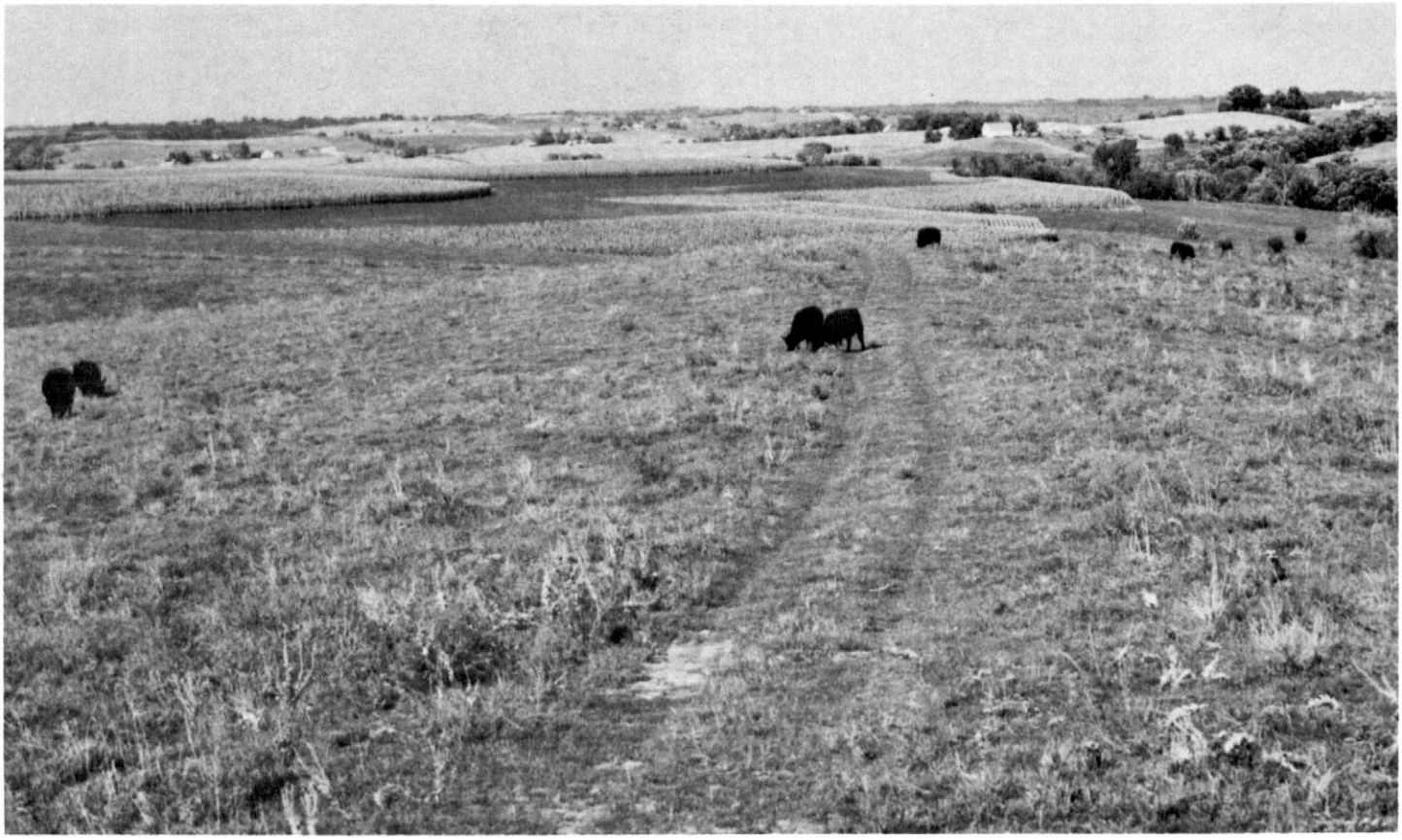
SOIL SURVEY OF

Warren County, Iowa



United States Department of Agriculture
Soil Conservation Service
In cooperation with
Iowa Agriculture and Home Economics Experiment Station and
Cooperative Extension Service, Iowa State University, and the
Department of Soil Conservation, State of Iowa

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

Major fieldwork for this soil survey was completed in the period 1968–72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service, the Iowa Agriculture and Home Economics Experiment Station and Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Warren County Soil Conservation District. Funds appropriated by Warren County were used to defray part of the cost of this survey.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and the environmental planting groups.

Foresters and others can refer to the section "Environmental plantings," where the soils of the county are grouped according to their suitability for growing trees and shrubs.

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and for recreation areas in the sections "Town and country planning" and "Recreation."

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

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

Newcomers in Warren County may be especially interested in the section "General soil map," where broad patterns of soils are described.

Cover: Typical landscape in Warren County. Beef cattle are grazing permanent pasture in foreground, and cultivated crops are in background. The soils are in the Sharpsburg-Lamoni association.

Contents

Issued August 1978

Index to mapping units

Summary of tables

SOIL SURVEY OF WARREN COUNTY, IOWA

BY ARTHUR A. BRYANT AND JOHN R. WORSTER, SOIL CONSERVATION SERVICE

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY, AND THE DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

WARREN COUNTY is in the south central part of Iowa (fig. 1). It has a total land area of about 365,980 acres. Indianola, the county seat and largest town, is about 17 miles south of Des Moines, the State capital.

The population of the county is largely urban and suburban. The close proximity to Des Moines has encouraged housing developments and suburban expansion in nearly all towns in the northern half of the county.

Most of the acreage in the county is in farms. Most farming is diversified, although cash grain enterprises are dominant in some areas and beef herds are dominant in others. The type of farm enterprise is controlled by the soil pattern. Most of the farm acreage is in cultivated crops or pasture. Corn, soybeans, hay, oats, and pasture are the principal crops, and corn is the leading cultivated crop. Most of the grain and forage that is grown on the farms is fed to hogs and beef cattle that are raised in the county.

About 50 percent of the soils in Warren County formed under prairie vegetation. The others formed under timber vegetation or a combination of prairie and timber vegetation. The climate is subhumid and continental. Winters are cold, and summers are warm. The growing season is long enough for the crops grown in the county to mature.

[1] WILLIAM BOYD, WALTER EPLEY, J. HERBERT HUDDLESTON, HARVEY LUCE, MAURICE MAUSBACH, HARLAN MCKIM, and DAVID MORRIS also helped with the field mapping.

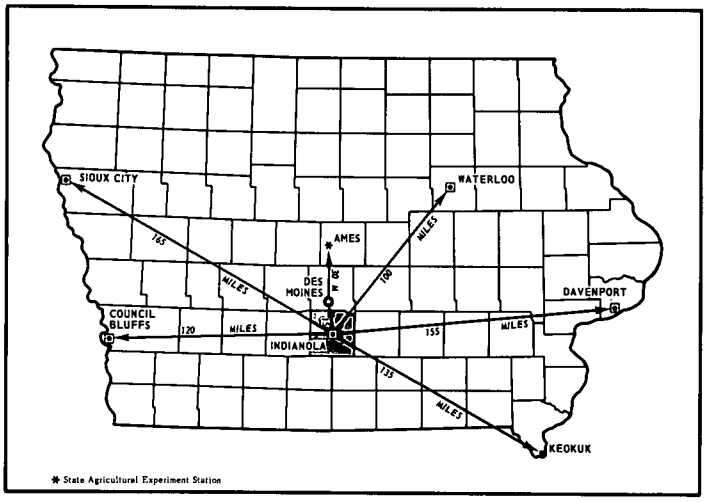

Figure 1.—Location of Warren County in Iowa.

