.

Ulrich (*25*, *26*) and Schafer[4] have discussed Wiesenbodens and Planosols that have developed in southwestern Iowa from loess.

[4] SCHAFER, GEORGE M. PROFILE PROPERTIES OF A LOESS-DERIVED WIESENBODEN SEQUENCE OF SOUTHEASTERN IOWA. 1954. (Unpublished Ph. D. thesis. Copy on file Iowa State University Library, Ames.)

Azonal order

In Adams County only the Nodaway series is in the azonal order. Azonal soils do not have well-developed soil characteristics; their youth, parent material, or relief have prevented definite profiles from developing. The soils of the Nodaway series probably formed after the county was settled, and the forces of soil formation have not had time to alter the parent material much. In some places Nodaway soils that are flooded and receive fresh alluvium only occasionally tend to develop an A horizon that is slightly darker than the parent material.

The azonal order is not subdivided into a suborder. In Adams County azonal soils are in the Alluvial great soil group. Alluvial soils have only A and C horizons in their profile.

Technical Descriptions of Soils

This section has been prepared for soil scientists and others who need more detailed descriptions of the soils in Adams County than are given elsewhere in this report. In the following pages each soil series is described. A profile of at least one soil type in each series is described in detail, and ranges of important characteristics of the soils within the series are stated.

The horizons are named in the way described in the "Soil Survey Manual" (*23*) except for the Adair, Clarinda, Gosport, and Arbor soils. In naming the horizons of those soils, the suggestions of Ruhe and Daniels (*13*) were followed.

Unless indicated otherwise, the Munsell notations designate the color of the soils when they are moist.

ADAIR SERIES

The Adair series consists of moderately well drained to imperfectly drained Brunizems that have developed from fine-textured horizons of exhumed paleosols. The dominant paleosol appears to have been a Gray-Brown Podzolic soil in sloping Kansan relief that formed during Sangamon time.

Adair soils are at the secondary level (step sequence) of the modern landscape. They occur on somewhat stabilized extended ridges or on the shoulders of steep slopes at the juncture of the loess and the till.

ADAIR CLAY LOAMS.—These soils typically have a moderately thick A horizon that is generally friable and grades to a very firm, very thick B horizon of gritty silty clay to clay. The parent material consists of firm, mottled glacial till or of sediments derived from till.

These soils are directly downslope from the loess-derived Sharpsburg and Ladoga soils and the till-derived Clarinda soils.

Adair clay loams are redder, firmer, and finer textured in the B horizon than are Shelby loams. They have a thinner B horizon that is less olive gray than Clarinda silty clay loams. The B horizon of Clarinda silty clay loams is 3 to 8 feet thick. Adair clay loams normally have a darker colored and thicker A horizon than Gara loams.

Adair clay loams are not extensive in Adams County but are important in the continuum of modern soils.

These paleosols are partly responsible for the pattern of ridge-slope relief in the county.

Profile of an Adair clay loam (10 feet south of fence in SW. corner of crossroads in the NE¼SW¼NE¼ sec. 15, T. 72 N., R. 34 W., on a smooth, convex, south-facing ridgetop with a slope of 6 percent):

A_p 0 to 5 inches, black (10YR 2/1) clay loam to gritty light silty clay loam; very dark gray (10YR 3/1, dry); weak, medium, platy to weak, fine, granular structure; slightly firm; slightly acid; abrupt boundary.

A_3 5 to 8 inches, very dark gray (10YR 3/1) gritty medium silty clay loam; few, fine, prominent, dark reddish-brown (5YR 3/3) peds, possibly mixed into this horizon by worms; moderate, fine, granular structure; friable; slightly acid; clear boundary.

B_1 8 to 13 inches, very dark gray (10YR 3/1) and dark reddish-brown (5YR 3/3) gritty heavy silty clay loam; moderate, very fine, subangular blocky structure; slightly firm to firm; clay films on reddish peds only; abundant weatherable sand grains; medium acid; abrupt boundary.

$IIPB_{21}$ 13 to 24 inches, dark reddish-brown (5YR 3/3) medium clay with common, fine, distinct, dark reddish-brown (2.5YR 3/4) mottles, and few, medium, faint, dark-brown (7.5YR 4/2) mottles; strong, fine, angular blocky structure; very firm; thick, continuous, dark reddish-gray clay films; sand grains abundant on exterior of peds; common fine pebbles; no pore space in peds; medium acid; clear boundary.

$IIPB_{22}$ 24 to 39 inches, dark-brown (7.5YR 4/4) medium clay with many, very coarse, distinct, dark reddish-brown (5YR 3/4) mottles; few, fine, distinct, dark-red (2.5YR 3/6) mottles; common, medium to coarse, distinct, olive-gray (5Y 5/2) mottles, and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; strong, medium, angular blocky structure to massive; very firm; weatherable minerals more common than in horizon above; sand grains throughout peds; common fine pebbles; clay films prominent on all peds; most pores filled with clay; slightly acid; clear boundary.

$IIPB_3$ 39 to 48 inches, dark-brown (7.5YR 4/4) light clay with common, very coarse, distinct, brown (7.5YR 5/2) mottles; common, coarse, prominent, olive-gray (5Y 5/2) mottles; few, fine, distinct, dark-red (2.5YR 3/6) mottles, and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; peds that have prominent olive-gray mottles on surface are dark grayish brown (10YR 4/2) and somewhat finer textured inside than peds not mottled with olive gray; strong, medium, angular blocky structure to massive; very firm; clay films common on vertical cleavage planes; pores usually filled with clay; abundant fine pebbles; abundant, coarse concretions of an oxide; slightly acid; clear boundary.

$IIPB_3C_1$ 48 to 60 inches, strong-brown (7.5YR 5/6) heavy clay loam; many, coarse, prominent, gray (5Y 5/1) mottles; common, fine, distinct, dark-brown (7.5YR 4/4) mottles, and few, fine, faint, brown (7.5YR 5/2) mottles; gray mottles have slightly darker interiors than the brown or dark-brown mottles; massive; firm; clay films discontinuous and not on all vertical cleavage planes; no pores; very gritty; pebbles as much as 1/4 inch in diameter; slightly acid to nearly neutral.

Range in characteristics.—Areas of this soil type that are not on ridgetops normally have truncated profiles. On slopes of more than 7 percent, the paleosol A and paleosol A_2 horizons have been removed by erosion in most places, and a thin cap of loess instead of a pedisediment is more evident as the material in which the A horizon has developed. Depending on slope and the degree of erosion, the A horizon ranges from 3 to 12 inches in thickness, but it is generally 6 to 8 inches thick. This horizon is black (10YR 2/1) to very dark gray (10YR 3/1) at most virgin sites but is very dark grayish brown (10YR 3/2) in eroded areas. Compaction by farm equipment may have caused the platiness in the plow layer.

A stone line usually occurs in the upper part of the B horizon if the profile has not been extremely truncated. Pebbles are common in the parent material II horizons. The dark-brown (7.5YR 4/4) B horizon is highly mottled with dark reddish brown (5YR 3/3) to dark reddish brown (2.5YR 3/4). Normally the depth to mottles is 12 to 16 inches. At the most developed part of the B horizon, the clay content is 45 to 50 percent. The B horizon is 34 to 42 inches thick. It ranges from slightly firm to very firm in consistence but is dominantly very firm.

The parent material ranges from strong brown (7.5YR 5/6) to dark yellowish brown (10YR 4/4). It is highly mottled with fine to coarse, olive-gray, strong-brown and yellowish-brown mottles. The dominant coarse mottles are generally olive gray.

Adair clay loams, thin solum.—The Adair clay loams with a thin solum are imperfectly drained to moderately well drained Brunizems that have developed from exhumed paleosols. These paleosols were formed from Kansan till and are of three kinds.

The first kind of paleosols is an exposed paleo Gray-Brown Podzolic soil that formed on the less stable relief during Sangamon time. These paleosols were less strongly developed than those from which the Adair clay loams have formed.

The second kind of paleosols is an exposed paleo Gray-Brown Podzolic soil similar to those in which the Adair clay loams have formed, but beveled or truncated by geologic erosion. The B horizon of Adair clay loams, thin solum, then developed from the lower part of the paleo-B horizon of a paleosol formed in Sangamon time.

The third kind of paleosols is an exposed paleo Planosol or paleo Humic Gley similar to that in which Clarinda silty clay loams have formed, but truncated by geologic erosion. The B horizon of the Adair clay loams, thin solum, may have formed from the lower part of the paleo-B horizon in this paleosol, which formed in Yarmouth and Sangamon ages.

The Adair clay loams, thin solum, occur on low ridgetops and abruptly rounded, convex side slopes that are generally less than 150 feet long. These soils are downslope from the till-derived Clarinda soils or loess-derived Sharpsburg soils. They are upslope from Shelby loam.

Adair clay loams, thin solum, contain more clay and are more intensely mottled in the B horizon than are Shelby loams. If they are uneroded, Adair clay loams, thin solum, have a thick to moderately thick A horizon and no A_2 whereas Gara loams have a thin A horizon that includes an A_2. The Adair clay loams, thin solum, differ considerably from the Adair clay loams. They have a thinner B horizon that ranges from a heavy clay loam to light clay, the depth to carbonates is less, and normally the structure of the B horizon is subangular blocky instead of angular blocky.

Profile of an Adair clay loam, thin solum (54 feet west and 1,680 feet north of the SE. corner of sec. 12, T. 72 N., R. 34 W., on a narrow ridge crest that has a slope of 7 percent and extends toward the north-northwest):

A_{1p} 0 to 6 inches, very dark gray (10YR 2.5/1) clay loam to medium gritty silty clay loam; cloddy breaking to weak, fine, granular structure; friable to slightly firm; many medium and fine roots; large open root channels and wormholes; some grains of fine sand that appear to be loess mixed with till; slightly to medium acid; clear boundary.

A_3 6 to 9 inches, very dark gray (10YR 2.5/1) gritty silty clay loam; weak, very fine, granular structure; friable; many fine roots; some open root channels and wormholes; worm casts; many fine sand grains that appear to be loess mixed with till; slightly to medium acid; gradual boundary.

A_3B_1 9 to 17 inches, very dark gray (10YR 3/1) and dark-brown (7.5YR 3/2) heavy gritty silty clay loam; weak, very fine, subangular blocky to fine, granular structure; many fine roots; large open root channels and wormholes; gradual increase in dark-brown colors with increasing depth; black (10YR 2/1) stains of organic matter finger down in cleavage planes from the A_3 horizon; some rocks; medium acid; gradual boundary.

B_{21} 17 to 25 inches, dark-brown (7.5YR 4/4) light clay with many, fine, distinct, dark reddish-brown (5YR 3/4) mottles; moderate to strong, fine, subangular blocky structure; firm; few very fine roots; few very fine open pores; many pores filled with clay; clay films on all peds; black (10YR 2/1) stains of organic matter on a few cleavage surfaces; intensity of dark reddish-brown mottles decreases with increasing depth; common fine pebbles; medium to strongly acid; gradual boundary.

B_{22} 25 to 34 inches, dark yellowish-brown (10YR 4/4) heavy clay loam with many, distinct, yellowish-brown (10YR 5/6) mottles; few, fine, distinct, brown (7.5YR 5/4) mottles, and few, fine, faint, grayish-brown (2.5Y 5/2) mottles; moderate, fine, subangular blocky structure; no roots; few fine pores; clay films on faces of some peds; few large peds of very dark grayish brown (10YR 3/2) that probably contain more organic matter than other peds; common fine pebbles; few, fine, distinct concretions of iron-manganese oxide; medium acid; diffuse boundary.

B_3 34 to 47 inches, dark yellowish-brown (10YR 4/4) clay loam with many, fine, distinct, yellowish-brown (10YR 5/6) mottles and many, medium to large, distinct, olive-gray (5Y 5/2) mottles; massive breaking to weak, medium, subangular blocky structure; no roots; few fine to very fine pores; some cleavage planes have a sheen, possibly caused by swelling and shrinking (pressure slides); pebbles as much as one-fourth inch in diameter; some splotches of dark-brown (7.5YR 4/2) material that may be organic matter; few, fine concretions of iron-manganese oxide; slightly acid; clear boundary.

C_{ca} 47 to 54 inches, yellowish-brown (10YR 5/6) clay loam with many, large, prominent, olive-gray (5Y 5/2) mottles grading to grayish-brown (2.5Y 5/2) mottles; massive with some fracture planes that indicate a weak, medium, angular blocky structure; no roots; few very fine pores; medium, distinct concretions of iron-manganese oxide; large pebbles common; many, large, soft concretions of lime as much as 1 inch in diameter; matrix slightly calcareous at 54 inches.

Range in characteristics.—The A horizon of the Adair clay loams, thin solum, ranges from clay loam to silty clay loam. It ranges from 4 to 15 inches in thickness but is 8 to 10 inches thick in most places. The A_p layer is black (10YR 2/1) to very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2), depending on degree of erosion. The A_3B_1 horizon varies in thickness.

The B_2 horizon is 16 to 22 inches thick and is normally dark brown (7.5YR 4/4) to yellowish brown (10YR 5/4). In areas below Clarinda soils, however, Adair soils have a dark-gray (10YR 4/1) to dark yellowish-brown (10YR 4/4) B horizon. Consistence is firm. Mottling ranges from dark reddish brown to olive gray and begins at a depth of 17 to 24 inches. The maximum content of clay in the B horizon is 39 to 45 percent.

The C horizon is a light clay loam to heavy clay loam and is firm in most places. The depth to calcium carbonate ranges from 40 to 48 inches.

ARBOR SERIES

The Arbor series consists of moderately well drained Brunizems that have developed from thick, gritty, local alluvium deposited over firm Kansan till. Here dark, friable material has accumulated as a result of geologic erosion of the loess and till uplands during Late Wisconsin and Recent times. These soils are at the base of the long slopes.

These soils occur on smooth, slightly concave to straight slopes that are adjacent to waterways in the hillside. They are above the Gravity or Olmitz soils on low foot slopes and occur with but are downslope from the Shelby and Adair soils.

The A horizon of these soils and the upper part of the B horizon have formed in the local alluvium. The subsoil is slightly firm to firm and moderately slow in permeability. The horizon boundaries are gradual. A thin strata of pebbles occur in some places at the juncture of the alluvium and the undisturbed till.

Arbor soils have a thicker, darker, and more friable A horizon than have Shelby soils on similar slopes. They are less friable than the Olmitz soils, which developed entirely from local alluvium. In most places the lower part of the B horizon and the C horizon of Arbor loam developed in firm till. Arbor soils have a thinner B horizon that contains less clay and is less firm than the B horizon in the thin solum phases of Adair clay loam. Their A horizon is darker than that in Gara soils, and their B horizon is less strongly developed.

Profile of Arbor loam (1/4 mile east and 150 feet south of the NW. corner of NE1/4 sec. 11, T. 72 N., R. 34 W., on a nearly straight, northwest-facing slope of 11 percent):

IA_{1p} 0 to 7 inches, black (10YR 2/1) heavy loam; moderate, fine to medium, granular structure; friable; medium acid; clear boundary.

IA_{12} 7 to 18 inches, very dark brown (10YR 2/2) heavy loam; weak, very fine, subangular blocky to weak, fine, granular structure; friable; medium acid; gradual boundary.

IB_{21} 18 to 26 inches, very dark grayish-brown (10YR 3/2) light clay loam; moderate, fine, subangular blocky structure; slightly firm; abundant well-rounded smooth pebbles at 24 to 26 inches; medium acid; gradual boundary.

IIB_{22} 26 to 32 inches, dark grayish-brown (10YR 4/2) to dark-brown (10YR 4/3) medium clay loam with few, fine, distinct, strong-brown (7.5YR 5/6) mottles and common, fine, faint, grayish-brown (10YR 5/2) mottles; moderate, fine to medium, subangular blocky structure; firm; few, thin, discontinuous clay films on ped faces; slightly acid; gradual boundary.

IIB_3 32 to 40 inches, dark-brown (10YR 4/3) medium clay loam with few, fine, distinct, strong-brown (7.5YR 5/6) mottles and many, fine, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium to coarse, blocky structure; thin clay films on vertical cleavage planes; slightly acid; gradual boundary.

IIC_1 40 to 54 inches +, dark yellowish-brown (10YR 4/4) clay loam with many, coarse, distinct, olive-gray (5Y 5/2) mottles and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; massive; slightly acid to nearly neutral.

Range in characteristics.—The alluvial material ranges from 18 to 30 inches in thickness. The thickness varies according to the position of the material on the slope. At the upper reaches of the slope where the alluvium is thinnest, Arbor soils are adjacent to the Shelby soils or the Adair soils with a thin solum. Downslope, where the alluvium is thickest, they grade to Olmitz or Gravity soils.

The texture of the A horizon ranges from loam to clay loam but is generally loam. The A horizon is moderately permeable and is underlain by a moderately permeable B horizon that is 16 to 24 inches thick. In a B horizon with maximum development, the clay content ranges from 30 to 36 percent. The consistence of the B horizon ranges from slightly firm to firm. The mottles in the subsoil are usually fine and range from few to abundant. They are generally strong brown (7.5YR 5/6) to yellowish brown (10YR 5/4). In the substratum mottles are mostly olive gray (5Y 5/2). The depth to mottles ranges from 24 to 30 inches.

BREMER SERIES

The Bremer series consists of poorly drained Humic Gleys that have developed from alluvial material of Late Wisconsin and Recent ages. They are the poorly drained members of a catena that includes imperfectly drained Nevin soils and well-drained Wiota soils. Bremer soils occupy nearly level, low stream terraces that are slightly higher than the flood plain.

These soils typically have a thick, dark, silty clay loam A horizon and a moderately developed, gleyed, light silty clay to heavy silty clay loam B horizon. The solum is commonly mottled below a depth of 16 to 20 inches.