How this survey was made

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

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

Soils that have profiles 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. Shelby and Winterset, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis

of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Sharpsburg silty clay loam, 2 to 5 percent slopes, is one of several phases within the Sharpsburg series.

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

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

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

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Adair-Shelby clay loams, 9 to 14 percent slopes, moderately eroded, is an example.

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

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

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

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

General soil map

The general soil map at the back of this survey shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments, and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Soil associations and delineations on the general soil map in this soil survey do not always agree fully with general soil maps of adjacent counties published at a different date. Differences are brought about by better knowledge of soils and modifications or refinements in soil series concepts. In addition, the uses of the general soil map have expanded in recent years, thus requiring a more precise and detailed map to accommodate the need. Still another difference is caused by the range in slope of the soils within an association.

The soil associations in this survey area are described on the pages that follow.

1. Tama association

Nearly level to strongly sloping, well drained soils that formed in loess on uplands and on high stream benches

This association consists mostly of gently sloping and moderately sloping soils that formed in loess on convex ridgetops and strongly sloping soils that formed in loess on side slopes (fig. 2). Gently sloping and moderately sloping, loess-covered stream benches make up about 15 percent of this association. Areas of this association border the south side of the Des Moines River.

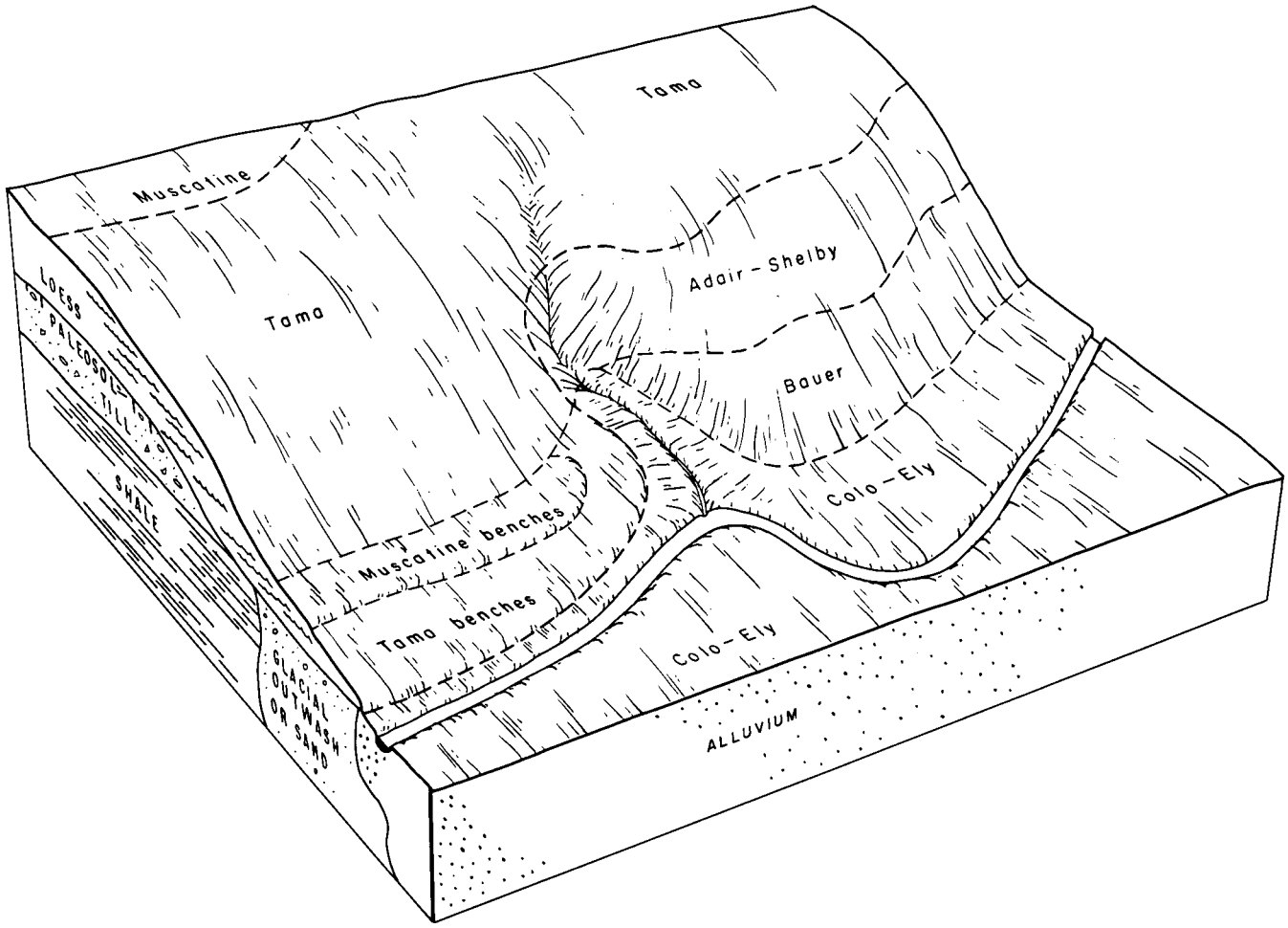

Figure 2.—**Relationship of slope and parent material to soils of the Tama association.**

This association makes up about 3 percent of the county. It is about 80 percent Tama soils, 7 percent Muscatine soils, and 13 percent Adair, Shelby, Bauer, Colo, and Ely soils.

Tama soils are on convex ridgetops, side slopes, and benches. These soils are nearly level to strongly sloping and are well drained. Typically, the surface layer is very dark brown silty clay loam about 13 inches thick. The subsoil is dark brown and dark yellowish brown silty clay loam.

Muscatine soils are on broad ridgetops and benches. These soils are nearly level and are somewhat poorly drained. The surface layer is thicker than in Tama soils. The subsoil is very dark grayish brown and dark grayish brown silty clay loam.

Adair and Shelby soils are strongly sloping to steep. They are on side slopes of glacial till. Bauer soils are strongly sloping to steep. They are on side slopes of residual shale. Colo and Ely soils are gently sloping. They are in waterways and on small stream bottoms.

The soils of this association are well suited to cultivated crops and are among the most productive soils in the county (fig. 3). Corn and soybeans can be grown intensively on the nearly level and gently sloping soils. Some steeper areas are used for hay and pasture. Farms are mostly diversified; but some are cash grain and some are livestock farms.

The main concern of management is controlling water erosion. Available water capacity is mainly high.

2. Downs-Fayette association

Nearly level to steep, well drained soils that formed in loess on uplands and on high stream benches

This association consists mostly of gently sloping and moderately sloping soils that formed in loess on convex ridgetops and strongly sloping to steep soils that formed in loess on side slopes (fig. 4). Gently sloping and moderately sloping, loess-covered stream benches make up only 2 percent of this association. Areas of this association border the south side of the Des Moines River and the sides of the South and Middle Rivers where they enter the Des Moines River flood plain.

This association makes up about 4 percent of the county. It is about 45 percent Downs soils, 25 percent Fayette soils, and 30 percent soils of minor extent.

Downs soils are nearly level to moderately steep. They are on convex ridgetops, side slopes, and benches

Figure 3.—**Typical landscape in an area of Tama association. The soils formed in loess, and the side slopes are intensively cultivated.**

and are well drained. The surface layer is very dark brown silt loam about 7 inches thick, and the subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is brown to yellowish brown silty clay loam.

Fayette soils are gently sloping to steep. They are on convex ridgetops and side slopes and are well drained. They have a surface layer of very dark gray silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 7 inches thick. The subsoil is brown silt loam and dark yellowish brown and yellowish brown silty clay loam.