The B horizon in Bremer soils is higher in clay and more gleyed than that of the Nevin soils. It is less brown, more mottled, and contains more clay than the B horizon in the Wiota soils. The Bremer soils have a moderately developed profile that contains a distinct light silty clay to heavy silty clay loam B horizon and a silty clay loam C horizon. Wabash silty clay loam does not have a distinct B horizon, and the lower C horizon is silty clay.

Profile of Bremer silty clay loam (NE. corner of SW¼ sec. 12, T. 71 N., R. 35 W., on a nearly level, low second bottom that slopes slightly to the north):

A_{1p} 0 to 8 inches, black (10YR 2/1) to dark-gray (10YR 4/1, dry) light silty clay loam to heavy silt loam; massive to weak, fine and very fine, granular structure; friable; abrupt boundary.

A_{12} 8 to 16 inches, black (10YR 2/1) light silty clay loam; weak, fine, subangular blocky to weak, medium, granular structure; friable; medium acid; clear boundary.

B_1 16 to 23 inches, black (10YR 2.5/1) heavy silty clay loam; moderate, very fine, subangular blocky to weak, fine, angular blocky structure; slightly firm; medium acid to slightly acid; gradual boundary.

B_{21g} 23 to 29 inches, very dark gray (10YR 3/1) light silty clay with few, fine, faint, dark grayish-brown (2.5Y 4/2) mottles; moderate, fine to very fine, angular blocky to weak, fine, subangular blocky structure; firm; plastic; slightly acid to neutral; clear boundary.

B_{22g} 29 to 34 inches, very dark gray (10YR 3/1) light silty clay with common, fine, faint, dark grayish-brown (2.5Y 4/2) mottles; weak, fine, angular blocky structure; firm when moist, plastic when wet; contains oxides; slightly acid to neutral; gradual boundary.

B_{3g} 34 to 45 inches, dark-gray (5Y 4/1) light silty clay containing some peds with very dark gray (10YR 3/1) faces; common, fine, faint, dark grayish-brown (2.5Y 4/2) mottles; weak, medium, angular blocky to moderate, very fine, angular blocky structure; firm when moist, plastic when wet; few concretions of an oxide; neutral; gradual boundary.

C_1 45 to 70 inches, gray (5Y 5/1) medium silty clay loam with common, fine, prominent, yellowish-brown (10YR 5/8) mottles; massive; slightly firm to firm; slightly coarser in texture with increasing depth; neutral.

Range in characteristics.—The A horizon of the Bremer soils is 14 to 20 inches thick and is dominantly light silty clay loam but is silt loam in places. The A_1 horizon is black (10YR 2/1) to very dark gray (10YR 3/1). The B horizon is generally 18 to 30 inches thick and very dark gray (10YR 3/1) to dark gray (10YR 4/1). The content of clay in the B horizon is as much as 38 to 44 percent. Clay films are not prominent in Bremer soils, but the faces of peds in the B horizon are distinctly shiny. Horizon boundaries are clear to gradual. Mottling generally begins at a depth of 16 to 20 inches and ranges from dark grayish brown (2.5Y 4/2) to yellowish brown (10YR 5/8). The profiles range from neutral to medium acid but are normally slightly acid. Acidity decreases with increasing depth. In some places lenses of sand occur below 8 feet.

CHARITON SERIES

The soils of the Chariton series are very poorly drained to poorly drained Planosols of Late Wisconsin and Recent ages. They have developed from alluvium on nearly level first bottoms and low second bottoms in moderately wide to wide river valleys.

These soils have a dark-colored A_1 horizon and a distinct, moderately thick, light-colored A_2 horizon. Gray coats commonly occur on the peds of the B_1 horizon. Chariton soils have a dark-colored, fine-textured B horizon that is mottled and gleyed. The B horizon grades gradually to a poorly defined C horizon that is less fine textured and more prominently mottled.

Chariton soils have much more distinct horizons than Wabash soils. The Wabash soils do not contain an A_2 horizon, and the increase of clay from the A horizon to maximum B is not so large as in the Chariton soils. The Chariton soils are also more developed than the Colo soils, which normally consist of dark-colored silty clay loam throughout the profile.

Profile of Chariton silt loam (75 feet west and 45 feet north of the SE corner of NE¼SW¼ sec. 6, T. 73 N., R. 33 W., on a nearly level to flat area that is slightly above the flood plain of the Middle Nodaway

River but is likely to be flooded by a side stream that empties into the river):

A_1 0 to 9 inches, black (10YR 2/1) heavy silt loam to light silty clay loam; moderate, fine, granular structure; friable; slightly acid; clear boundary.

A_1A_2 9 to 13 inches, very dark gray (10YR 3/1) to dark gray (10YR 4/1) silt loam; weak, fine to medium, platy structure; friable; medium acid; gradual boundary.

A_2 13 to 19 inches, dark-gray (10YR 4/1) to gray (10YR 5/1) silt loam; moderate, very thin, platy structure; friable; medium acid; clear boundary.

B_1 19 to 24 inches, dark-gray (10YR 4/1) light silty clay loam; weak, medium, platy to weak, fine, subangular blocky structure; friable; gray (10YR 6/1, dry) coats of silt on peds; medium acid; gradual boundary.

B_{21g} 24 to 36 inches, black (10YR 2/1) medium silty clay; weak, medium to coarse, prismatic structure to weak, very fine, subangular blocky structure; very firm; clay films on ped faces; slightly acid; gradual boundary.

B_{22g} 36 to 48 inches, very dark gray (10YR 3/1) medium silty clay; weak, coarse, prismatic structure to massive; very firm; very small slick patches on peds; gradual boundary.

B_{3g} 48 to 55 inches, very dark gray (2.5Y 3/1) medium silty clay with few, fine, dark grayish-brown (2.5Y 4/2) mottles; massive; firm; slightly acid; gradual boundary.

C_1 55 to 67 inches, gray (5Y 5/1) heavy silty clay loam to light silty clay with common, medium, prominent, yellowish-brown (10YR 5/8) mottles; massive; firm; clay in root channels.

Range in characteristics.—This soil has a black (10YR 2/1) to very dark gray (10YR 3/1) A_1 horizon, 6 to 12 inches thick. It is underlain by a platy, dark-gray to gray (10YR 4/1 to 6/1) prominent A_2 horizon, 6 to 12 inches thick. The B horizon is black (10YR 2/1) to very dark gray (10YR 3/1 to 2.5Y 3/1) and is 24 to 40 inches thick. It is plastic and sticky. At the most developed part of the B horizon the content of clay ranges from 45 to 55 percent. Typically the B horizon has about twice the clay content as the A horizon. Dark grayish-brown (2.5Y 4/2) to yellowish-brown (10YR 5/6) mottles are present in the solum, but the mottles are often faint in the B horizon. The depth to pronounced mottling is normally below 36 inches.

Water commonly seeps in laterally immediately above the silty clay B_1 horizon. The permeability of the subsoil ranges from very slow to slow. Reaction is normally slightly acid but ranges from medium acid to neutral.

CLARINDA SERIES

The Clarinda series consists of poorly drained to very poorly drained Humic Gleys that have developed mainly from very thick, fine-textured horizons of exhumed paleosols. The paleosols were old fine-textured soils that formed on the nearly level to slightly undulating Kansan till plain during the Yarmouth and Sangamon ages. They were later buried by loess deposited during Early Wisconsin time but have been uncovered by geologic erosion.

Clarinda soils commonly occur in the coves of drainageways that extend into broad, moderately sloping uplands or the main divides. They may also occur on steeper side slopes as a narrow band in places where the higher loess-derived soils meet the lower till-derived soils. Where they are closely associated with Shelby and Adair soils, Clarinda soils are above those soils and below the Sharpsburg soils.

Clarinda soils normally have a dark-colored, silty clay loam A horizon underlain by a very firm, gleyed B horizon of silty clay or clay. The B horizon is 3 to 8 feet thick and contains few or no weatherable minerals. It is very slow in permeability.

Clarinda soils have a grayer B horizon than have the Adair soils and fewer weatherable minerals in the solum. Their B horizon is firm to very firm and contains more clay than the firm, yellowish-brown B horizon of the Shelby soils.

Partly responsible for the broad upland flats that exist today are the fine-textured horizons in which Clarinda soils formed and their resistance to geologic erosion.

Profile of a Clarinda silty clay loam (610 feet south and 20 feet west of NE. corner of SE¼ sec. 1, T. 71 N., R. 33 W., on a north-facing ridgetop with a slope of 5 percent):

IA_1 0 to 6 inches, black (10YR 2/1) light silty clay loam with few, fine, faint, dark-brown (10YR 3/3) mottles; loesslike; moderate, fine, granular structure; friable; strongly acid; clear boundary.

IA_3 6 to 10 inches, very dark gray (10YR 3/1) medium silty clay loam with few, fine, faint, dark-brown (10YR 4/3) mottles and few, fine, prominent, yellowish-brown (10YR 5/4) mottles; loesslike; moderate, fine, subangular blocky structure; friable; a few fingers of dark grayish-brown (2.5Y 4/2) light silty clay with prominent clay films extended from the horizon below; many fine pores in peds; medium acid; clear, wavy boundary.

$IIPB_{1g}$ 10 to 15 inches, dark grayish-brown (2.5Y 4/2) light silty clay with few, fine, faint, dark grayish-brown (10YR 4/2) mottles and few, fine, distinct, dark-brown (7.5YR 4/4) mottles; moderate, fine, angular blocky structure; firm; few, fine concretions of an oxide; prominent clay films entirely cover peds; pores mostly filled with clay; medium acid; clear boundary.

$IIPB_{21g}$ 15 to 28 inches, dark grayish-brown (2.5Y 4/2) medium silty clay with common, coarse, distinct, dark yellowish-brown (10YR 4/4) mottles, few, fine, faint, dark grayish-brown (10YR 4/2) mottles, and common, medium, faint, very dark gray (10YR 3/1) mottles; strong, fine, angular blocky structure to massive; very firm; common concretions of an oxide as much as 1/16 inch in diameter; thick, continuous clay films on peds; pores filled with clay; medium acid; clear boundary.

$IIPB_{22g}$ 28 to 44 inches, olive-gray (5Y 5/2) heavy silty clay with common, coarse, distinct, yellowish-brown (10YR 5/4) mottles, few, fine, faint, brown (10YR 5/3) mottles, and few, fine, distinct, very dark gray (10YR 3/1) mottles; very dark gray mottles are less common than in B_{21} horizon; massive to weak, medium, angular blocky structure; very firm; clay films prominent; old root channels filled with clay; no pores in peds; medium acid; gradual boundary.

$IIPB_{3g}$ 44 to 58 inches, gray (5Y 5/1) heavy silty clay with many, medium to coarse, distinct, dark-brown (7.5YR 4/4) mottles; and common, coarse, prominent, dark yellowish-brown (10YR 4/4) mottles; massive to weak, medium, angular blocky structure; very firm; old root channels filled with very dark gray clay; thick, continuous clay films; few fine grains of quartz; few concretions of an oxide; medium acid.

Range in characteristics.—The A horizon is dominantly black (10YR 2/1) but grades to very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in cultivated areas. Except in severely eroded areas, the A horizon is 3 to 12 inches thick. The B horizon ranges from dark grayish brown (2.5Y 4/2) to olive gray (5Y 5/2). In the part of the B horizon that contains the most clay, the content of clay is as much as 50 to 65 percent. The B horizon ranges from 3 to 8 feet in thickness but normally is about 5 feet thick. Mottles are dark brown (10YR 4/3) to yellowish brown (10YR 5/4) and generally occur below a depth of 12 to 18 inches. The permeability of the A horizon is moderate, and that of the subsoil is very slow.

CLEARFIELD SERIES

In the Clearfield series are imperfectly drained Brunizems that intergrade toward Humic Gleys. They have developed from Wisconsin loess during Middle Wisconsin and Recent ages. These soils are underlain by a fine-textured paleosol at a depth of about 4 feet. The imperfect drainage is a result of the position of these soils and a very slowly permeable layer in the profile. Moisture percolates through the permeable loess upslope and seeps out on side slopes at the junction of the permeable loess and the very slowly permeable paleosol.

These soils occur on the upper slopes around the head of draws that extend into the broad upland flats. The slopes are generally straight to slightly concave.

The Clearfield soils have a dark-colored A horizon that grades to a distinctly grayish, moderately developed, highly mottled B horizon.

They occur with Macksburg soils but at a lower elevation. Their A horizon is thinner than that in Macksburg soils, and they are shallower to the very slowly permeable paleosol. The subsoil of Clearfield soils is grayer and more mottled than that of Sharpsburg soils, which have developed in a thicker layer of loess.

Profile of a Clearfield silty clay loam (1/4 mile east and 150 feet south of the NW. corner of sec. 32, T. 72 N., R. 32 W., on a slope of 7 percent that faces west-southwest and is in a concave cove dissected by many small, crossable drains):

A_{1p} 0 to 6 inches, black (10YR 2/1) light silty clay loam; moderate, fine, granular structure; friable when moist, cloddy when dry; slightly acid; abrupt boundary.

A_3 6 to 13 inches, very dark gray (10YR 3/1) medium silty clay loam; moderate, fine, granular structure; friable to slightly firm; discontinuous coats, probably of organic matter, on peds; neutral; clear boundary.

B_{21} 13 to 20 inches, very dark grayish-brown (2.5Y 3/2) heavy silty clay loam with common, fine, distinct, olive (5Y 5/3) mottles and few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; moderate, fine, subangular blocky structure; slightly firm to firm; organic coats on vertical cleavage planes; neutral; clear boundary.

B_{22} 20 to 29 inches, olive-gray (5Y 4/2) heavy silty clay loam with common, fine, distinct, dark-brown (7.5YR 4/4) mottles, and few, fine, faint, dark yellowish-brown (10YR 4/4) mottles, and few, fine, faint, grayish-brown (2.5Y 5/2) mottles; weak, fine, prismatic to weak, fine, blocky structure; firm; neutral; gradual boundary.

B_3C_1 29 to 43 inches, olive-gray (5Y 4.5/2) medium silty clay loam with common, medium, distinct, dark yellowish-brown (10YR 4/4) mottles, and few, fine, faint, olive-brown (2.5Y 4/4) mottles, and common, medium, faint, olive (5Y 4/4) mottles; weak, fine, prismatic to weak, fine, blocky structure; firm; tube-shaped concretions cemented with iron about three-eights inch in diameter; neutral; clear boundary.

D 43 to 60 inches, dark-gray (N 4/0) to gray (5Y 6/1, dry) light silty clay; massive; very firm; mottles are few and faint; horizon is part of a highly weathered fine-textured paleosol, possibly alluvial; perched water table at 42 inches.

Range in characteristics.—In uneroded areas the A horizon ranges from 8 to 16 inches in thickness and is black (10YR 2/1). It is thinner in eroded areas and ranges from black to dark grayish brown (10YR 4/2). The B horizon ranges from very dark grayish brown (2.5Y 3/2) to olive gray (5Y 5/2) and is generally 24 to 32 inches thick. Clay makes up as much as 34 to 38 percent of the B horizon. The depth to the underlying paleosol ranges from 3 to 6 feet but is about 4 feet in most places. Mottles begin at 6 to 16 inches and are common. They range from dark brown (7.5YR 4/4) to olive (5Y 4/4) but are mostly olive. The lower horizons of Clearfield soils are generally deoxidized, but apparently the upper part of the B horizon is being reoxidized in some places.

CLINTON SERIES

The Clinton series consists of moderately well drained Gray-Brown Podzolic soils that have developed from Wisconsin loess during Middle Wisconsin to Recent ages. These soils occupy the narrow, convex ridges and the upper side slopes in the strongly dissected areas that parallel the main rivers.

The Clinton soils typically have a very thin A_1 horizon and a prominent A_2 horizon. The B horizon is well developed, firm, and moderately slow in permeability.

The A_1 horizon of Clinton soils is thinner than that of Ladoga soils, and the A_2 horizon is better defined. Clinton soils have a thinner A horizon than Sharpsburg soils and a better developed B horizon. An A_2 horizon has not formed in the Sharpsburg soils.

Profile of a Clinton silt loam (10 feet north of the east-west road in SW1/4NE1/4 sec. 23, T. 73 N., R. 34 W., on a narrow, rounded ridgetop extending in a north-northwest direction):

A_1 0 to 2 inches, very dark grayish-brown (10YR 3/2) to grayish-brown (10YR 5/2, dry) silt loam; weak, thin, platy to weak, fine, granular structure; very friable; slightly acid; abrupt boundary.

A_2 2 to 9 inches, grayish-brown (10YR 5/2) to light brownish-gray (10YR 6/2, dry) silt loam with few, fine, distinct, yellowish-brown (10YR 5/4) mottles and few, fine, distinct, dark yellowish-brown (10YR 3/4) mottles; moderate, thin to medium, platy structure; friable; very strongly acid; clear boundary.

A_2B_1 9 to 14 inches, dark-brown (10YR 4/3) light silty clay loam with few, fine, faint, yellowish-brown (10YR 5/4) mottles; strong, fine, angular blocky structure; friable to slightly firm; abundant gray coats of silt on peds, mainly on the vertical cleavage planes; peds hard when dry; very strongly acid; clear boundary.

B_{21} 14 to 21 inches, dark-brown (10YR 4/3) heavy silty clay loam with few, fine, faint, dark yellowish-brown (10YR 4/4) mottles; strong, fine to very fine, angular blocky structure; firm when moist, plastic when wet, hard when dry; clay films cover peds; tree roots 1 inch in diameter; very strongly acid; clear boundary.

B_{22} 21 to 33 inches, dark-brown (10YR 4/3) light silty clay with common, fine, distinct, yellowish-brown (10YR 5/4) mottles and few, fine, prominent, olive-gray (5Y 4/2) mottles; strong, medium, angular blocky structure; firm; clay films cover peds; peds very hard when dry; very strongly acid; gradual boundary.