Of minor extent in this association are Gara, Gosport, Lindley, Colo, and Ely soils and Steep rock land. Gara and Lindley soils are strongly sloping to very steep and are on glacial till side slopes. Gara soils are associated with Downs soils, and Lindley soils are associated with Fayette soils. Gosport soils are strongly sloping to very steep and are on mainly shale side slopes bordering major streams, but some sandstone crops out at the surface. Colo and Ely soils are in valleys.

The soils of this association are better suited to hay, pasture, and woodland than to most other uses. Many areas are in woodland. Most of the nearly level to moderately sloping soils are used for cultivated crops. Farms are diversified.

The main concerns in management are controlling water erosion and maintaining tilth. Content of organic matter is moderate to very low, and puddling and crusting of the surface is of concern in maintaining tilth. Available water capacity is high in most soils of this association.

3. Macksburg-Sharpsburg-Winterset association

Nearly level to moderately sloping, moderately well drained to poorly drained soils that formed in loess on summits of uplands and on high stream benches

This association consists mostly of nearly level soils on stable ridge summits (fig. 5) and gently sloping and moderately sloping soils on ridge shoulders and at the heads of drainageways. Nearly level to moderately sloping soils on high stream benches make up 3 percent of this association.

This association makes up about 9 percent of the county. It is about 40 percent Macksburg soils, 25 percent Sharpsburg soils, 12 percent Winterset soils, and 23 percent soils of minor extent.

Macksburg soils are nearly level to gently sloping and are somewhat poorly drained. They have a thick surface layer of black and very dark brown silty clay loam and a subsoil of very dark grayish brown to olive gray, mottled silty clay loam.

Sharpsburg soils are nearly level to moderately slop-

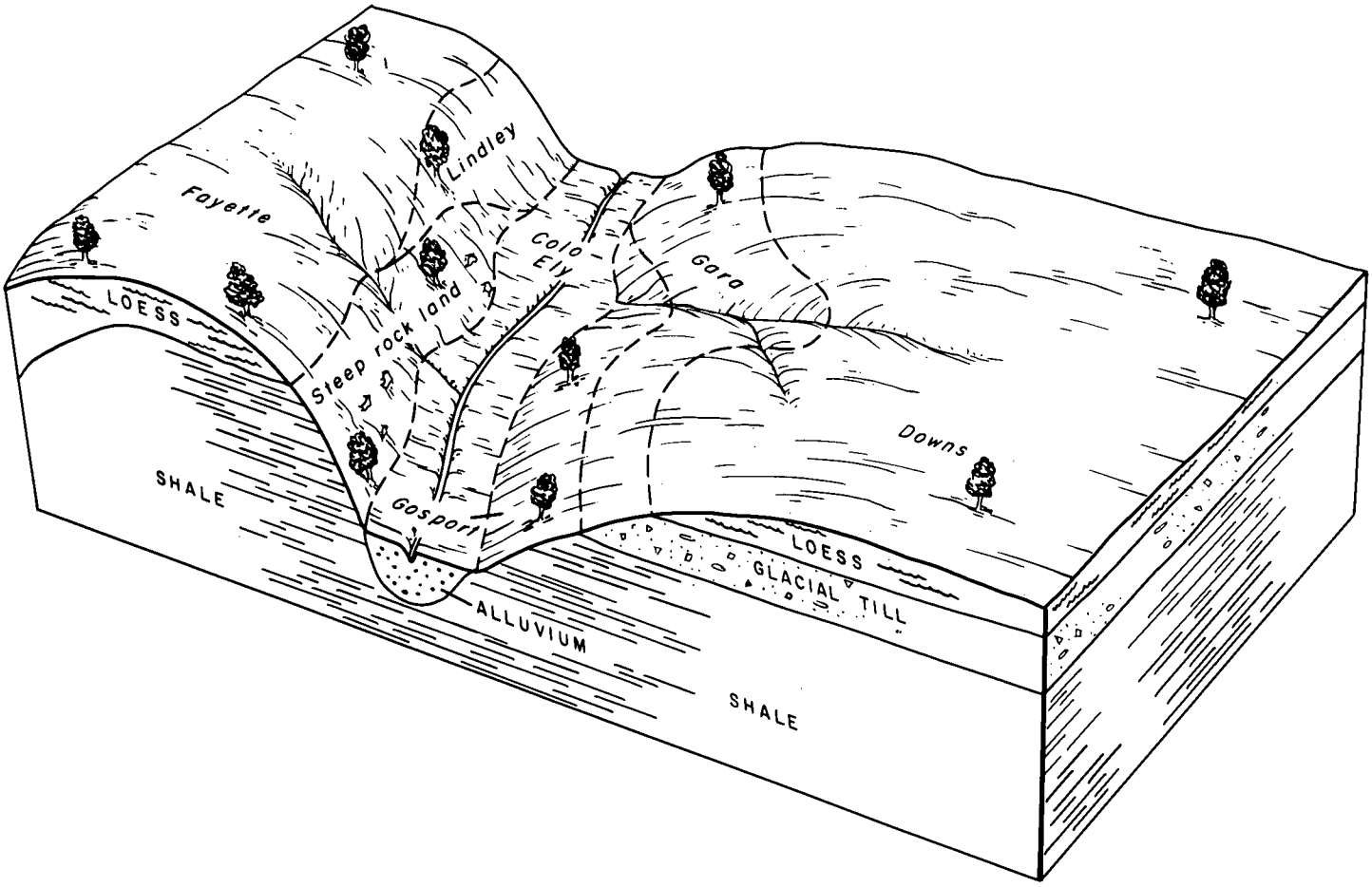

Figure 4.—**Relationship of slope and parent material to soils of the Downs-Fayette association.**

ing and are moderately well drained. They have a surface layer of very dark brown and very dark grayish brown silty clay loam about 16 inches thick and a subsoil of brown to yellowish brown silty clay loam.

Winterset soils occupy the most nearly level areas of this association and are poorly drained. They have a surface layer of black silty clay loam that is thicker than the surface layer of other soils in this association. The subsoil is mottled very dark gray, dark gray, gray, and olive gray silty clay loam.

Soils of minor extent in this association are Clarinda, Clearfield, Nira, and Sperry soils. The poorly drained, moderately sloping Clarinda soils formed in gray clayey glacial till and occupy the lower part of the heads of drainageways. The poorly drained to somewhat poorly drained Clearfield soils and the moderately well drained Nira soils are gently sloping and moderately sloping. They occupy the upper part of the heads of drainageways and are above the Clarinda soils. Sperry soils are in depressional areas on the ridge summits and are poorly drained to very poorly drained.

The soils of this association are well suited to crops and are among the most productive soils in the county. Corn and soybeans are grown nearly continuously on the nearly level and gently sloping soils. Cash grain farming is a major enterprise.

The main concerns in management are control of water erosion and improvement of drainage. Available water capacity is high in most soils of this association.

4. Sharpsburg-Lamoni association

Gently sloping to strongly sloping, moderately well drained and somewhat poorly drained soils that formed in loess and glacial till

This association consists mostly of gently sloping to strongly sloping, loess-covered ridgetops and side slopes (fig. 6). Nearly level to moderately sloping loess-covered high stream benches make up about 5 percent of this association.

This association makes up about 16 percent of the county. It is about 52 percent Sharpsburg soils, 18 percent Lamoni soils, and 30 percent soils of minor extent.

Sharpsburg soils are gently sloping to strongly sloping and are on convex ridgetops and the upper part of side slopes. They are moderately well drained. They have a surface layer of very dark brown and very dark grayish brown silty clay loam about 16 inches thick and a subsoil of brown to yellowish brown silty clay loam.