B_{23} 33 to 42 inches, dark-brown (10YR 4/3) to dark yellowish-brown (10YR 4/4) heavy silty clay loam with common, fine, distinct, olive-gray (5Y 4/2) mottles and many, medium, faint, yellowish-brown (10YR 5/4) mottles; moderate, fine, angular blocky structure; firm; few concretions of an oxide; strongly acid; diffuse boundary.

B_3C_1 42 to 54 inches, dark yellowish-brown (10YR 4/4) medium silty clay loam with many, medium, faint, yellowish-brown (10YR 5/4) mottles and few, fine, distinct, olive-gray (5Y 4/2) mottles; moderate, medium, subangular blocky structure to massive; slightly firm; concretions of an oxide; slightly acid.

Range in characteristics.—The A_1 horizon ranges from very dark gray (10YR 3/1) to grayish brown (10YR 5/2). The thickness of the A_1 horizon combined with the A_2 horizon ranges from 3 to 10 inches. The well-developed B horizon is 36 to 42 percent clay and is 24 to 32 inches thick. Distinct, continuous clay films occur in some places. The mottles range from yellowish brown (10YR 5/4) to olive gray (5Y 5/2) but are generally yellowish brown. They are most abundant below a depth of 30 inches. These soils range from slightly acid in the A_1 and C horizons to very strongly acid to strongly acid in the B horizon.

COLO SERIES

The soils of the Colo series are poorly drained Humic Gley soils that intergrade toward Alluvial soils. They are on nearly level first bottoms, where they formed during Late Wisconsin and Recent ages. The parent material is dark-colored, moderately fine textured, silty alluvium.

These are the dominant soils on bottom lands, regardless of the width of the flood plain. They are in areas that are adjacent to and, in many places, include the stream channel.

Colo soils have a distinct, dark profile with weak horizons. The A horizon is black to very dark gray silty clay loam, and the C horizon is black to dark-gray medium silty clay loam. No B horizon has formed. Silty clay may occur at a depth of 32 inches in some places.

These soils are closely associated with Nodaway soils and are darker, finer textured, and more slowly permeable than those soils. They are similar to Wabash silty clay loam, but the Wabash soil has a distinctly gleyed, silty clay to clay horizon below a depth of 18 to 30 inches. Colo soils are more poorly drained, less friable, and more clayey than Kennebec soils.

Profile of Colo silty clay loam (200 feet east of road bridge and 25 feet north of road in S½SW¼ sec. 29, T. 73 N., R. 33 W., on a bottom, less than ⅛ mile wide, that slopes to the west toward the stream channel; slope of 2 percent; surface puddled):

A_p 0 to 3 inches, black (10YR 2.5/1) light silty clay loam; massive to weak, fine, granular structure; slightly firm when moist, cloddy when dry; neutral; clear boundary.

A_{12} 3 to 7 inches, black (10YR 2.5/1) light silty clay loam; weak, fine, subangular blocky to weak, fine, granular structure; friable when moist, slightly sticky when wet; slightly acid; clear boundary.

A_3 7 to 12 inches, black (10YR 2.5/1) light silty clay loam; weak, fine, angular blocky to weak, medium, prismatic structure; friable; some strata of dark grayish-brown silt; slightly acid; gradual boundary.

AC 12 to 22 inches, black (10YR 2/1) light silty clay loam; weak, fine, angular blocky to weak, medium, prismatic structure; slightly firm; root channels filled with dark grayish-brown silt; slightly acid; gradual boundary.

C_1 22 to 42 inches, black (10YR 2/1) light silty clay loam; massive; slightly firm; perched water table at 40 inches; slightly acid.

Range in characteristics.—The A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) unless it has been modified by recent deposits. At a depth of about 18 to 40 inches the color is generally very dark gray (10YR 3/1) but ranges from black (10YR 2/1) to dark gray (10YR 4/1). Horizon boundaries are gradual to clear. The content of clay in the profile ranges from 28 to 38 percent. Permeability is moderate to moderately slow but is generally moderately slow. Mottling is usually masked by the gray color of the peds.

Some Colo soils are severely channeled and others are adjacent to stream channels. In some places a layer of lighter colored material, 16 to 24 inches thick, has been recently deposited on the surface. These soils are classed as poorly drained, but the channeled phase and the overwash phase grade toward imperfectly drained.

GARA SERIES

The Gara series consists of moderately well drained Gray-Brown Podzolic soils that intergrade toward Brunizems. They were derived mostly from Kansan glacial till but in some places formed from Nebraskan till. These soils were formed during Sangamon to Recent ages.

The Gara soils are generally along the major rivers in areas that have been strongly dissected by geologic erosion.

Uneroded Gara soils normally have a thin, dark A_1 horizon, a very thin, weak A_2 horizon, and a moderately strong B horizon. Some clay has accumulated in the B horizon. Eroded Gara soils have either a very thin A_2 horizon or gray silt coats on the peds in the B_1 horizon.

Gara soils are associated with the Shelby and Adair soils. They normally are thinner and lighter colored in the A horizon than the Shelby soils, which do not have an A_2 horizon. The B horizon of Gara soils contains more clay and is more strongly developed than that in Shelby soils. In most places Gara soils have a browner and less fine-textured B horizon than Adair soils.

Profile of Gara loam (⅛ mile north and 10 feet west of SE. corner of sec. 23, T. 72 N., R. 35 W., on a convex, northwest-facing ridge crest with a slope of 7 percent):

A_{1p} 0 to 6 inches, very dark gray (10YR 3/1) to dark gray (10YR 4/1, dry) heavy loam to light silty clay loam that may be loess; moderate, fine, granular structure; very friable; slightly acid; abrupt boundary.

A_2 6 to 8 inches, very dark gray (10YR 3/1) to grayish-brown (10YR 5/2, dry) light silty clay loam; weak, thin, platy to weak, fine, granular structure; friable; few, fine, faint, dark grayish-brown (10YR 4/2) peds; medium acid; abrupt boundary.

B_1 8 to 12 inches, dark grayish-brown (10YR 4/2) medium silty clay loam with a few very dark gray (10YR 3/1) peds; moderate, fine, angular blocky structure; slightly firm; grayish-brown (10YR 5/2) silt coats on ped faces; strongly acid; abrupt boundary.

B_{22} 12 to 26 inches, dark-brown (10YR 3/3) clay loam to light clay with few, fine, distinct, very dark gray (10YR 3/1) mottles, few, fine, faint, dark-brown (7.5YR 3/2) mottles, and few, very fine, distinct, yellowish-brown (10YR 5/4) mottles; strong, medium, angular blocky structure; very firm; pebbles as much as half inch in diameter; thick, continuous clay films cover peds; no pore space in peds; some stains of organic matter on vertical cleavage planes; medium acid; clear boundary.

B_{23} 26 to 36 inches, yellowish-brown (10YR 5/4) heavy clay loam with common, medium, faint, dark grayish-brown (10YR 4/2) mottles and few, fine, faint, yellowish-brown (10YR 5/6) mottles; strong, medium, angular blocky structure; firm; fine concretions of an oxide; many pebbles; discontinuous clay films on vertical faces of peds; peds nonporous; medium acid; clear boundary.

B_3C_1 36 to 42 inches, dark yellowish-brown (10YR 4/4) medium clay loam with common, fine, distinct, dark grayish-brown (10YR 4/2) mottles, few, fine, distinct, yellowish-brown (10YR 5/6) mottles, common, fine, distinct, dark-brown (7.5YR 3/2) mottles, and few, very fine, prominent, dark reddish-brown (5YR 3/4) concretions of an oxide; strong, medium, angular blocky structure to massive; firm; oxides abundant; thin seam of sand and gravel mixed into horizon; few clay films; medium acid; gradual boundary.

C_{ca} 42 to 60 inches, dark yellowish-brown (10YR 4/4) medium clay loam; few dark grayish-brown (10YR 4/2) coats on peds; many, coarse, prominent olive-gray (5Y 5/2) mottles and common, fine, faint, yellowish-brown (10YR 5/6) mottles; massive; firm; little or no pore space; matrix weakly calcareous but soft lime concretions as much as 2 inches in diameter present.

Range in characteristics.—Depending on the degree of erosion, the A_1 horizon ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2) in color and from 2 to 10 inches in thickness. It is loam in most places but in other places is light silty clay loam. In some places the A_2 horizon is absent, but where it occurs, it is as much as 4 inches thick and is very dark gray (10YR 3/1) to grayish brown (10YR 5/2). Silt that is light colored when dry coats the peds in the B_1 horizon.

Gara soils have a B_2 horizon that is 16 to 24 inches thick and has a maximum content of clay that ranges from 34 to about 42 percent. The subsoil is slow to moderately slow in permeability. The B horizon generally has a strong, angular blocky structure, continuous clay skins, and common, yellowish-brown (10YR 5/4) mottles. Mottling begins at 20 to 30 inches. In the substratum the mottles are mostly olive gray (5Y 5/2). The solum ranges from slightly acid to strongly acid but is medium acid in most places. The matrix of the substratum is calcareous at a depth ranging from 36 to 60 inches, but in most places the matrix is calcareous at a depth of about 48 inches.

GOSPORT SERIES

The Gosport series consists of moderately well drained Gray-Brown Podzolic soils that intergrade toward Lithosols. These soils have developed from weathered Pennsylvania shale. A thin layer of loess or loess and till may overlie the shale in many places.

Gosport soils are surrounded by the Gara or Shelby soils and are generally downslope from the Adair, Ladoga, or Clinton soils. They occur in steeply sloping areas that parallel the major rivers in the county and have been strongly dissected by geologic erosion.

These soils commonly have a thin, moderately dark colored A_1 horizon and in many places a thin, light-colored A_2 horizon. Their B horizon is moderately developed and highly varied in color.

The subsoil and substratum of Gosport soils were derived from shale, whereas those of the Ladoga soils were derived from loess. The subsoil and substratum of the Gara soils were derived from till.

Profile of Gosport silt loam (in cut on south side of road, approximately 600 feet west of the NE. corner of the NW¼ sec. 21, T. 72 N., R. 35 W., on an abrupt, moderately short, east-facing slope of 30 percent):

IA_1 0 to 5 inches, dark-gray (10YR 3.5/1) silt loam; weak, fine, granular structure; friable; few, small, round concretions of iron; medium acid; clear boundary.

IA_2 5 to 8 inches; brown (10YR 5/3) to light brownish-gray (10YR 6/2, dry) silt loam; weak, thin, platy to weak, fine, subangular blocky structure; friable; many fragments, ⅛ inch wide and ½ to 1 inch long, that are cemented with iron; strongly acid; abrupt boundary.

IIB_{21} 8 to 18 inches, strong-brown (7.5YR 5/6) clay; strong, fine, angular blocky structure; very firm; many soft concretions of an oxide; mixture of rocks 3 inches in diameter and fine grains of quartz; mixture may be from till and shale; thick, continuous clay films; strongly acid; clear boundary.

$IIIB_{22}$ 18 to 30 inches, strong-brown (7.5YR 5/8) clay with common, coarse, gray (N 5/0) mottles and few, medium, faint, yellowish-brown (10YR 5/8) mottles; strong, fine, angular blocky structure; very firm; many dark concretions of an oxide; very strongly acid; clear boundary.

$IIIB_{23}$ 30 to 39 inches, gray (N 5/0) clay; strong, medium, angular blocky structure; very firm; iron stains on horizontal faces of peds; very strongly acid; clear boundary.

$IIIB_3C_1$ 39 to 43 inches, strong-brown (7.5YR 5/8) clay; weak, thick, platy to strong, medium, angular blocky structure; very firm; iron stains continuous on horizontal cleavage planes; medium acid; clear boundary.

$IIIC_{12}$ 43 to 65 inches, olive-gray (5Y 5/2) clay with gray (N 5/0) coats on vertical faces; weak, medium, platy to weak, medium, blocky structure; very firm; horizontal cleavage planes stained discontinuously with iron; light olive-brown (2.5Y 5/6) to yellowish-brown (10YR 5/6) fragments of shale in lower part.

Range in characteristics.—The A_1 horizon was derived from loess and ranges from 3 to 8 inches in thickness. An A_2 horizon, 2 to 4 inches thick, occurs in some uneroded areas. The A_1, A_2, and B_1 horizons may have developed from loess or till material. This material, however, is generally less than 18 inches thick and is underlain by weathered shale. The degree of weathering depends on the slopes and depth to shale.

The B horizon ranges from strong brown (7.5YR 5/6) through gray (N 5/0) to dark red (2.5YR 3/6) but strong-brown colors are most common. The content of clay in the lower B horizon is normally more than 50 percent. The subsoil is slowly permeable to very slowly permeable and is more than 30 to 54 inches thick.

In some places there are thin layers, which consist of flat fragments cemented with iron or ferruginous plates interbedded with the shale. Horizons containing these thin layers range from less than an inch to several feet in thickness.

GRAVITY SERIES

The soils of the Gravity series are imperfectly drained to poorly drained Brunizems that intergrade toward Humic Gleys. They have developed during Late Wisconsin to Recent ages from silty local alluvium that was washed from soils derived from till or loess. They are on old alluvial fans or low foot slopes at the base of upland slopes in areas where the soils typically were derived from till.

Gravity soils have a dark A horizon that is gritty in some places. The B horizon is weakly developed and moderately fine textured. It is firm to slightly firm and moderately slow in permeability.

Gravity soils are slightly darker colored in the profile than are Olmitz soils and, in most places, are less gritty and less friable. They contain more clay in all horizons than the Olmitz soils. They are lower on the foot slopes than the better drained Arbor soils, which are underlain by firm till at a depth of 18 to 30 inches.

Profile of Gravity silty clay loam (1/8 mile north and 75 feet east of SW. corner of SE1/4 sec. 31, T. 71 N., R. 34 W., on a slightly concave, west-facing slope of 2 percent):

A_{1p} 0 to 7 inches, very dark gray (10YR 3/1) gritty silty clay loam; massive to weak, fine, granular structure; slightly firm; large amount of very dark grayish-brown (10YR 3/2), recently deposited sediments derived from till mixed in horizon; many sand grains and small pebbles; neutral; abrupt boundary.

A_{12} 7 to 12 inches, very dark gray (10YR 3/1) gritty silty clay loam; few very dark grayish-brown (10YR 3/2) peds; few, fine, faint, very dark brown (10YR 2/2) mottles; moderate, fine, granular structure; slightly firm; pebbles as much as one-fourth inch in diameter; slightly acid; clear boundary.

A_{13} 12 to 22 inches, black (10YR 2/1) gritty silty clay loam; very dark brown (10YR 2/2, dry) when crushed; moderate, very fine, subangular blocky structure; slightly firm to friable; high sheen on peds that may be organic matter; slightly acid; gradual boundary.

AB 22 to 34 inches, black (10YR 2/1) gritty silty clay loam with few, fine, faint, very dark grayish-brown (10YR 3/2) mottles; moderate, fine, subangular blocky structure; slightly firm; high sheen on peds; small amount of pore space in peds; sand grains throughout horizon; slightly acid; diffuse boundary.

B_{21} 34 to 45 inches, black to very dark gray (10YR 2.5/1) gritty heavy silty clay loam with many, fine, distinct, dark-brown (7.5YR 3/2) mottles and common, fine, faint, dark yellowish-brown (10YR 3/4) mottles; weak, medium, subangular blocky to moderate, fine, subangular blocky structure; slightly firm to firm; few, very fine, dark reddish-brown concretions of an oxide; few, discontinuous, thin films of clay; slightly acid; gradual boundary.

B_3 45 to 56 inches, very dark gray (10YR 3/1) gritty heavy silty clay loam with many, medium, dark-brown (10YR 3/3) mottles; moderate, fine to medium, angular blocky structure to massive; slightly firm; numerous, dark reddish-brown concretions of an oxide; thin films of clay on some ped faces; coarse pebbles; few pores in peds; slightly acid.

Range in characteristics.—In most places Gravity soils have a layer of recently deposited material, 0 to 12 inches thick, on the surface. In areas that have not received overwash recently the A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). The A horizon generally is silty clay loam but is clay loam in some places. The entire profile may be somewhat gritty. It consists of weakly developed horizons that vary from each other only slightly in structure and color. The B horizon is 16 to 24 inches thick and is 32 to 38 percent clay. Some ped faces in the B horizon may be covered with clay films. Mottles begin at 16 to 20 inches in some profiles and range from few to many and from dark brown (7.5YR 3/2) to very dark grayish brown (10YR 3/2). The B horizon is generally firm but grades to slightly firm. Gravity soils are imperfectly drained; they are generally between better drained soils that are upslope and more poorly drained soils that are downslope.

HAGENER SERIES

The Hagener series consists of excessively drained Brunizems that intergrade toward Regosols and have developed from eolian sand during Early Wisconsin to Recent ages. The eolian sand is commonly in a layer more than 48 inches thick. This layer is stratigraphically within loess deposits that are on the uplands near the east side of the major rivers.

Hagener soils have developed only weak horizons. The A_1 or the A_p horizon is 3 to 7 inches thick and is moderately dark colored in most places. The A horizon is underlain by a friable B horizon that is moderately thick but poorly defined and is commonly stained with organic matter.

Hagener soils generally have a thinner A_1 horizon than have Sharpsburg soils. Their B horizon is not so well developed nor so high in clay as that in the Sharpsburg soils, which developed from loess instead of sand.

Profile of Hagener loamy fine sand (60 feet west of road and 150 feet south of NE. corner of SE1/4SE1/4 sec. 4, T. 72 N., R. 32 W., on a convex slope of 9 percent below a ridge crest that slopes to the northwest):

A_{1p} 0 to 6 inches, very dark grayish-brown (10YR 3/2) to brown (10YR 5/3, dry) loamy fine sand; weak, fine, granular structure to single grain; friable to loose; organic matter binds material in horizon; medium acid; clear boundary.