Lamoni soils are strongly sloping and are in coves

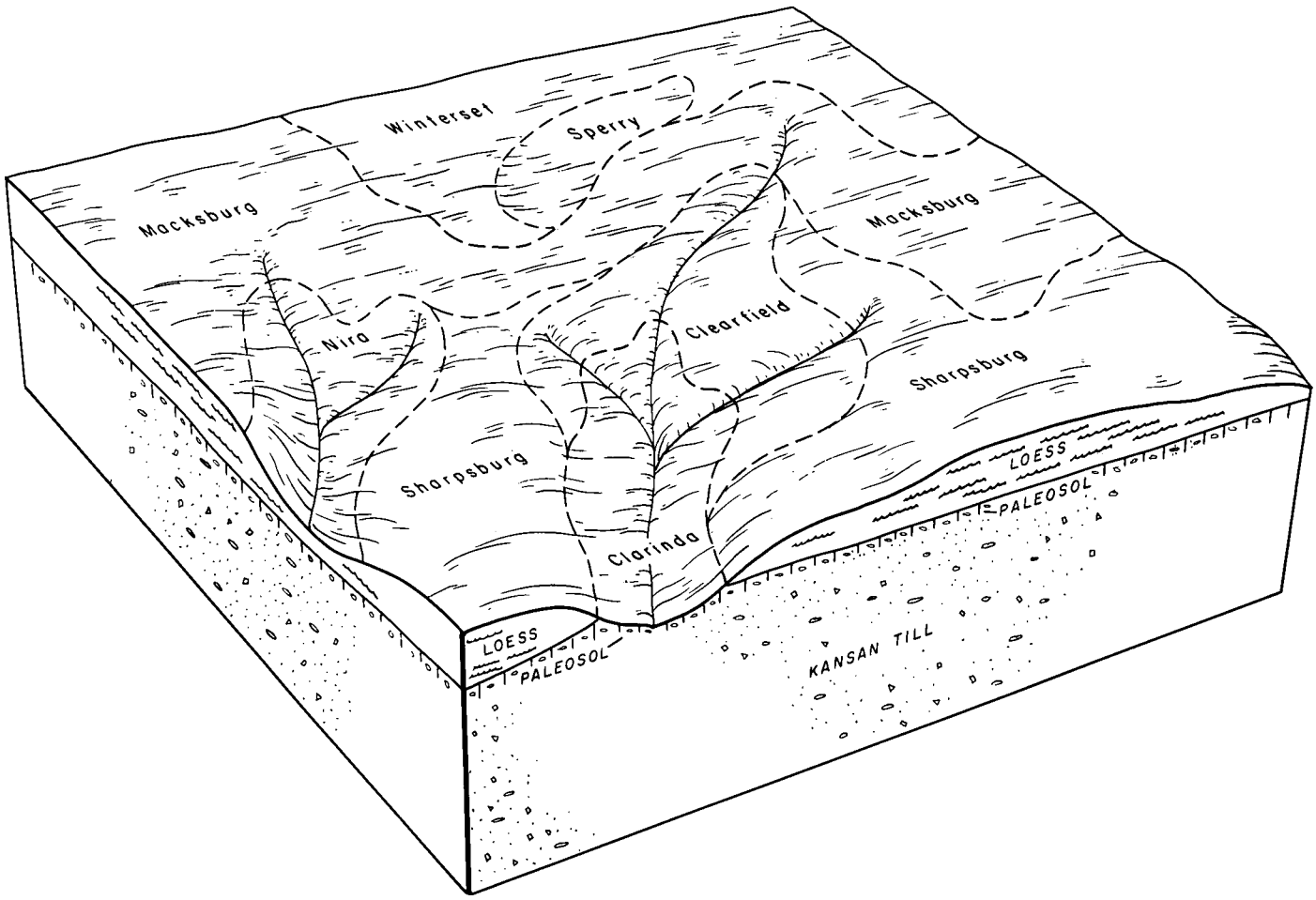

Figure 5.—**Relationship of slope and parent material to soils of the Macksburg-Sharpsburg-Winterset association.**

and on convex side slopes at the upper end of drainageways. They are somewhat poorly drained. They have a surface layer of black silty clay loam about 11 inches thick and a subsoil of very dark gray to yellowish brown and olive gray clay loam and clay.

The soils of minor extent in this association are Adair, Bauer, Colo, Ely, Macksburg, and Shelby soils. Adair and Shelby soils are strongly sloping to steep and are on glacial till side slopes. Bauer soils are strongly sloping to moderately steep and are on shale side slopes. Colo and Ely soils are nearly level or gently sloping and are on waterways and small stream bottoms. Macksburg soils are nearly level to gently sloping and are on stable ridgetops.

The gently sloping and moderately sloping soils of this association are well suited to cultivated crops, but the strongly sloping and moderately steep soils are better suited to hay and pasture. Farming ranges from cash grain to livestock, and most farms are diversified.

The main concern in management is controlling erosion. Available water capacity is high in most soils of this association.

5. Ladoga-Gara-Armstrong association

Nearly level to very steep, well drained to somewhat poorly drained soils that formed in loess and glacial till

This association consists mostly of nearly level to strongly sloping soils on loess-covered ridgetops and side slopes and strongly sloping to very steep soils that formed in glacial till (fig. 7). Nearly level to moderately sloping soils on high loess-covered stream benches make up 3 percent of this association, and moderately sloping to moderately steep soils that formed in old alluvium derived from glacial material make up about 6 percent.

This association makes up about 36 percent of the county. It is about 25 percent Ladoga soils, 15 percent Gara soils, 5 percent Armstrong soils, and 55 percent soils of minor extent.

Ladoga soils are nearly level to strongly sloping and formed in loess. They are moderately well drained. They have a surface layer of very dark grayish brown silt loam about 9 inches thick. In places they have a dark grayish brown silt loam subsurface layer. The subsoil is brown silty clay loam.

Gara soils are strongly sloping to very steep and formed in glacial till. They are moderately well drained to well drained. They have a surface layer of very dark gray loam about 8 inches thick. The subsurface

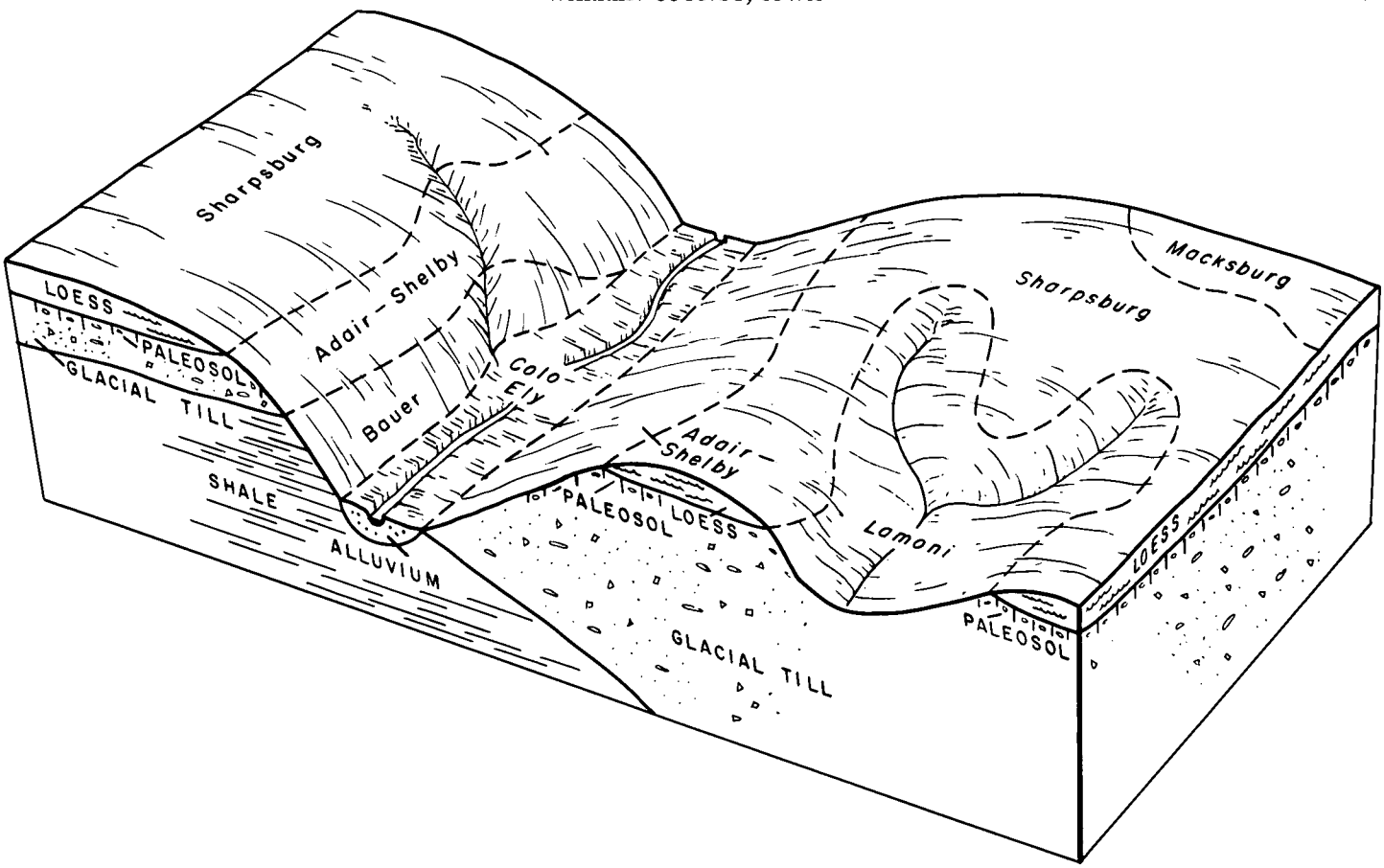

Figure 6.—**Relationship of slope and parent material to soils of the Sharpsburg-Lamoni association.**

layer is dark grayish brown loam about 6 inches thick. The subsoil is brown and yellowish brown clay loam.

Armstrong soils are strongly sloping to moderately steep and formed in weathered, reddish glacial till. They are moderately well drained to somewhat poorly drained. The surface layer is very dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is brown, dark yellowish brown, and yellowish brown clay and clay loam.

Soils of minor extent in this association are Clinton, Colo, Ely, Gosport, Lindley, Keswick, Mystic, and Caleb soils.

Clinton soils are moderately well drained. They are gently sloping to moderately steep, and they formed in loess under timber. Colo and Ely soils are in gently sloping waterways and small stream bottoms. Gosport soils are strongly sloping to very steep and are on shale side slopes. Lindley and Keswick soils are strongly sloping to very steep and are on glacial till side slopes. They formed under timber. Mystic and Caleb soils formed in old alluvium derived from glacial material. They are moderately sloping to moderately steep and they are on side slopes and scarps of stream terraces and on uplands that grade to stream bottoms.

The nearly level to moderately sloping soils of this association are suited to row crops. The steeper soils are better suited to hay, pasture, and woodland, and the steep and very steep soils are better suited to pasture, and woodland. Much of this association is used for hay, pasture, and woodland (fig. 8). Farms are diversified, and beef herds are common.

The main concerns in management are controlling erosion and maintaining fertility. Gullies are common in the association, and they hamper the use of large farm machinery. Content of organic matter is moderate to low, and puddling and crusting of the surface is a concern in maintaining tilth. Available water capacity is high in most soils of this association.

6. Grundy-Arispe-Winterset association

Nearly level to moderately sloping, moderately well drained to poorly drained soils that formed in loess on upland divides, ridgetops, and high stream benches

This association consists mostly of nearly level and gently sloping soils on stable ridge summits (fig. 9). Gently sloping and moderately sloping soils on high stream benches make up less than 1 percent of this association. Moderately sloping soils are on ridgetops and sides of less stable ridges.

This association makes up about 7 percent of the county. It is about 30 percent Grundy soils, 30 percent Arispe soils, 20 percent Winterset soils, and 20 percent soils of minor extent.

Grundy soils are gently sloping and are somewhat poorly drained. They have a surface layer of very

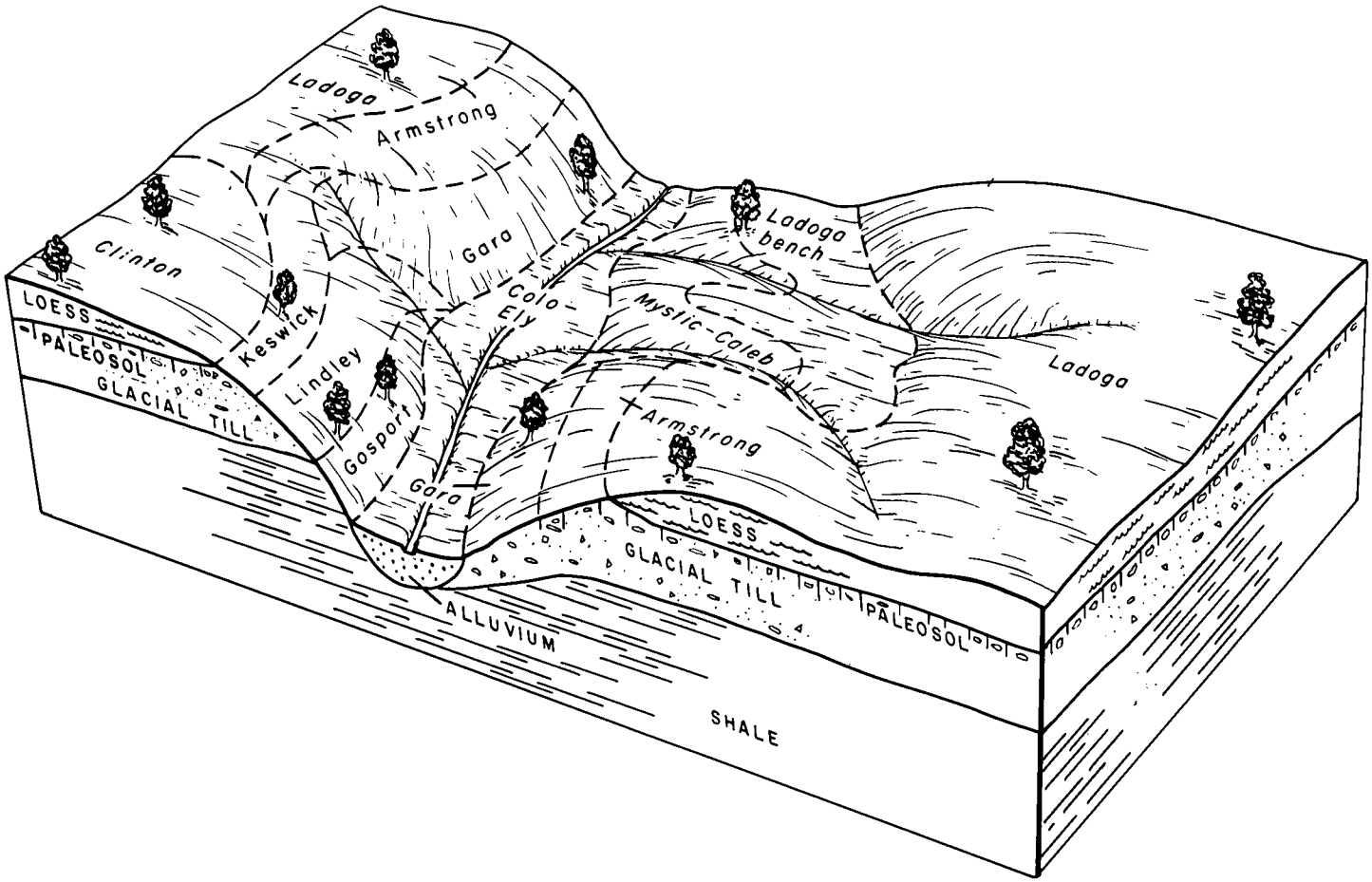

Figure 7.—**Relationship of slope and parent material to soils of the Ladoga-Gara-Armstrong association.**