B 6 to 15 inches, dark grayish-brown (10YR 4/2) sandy loam; weak, fine, granular structure; friable; stains of very dark grayish-brown (10YR 3/2) organic matter; medium acid; abrupt boundary.

C_1 15 to 28 inches, yellowish-brown (10YR 5/6) loamy fine sand; single grain; very loose; medium acid; gradual boundary.

C_2 28 to 39 inches, yellowish-brown (10YR 5/4) loamy fine sand; single grain; loose; thin lenses of grayish-brown (10YR 5/2) sand; abundant iron; slightly acid; clear boundary.

C_3 39 to 48 inches +, brown (10YR 5/3) loamy fine sand; massive to single grain; friable; some lenses of grayish-brown (10YR 5/2) sand; common, distinct, yellowish-brown (10YR 5/8) bands weakly cemented with iron; slightly acid.

Range in characteristics.—The A and B horizons range from sandy loam to loamy fine sand. The A horizon is 3 to 7 inches thick. Because Hagener soils occur within areas of the Sharpsburg soils, loesslike material is common on the surface of Hagener soils. The B horizon is 6 to 12 inches thick and is very weakly developed in texture and structure. Iron bands occur below a depth of 36 inches in some profiles. Sand grains in the C horizon are coated with a yellowish-brown iron oxide that stains the hands. Reaction ranges from slightly acid to medium acid.

JUDSON SERIES

The soils of the Judson series are well drained to moderately well drained Brunizems that intergrade toward Alluvial soils and have developed from local alluvium of Late Wisconsin and Recent ages. Most of this alluvium has washed from higher lying soils that were derived from loess. Judson soils occur in low positions on foot slopes, generally downslope from relatively long slopes covered with loess. They also occur on fans at the outlet of upland drains. In most places the slopes are nearly straight to slightly concave.

These soils have a thick, dark-colored, friable A horizon, 18 to 30 inches thick, that grades clearly to a moderately developed brownish B horizon. The clay content of the B horizon is about the same or slightly more than that of the A horizon.

Judson soils are better drained than Gravity soils and are less gray in the solum. They contain less sand and are less gritty than the Olmitz soils. Judson soils are normally more friable than Sharpsburg soils and have a thicker A horizon and generally a more weakly developed B horizon.

Profile of Judson silt loam (300 feet east and 150 feet south of NW. corner of NE¼ sec. 31, T. 72 N., R. 34 W., low on a foot slope of 3 percent that slopes toward the east):

A_{1p} 0 to 8 inches, very dark brown (10YR 2/1.5) heavy silt loam to light silty clay loam; very dark brown (10YR 2/2) when crushed; moderate, fine, granular structure; friable; slightly acid; abrupt boundary.

A_{12} 8 to 16 inches, very dark brown (10YR 2/2) heavy silt loam to light silty clay loam; very dark grayish brown (10YR 3/2) when crushed; moderate, fine, granular structure; friable; abundant worm casts; slightly acid; clear boundary.

A_{13} 16 to 25 inches, very dark brown (10YR 2/2) light silty clay loam; weak, fine to medium, angular blocky to weak, fine, granular structure; friable; peds very porous; faint, discontinuous coats of organic matter on peds; slightly acid; clear boundary.

AB 25 to 35 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; dark brown (10YR 3/3) when crushed; few, fine, faint, dark grayish-brown (10YR 4/2) mottles; weak, coarse, subangular blocky to moderate, very fine, subangular blocky structure; slightly firm; very thin, discontinuous clay films on peds; many pores in peds; slightly acid; clear boundary.

B 35 to 44 inches, dark-brown (10YR 4/3) medium silty clay loam with few, fine, faint, dark grayish-brown (10YR 4/2) mottles and common, fine, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, prismatic to weak, fine, angular blocky structure; slightly firm; pore space in peds; slightly acid; gradual boundary.

C 44 to 58 inches, dark-brown (10YR 4/3) light silty clay loam with few, coarse, distinct, dark grayish-brown (2.5Y 4/2) mottles, few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles, and few, fine, distinct, yellowish-brown (10YR 5/6) mottles; massive; slightly firm; slightly acid.

Range in characteristics.—The A_1 horizon ranges from very dark brown (10YR 2/2) to very dark gray (10YR 3/1) but is dominantly very dark brown. It is generally very dark gray where these soils continue to receive deposits. The A horizon generally is 18 to 30 inches thick. It is typically heavy silt loam near the major rivers and in the northwestern part of the county. In other places it ranges from heavy silt loam to light silty clay loam.

The B horizon is weakly developed in structure and texture. It ranges from 8 to 16 inches in thickness. Clay generally makes up less than 34 percent of the B horizon. The lower subsoil may be flecked with few, fine, faint, dark grayish-brown (10YR 4/2) mottles to common, fine, distinct, yellowish-brown (10YR 5/4) mottles. Through the profile, consistence ranges from friable to slightly firm.

KENNEBEC SERIES

The soils of the Kennebec series are moderately well drained to imperfectly drained Brunizems that intergrade toward Alluvial soils. They have formed from medium-textured alluvium during Late Wisconsin and Recent ages. These soils normally are on the nearly level first bottoms within the U-shaped part of sharp river bends.

Kennebec soils have a black to very dark gray, friable silt loam A horizon. The B horizon is weakly developed, dark-colored, friable to slightly firm silt loam to light silty clay loam. It is lighter colored when it is dry than when it is wet. The profiles of Kennebec soils show no evidence of clay accumulation, but texture may vary from one horizon to another as a result of different kinds of parent materials having been deposited at different times.

Kennebec soils are less clayey, more friable, and better drained than the Colo soils. They are similar to the Nodaway soils but are darker colored, are less stratified with silt or sand lenses, and are normally better drained. They are higher in organic matter than the Nodaway soils.

Profile of Kennebec silt loam (150 feet west of pasture fence and 20 feet south of Kemp Creek in SE. corner of SE¼NW¼ sec. 10, T. 72 N., R. 34 W., within an oxbow on a nearly level to slightly undulating part of a first bottom and adjacent to a Colo soil):

A_{1p} 0 to 6 inches, black (10YR 2/1) silt loam with few, fine, faint, dark-gray (10YR 4/1) mottles; moderate, fine, granular structure; friable; slightly acid; abrupt boundary.

A_{12} 6 to 16 inches, black (10YR 2/1) silt loam with few, fine, faint, very dark grayish-brown (10YR 3/2) mottles; weak, fine, subangular blocky to weak, fine, granular structure; friable; medium acid; gradual boundary.

A_3 16 to 30 inches, very dark gray (10YR 2.5/1) heavy silt loam with few, fine, faint, dark-gray (10YR 4/1) ped surfaces; few, fine, faint, very dark grayish-brown (10YR 3/2) mottles; weak, fine, granular structure; friable; medium acid; gradual boundary.

B 30 to 38 inches, very dark gray (10YR 3/1) light silty clay loam with common, fine, faint, dark-gray (10YR 4/1) to gray (10YR 5/1, dry) ped surfaces; few, very fine, faint, very dark grayish-brown (10YR 3/2) mottles; weak, very fine, subangular blocky structure; slightly firm; medium acid.

Range in characteristics.—The A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) but is black in most places. The A horizon is friable, granular, and contains less than 27 percent clay. The B horizon is generally very dark gray (10YR 3/1) and is friable to slightly firm. The dominant mottles, which are few, fine, and faint, are very dark grayish brown (10YR 3/2). In most places the upper horizons are silt loam, but in some places the profile may be light silty clay loam below a depth of 30 inches. This variation in texture is probably the result of different kinds of alluvial materials having been deposited instead of the weathering of the profile. Horizon boundaries are gradual in most profiles.

LADOGA SERIES

The Ladoga series consists of Gray-Brown Podzolic soils that intergrade toward Brunizems. Ladoga soils have developed from Wisconsin loess during Middle Wisconsin to Recent ages. These soils are moderately well drained. They normally occupy slightly rounded ridgetops, ridge crests, and high side slopes of uplands that border the valleys of major rivers. A few areas are on benches.

Uneroded Ladoga soils generally have a moderately thick, dark A_1 horizon. A very thin, weakly developed A_2 horizon is present in most places. The B horizon is firm, distinctly blocky, and moderately slow in permeability.

The A_1 horizon in Ladoga soils is thicker and darker colored than that in associated Clinton soils, which have a prominent A_2 horizon. Ladoga soils have an indistinct A_2 horizon, and silt coatings on the B horizon, which has not developed in the Sharpsburg soils. The B horizon in Ladoga soils is strong and angular blocky in structure, but the structure of the subsoil in Sharpsburg soils is only moderately developed.

Profile of Ladoga silt loam (1/8 mile south and 10 feet west of the NE. corner of sec. 26, T. 72 N., R. 35 W., on a narrow, convex ridgetop that slopes at a 5-percent gradient toward the north):

A_{1p} 0 to 6 inches, very dark gray (10YR 3/1) heavy silt loam to light silty clay loam; moderate, fine, granular structure; very friable; slightly acid; abrupt boundary.

A_2 6 to 8 inches, very dark gray (10YR 3/1) heavy silt loam to light silty clay loam; weak, thin, platy to weak, fine, granular structure; friable; platiness may be caused by a plowsole; dark-gray (10YR 4/1) to grayish-brown (10YR 5/2, dry) coats on peds; horizon believed to be a composite of A_2 and A_3 horizons; slightly acid; clear boundary.

B_1 8 to 12 inches, very dark grayish-brown (10YR 3/2) medium silty clay loam with few, very fine, distinct, yellowish-brown (10YR 5/4) mottles; moderate, very fine, subangular blocky structure; slightly firm; common, dark-gray (10YR 4/1) to grayish-brown (10YR 5/2, dry) silt coats on peds; slightly acid; clear boundary.

B_{21} 12 to 21 inches, dark-brown (10YR 4/3) heavy silty clay loam with few, fine, distinct, yellowish-brown (10YR 5/6) mottles; strong, fine, angular blocky structure; firm; discontinuous dark-gray (10YR 4/1) to dark grayish-brown (10YR 4/2) silt coats on peds; thin films of clay on peds; most pores in peds are open; medium acid; clear boundary.

B_{22} 21 to 35 inches, dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/4, dry) heavy silty clay loam with common, fine, faint, yellowish-brown (10YR 5/6) mottles and few, fine, distinct, dark-gray (10YR 4/1) mottles; strong, medium, angular blocky structure; firm; dark grayish-brown (10YR 4/2) to brown (10YR 5/3, dry) silt coats on peds; few, discontinuous clay films; fine, common concretions of an oxide; some pore space in peds; strongly acid; clear boundary.

B_3C_1 35 to 42 inches, dark grayish-brown (10YR 4/2) medium to light silty clay loam with common, fine, distinct, yellowish-brown (10YR 5/6) mottles and many, fine, prominent, olive-gray (5Y 5/2) mottles; weak, medium, angular blocky structure to massive; slightly firm; few concretions of an oxide; pore space abundant in peds; medium acid; gradual boundary.

C_2 42 to 60 inches, brown (10YR 5/3) heavy silt loam to light silty clay loam with many, very coarse, prominent, olive-gray (5Y 5/2) mottles; massive; slightly firm; few, fine concretions of an oxide; mottles appear to be relict.

Range in characteristics.—The A_1 horizon is typically very dark gray (10YR 3/1) but is dark grayish brown (10YR 4/2) in eroded areas. It ranges from 3 to 9 inches in thickness and is commonly 6 inches thick in eroded Ladoga soils. A very thin A_2 horizon has developed in most places. The A horizon is normally silt loam but ranges from silt loam to light silty clay loam. Grayish-brown (10YR 5/2, dry) coats generally occur on the peds in the B horizon. In virgin areas a distinct A_2 horizon may occur, but it is generally less than 4 inches thick. The maximum content of clay in the B horizon ranges from 36 to 40 percent. The B horizon is 24 to 30 inches thick in most places.

Mottles are generally at a depth of 18 to 24 inches and above the C horizon are few and fine. Yellowish-brown (10YR 5/4 to 5/6) mottles are dominant.

MACKSBURG SERIES

The Macksburg series consists of imperfectly drained Brunizems that have developed from Wisconsin loess. These soils are Middle Wisconsin in age. These soils are members of a catena that includes Winterset soils, which are poorly drained, and Sharpsburg soils, which are well drained to moderately well drained.

Macksburg soils occur on moderately wide divides and in coves that slope gently from broad upland flats. The A horizon of these soils is thick and dark. It is underlain by a moderately developed B horizon that is mottled in most places. The subsoil is slightly firm and moderately slow to moderate in permeability.

The Macksburg soils have a slightly thicker A horizon and more mottling in the solum than the Sharpsburg soils, and thicker clay films in the B horizon. The B horizon of Macksburg soils is commonly very dark grayish brown (10YR 3/2), but the B horizon of the Winterset soils is very dark gray (10YR 3/1) and gleyed.

Profile of Macksburg silty clay loam (100 feet south of Highway No. 34 and 660 feet east of the NW. corner of SE1/4 sec. 5, T. 71 N., R. 33 W., on a nearly level, broad upland ridgetop):

A_{1p} 0 to 6 inches, black (10YR 2/1) light silty clay loam; very dark brown (10YR 2/2) when crushed; massive to weak, very fine, granular structure; slightly firm; abrupt boundary.

A_{12} 6 to 11 inches, black (10YR 2/1.5) light silty clay loam; very dark brown (10YR 2/2) when crushed; weak, fine, subangular blocky to moderate, fine, granular structure; friable; worm casts; clear boundary.

A_3 11 to 18 inches, black (10YR 2/1.5) light silty clay loam; very dark brown (10YR 2/2) when crushed; few, fine, faint, very dark gray (10YR 3/1) mottles; weak, fine, subangular blocky to weak, fine, granular structure; friable; abundant worm casts; many pores in peds; clear boundary.

B_{21} 18 to 28 inches, very dark grayish-brown (10YR 3/2) heavy silty clay loam; the same color when crushed; common, fine, faint, dark grayish-brown (10YR 4/2) mottles; moderate to strong, fine, subangular blocky structure; slightly firm; thin films of clay on vertical cleavage planes; a few peds entirely coated with clay; some very dark brown (10 YR 2/2) coats on ped exteriors; pores in peds; clear boundary.

B_{22} 28 to 38 inches, very dark grayish-brown (10YR 3/2) heavy silty clay loam to light silty clay; dark yellowish-brown (10YR 4/4) interior; few, very fine, faint, dark grayish-brown (10YR 4/2) mottles and few, fine, faint, dark-gray (10YR 4/1) mottles; weak, medium, prismatic to moderate, fine, subangular blocky structure; firm; few, distinct concretions of an oxide; thin films of clay on peds; some pores filled with clay; gradual boundary.

B_3 38 to 46 inches, dark-brown (10YR 4/3) medium silty clay loam with common, coarse, faint, dark grayish-brown (2.5Y 4/2) mottles, many, coarse, prominent, olive-gray (5Y 5/2) mottles, and common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, coarse, prismatic to moderate, fine, subangular blocky structure; slightly firm; pore space in peds common; few discontinuous films of clay on peds; gradual boundary.

C_1 46 to 59 inches, olive-gray (5Y 5/2) light silty clay loam with common, fine, distinct, yellowish-brown (10YR 5/6) mottles and few, fine, faint, dark grayish-brown (10YR 4/2) mottles; massive; slightly firm to friable; horizon appears to be a deoxidized layer.

Range in characteristics.—The A_1 horizon of Macksburg soils is black (10YR 2/1) in most places, but it is very dark brown (10YR 2/2) on gentle slopes and very dark gray (10YR 3/1) in slight depressions. The A horizon ranges from 16 to 20 inches in thickness. The B horizon is generally very dark grayish brown (10 YR 3/2) with common dark grayish-brown (10YR 4/2) to dark yellowish-brown (10YR 4/4) mottles. Mottling in the B horizon begins at a depth of 16 to 20 inches. The B horizon is 18 to 30 inches thick in most places. The maximum content of clay ranges from 36 to 42 percent. The B horizon is normally heavy silty clay loam but is light silty clay in some places. Reaction is generally slightly acid through the profile, but some Macksburg soils are medium acid.

NEVIN SERIES

The Nevin series consists of imperfectly drained Brunizems that have developed from alluvial material. These materials were deposited in Late Wisconsin and Recent ages. They occur on nearly level second bottoms that lie slightly above the flood plains in the river valleys.

The Nevin soils are moderately developed. They generally have a thick A horizon of dark heavy silt loam. The B horizon is dark, mottled, slightly gleyed heavy silty clay loam. A few thin films of clay are on the peds of the B horizon in some places.

Nevin soils have a grayer, more mottled B horizon than Wiota soils, and a thinner, coarser textured B horizon than the Bremer soils.

Profile of a Nevin silt loam (300 feet south and 180 feet west of NE. corner of NE¼SW¼ sec. 6, T. 73 N., R. 33 W., on a nearly level, low second bottom that slopes slightly toward the Middle Nodaway River):

A_{1p} 0 to 7 inches, black (10YR 2/1) heavy silt loam; moderate, fine, granular structure; friable; slightly acid; abrupt boundary.

A_{12} 7 to 12 inches, black (10YR 2/1) heavy silt loam; weak, fine, subangular blocky to weak, fine, granular structure; friable; neutral; gradual boundary.

A_3 12 to 17 inches, black (10YR 2/1) heavy silt loam; very dark gray (10YR 2.5/1) when crushed; moderate, fine, subangular blocky structure; friable; slightly acid; clear boundary.

B_{21} 17 to 25 inches, very dark gray (10YR 3/1) to very dark brown (10YR 2/2) light silty clay loam; moderate, fine, subangular blocky structure; friable; neutral; gradual boundary.