dark brown and very dark grayish brown silty clay loam about 13 inches thick and a subsoil of brown, very dark grayish brown, dark grayish brown, and grayish brown silty clay loam.

Arispe soils are moderately sloping and are moderately well drained to somewhat poorly drained. They have a surface layer of very dark gray silty clay loam about 10 inches thick. The subsoil is brown to grayish brown silty clay loam.

Winterset soils are nearly level and are poorly drained. In this association, they have a black surface layer about 15 inches thick, which is a little thinner than is typical for Winterset soils in other parts of the county. They also have less clay in the surface layer and more clay in the subsoil. The subsoil is very dark gray to olive gray heavy silty clay loam.

The soils of minor extent in this association are Adair, Shelby, Bauer, Colo, Ely, and Lamoni soils. Adair soils formed in reddish clayey glacial till. Shelby soils formed in glacial till. Bauer soils are well drained to moderately well drained, and they formed in residual shale on the lower part of side slopes. Lamoni soils are somewhat poorly drained, and they formed in gray, weathered glacial till. Colo and Ely soils are in valleys.

The soils of this association are used for row crops, hay, and pasture. The nearly level soils are cropped intensively, and cash grain farming is a major enterprise (fig. 10).

The main concerns in management are controlling erosion and improving drainage. Available water capacity is high in most of these soils.

7. Gara-Gosport-Pershing association

Gently sloping to very steep, well drained to somewhat poorly drained soils that formed in shale residuum, glacial till, and loess

This association consists mostly of strongly sloping to very steep soils that formed in shale and glacial till on upland side slopes and gently sloping to strongly sloping soils on loess-covered ridgetops. Gently sloping and moderately sloping soils on loess-covered high stream benches make up less than 1 percent of this association.

This soil association makes up about 10 percent of the county. It is about 25 percent Gara soils, 25 percent Gosport soils, 13 percent Pershing soils, and 37 percent soils of minor extent.

Gara soils are strongly sloping to very steep and are on convex side slopes. They are moderately well drained to well drained. The surface layer is very dark gray loam about 8 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The subsoil is brown and yellowish brown clay loam.

Figure 8.—**Typical landscape in an area of Ladoga-Gara-Armstrong association. The landform is rough, and trees are in a large part of the areas.**

Gosport soils are strongly sloping to very steep soils and are on convex side slopes. They are moderately well drained. The surface layer is very dark gray heavy silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The subsoil is yellowish brown, light olive brown, and olive brown silty clay shale that has thin strata of siltstone or sandstone.

Pershing soils are gently sloping to strongly sloping and are on convex ridgetops and side slopes. They are moderately well drained to somewhat poorly drained. The surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is very dark grayish brown silt loam about 6 inches thick. The subsoil is dark grayish brown, grayish brown, and olive gray silty clay loam and a thin layer of silty clay.

The soils of minor extent in this association are Armstrong, Colo, Ely, Grundy, Keswick, Lindley, and Weller soils. Armstrong soils are moderately well drained to somewhat poorly drained soils that formed in reddish clayey glacial till. Colo and Ely soils are poorly drained and somewhat poorly drained and are in small upland waterways and stream bottoms. Grundy soils are similar to Pershing soils, but have a thicker surface layer and do not have a subsurface layer. Keswick soils are similar to Armstrong soils but have a thinner surface layer. Lindley soils are similar to Gara soils, but have a thinner surface layer. Weller soils are similar to Pershing soils, but have a thinner surface layer.

The soils of this association are used mostly for hay, pasture, and woodland (fig. 11). Row crops are grown on the less sloping soils. Farms are diversified, and beef herds are one of the major enterprises.

The main concern in management is controlling erosion. Content of organic matter is moderate to low, and puddling and crusting of the surface is a concern in maintaining tilth. Available water capacity is low to moderate in Gosport soils and moderate or high in the other soils of this association.

8. Zook-Wabash-Nodaway association

Nearly level, very poorly drained to moderately well drained soils that formed in alluvium on first bottoms of major streams

This association consists mostly of nearly level, poorly drained and very poorly drained soils on first and second bottoms of major streams. Nearly level, moderately well drained and somewhat poorly drained soils make up 33 percent of the association. Gently sloping, moderately well drained and somewhat poorly drained soils make up only 2 percent.

This association makes up about 15 percent of the county. It is about 33 percent Zook soils, 10 percent Wabash soils, 10 percent Nodaway soils, and 47 percent soils of minor extent.

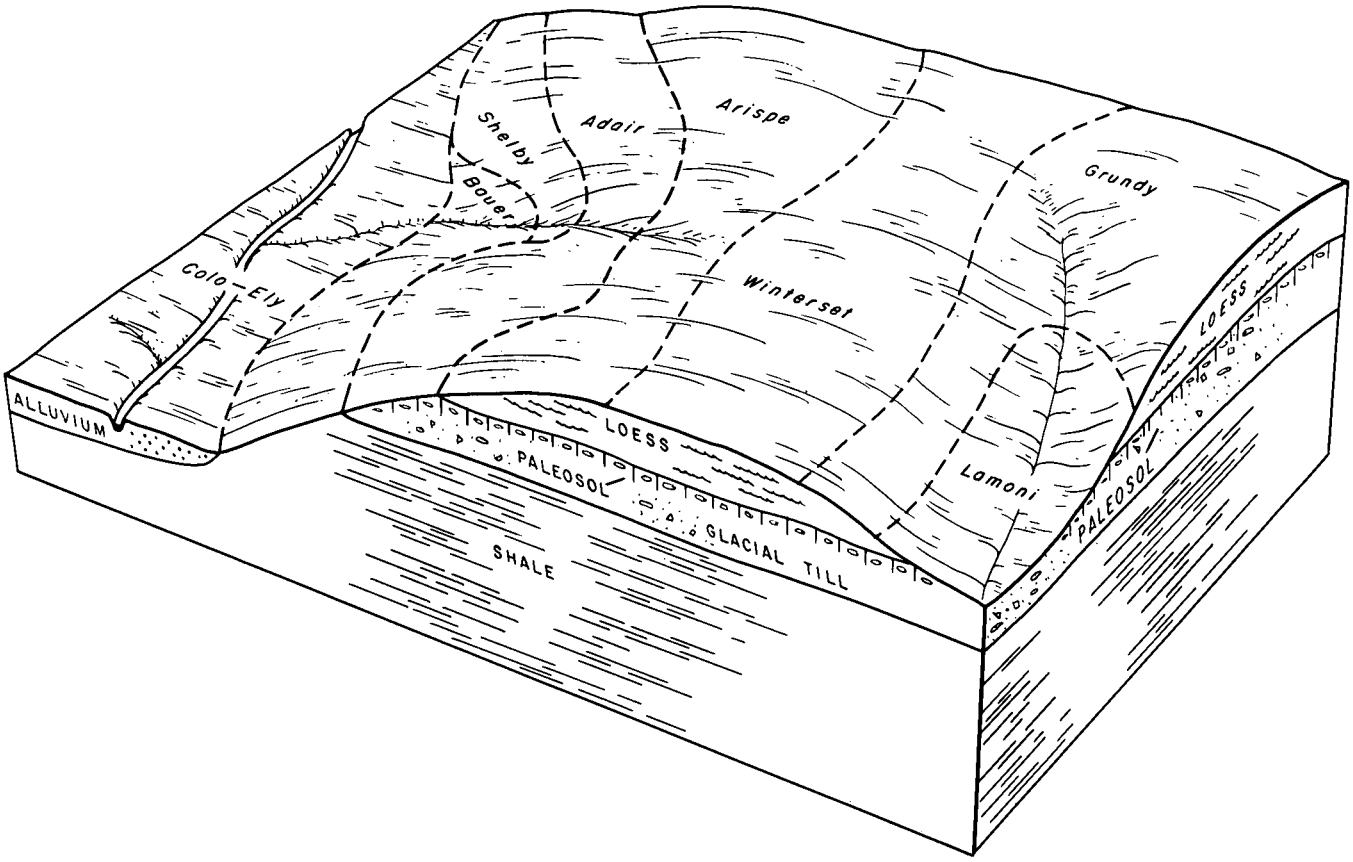

Figure 9.—**Relationship of slope and parent material to soils of the Grundy-Arispe-Winterset association.**

Zook soils are nearly level, are poorly drained, and are on first bottoms. The surface layer is 36 inches thick; the upper part is black silty clay loam, and the lower part is black silty clay. The subsoil is very dark gray silty clay and silty clay loam.

Figure 10.—**Typical landscape in an area of Grundy-Arispe-Winterset association. Fall plowing is a common practice in management.**

Wabash soils are nearly level, are very poorly drained, and are back from the stream channel near the base of uplands. The surface layer is 36 inches thick; the upper part is black silty clay loam or silty clay, and the lower part is black silty clay. The subsoil is dark gray silty clay.

Nodaway soils are nearly level, are moderately well drained, and are near stream channels or former stream channels. The surface layer is very dark grayish brown silt loam about 5 inches thick. The substratum is stratified very dark grayish brown to grayish brown silt loam.

Of minor extent in this association are Amana, Bremer, Colo, Kennebec, and Nevin soils and Alluvial land. Alluvial land varies in texture and drainage. It is next to old stream meanders or along current stream channels. Amana soils are somewhat poorly drained and are on first bottoms near the original stream channel and on old stream channel levees. Bremer soils are poorly drained and are on second bottoms. Colo soils are poorly drained and are on first bottoms. Kennebec soils are moderately well drained and are on first bottoms near the stream channel and on old stream levees. Nevin soils are somewhat poorly drained and are on second bottoms.

The soils of this association are used for intensive rowcropping. Some areas are in pasture and timber. Cash grain farming is the major enterprise.

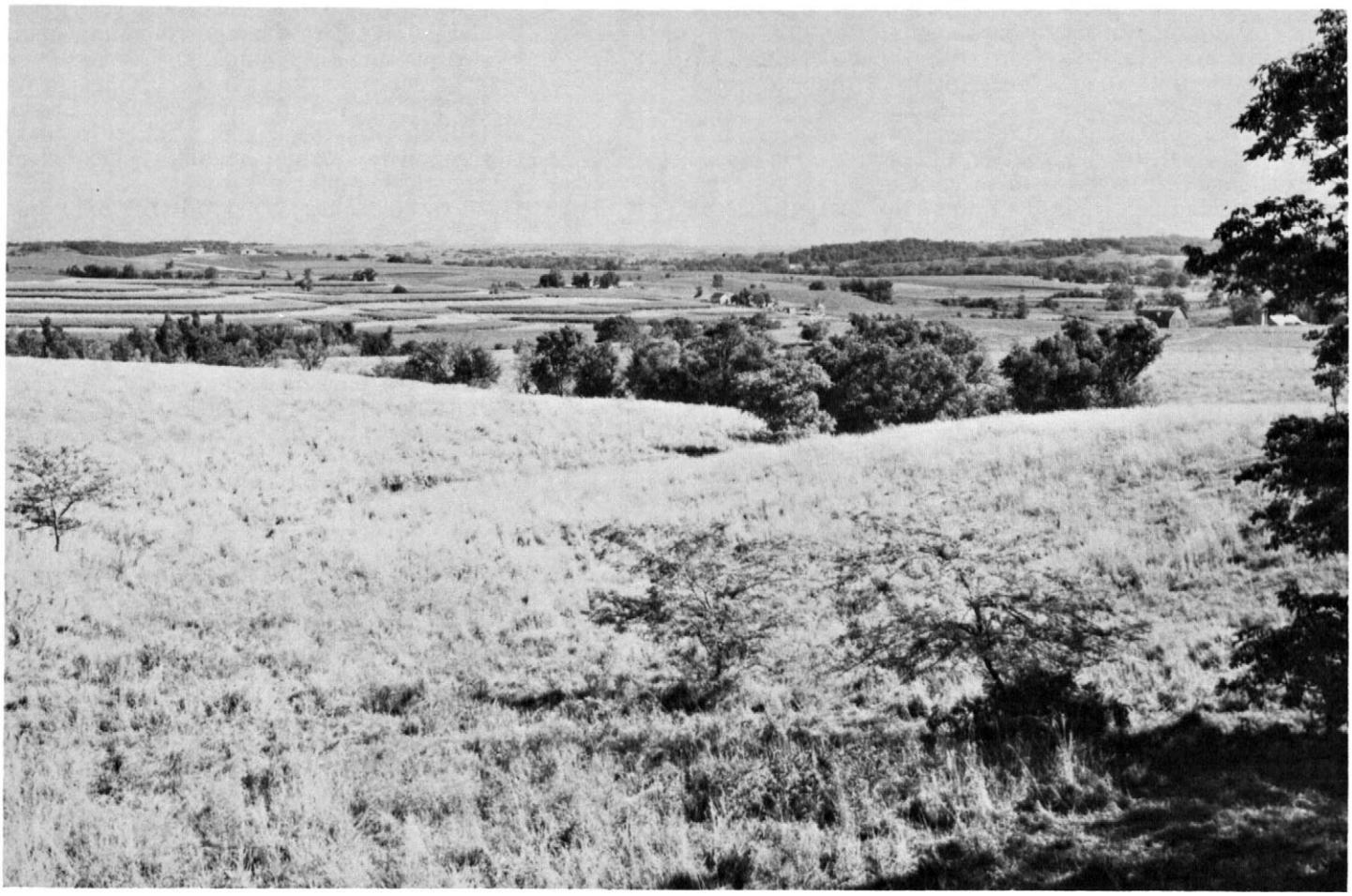

Figure 11.—Typical landscape in an area of Gara-Gosport-Pershing association showing improved pasture in the foreground. Trees are along the waterways and streams.

Figure 12.—Typical landscape in an area of Zook-Wabash-Nodaway association. Fall plowing is a common practice in management.