B_{22} 25 to 32 inches, very dark gray to dark gray (10YR 3.5/1) medium silty clay loam with common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; moderate, fine to very fine, subangular blocky structure; slightly firm; neutral; gradual boundary.

B_{23} 32 to 42 inches, dark gray to gray (10YR 4.5/1) medium to heavy silty clay loam with many, medium to fine, prominent, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; slightly firm to firm; concretions of an oxide; gradual boundary.

B_3C_1 42 to 52 inches, gray (5Y 5/1) medium silty clay loam; brown (10YR 5/3) when crushed; many, medium, dark yellowish-brown (10YR 4/4 to 4/6) mottles; massive; few vertical and horizontal cleavage faces; slightly firm; concretions of an oxide.

Range in characteristics.—The A_1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). The A horizon is 12 to 18 inches thick. The B horizon is very dark gray (10YR 3/1) through very dark brown (10YR 2/2) to dark grayish brown (2.5Y 4/2). It is moderately developed and friable to firm. The maximum content of clay in the B horizon ranges from 30 to 36 percent. In some places clay films occur in the B horizon and are generally thin and discontinuous. Mottles begin at a depth of 20 to 25 inches and range from few to common. They range from dark brown (10YR 4/3) to yellowish brown (10YR 5/6), but the yellowish-brown mottles are dominant in the solum. These soils are slightly acid and the reaction from the A to the C horizon is about the same. Sandy material is below 6 to 8 feet in some places.

NODAWAY SERIES

The Nodaway series consists of moderately well drained to imperfectly drained Alluvial soils. These soils have formed from light-colored, medium-textured sediments that are of Recent age. The soils are in positions that are adjacent to and include river channels and old meandering streams. They are susceptible to flooding in periods of high rainfall.

The horizons in Nodaway soils are very weakly developed. The profile is generally brownish in color, friable, and stratified with coarse silt. It is moderately permeable.

Nodaway soils are lighter colored and coarser textured than Colo soils and are less firm and better drained. In some places the Nodaway soils are underlain by a dark-colored, buried soil at a depth of 36 to 42 inches or more. Colo silty clay loam, overwashed phase, is also underlain by a dark-colored, clayey buried soil, but at a depth of only 16 to 24 inches.

Profile of Nodaway silt loam (50 feet west of the Y branch in road ⅛ mile west of Carbon on west side of NE¼SW¼ sec. 12, T. 72 N., R. 35 W., on the nearly level flood plain of the Middle Nodaway River):

A_{1p} 0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam; weak, very fine, granular structure to massive; friable; abundant brown (10YR 5/3) silt strata; slightly acid; abrupt boundary.

C_1 6 to 12 inches, dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2, dry) silt loam; weak, thin, platy to weak, fine, granular structure; friable; some brown (10YR 5/3) silt coats on horizontal faces of plates; slightly acid to neutral; abrupt boundary.

C_2 12 to 16 inches, brown (10YR 5/3) and dark-gray (10YR 4/1) highly stratified silt loam; weak, thin to thick, platy to weak, fine, granular structure; friable; very porous; slightly acid to neutral; clear boundary.

C_3 16 to 23 inches, dark grayish-brown (10YR 4/2) silt loam; dark gray (10YR 4/1) to grayish brown (10YR 5/2, dry) when crushed; massive; friable; much dark-gray (10YR 4/1) coloring that appears to be the result of worm activity; neutral; abrupt boundary.

C_4 23 to 39 inches, stratified brown (10YR 5/3) and dark-gray (10YR 4/1) silt loam with few, very fine, distinct, dark yellowish-brown (10YR 4/4) mottles and common, fine, faint, dark-brown (10YR 4/3) mottles; weak, thick, platy to weak, fine, granular structure; friable; brown, mottled silt coats on dark-gray plates; many pores in peds; few, soft concretions of an oxide; neutral; gradual boundary.

A_b 39 to 54 inches, very dark grayish-brown (10YR 3/2) to dark-gray (10YR 4/1, dry) silt loam; dark gray (10YR 4/1) to brown (10YR 5/3, dry) when crushed; few, fine, faint, dark-brown (10YR 4/3) mottles; weak, fine, subangular blocky structure to massive; friable; few worm casts; peds very porous; neutral.

Range in characteristics.—The A horizon of Nodaway soils is dark grayish brown (10YR 4/2) in most places but ranges from dark grayish brown through dark gray (10YR 4/1) to brown (10YR 5/3). The dark-gray colors are common in Nodaway soils that are flooded less frequently than normal and that have been cultivated for several years. Adjacent to river channels, Nodaway soils that recently have received a large amount of sediments normally have a brown A horizon.

The silt loam extends from the surface to a depth of 36 to 60 inches. Horizon boundaries range from abrupt to clear and are varied within a single profile. If mottles occur, they are at a depth of 20 to 30 inches and are few, fine, and faint. Their occurrence depends on the frequency and duration of overflow. Nodaway soils are slightly acid to neutral.

OLMITZ SERIES

The Olmitz series consists of well drained to moderately well drained Brunizems that have developed from very thick local alluvial materials during Late Wisconsin and Recent ages. These soils are on foot slopes or alluvial fans. They are downslope from upland areas that are occupied mostly by exposed soils derived from till.

If they have not received deposits recently, Olmitz soils have a dark surface soil that grades to a weakly developed subsoil. The subsoil is moderate to moderately slow in permeability.

Local alluvium in Olmitz soils extends to a depth of more than 30 inches, but in Arbor soils it extends to only 18 to 30 inches. The Olmitz soils, therefore, developed entirely in local alluvium, but the lower part of the B horizon and the C horizon of Arbor soils consists of firm material derived from till. Olmitz soils commonly are more friable and weaker in horizonation than Arbor soils. They are less clayey, more friable, and better drained than Gravity soils.

Profile of Olmitz loam (1/4 mile south and 84 feet west of NE. corner of sec. 10, T. 73 N., R. 35 W., on an alluvial fan, that extends northward, and has a slope of 3 percent):

A_{1p} 0 to 6 inches, very dark gray to very dark grayish-brown (10YR 3/1.5) heavy loam; material recently deposited; moderate, fine, granular structure; friable; medium to slightly acid; abrupt boundary.

A_{12} 6 to 11 inches, very dark gray (10YR 3/1) heavy loam; material recently deposited; moderate, fine, granular structure; friable; medium to slightly acid; clear boundary.

A_{13} 11 to 18 inches, black (10YR 2/1) heavy loam; weak, medium, prismatic to weak, fine, granular structure; friable; slightly acid; clear boundary.

AB 18 to 28 inches, very dark grayish-brown (10YR 3/2) to very dark gray (10YR 3/1) light clay loam; weak, fine to very fine, subangular blocky structure; friable; pebbles as much as one-half inch in diameter; medium to slightly acid; gradual boundary.

B 28 to 38 inches, very dark grayish-brown (10YR 3/2) light clay loam; dark brown (10YR 4/3, dry) when crushed; weak, fine, subangular blocky structure; friable to slightly firm; many small pebbles; weak, discontinuous, gray coats on peds may be organic matter; medium acid; clear boundary.

C_1 38 to 56 inches, very dark grayish-brown (10YR 3/1.5) light clay loam; moderate, medium to fine, subangular blocky structure; slightly firm to friable; medium acid; clear boundary.

C_2 56 to 70 inches, very dark grayish-brown (10YR 3/2) to dark-brown (10YR 3/3) light clay loam; slightly firm; massive.

Range in characteristics.—Olmitz soils have as much as 18 inches of recently deposited, very dark gray (10YR 3/1) material on the surface. The A horizon is loam to light clay loam and is normally friable. Before material was deposited on the surface, the A_{13} horizon was the surface layer. The weakly developed B horizon is 10 to 16 inches thick. The maximum content of clay in the B horizon is 30 to 34 percent. Firm till is at a depth of 30 to 60 inches or more.

If they are present, mottles are few, fine, and yellowish brown (10YR 5/4). They generally occur in the lower part of the B or in the C horizon. Olmitz soils range from medium acid to neutral.

SHARPSBURG SERIES

The Sharpsburg series consists of well drained to moderately well drained Brunizems that formed from Wisconsin loess. They are of Middle Wisconsin to Recent ages. These soils are in a catena that includes the poorly drained Winterset and the imperfectly drained Macksburg soils. They occur on smooth convex ridgetops, ridge crests, and side slopes.

Uneroded Sharpsburg soils have a dark, thick A horizon that is friable and well granulated. The B horizon is moderately developed, slightly firm, and moderate to moderately slow in permeability. The subsoil is distinctly dark brown and, below a depth of 30 inches, may grade to a deoxidized olive-gray layer.

Sharpsburg soils have a thicker A_1 horizon than Ladoga soils. An indistinct A_2 horizon has formed, and the B horizon has a strong, angular blocky structure. The A horizon in Sharpsburg is thinner than that in Macksburg soils, and the B horizon is less distinctly mottled and less developed. Sharpsburg soils have a thinner A_1 horizon than Winterset soils. The B horizon in Winterset soils is gray, gleyed, and distinctly mottled.

Profile of Sharpsburg silty clay loam (150 feet east and 15 feet north of the SW. corner of SE1/4SE1/4 sec. 22, T. 72 N., R. 35 W., on a west-facing side slope with a 9-percent gradient):

A_1 0 to 9 inches, black (10YR 2/1) to very dark gray (10YR 3/1, dry) light silty clay loam; weak, fine, subangular blocky to moderate, fine, granular structure; friable; abundant root hairs; medium acid; clear boundary.

A_3 9 to 15 inches, black (10YR 2/1.5) to very dark brown 10YR 2/2, dry) light silty clay loam; weak to moderate, very fine, subangular blocky structure; friable; medium acid; clear boundary.

B_2 15 to 28 inches, dark-brown (10YR 3.5/3) to (10YR 4/3, dry) heavy silty clay loam with few, fine, faint, very dark gray (10YR 3/1) mottles; moderate, fine, subangular blocky structure; slightly firm; few dark grayish-brown (10YR 4/2, dry) clay films may be on peds; many pores in peds; medium to slightly acid; clear boundary.

B_3 28 to 40 inches, dark-brown (10YR 4/3) medium silty clay loam; yellowish brown (10YR 5/4, dry) when crushed; many, medium, distinct, grayish-brown (2.5Y 5/2) mottles, few, fine, distinct, dark-brown (7.5YR 4/4) mottles, and common, fine, faint, dark grayish-brown (10YR 4/2) mottles; moderate to weak, medium, subangular blocky structure to massive; very coarse concretions of an oxide; abundant pore space in peds; medium to slightly acid; clear boundary.

C_1 40 to 50 inches, olive-gray (5Y 5/2) light silty clay loam with common, very coarse, prominent, dark-brown (7.5YR 4/4) mottles and few, fine, distinct, yellowish-brown (10YR 5/6) mottles; massive; slightly firm; few, fine concretions of an oxide; abundant pore space; large channels left by decayed roots; olive-gray matrix appears to be relic rather than related to modern soil genesis; medium acid; gradual boundary.

C_2 50 to 62 inches, olive-gray (5Y 5/2) light silty clay loam with common, medium, distinct, yellowish-brown (10YR 5/4) mottles and few, fine, faint, dark grayish-brown (10YR 4/2) mottles; massive; slightly firm; abundant pore space; gray matrix appears relic as in C_{11} horizon; medium to slightly acid.

Range in characteristics.—The A horizon in Sharpsburg soils ranges from 3 to 16 inches in thickness and from black (10YR 2/1) to dark grayish brown (10YR 4/2) in color. In uneroded soils the A_1 horizon is typically 9 to 12 inches thick and black (10YR 2/1) to very dark gray (10YR 3/1). In most places the B horizon is 12 to 26 inches thick. It is thickest on the more gentle slopes. Clay films generally occur on the peds in the B horizon but in many profiles are thin and discontinuous. The maximum content of clay in the B horizon normally ranges from 34 to 38 percent.

Except in the relict deoxidized zone that in some places occurs at a depth of 30 to 48 inches, most mottles are yellowish brown (10YR 5/4). The mottling generally begins at a depth of 20 to 30 inches.

Sharpsburg soils are slightly acid to medium acid. Horizon boundaries are generally clear or gradual.

The C horizon is normally silty clay loam. In Lincoln township, however, and in townships bordering the Nodaway River, the C horizon is heavy silt loam in some places.

SHELBY SERIES

The Shelby series consists of well drained to moderately well drained Brunizems that developed from material weathered from Kansan or Nebraskan till. These soils are of Late Wisconsin and Recent ages. They occur on smooth to rough, convex side slopes that are 150 to 300 feet long. If uneroded these soils typically have a moderately thick, dark-colored A horizon of loam to clay loam. Their B horizon is firm to friable, medium to heavy clay loam that is commonly mottled and is leached of lime. It is dark brown to yellowish brown and is moderately slow in permeability. Shelby soils have a firm, mottled, clay loam C horizon that is calcareous in most places.

When dry, the Shelby soils generally have a darker colored A_1 horizon than have the Gara soils. An A_2 horizon does not occur in the Shelby soils, but one is evident in the Gara soils. The B horizon in the Shelby soils is less firm and less strongly developed than that in Gara soils. Shelby soils have a less clayey, thinner, and less well developed B horizon than have the Adair soils with a thin solum.

Profile of Shelby loam (100 feet south of pasture fence and 100 feet east of road in SW¼NW¼NW¼ sec. 20, T. 72 N., R. 32 W., on a long, west-facing slope of 12 percent):

A_{1p} 0 to 7 inches, very dark gray (10YR 2.5/1) heavy loam; moderate, fine, granular structure; friable; many dark-brown (10YR 4/3) worm casts; few small rocks and pebbles on surface and throughout horizon; medium acid; abrupt boundary.

A_3 7 to 11 inches, very dark grayish-brown (10YR 3/2) light clay loam; moderate, fine, granular structure; friable; worm casts; small pebbles; abundant very dark gray (10YR 3/1) stains of organic matter on peds; medium acid; clear boundary.

AB 11 to 16 inches, dark-brown (10YR 4/3) and very dark gray (10YR 3/1) clay loam; weak to moderate, fine, subangular blocky structure; friable; more pebbles than in A horizon; very porous peds; medium acid; clear boundary.

B_{21} 16 to 29 inches, dark yellowish-brown (10YR 4/4) medium clay loam with common, medium, distinct, yellowish-brown (10YR 5/6) mottles and few, fine, faint, dark-brown (10YR 4/3) mottles; moderate, fine, subangular blocky structure; slightly firm to friable; abundant pebbles 1 inch in diameter; many pores in peds; medium to slightly acid; gradual boundary.

B_{22} 29 to 43 inches, dark yellowish-brown (10YR 4/4) medium clay loam, with many, coarse, distinct, yellowish-brown (10YR 5/6) mottles, common, fine, faint, dark grayish-brown (10YR 4/2) mottles, and few, very fine, distinct, dark-brown (7.5YR 4/4) mottles; moderate, medium, angular blocky structure; firm to slightly firm; few, fine, dark concretions of an oxide; boulders, as much as 6 inches in diameter, below 38 inches; clay films on some peds; some pores in peds; slightly acid; clear boundary.

C_{ca} 43 to 52 inches, medium to light clay loam; dark yellowish brown (10YR 4/4) inside peds and olive gray (5Y 5/2) on peds; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, very coarse, angular blocky structure to massive; firm; many concretions of an oxide; abundant concretions of lime, some in the form of hard nodules that appear to be around gypsum centers; soft smears of lime on cleavage planes; abundant pebbles and other rocks.

Range in characteristics.—The texture of the A horizon depends on the degree of slope and the texture of the soils that occur directly upslope. Loam and clay loam are dominant, but if the soil upslope was derived from loess the Shelby soil may approach a silty clay loam. The A horizon ranges from very dark gray (10YR 2.5/1) in uneroded areas to very dark grayish brown (10YR 3/2) in moderately eroded areas. The B horizon is 18 to 30 inches thick and has a maximum content of clay of 32 to 40 percent.

Mottles generally begin at a depth of 18 to 24 inches and are yellowish brown (10YR 5/6) to olive gray (5Y 5/2). Yellowish-brown mottles are most common in the B horizon, and olive-gray mottles are most common in the C horizon. Shelby soils generally were derived from Kansan till but in some places were derived from Nebraskan till. The depth to carbonates is varied but generally ranges from 30 to 60 inches.

SPERRY SERIES

The Sperry series consists of very poorly drained Planosols that have developed from loess. They are Middle Wisconsin in age. These soils are in shallow depressions in broad, nearly level uplands and are in weakly defined drainage coves on benches mantled with loess.

Sperry soils have a dark, moderately thick, silt loam A_1 horizon and a prominent gray A_2 horizon. Their B horizon is dark colored, very firm silty clay. It is very plastic and sticky when wet and is slowly permeable to very slowly permeable. The C horizon is grayish and prominently mottled.

Sperry soils differ from Winterset soils by having a silt loam instead of a silty clay loam A_1 horizon and a prominent A_2 horizon. An A_2 horizon has not formed in Winterset soils. The B horizon of Sperry soils is gleyed and has a strong structural development that is not evident in Macksburg soils.

Profile of Sperry silt loam (50 feet west and 800 feet north of the SE. corner sec. 5, T. 71 N., R. 33 W., in a depression that is surrounded by a Winterset soil):

A_{1p} 0 to 7 inches, black (10YR 2/1) silt loam; massive to weak, fine, granular structure; slightly firm; slightly acid; abrupt boundary.

A_{12} 7 to 10 inches, black (10YR 2/1) and some grayish-brown (2.5Y 5/2) silt loam; moderate, fine, granular structure; friable to slightly firm; slightly acid; abrupt boundary.

A_{21} 10 to 17 inches, grayish-brown (2.5Y 5/2) to light brownish-gray (2.5Y 6/2, dry) silt loam with few, fine, distinct, dark-brown (10YR 4/3) mottles and few, fine, faint, dark-gray (10YR 4/1) mottles; weak, thin, platy structure; very friable; medium acid; clear boundary.

A_2B_1 17 to 20 inches, light silty clay loam; very dark gray (10YR 3/1) on peds and grayish brown (2.5Y 5/2) inside of peds; few, fine, distinct, dark-brown (10YR 4/3) mottles; weak, thick, platy to weak, medium, angular blocky structure; slightly firm; clay films or stains of organic matter on vertical planes of peds; medium acid; clear boundary.

B_{21g} 20 to 26 inches, black (10YR 2/1) light silty clay with few, fine, faint, dark grayish-brown (2.5Y 4/2) to dark grayish-brown (10YR 4/2) mottles and few, fine, distinct, dark-brown (10YR 4/3) mottles; strong, coarse, angular blocky to strong, very fine, subangular blocky structure; firm; prominent clay films cover peds; pores filled with clay; medium acid to slightly acid; clear boundary.

B_{22g} 26 to 32 inches, very dark gray (10YR 3/1) medium silty clay with many, medium, faint, dark grayish-brown (10YR 4/2) mottles and few, fine, distinct, dark-brown (10YR 4/3) mottles; massive to moderate, fine, subangular blocky structure; very firm; thin films of clay cover peds; few pores; medium acid to slightly acid; clear boundary.

B_{3g} 32 to 41 inches, dark-gray (5Y 4/1) light silty clay; massive to strong, medium, subangular blocky structure; very firm; mottles masked by matrix color; clay films thin but common on vertical cleavage planes; pore space in peds; slightly acid; clear boundary.

B_3C_1 41 to 50 inches, dark-gray (5Y 4/1) heavy silty clay loam with many, fine, faint, very dark gray (10YR 3/1) mottles, many, coarse, prominent, yellowish-brown (10YR 5/4) mottles, and few, fine, distinct, brown (7.5YR 5/4) mottles; massive; firm; few pores in peds; no clay films; root channels common; slightly acid; gradual boundary.

C_2 50 to 58 inches, dark-gray (5Y 4/1) silty clay loam with many, coarse, distinct, dark yellowish-brown (10YR 4/4) mottles, common, fine, distinct, dark-brown (7.5YR 4/4) mottles, and few, fine, faint, dark-gray (10YR 4/1) mottles; massive; slightly firm; dark-gray stains in old root channels; concretions of an oxide 1/16 to 1/8 inch in size; slightly acid.

Range in characteristics.—The A_1 horizon is 6 to 12 inches thick in most places. The A_2 horizon is 4 to 10 inches thick and is grayish brown (2.5Y 5/2) to light brownish gray (2.5Y 6/2, dry). The B horizon is gleyed in most places and is firm to very firm in consistence. Its maximum content of clay is 40 to 45 percent. From the A to the B horizon the content of clay distinctly increases. Mottling usually begins in the A_2 horizon and occurs throughout the underlying horizons. The mottles range from yellowish brown (10YR 5/4) to dark gray (10YR 4/1). Unweathered parent material is at a depth of 42 to 60 inches. The C horizon is generally dark gray (5Y 4/1) to olive gray (5Y 4/2).

Sperry soils are medium to slightly acid. Their A_2 and upper B horizons are generally medium acid. The A and C horizons are slightly acid.

WABASH SERIES

The Wabash series consists of poorly drained to very poorly drained Humic Gleys that have developed from alluvium on bottom lands. These soils are of Late Wisconsin and Recent ages. Wabash silty clay and Wabash silty clay loams are described separately.

WABASH SILTY CLAY.—This soil is poorly drained to very poorly drained. It commonly occurs in slack water areas that have poor surface drainage. In many places these areas are bayous or flats that lie fairly distant from the present stream channels.

Wabash silty clay has a black, firm to very firm, silty clay A horizon. The silty clay extends to a depth of 16 to 20 inches and is underlain by very dark gray, very firm heavy silty clay or clay. The profile is gleyed and firm to very firm throughout.

This soil differs from Wabash silty clay loams in texture and consistence of the A horizon. Wabash silty clay loams have a slightly firm A horizon. The silty clay in Wabash silty clay extends to a depth of 3 to 8 feet in most places and is firm to very firm. Colo silty clay loam is normally silty clay loam to 32 inches or more and is slightly firm to firm throughout the profile.

Profile of Wabash silty clay (1,200 feet south and 50 feet west of the NE. corner of SW1/4 sec. 31, T. 72 N., R. 34 W., on a nearly level bottom, 1/4 mile east of Kemp Creek):

A_p 0 to 6 inches, black (10YR 2/0.5) light silty clay; massive to moderate, fine, angular blocky structure; firm; slightly acid; abrupt boundary.

A_3 6 to 16 inches, black (10YR 2/0.5) medium silty clay that remains dark when dry; strong, very fine, subangular blocky structure to massive; very firm; no pore space in peds; slightly acid; clear boundary.

C_1 16 to 20 inches, black to very dark gray (10YR 2.5/1) heavy silty clay with few, fine, faint, dark-gray (10YR 4/1) mottles; massive; very firm; no pore space; slightly acid; gradual boundary.

C_{2g} 20 to 48 inches, very dark gray (10YR 3/1) heavy silty clay or clay with few, very fine, distinct, very dark brown (10YR 2/2) mottles and few, fine, faint, dark-gray (10YR 4/1) mottles; massive; very firm; no pore space; slightly acid to neutral.

Range in characteristics.—Wabash silty clay has a black (10YR 2/0.5 to 10YR 2/1) A horizon that is 40 to 45 percent clay. The subsoil is 45 to 55 percent clay.

This soil has formed in fine-textured alluvium that is more than 3 feet thick. It is firm to very firm throughout the profile. It ranges from slightly acid to neutral but is generally slightly acid.

WABASH SILTY CLAY LOAMS.—These soils are poorly drained Humic Gleys that have developed from alluvium laid down in Late Wisconsin and Recent ages. They are generally on first bottoms at least one-fourth mile wide.

The surface layers of these soils are generally dark silty clay loam that extends to a depth of about 18 inches and is underlain by dark silty clay or clay. The A horizon is firm and moderately permeable whereas the subsoil is very firm and slowly to very slowly permeable.

Wabash silty clay loams contain less clay than Wabash silty clay and are less firm in the A horizon. Their silty clay or clay subsoil is gleyed, but that of Colo silty clay loams is not. Wabash silty clay loams are of texture and drainage that are intermediate between the texture and drainage of Colo silty clay loams and Wabash silty clay.

Profile of a Wabash silty clay loam (80 feet north of road and 440 feet east of the SW. corner of NE¼NE¼ sec. 11, T. 71 N., R. 35 W., on a nearly level first bottom adjacent to the mouth of Kemp Creek):

A_p 0 to 8 inches, very dark gray to black (10YR 2.5/1) light silty clay loam; massive to weak, fine, granular structure; slightly firm; medium to slightly acid; abrupt boundary.

A_{12} 8 to 13 inches, black (10YR 2/1) light silty clay loam; few, fine, faint, very dark gray (10YR 3/1) mottles; weak, very fine, subangular blocky to weak, fine, granular structure; slightly firm to friable; abundant pores and root channels; slightly acid; gradual boundary.

A_3 13 to 20 inches, very dark gray to black (10YR 2.5/1) heavy silty clay loam with few, fine, distinct, dark yellowish-brown (10YR 3/4) mottles; moderate, very fine, subangular blocky structure; slightly firm to friable; abundant pores in peds; medium acid; clear boundary.

C_{1g} 20 to 39 inches, black (10YR 2/1) light to medium silty clay with few, fine, faint, very dark brown (10YR 2/2) mottles; massive to weak, very fine, subangular blocky structure; firm; little pore space; some root channels; medium acid; gradual boundary.

C_{2g} 39 to 54 inches, very dark gray (10YR 3/1) medium silty clay with common, fine, faint, very dark brown (10YR 2/2) mottles; massive; very firm; few rusty stains; no pore space; slightly acid.

Range in characteristics.—The silty clay loam ranges from 16 to 24 inches in thickness but is generally about 18 inches thick. In some places the surface horizon consists of as much as 12 inches of recently deposited very dark gray (10YR 3/1) material. The A horizon is moderately permeable, but the subsoil is slowly permeable. The surface horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) but is very dark gray in most places. The C_1 horizon formerly may have been the surface horizon. These soils are generally slightly acid but range from slightly acid to medium acid.

WINTERSET SERIES

The Winterset series consists of poorly drained Humic Gleys that were derived from loess. They are Middle Wisconsin in age. These soils are members of a catena that includes Sharpsburg and Macksburg soils. Sharpsburg soils are well drained to moderately well drained, and Macksburg soils are imperfectly to moderately well drained. The Winterset soils are on broad, nearly level flats of uplands.

These soils typically have a thick, dark silty clay loam A horizon that grades to a dark-colored, gleyed, light silty clay B horizon. The B horizon is firm and is normally mottled. The horizons are moderately developed.

The B horizon in Winterset soils is grayer and more gleyed than that in Macksburg soils and is generally finer textured. Winterset soils have a thicker A horizon than have Clearfield soils and a finer textured B horizon. Their A horizon is thicker than that in the Sharpsburg soils, and their B horizon is less brown and contains more clay. The solum of Winterset soils is more mottled than that of Sharpsburg soils.

Profile of Winterset silty clay loam (550 feet south and 550 feet west of sec. 14, T. 73 N., R. 33 W., on a moderately wide to wide, nearly level ridgetop that is a watershed divide):

A_{1p} 0 to 6 inches, black (10YR 2/1) light silty clay loam; moderate, fine, granular structure; friable; high in organic matter; neutral; abrupt boundary.

A_{12} 6 to 12 inches, black (10YR 2/1) light silty clay loam; weak, fine, subangular blocky to weak, fine, granular structure; friable; slightly acid; gradual boundary.

A_3 12 to 19 inches, black to very dark gray (10YR 2.5/1) medium silty clay loam with few, very fine, faint, very dark grayish-brown (10YR 3/2) mottles; strong, fine, subangular blocky structure; slightly firm; few coats of organic matter on peds, especially on vertical faces; slightly acid to medium acid; clear boundary.

B_{21} 19 to 26 inches, very dark grayish-brown (10YR 3/2) heavy silty clay loam to light silty clay with few, fine, faint, very dark gray (10YR 3/1) mottles and few, very fine, distinct, yellowish-brown (10YR 5/4) mottles; strong, fine to medium, subangular blocky structure; firm to slightly firm; concretions of an oxide; thin, discontinuous clay films on peds; some pores filled with clay; medium acid; gradual boundary.

B_{22g} 26 to 42 inches, very dark gray to dark gray (10YR 3.5/1) light silty clay to heavy silty clay loam with common, fine, faint, dark grayish-brown (10YR 4/2) mottles; strong, medium to fine, angular blocky structure; firm; thin clay films on peds; concretions of an oxide as much as one-fourth inch in diameter; medium acid; clear boundary.

B_3C_1 42 to 50 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam with few, fine, distinct, dark-brown (10YR 4/3) mottles and common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium angular blocky structure to massive; slightly firm; medium to slightly acid.

Range in characteristics.—The A_1 horizon is black (10YR 2/1) in most places but ranges from black to very dark gray (10YR 3/1). It is very dark gray in depressions. The A_1 horizon of this soil is light silty clay loam, but some inclusions have a heavy silt loam A_1 horizon. The A horizon ranges from 18 to 24 inches in thickness. The B horizon is dark gray (10YR 4/1) to very dark grayish brown (10YR 3/2) and is commonly 20 to 30 inches thick. Dark grayish-brown (10YR 4/2) to yellowish-brown (10YR 5/6) mottles are most common. The mottling generally begins at a depth of 14 to 20 inches. The maximum content of clay in the B horizon ranges from 38 to 43 percent. Horizon boundaries are gradual to abrupt. The horizons range from neutral to medium acid; the B_2 horizon is generally the most acid.

WIOTA SERIES

The Wiota series consists of well-drained Brunizems that have developed from medium to moderately fine textured alluvium that was deposited during Late Wisconsin and Recent ages. These soils occur on nearly level to gently sloping second bottoms that lie slightly above the flood plains of rivers.

These soils have a dark, friable, silt loam A horizon and a moderately dark, silty clay loam B horizon. Horizon development is moderate to weak, and boundaries are gradual to clear. The solum is relatively free of mottles. Strata of sand occur below a depth of 6 to 10 feet in some places.

The Wiota soils have weaker horizons and a coarser textured A horizon than have Sharpsburg soils and are less mottled in the subsoil and substratum. Their B horizon is browner, less mottled, and less firm than that in Nevin soils. It is less clayey, less developed, and thinner than the B horizon in Bremer soils. The subsoil in Bremer soils is grayish and highly mottled. Wiota soils are friable to slightly firm throughout the solum, but the B horizon in Bremer soils is firm, plastic, and gleyed.

Profile of Wiota silt loam (38 yards west and 138 yards south of gate in SW. corner of farmstead that is about 180 yards west of the center of sec. 12, T. 71 N., R. 35 W., on a nearly level, low bench that slopes slightly toward the north):

A_{1p} 0 to 6 inches, black to very dark gray (10YR 2.5/1) heavy silt loam; moderate, very fine, granular structure; friable; slightly acid; abrupt boundary.

A_{12} 6 to 10 inches, black to very dark gray (10YR 2.5/1) heavy silt loam; very dark grayish brown (10YR 3/2, dry) when crushed; moderate, fine, granular structure; friable; slightly acid; gradual boundary.

A_3 10 to 18 inches, very dark gray (10YR 3/1) heavy silt loam; dark grayish brown (10YR 4/2, dry) when crushed; weak, fine, subangular blocky to weak, fine, granular structure; friable; slightly acid; clear boundary.

B_1 18 to 26 inches, very dark gray (10YR 3/1) light silty clay loam; very dark grayish brown (10YR 3/2; 10YR 3/3, dry) when crushed; weak to moderate, very fine to fine, subangular blocky structure; friable; coats of sand on peds; slightly acid; gradual boundary.

B_{21} 26 to 32 inches, very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/1.5) light silty clay loam; dark brown (10YR 4/3) when crushed; weak to moderate, medium to fine, subangular blocky structure; friable; coatings of coarse sand; slightly acid; gradual boundary.

B_{22} 32 to 43 inches, very dark grayish-brown (10YR 3/2) medium silty clay loam; dark brown (10YR 3.5/3) when crushed; weak, medium, prismatic to weak, fine, angular blocky structure; slightly firm; slightly acid; clear boundary.

B_3C_1 43 to 48 inches, dark-brown (10YR 4/3) to very dark grayish-brown (10YR 3/2) light silty clay loam; weak, medium, angular blocky structure; slightly firm; sand grains as much as one-eighth inch in diameter; slightly acid; clear boundary.

C_1 48 to 58 inches, dark yellowish-brown (10YR 4/4) to dark-grayish brown (2.5Y 4/2) light silty clay loam; few, very fine, prominent, dark reddish-brown (5YR 3/4) mottles, few, very fine, faint, yellowish-brown (10YR 5/8) mottles, and few, fine, faint, dark-brown (10YR 4/3) mottles; weak, fine, angular blocky structure to massive; slightly firm; dark-brown concretions of an oxide; sand coats on vertical cleavage planes; slightly acid; gradual boundary.

C_2 58 to 66 inches +, dark-brown (10YR 4/3) medium silty clay loam with few, fine, distinct, yellowish-brown (10YR 5/6) mottles; massive; slightly firm; few concretions of an oxide; sandy loam strata at 8 feet.

Range in characteristics.—The A horizon is 12 to 18 inches thick and ranges from black (10YR 2/1) to very dark gray (10YR 3/1). Horizon development is weak to moderate, and boundaries are gradual to clear. The material of the B horizon is browner when it is crushed than when it is in place. In some profiles sand grains occur in the solum, but the depth to sandy material is 6 to 10 feet. If clay films are in the B horizon, they are very thin and discontinuous. The maximum content of clay in the B_2 horizon ranges from 30 to 36 percent. Reaction is generally slightly acid in all horizons.

Engineering Applications

For a long time engineers have studied soil characteristics that affect construction and have devised systems of soil classification based on these characteristics. The engineers consider the characteristics of soils when they design and construct engineering works. Most of these studies, however, have been at the site of construction, for general information about the soils of an area has not been readily available.

If properly interpreted, the information in this report can be very helpful to the planning engineer. *Because it is somewhat general, it should not be used to replace information that can be obtained only by detailed investigations at individual sites. This report, however, will be valuable in planning the detailed investigations.*

At many construction sites, major variations occur in a soil within the depth of proposed excavation and several soil units occur within short distances. By using the information in a soil survey report the soils engineer can concentrate on the most important soil units. Then he can obtain a minimum number of soil samples for laboratory testing and can make adequate soil investigations at minimum cost.

This soil survey report contains information that can be used by engineers to:

1. Make studies of soil and land use that will aid in the selection and development of industrial, business, residential, and recreational sites.
2. Assist in planning and designing erosion and flood control structures, drainage improvements, and other structures for soil and water conservation.
3. Make reconnaissance surveys of soil and ground conditions that will aid in selecting highway and airport locations and in planning detailed soil surveys for the intended locations.
4. Correlate performance of engineering structures with soil mapping units and thus develop information that will be useful in designing and maintaining these structures.
5. Determine the suitability of soil units for cross-country movements of vehicles and construction equipment.
6. Supplement information obtained from other published maps and reports and from aerial pho-

tographs for the purpose of making soil maps and reports that can be used readily by engineers.

Soil Science Terminology

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and some words —for example, soil, clay, silt, and sand—may have special meanings in soil science. These and other special terms used in the soil survey report are defined in the Glossary in the back of this report.

Engineering 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 clayey soils having low strength when wet.

Some engineers prefer to use the Unified soil classification system (*28*). In this system soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic. An approximate classification can be made in the field. The soil series and miscellaneous land types in Adams County have been classified by the AASHO and Unified systems in table 9.

Soil Engineering Data and Interpretations

Some information valuable to engineering can be obtained from the soil map. Other information can be obtained from other parts of the report, particularly from the sections "General Soil Map," "Descriptions of Soils," "Geology, Landforms, and Drainage," "Genesis, Morphology, and Classification of Soils," and "Technical Descriptions of Soils."

The information and interpretation in table 9 are based on the test data in table 10, on information in other parts of the report, and on experience in other counties with soils that are similar to those in this county.

Soil Features Affecting Road Construction [5]

Many of the soils in Adams County have formed from loess that overlies glacial till of Kansan age. The loess ranges from as much as 12 feet in thickness on the nearly level uplands and the tops of ridges to a very thin layer in more sloping areas. In many places in uplands the loess is absent, and the parent material consists of weathered glacial till.

The Winterset, Macksburg, and other soils derived from loess in nearly level areas are very fine textured. They are classified A–7 (OH, CH) and have high group index numbers. The soil from the surface to a depth of about 2 feet is highly organic and is difficult to compact to good density. The subsoil is a plastic silty clay that expands readily and does not make a good upper subgrade. The Sharpsburg, Ladoga, Clinton, and other soils have formed in loess in sloping areas. These soils have a less well developed surface layer and a less plastic subsoil than soils formed in nearly level areas. The subsoil material is classified A–7 (CL-CH) and has high group index numbers.

The soils derived from loess erode easily if runoff is concentrated. Sodding, paving, or check dams may be needed in gutters and ditches to prevent excessive erosion.

In the soils derived from loess the seasonally high water table is usually above the juncture of the glacial till and the loess. In the nearly level areas a perched water table occurs above the B horizon in places. The density of the loess in places is relatively low and the moisture content is high in areas where the water table is high. Excess moisture may cause instability in embankments unless it is controlled enough for the soil to be compacted to high density. Soils that developed from weathered Kansan till have high density, in places, and generally a moisture content that is not excessively high. These soils are, therefore, more easily compacted than soils derived from loess.

The weathered Kansan till that underlies the loess is heterogeneous and of poor quality for construction work. On the nearly level to gently rolling uplands this till is the remains of the original Kansan till plain. The upper layer is a very plastic clay called gumbotil. It is classified A–7–6(18–20). It is not stable enough to be used for a highway subgrade and should not be used within 5 feet of a finished grade. This plastic clay crops out in sloping areas where the loess is thin, and the Clarinda and Adair soils have formed from it. Gumbotil in roadcuts should be removed to a depth of 2 feet and should be replaced with a backfill of good glacial till or of coarse-textured soil.

Heterogeneous Kansan till is below the gumbotil and outcrops on lower slopes. Most of this material has been classified A–6 (CL). It is the parent material of Gara and Shelby soils. If it is found in or along grading projects, it is normally placed in the upper subgrade in unstable areas. Pockets and lenses of sand and gravel are commonly interspersed throughout the till and in many places are water bearing. Frost heaving is likely if the road grade is only a few feet above such pockets and loess or silty till overlies them. To prevent frost heaving the pockets should be drained or the soil above them replaced with a backfill of coarse-textured material or clay till.

The bedrock in Adams County is shale, limestone, or sandstone. On slopes where shale crops out below loess or till, Gosport soils have formed. Unless care is taken in these places, the soil above the shale may come down in a landslide if the natural slope is disturbed during construction.

The soils on the bottom lands were developed from recent alluvium. Of these soils the Colo, Wabash, Judson, and Kennebec have a thick surface layer that is high in organic matter. The soil material in this surface layer may consolidate erratically under the load of a heavy embankment. The Chariton, Colo, and Wabash soils are classified A–7 (CH). They have a low density in places, and a high content of moisture. For an embankment more than 15 feet high, these soils should be carefully investigated to be sure that they are strong enough to support the embankment. Roadways

[5] This subsection and table 9 were prepared by DONALD A. ANDERSON, soils engineer, Iowa State Highway Commission.

TABLE 9.—*Soil characteristics*

Soil series or miscellaneous land type	Brief description of soil profile and ground condition	Parent material
Adair (AaC, AaD2, AdD3)	Imperfectly drained; very firm silty clay to clay subsoil over firm clay loam at a depth of about 48 inches.	Glacial till
Adair, thin solum (AcC2, AcD, AcD2, AcE2, AmC3, AmD3).	Imperfectly drained to moderately well drained; firm to very firm heavy clay loam to clay subsoil over a firm clay loam at a depth of about 36 inches.	Glacial till
Adair-Shelby complex (ApC2, ApD, ApD2, ApD3, ApE2, ApE3).	A complex area of Adair, Clarinda, or Adair, thin solum, on upper slope with Shelby on the lower slope. (See individual series for description.)	Glacial till
Alluvial land (Av)	Stratified deposits of recent alluvium on flood plains; texture ranges from loamy fine sand to a silty clay.	Recent alluvium
Arbor (AwD)	Well drained; slightly firm to firm clay loam subsoil over firm clay loam.	Local alluvium over glacial till.
Bremer (Br)	Poorly drained; heavy silty clay loam to light silty clay subsoil; sandy lenses below a depth of 8 feet in some places; high content of organic matter in upper 1½ feet.	Alluvium
Chariton (Ca)	Poorly drained to very poorly drained; very firm silty clay subsoil	Alluvium
Clarinda (CcC, CcC2, CcD, CcD2, CdC3, CdD3).	Poorly drained to very poorly drained; very firm, plastic silty clay or clay subsoil 3 to 8 feet thick over firm clay loam; clay to silty clay subsoil called gumbotil.	Glacial till
Clearfield (CfC, CfC2)	Imperfectly drained to poorly drained; slightly firm to firm silty clay loam subsoil; a very firm, plastic silty clay at a depth of 36 to 72 inches.	Loess over glacial till
Clinton (ClC2, ClD2)	Moderately well drained; firm silty clay loam to light silty clay subsoil over slightly firm to firm silty clay loam to silt loam; clay to to clay loam weathered from Kansan till at a depth of 10 to 16 feet.	Loess
Colo (Cm, Cn, Co)	Poorly drained; slightly firm to firm silty clay loam subsoil; high content of organic matter in upper 3½ feet or more.	Alluvium
Colo-Gravity complex (CxB)	Complex area of Colo and Gravity soils. (See individual series for description.)	Alluvium
Gara (GaC2, GaD, GaD2, GaE, GaE2, GaF, GaG, GbE3).	Moderately well drained; firm to very firm clay subsoil over a firm clay loam at a depth of about 3½ feet.	Glacial till
Gosport (GpD, GpF, GpG)	Moderately well drained; very firm silty clay subsoil over very firm shale.	Thin layer of loess or loess and till over shale.
Gravity (GrB)	Imperfectly drained to poorly drained; slightly firm to firm clay loam to silty clay loam throughout; high content of organic matter in upper 2 to 3 feet.	Local alluvium
Gullied land (Gu)	Imperfectly drained to poorly drained alluvial material in narrow drainageways; dominantly silty clay loam throughout; high content of organic matter in most places.	Alluvium
Hagener (HaC2, HaD2)	Excessively drained; loose, loamy fine sand over loamy sand	Wind-deposited sands
Judson (JuA, JuB, JuC)	Well drained to moderately well drained; friable to slightly firm silty clay loam subsoil; high content of organic matter in upper 2 feet.	Local alluvium
Kennebec (Kb)	Moderately well drained; friable silty clay loam to silt loam subsoil over silty clay loam; high content of organic matter in upper 2 to 3 feet.	Alluvium
Ladoga (LaB, LaB2, LaC, LaC2, LaD, LaD2, LdC3).	Moderately well drained; heavy silty clay loam to light silty clay subsoil over light silty clay loam; clay to clay loam derived from Kansan till at a depth of 10 to 16 feet.	Loess
Ladoga, benches (LbA, LbB)	Moderately well drained; heavy silty clay loam to light silty clay subsoil over light silty clay loam; alluvial material below a depth of 15 feet or more.	Loess
Macksburg (MaA, MaB)	Imperfectly drained; have firm to slightly firm heavy silty clay loam to light silty clay subsoil over slightly firm silty clay loam; clay to clay loam material derived from Kansan till below a depth of 10 to 16 feet; high content of organic matter in upper 1½ feet.	Loess
Nevin (Nn)	Imperfectly drained; slightly firm to firm silty clay loam subsoil; sandy lenses below a depth of 6 to 8 feet in some places; high content of organic matter in upper 1½ feet.	Alluvium
Nodaway (No, Nw)	Moderately well drained to imperfectly drained; friable silt loam throughout; in some places black silty clay loam, high in organic matter below a depth of 3 feet.	Alluvium
Olmitz (OmB, OmC)	Well to moderately well drained; friable to slightly firm clay loam subsoil.	Local alluvium

[1] Seasonally wet because of seepage from more permeable, higher lying soils derived from loess.

that affect engineering

Slope	Depth to seasonally high water table	Engineering classification		Suitability as source of—	
		AASHO	Unified	Topsoil	Borrow for highway construction
Percent	*Feet*				
5–14	(1)	A–7–6(17–19) over A–6(12) to A–7–6(15).	CH over CL	Unsuitable	Unsuitable above depth of 48 inches; good below.
5–18	(1)	A–7–6(14–18) over A–6(10) to A–7–6(16).	CH over CL	Unsuitable	Fair to unsuitable above 36 inches; good below.
5–18	(1)	A–6(10) to A–7–6(20)	CL, CH	Unsuitable	Variable.
0–2	0–1½	Variable	Variable	Variable	Variable.
9–14	3–5	A–6(8) to A–7–6(16)	CL, CH	Fair to depth of dark surface layer.	Good.
0–2	2½–3	A–7–6(12) to A–7–5(20)	OL, CH	Good to depth of dark surface layer.	Unsuitable.
0–2	½–1	A–7–6(16–20)	CL, CH	Unsuitable	Unsuitable.
5–14	(1)	A–7–6(15–20)	CH	Unsuitable	Unsuitable.
5–9	1½–3	A–7–6(13–19)	CL, CH	Fair to depth of dark surface layer.	Unsuitable.
5–14	5+	A–7–6(12–17)	CL, CH	Unsuitable	Poor.
0–2	1–2	A–7–6(14–18)	OL, CH	Excellent	Unsuitable.
2–5	0–1½	A–7–6(12–18)	OL, CH	Excellent	Poor to unsuitable.
5–35	3–5	A–6(12) to A–7–6(16)	CL, CH	Unsuitable	Good.
5–40	5+	(2)	(2)	Unsuitable	Unsuitable.
2–5	1–2	A–7–6(12–16)	OL, CH	Excellent	Poor.
2–5	2–5	A–7–6(14–18)	OL, CH	Excellent	Poor to unsuitable.
5–14	5+	A–2 to A–3	SM, SP	Unsuitable	Good.
0–9	3–5	A–6(12) to A–7–6(14)	OL, CL	Excellent	Poor.
0–2	>2½	A–6(12) to A–7–6(16)	OL, CL	Excellent	Unsuitable.
2–14	5+	A–6(10) to A–7–6(16)	ML, CL, CH	Poor	Poor.
0–5	5+	A–6(10) to A–7–6(16)	ML, CL, CH	Poor	Poor.
0–5	1½–5	A–7–6(13–19)	OL, CH	Good to depth of dark surface layer.	Unsuitable.
0–2	3–5	A–7–6(13–19)	OL, CH	Good to depth of dark surface layer.	Unsuitable.
0–2	3–5	A–6(9) to A–7–6(12)	CL over OL	Excellent	Fair above black silty clay loam.
2–9	3–5	A–6(10) to A–7–6(14)	ML, CL	Excellent to depth of dark surface layer.	Fair.

[2] Shale; classify visually.

TABLE 9.—*Soil characteristics that*

Soil series or miscellaneous land type	Brief description of soil profile and ground condition	Parent material
Sharpsburg (SaA, SaB, SaB2, SaC, SaC2, SaD, SaD2, SaE).	Well drained to moderately well drained; slightly firm to friable silty clay loam subsoil over slightly firm silty clay loam to silt loam; clay to clay loam derived from Kansan till at a depth of 10 to 16 feet.	Loess
Sharpsburg, benches (SbA, SbB)	Well drained to moderately well drained; slightly firm to friable silty clay loam subsoil over slightly firm silty clay loam; alluvial materials below a depth of 15 feet.	Loess
Shelby (ShC2, ShD, ShD2, ShE, ShE2, ShF, ShG, SoD3, SoE3).	Well drained to moderately well drained; firm clay loam subsoil over a firm light clay loam to medium clay loam; pebbles, stones, and a few sand pockets.	Glacial till
Sperry (Sp, St)	Very poorly drained soils; very firm silty clay subsoil over a slightly firm silty clay loam; Kansan glacial material at a depth of 10 feet or more.	Loess
Wabash (Wa, Wb, Wc)	Poor to very poorly drained; firm to very firm silty clay subsoil; high content of organic matter in upper part.	Alluvium
Winterset (Wr)	Poorly drained soils; heavy silty clay loam to light silty clay subsoil over a slightly firm silty clay loam; clay to clay loam material derived from Kansan till at a depth of 10 to 16 feet; high content of organic matter in upper 2 feet.	Loess
Wiota (WtA, WtB)	Well drained soils; friable to slightly firm silty clay loam subsoil over a slightly firm silty clay loam; sandy lenses below a depth of 6 feet in some places.	Alluvium

TABLE 10.—*Engineering*

Soil name and location	Parent material	Depth	Horizons	Maximum dry density [2]	Optimum moisture content [2]
Adair clay loam:		*Inches*		*lbs. per cu. ft.*	*Percent*
10 feet S. of fence SW. of crossroads in NE¼SW¼NE¼ sec. 15, T. 72 N., R. 34 W. (modal profile).	Kansan till	0–8	IA_{1p} and IA_3	97. 1	21. 6
		13–39	$IIPB_{21}$ and $IIPB_{22}$	95. 4	23. 4
		48–60	$IIPB_3C_1$	107. 2	17. 5
Clarinda silty clay loam:					
610 feet S. and 20 feet W. of NE. corner of SE¼ sec. 1, T. 71 N., R. 33 W. (modal profile).	Kansan till	0–10	IA_1 and IA_3	85. 9	29. 9
		15–44	$IIPB_{21g}$ and $IIPB_{22g}$	94. 0	23. 5
Macksburg silty clay loam:					
100 feet S. of U.S. Highway 34 and 660 feet E. of NW. corner of SE¼ sec. 5, T. 71 N., R. 33 W. (modal profile)	Wisconsin loess	0–18	A_{1p}, A_{12}, and A_3	89. 2	26. 6
		18–38	B_{21} and B_{22}	88. 7	26. 2
		38–59	B_3 and C	91. 2	25. 5
Nodaway silt loam:					
50 feet W. of the Y branch in road ⅛ mile W. of town of Carbon on W. side of NE¼SW¼ sec. 12, T. 72 N., R. 35 W. (modal profile).	Alluvium	12–29	C	102. 2	17. 1
Shelby loam:					
100 feet S. of pasture fence and 100 feet E. of road in SW¼NW¼NW¼ sec. 20, T. 72 N., R. 32 W. (modal profile).	Kansan till	0–11	A_p and A_3	99. 4	19. 0
		16–43	B_{21} and B_{22}	108. 2	15. 8
		43–52	C_{ca}	112. 6	15. 4
Wabash silty clay loam:					
80 feet N. of road and 440 feet E. of SW. corner of NE¼NE¼ sec. 11, T. 71 N., R. 35 W. (modal profile).	Alluvium	0–13	A_p and A_{12}	91. 0	25. 3
		20–48	C_{1g} and C_{2g}	89. 0	27. 2

[1] Tests performed by Iowa State Highway Commission according to standard procedures of the American Association of State Highway Officials (AASHO.) (*1*).

[2] Based on the moisture-density relations of soils that were determined when a 5.5-pound rammer and a 12-inch drop were used in a test for compaction and density: AASHO Designation T 99–57, Method A.

[3] According to the AASHO Designation: T 88–54. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the 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.

affect engineering—Continued

Slope	Depth to seasonally high water table	Engineering classification: AASHO	Engineering classification: Unified	Suitability as source of—: Topsoil	Suitability as source of—: Borrow for highway construction
Percent	*Feet*				
0–18	5+	A–6(10) to A–7–6(16)	ML, CL	Good to depth of dark surface layer.	Poor.
0–5	4–8	A–6(10) to A–7–6(16)	ML, CL	Good to depth of dark surface layer.	Poor.
5–35	5+	A–6(8) to A–7–6(16)	CL, CH	Fair to depth of dark surface layer.	Good.
0–1	1–1½	A–7–6(16–20)	CL, CH	Poor	Unsuitable.
0–2	0–2	A–7–6(13–20)	OL, CH	Poor	Unsuitable.
0–2	1–3	A–7–6(12) to A–7–5(20)	OL, CH	Good to depth of dark surface layer.	Unsuitable.
0–5	5+	A–6(10) to A–7–6(16)	ML, CL	Good to depth of dark surface layer.	Poor.

test data [1]

Mechanical analyses [3]								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than—							
No. 10 (2.0 mm.)	No. 40 (0.42 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	98	92	81	75	53	34	28	39	17	A–6(11)	CL.
100	97	92	81	76	62	48	43	54	32	A–7–6(19)	CH.
100	93	86	70	63	48	35	31	40	23	A–6(12)	CL.
		100	98	93	71	45	38	51	23	A–7–6(15)	OH or MH, CH.
		100	99	95	77	54	47	59	35	A–7–6(20)	CH.
			100	92	69	41	32	47	19	A–7–6(13)	ML, OL.
			100	93	72	46	38	53	25	A–7–6(17)	OH or MH, CH.
			100	94	71	45	38	56	30	A–7–6(19)	CH.
	100	99	93	81	43	23	19	33	13	A–6(9)	CL.
98	93	85	61	54	43	31	24	37	16	A–6(8)	CL.
95	87	79	61	57	47	36	30	39	20	A–6(9)	CL.
96	89	83	66	59	49	36	30	39	23	A–6(11)	CL.
		100	99	96	77	43	32	46	20	A–7–6(13)	CL.
		100	98	96	87	63	53	68	40	A–7–6(20)	CH.

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.

[4] According to the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHO Designation: M 145–49 (*1*).

[5] According to the Unified Soil Classification System (*28*).

through bottom lands should be constructed on a continuous embankment that extends above the flood level. Because the Nodaway soils contain lenses of fine sand in places, an embankment constructed only a few feet above the water table on these soils may be damaged by frost heaving. To prevent this damage, the soils should be drained or materials not susceptible to frost action should be used in the subgrade.

To assist the highway engineers, ratings are given in table 9 to show the suitability of the soils of Adams County as sources of topsoil and of borrow material for road construction. Good topsoil favors the growth of vegetation on embankments, on cut slopes, and in ditches.

The suitability of the soil material as borrow for highway construction depends largely on the texture and natural water content of the soil. Highly plastic soils that contain a large amount of natural water are rated unsuitable because they are difficult to handle, to dry, and to compact. The Adair and Clarinda soils are of this kind. Soils that are very high in organic matter, such as the Bremer and Colo soils, are rated unsuitable because they are usually very compressible and have other characteristics undesirable in construction.

Conservation Engineering [6]

In Adams County engineering work for soil conservation consists mainly of building erosion control structures that reduce the loss of soil and of carrying out practices that increase productivity.

Erosion control structures

Terraces.—A terrace is a channel built across a slope to intercept runoff and seepage and to control erosion. Graded terraces can be used on many soils in Adams County to discharge runoff water at a nonscouring velocity. These terraces control erosion by reducing the length of the slope so that cropping, without excessive soil loss, can be more intensive than on long slopes. The slopes of terraces should average between 0.3 and 0.6 percent but can be varied within safe limits so that parallel terraces can be built. On the Sharpsburg and other deep soils there is more freedom than on shallow soils in alining terraces, for deeper cuts and higher fills can be made.

Terracing is needed on many soils in Adams County and is effective on many parts of the uplands. The Sharpsburg, Macksburg, Ladoga, and Shelby soils on slopes of less than 14 percent are generally well suited to terracing. Clearfield soils are well suited to terracing but are seepy and need tile lines as well as terraces. Many areas of the Adair, Gara, and Clinton soils and of the Adair-Shelby complex can be terraced, but some slopes are so irregular that it is difficult to lay out a terrace system. Interceptor tile drains are needed in soils upslope if Adair soils are to be terraced and cropped. Small areas of Clarinda and of Hagener soils may be included in terraces built in large areas of other soils.

Particularly in the steeper soils, infertile subsoil material may be exposed in the terrace channel. These exposed areas should be topdressed with surface material and manure.

Diversions.—A diversion is a channel constructed across slope to intercept surface water and conduct it to a safe outlet. Diversions can be used in Adams County to protect nearly level soils in bottom lands and on natural terraces from being flooded by surface runoff from higher lying soils. They can also be used to protect sloping soils that ordinarily would receive much runoff from the soils above them. The Arbor, Judson, Olmitz, Nevin, and Wiota soils commonly occur on low toeslopes or on alluvial fans. A diversion built upslope from these soils will carry away excess water and prevent excessive erosion if the soils are tilled on the contour.

If a diversion receives a great amount of water from large areas of unprotected cropland, its channel may be filled with soil material and may not function properly. Diversions should not be used in place of terraces.

Grassed waterways.—A grassed waterway is a vegetated channel that conducts runoff water at a nonerosive velocity to a stable outlet. Watercourses are erosive in almost all of the upland in Adams County, and many miles of grassed waterways are needed. Because many of the watercourses are gullied, large quantities of earth will have to be moved before the channels can be shaped properly. Grassed waterways are also needed as outlets for terraces and diversions.

In Adams County grassed waterways ordinarily can be shaped to withstand velocities of 4 to 5 feet per second. In some places grade-control structures are needed to slow the velocity to a safe rate.

Most soils in Adams County can grow enough vegetation to prevent erosion when the channels carry water at a velocity of as much as 4 to 5 feet per second. Many large waterways are in the Colo-Gravity soils, which are very fertile. Where infertile soil material has been exposed by earth moving, it may be necessary to topdress with surface material, manure, and mulch so that there will be enough vegetation to protect the waterway.

In many places waterways need to be drained by tile lines so that a desirable species of grass can be established and the waterways can be made dry enough for farm machinery to cross them.

Other structures for erosion control.—Drop inlets that control a head of 10 to 12 feet are commonly used in Adams County to stabilize many of the waterways. Many of these structures can be used in Colo-Gravity soils. Earthfills that are relatively impervious can usually be built in these soils by excavating a core trench in the highly organic surface layer and backfilling with more impervious material.

Earth dams can be built easily in Adams County because suitable borrow material is available. This material is generally the subsoil of soils derived from glacial till and has a Unified soil classification of CL or CH. Such material compacts to a high density and makes good fills for structures that support low heads. The stability of slopes is a problem on high fills, and toe drainage and other measures are needed.

Each erosion control structure presents difficult problems. Technical assistance should be obtained before major structures are planned. Such assistance is avail-

[6] This subsection was written by DEWEY T. BONDURANT, agricultural engineer, Soil Conservation Service.

able through the Soil Conservation District of the county.

Farm ponds.—By making water available to livestock in all parts of a farm, ponds help in controlling erosion because more land can be used for rotation grazing.

In many parts of Adams County wells go dry during extended periods of low rainfall. Farm ponds furnish supplemental water to livestock during these periods. The ponds can be established in most places in the county. They are usually constructed in the rolling soils that were derived from till or in soils derived from alluvium and colluvium. Watertight ponds can be constructed in most places if a core trench is excavated through the highly organic topsoil and is backfilled with more impervious material. A stratum or pocket of sand occurs occasionally in glacial material of pond sites. Because these coarser materials present special problems, each site should be investigated thoroughly. Technical assistance is available through the local Soil Conservation District.

Water from erosion control structures can be used to supply ponds.

Practices that increase soil productivity

Drainage.—Many soils of Adams County require artificial drainage for maximum production. Both tile lines and open ditches are used. If outlets are available, tile drainage is preferred in most areas that are moderately to moderately slowly permeable. Open ditches are used in soils not suited to tile or in places where an outlet for the tile would be expensive.

Tile can be used successfully to drain the Clearfield, Colo, Gravity, Winterset, and Bremer soils. Ordinarily, these soils can be drained very well by tile lines that are laid 80 to 90 feet apart and at a depth of 3½ to 4 feet. The outlets for tile in the Winterset and Bremer soils may be difficult to obtain because they may be far from the area drained or may be at an excessive depth.

The Gravity, Macksburg, and Nevin soils are imperfectly drained and may need tile drainage in some areas. Many areas of Macksburg soils are crossed by small waterways that generally should be tiled. The Gravity, Nevin, and Judson soils are on the lower parts of foot slopes and may receive seepage from the higher lying soils. By placing interceptor tile at the upper boundary of the Gravity, Nevin, and Judson soils, this seepage can be reduced.

Interceptor tile can also reduce wetness in the Clarinda, Adair, and the Adair-Shelby soils. Because their subsoil is slowly permeable, tile placed directly in these soils will not work. The tile, however, will intercept the seepage if the lines are placed immediately upslope at the junction of the till or gumbotil and the overlying loess. The interceptor lines are laid at a depth of 3½ to 4½ feet. This practice is common in Adams County because small seepy areas on hillsides may prevent farmers from cultivating an entire field at one time.

Tile drainage is difficult in the Sperry and Chariton soils because their subsoil is slowly to very slowly permeable. The tile lines should be laid 50 to 70 feet apart in these soils but, even at that spacing, they may not be satisfactory. Surface water can be removed from Sperry soils, which are in small depressions in the uplands, by shallow surface ditches. The Wabash soils generally occur with Chariton soils and occupy large areas of bottom land. They are best drained by collector ditches spaced 600 to 1000 feet apart. If Wabash soils are planted to row crops, each row should drain to these collection ditches. A bedding system or land grading may be necessary to obtain such row drainage.

Colo soils and other soils on bottom lands also can be drained by open ditches, particularly in areas where they are associated with the Wabash soils and tile drainage is impractical.

Detailed information concerning drainage suggestions for the soils of the county can be obtained from "Iowa Drainage Guide," published by the Iowa State University (*5*). This report was prepared jointly by the Soil Conservation Service, the Iowa Agricultural Experiment Station, and the Iowa Agricultural Extension Service.

Irrigation.—The opportunity for irrigated farming is limited in Adams County because the supply of water is inadequate. The flow of streams is small, adequate wells are not available, and reservoirs are usually impractical. Reservoirs would be expensive to build and because of high rates of sedimentation, they would be difficult to maintain.

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Glossary

Acidity. (See Reaction.)

Alluvium. Sand, silt, clay, or other soil materials moved from one place to another by water.

Alluvium, local. Soil material that has been moved a short distance and deposited at the base of slopes and along small drainageways. It includes the poorly sorted material near the base of slopes that has been moved by gravity, frost action, soil creep, and local wash.

Bench position. A high, shelflike position.

Bottom land. The normal flood plain of a stream and the old alluvial plain that is seldom flooded. (See Bottoms, first, and Bottoms, second.)

Bottoms, first. The normal flood plain of a stream; land along the stream subject to overflow.

Bottoms, second. An old alluvial plain, usually flat or smooth, that borders a stream but is seldom flooded.

Clay. (See Texture.)

Color, soil. Soil colors are described in the section, "Technical Descriptions of Soils," by such terms as grayish brown or reddish brown, used with the corresponding symbols of a modified Munsell color chart. In this chart, colors are arranged by hue, value, and chroma. *Hue* is the dominant spectral (rainbow) color. *Value* is the relative lightness or darkness of color. *Chroma* is the strength, saturation, or intensity of color. In technical descriptions of a soil, neither a color name nor symbol is adequate when used alone. Both must be used together to ensure a definite understanding of color; for example, dark yellowish brown (10YR 4/4). In this example the 10YR designates the hue, the first 4 the value, and the second 4 the chroma.

Consistence. The combined properties of soil material that cause the aggregates to hold together or fall apart, or to resist deformation. Some of the terms commonly used to describe consistence are:

Loose.—When moist or dry, noncoherent.

Friable.—When moist, soil material crushes easily under moderate pressure between the thumb and forefinger and coheres when pressed together.

Firm.—When moist, soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly felt.

Very firm. When moist, soil material crushes under strong pressure; barely crushable between thumb and forefinger.

Hard.—When dry, soil material is moderately resistant to pressure; can be broken in the hands but is barely breakable between thumb and forefinger.

Extremely hard.—Soil material is extremely resistant to pressure; cannot be broken by hand.

Slightly sticky.—When wet, soil material adheres to both thumb and forefinger after pressure is applied but comes off one or the other cleanly.

Sticky.—When wet, soil material adheres to both thumb and forefinger after pressure is applied and tends to stretch somewhat and pull apart rather than pulling free from either digit.

Plastic.—When wet, soil material is wire formable and can be deformed under moderate pressure.

Contour tillage. Cultivation that follows the contour of the land, generally almost at right angles to the slope.

Erosion, soil. The wearing away or removal of soil by water or wind.

Firm. (See Consistence.)

Flood plain. The nearly flat lands along streams that overflow during floods.

Friable. (See Consistence.)

Genesis, soil. The origin or development of soil from the parent material.

Great soil group. Any one of several broad groups of soil having fundamental characteristics in common. The great soil groups in Adams County are Brunizem, Gray-Brown Podzolic, Humic Gley, Planosol, and Alluvial.

Hard. (See Consistence.)

Horizon, soil. A layer of soil, approximately parallel to the soil surface, with distinct characteristics produced by soil-forming processes.

Horizon A.—The upper horizon of the soil mass from which material has been removed by percolating waters; the eluviated part of the solum; the surface soil. This horizon is generally divided into two or more subhorizons, of which A_0 is not a part of the mineral soil but is the accumulation of organic debris on the surface. Other subhorizons are designated as A_1, A_2, and so on.

Horizon B.—The horizon to which materials have been added by percolating water; the illuviated part of the solum; the subsoil. This horizon also may be divided into several subhorizons according to the color, structure, consistence, and character of the material deposited. These subhorizons are designated as B_1, B_2, B_3, and so on.

Horizon C.—The horizon of partly weathered material underlying the B horizon; the substratum; generally the parent material.

Horizon D.—Any substratum underneath the soil, such as hard rock or layers of clay and sand, that is not parent material but which may have significance to the overlying soil.

Leaching, soil. The removal of materials in solution by the passage of water through soil.

Loose. (See Consistence.)

Morphology, soil. The constitution of the soil, including the texture, structure, consistence, color, and other physical, chemical, and biological properties of the various soil horizons that make up the soil profile.

Mottles. Streaks or spots of color in soil caused by accumulations of lime, organic matter, colloids, iron compounds, or by some soil-forming process. Generally, gray or brown mottles indicate impeded drainage, but mottles of other colors may not be related to drainage. Mottles are described by noting contrast, abundance, and size. *Contrast* is described by the terms faint, distinct, and prominent; *abundance* by few, common, and many; *size* by fine, medium, and coarse.

Paleosol. An antiquated soil that was formed during the geologic past and was buried and preserved by more recent sedimentation. This kind of buried soil is often re-exposed on the modern surface by subsequent erosion. It then occurs within the continuum of soils on the modern surface and is called an *Exhumed paleosol.*

Parent material. The weathered rock or partly weathered soil material from which the soil was formed. Horizon C of a soil profile.

Percolation. The downward movement of water through soil.

Permeability, soil. The quality of a soil that enables water or air to move through it. Permeability can be measured in terms of rate of flow of water through a unit cross section in unit time. The permeability of a soil may be reduced by a nearly impermeable horizon even though the other horizons are permeable. Classes of soil permeability and their possible rates of flow are as follows:

Class	*Inches per hour*
Very slow	Less than 0.05
Slow	0.05 to 0.20
Moderately slow	0.20 to 0.80
Moderate	0.80 to 2.50
Moderately rapid	2.50 to 5.00
Rapid	5.00 to 10.00
Very rapid	More than 10.00

Plastic. (See Consistence.)

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction. The degree of acidity or alkalinity of the soil mass, expressed in pH values or in words as follows:

Words	*pH*
Extremely acid	Below 4. 5
Very strongly acid	4. 5–5. 0
Strongly acid	5. 1–5. 5
Medium acid	5. 6–6. 0
Slightly acid	6. 1–6. 5
Neutral	6. 6–7. 3
Mildly alkaline	7. 4–7. 8
Moderately alkaline	7. 9–8. 4
Strongly alkaline	8. 5–9. 0
Very strongly alkaline	9. 1 and higher.

Relief. Elevations or inequalities of the surface of the land considered collectively.

Sand. (See Texture.)

Series, soil. A group of soils that developed from the same kind of parent material and, except for the surface layer, have soil horizons similar in characteristics and in arrangement in the profile.

Silt. (See Texture.)

Soil. The natural medium for the growth of land plants. A dynamic natural body on the surface of the earth composed of mineral and organic materials and living forms.

Solum, soil. The part of a soil profile, above the parent material, in which the soil has been or is being formed. The solum in mature soils includes the A and B horizons.

Sticky. (See Consistence.)

Structure, soil. The way in which individual particles of soil are arranged in aggregates or clumps. Soil structure is classified according to grade, class, and type.

Grade.—Distinctness of soil aggregates. Terms: *Structureless* (single grain or massive), *weak, moderate,* and *strong.*

Class.—Size of soil aggregates. Terms: *Very fine* or *very thin, fine* or *thin, medium, coarse* or *thick,* and *very coarse* or *very thick.*

Type.—Shape of soil aggregates. Terms: *Platy, prismatic, columnar, blocky, subangular blocky, granular,* and *crumb.*

Subsoil. That part of the profile below plow depth.

Substratum. Material underlying the subsoil or the solum.

Surface soil. That part of the upper profile usually stirred by plowing; about 5 to 8 inches thick.

Terrace (structural). An embankment or ridge of earth constructed across a slope to control water runoff and prevent erosion.

Texture, soil. The relative proportions of the size groups (sand, silt, and clay) of individual soil particles in a mass of soil. The size groups are defined as follows:

Sand.—Small rock or mineral fragments ranging from 0.05 millimeter (0.002 inch) to 2.0 millimeters (0.079 inch) in diameter.

Silt.—Small mineral soil grains ranging from 0.002 millimeter (0.000079 inch) to 0.05 millimeter (0.002 inch) in diameter.

Clay.—Small mineral soil grains less than 0.002 millimeter (0.000079 inch) in diameter.

As textural classes *sand* is soil material that contains 85 percent or more of sand and not more than 15 percent of silt and clay; *silt* is soil material that contains 80 percent or more of silt and less than 12 percent of clay; and *clay* is soil material that contains 40 percent or more of clay, less than 45 percent of sand, and less than 40 percent of silt. Some of the other textural classes are loamy sand, sandy loam, loam, silt loam, clay loam, sandy clay, and silty clay.

Tilth, soil. The physical condition of a soil in respect to its fitness for the growth of a specified plant or sequence of plants. Ideal soil tilth is not the same for each kind of crop, nor is it uniform for the same kind of crop growing on different kinds of soil.

Type, soil. A group of soils that developed from the same kind of parent material and that have soil horizons, including the surface horizon, similar in characteristics and in arrangement in the profile; a subdivision of the soil series.

Upland. Land above the lowlands along rivers or between hills.

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