The main concerns in management are controlling flooding and improving drainage. Tile drains normally function satisfactorily in all of these soils except Wabash soils. Most areas of these soils are subject to flooding; the soils on second bottoms are flooded infrequently. Soils on bottom land of the North River have the most severe flooding hazard. Diversion terraces and drainage ditches are useful in preventing runoff overflow from adjacent uplands. Many of these soils are plowed in fall. The winter weather breaks up clods and mellows the soil (fig. 12). Also, these soils have a narrow moisture range for optimum workability. If worked when wet they become cloddy and hard. In most of the soils content of organic matter is high, but in some soils it is low or moderate. The available water capacity is mostly moderate or high.

Descriptions of the soils

This section describes the soil series and mapping units in Warren County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil

series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

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

As mentioned in the section "How this survey was made," not all mapping units are members of a soil series. Alluvial land, for example, does not belong to a soil series, but nevertheless, is listed in alphabetical order along with the soil series.

Preceding the name of each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and environmental planting group in which the mapping unit has been placed.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*12*).[2]

Ackmore series

The Ackmore series consists of deep, nearly level, somewhat poorly drained soils. These soils are on narrow flood plains of small streams. They formed in recent alluvium under a native vegetation of trees and prairie grasses.

In a representative profile the surface layer is very dark grayish brown silt loam about 6 inches thick. The substratum extends to a depth of 25 inches; it is stratified very dark gray and dark grayish brown silt loam. The next layer is the surface layer of a buried soil; it is black silty clay loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium.

Ackmore soils are used mainly for row crops. Some areas are in pasture. The major hazard is flooding, and the major limitation is wetness.

Representative profile of Ackmore silt loam, 0 to 2 percent slopes, in a pasture, 2,230 feet west and 275 feet south of the northeast corner of sec. 5, T. 75 N., R. 25 W.:

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

C—6 to 25 inches; stratified very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) silt loam; weak thin platy structure; friable; medium acid; clear smooth boundary.

IIA11b—25 to 30 inches; black (10YR 2/1) medium silty clay loam; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; clear smooth boundary.

IIA12b—30 to 44 inches; black (10YR 2/1) heavy silty clay loam; weak medium prismatic structure parting to moderate very fine and fine subangular blocky; friable; few fine dark oxides; slightly acid; clear smooth boundary.

IIA13b—44 to 60 inches; black (10YR 2/1) heavy silty clay loam; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; firm; few fine dark oxides; neutral.

The buried soil is at a depth of 20 to 40 inches.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick. It is medium acid to mildly alkaline.

The C horizon is stratified. It is very dark gray (10YR 3/1) to grayish brown (10YR 5/2). It is 14 to 30 inches thick. It is medium acid to mildly alkaline.

The IIAb horizon is black (10YR 2/1) to very dark gray (N 3/0). It ranges from medium acid to mildly alkaline.

Ackmore soils formed in parent material similar to that of the Colo, Nodaway, and Zook soils. They are lighter colored, have a thinner surface layer, and contain less clay than Colo and Zook soils. They have a buried soil at a depth of 20 to 40 inches, which Nodaway soils do not have.

430—Ackmore silt loam, 0 to 2 percent slopes. This nearly level soil is on narrow flood plains of small streams. Areas are irregular in shape and range from a few acres to 50 acres in size.

Included with this soil in mapping are small areas of Colo and Nodaway soils. Also included are wet spots, which are indicated on the soil map by a special symbol.

This Ackmore soil is well suited to intensive row crops. Some areas are in pasture. It is susceptible to overflow. Artificial drainage is commonly needed. The organic matter content is moderate. Capability unit IIw–2; environmental planting group 1.

Adair series

The Adair series consists of deep, strongly sloping and moderately steep, moderately well drained to somewhat poorly drained soils. These soils are on convex ridgetops and the upper part of side slopes on uplands. They formed in weathered reddish glacial till under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is very dark gray clay loam about 7 inches thick. The clay

[2] Italic numbers in parentheses refer to References, p. 130.

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

Mapping unit	Acres	Percent
Ackmore silt loam, 0 to 2 percent slopes	1,000	0.3
Adair clay loam, 9 to 14 percent slopes, moderately eroded	1,050	.3
Adair-Shelby clay loams, 9 to 14 percent slopes, moderately eroded	8,400	2.3
Adair-Shelby clay loams, 14 to 18 percent slopes, moderately eroded	4,200	1.2
Adair-Shelby clay loams, 14 to 18 percent slopes, severely eroded	445	.1
Alluvial land	1,840	.5
Alluvial land, channeled	1,510	.4
Amana silt loam, 0 to 2 percent slopes	4,100	1.1
Arbor loam, 9 to 14 percent slopes	400	.1
Arispe silty clay loam, 5 to 9 percent slopes	635	.2
Arispe silty clay loam, 5 to 9 percent slopes, moderately eroded	6,340	1.7
Armstrong loam, 9 to 14 percent slopes, moderately eroded	3,585	1.0
Armstrong-Gara loams, 9 to 14 percent slopes, moderately eroded	5,260	1.4
Armstrong-Gara loams, 14 to 18 percent slopes, moderately eroded	6,600	1.8
Armstrong-Gara clay loams, 14 to 18 percent slopes, severely eroded	1,200	.3
Bauer silt loam, 9 to 14 percent slopes, moderately eroded	3,105	.8
Bauer silt loam, 14 to 18 percent slopes, moderately eroded	2,160	.6
Bauer soils, 14 to 18 percent slopes, severely eroded	410	.1
Bremer silty clay loam, 0 to 2 percent slopes	1,000	.3
Caleb loam, 9 to 14 percent slopes, moderately eroded	1,600	.4
Chelsea loamy fine sand, 5 to 9 percent slopes, moderately eroded	145	(1)
Chelsea loamy fine sand, 9 to 18 percent slopes, moderately eroded	220	.1
Clarinda silty clay loam, 5 to 9 percent slopes	585	.2
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	1,425	.4
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	1,000	.3
Clearfield silty clay loam, 5 to 9 percent slopes	2,300	.6
Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded	6,000	1.6
Clinton silt loam, 2 to 5 percent slopes	625	.2
Clinton silt loam, 5 to 9 percent slopes, moderately eroded	3,635	1.0
Clinton silt loam, 9 to 14 percent slopes, moderately eroded	3,045	.8
Colo silty clay loam, 0 to 2 percent slopes	4,175	1.1
Colo silty clay loam, 2 to 5 percent slopes	6,600	1.8
Colo-Ely silty clay loams, 2 to 5 percent slopes	7,100	2.0
Downs silt loam, 0 to 2 percent slopes	160	(1)
Downs silt loam, 2 to 5 percent slopes	1,530	.4
Downs silt loam, 5 to 9 percent slopes, moderately eroded	2,500	.7
Downs silt loam, 9 to 14 percent slopes, moderately eroded	2,355	.6
Downs silt loam, benches, 2 to 5 percent slopes	255	.1
Ely silty clay loam, 2 to 5 percent slopes	3,900	1.1
Fayette silt loam, 2 to 5 percent slopes	465	.1
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	1,005	.3
Fayette silt loam, 9 to 14 percent slopes, moderately eroded	955	.3
Fayette silt loam, 14 to 18 percent slopes, moderately eroded	725	.2
Fayette silt loam, 18 to 25 percent slopes, moderately eroded	335	.1
Gara loam, 9 to 14 percent slopes, moderately eroded	885	.2
Gara loam, 14 to 18 percent slopes, moderately eroded	11,020	3.0
Gara loam, 18 to 25 percent slopes, moderately eroded	9,540	2.6
Gara loam, 25 to 40 percent slopes	1,000	.3
Givin silt loam, 0 to 2 percent slopes	675	.2
Gosport silt loam, 9 to 14 percent slopes	1,105	.3
Gosport silt loam, 14 to 18 percent slopes	5,080	1.4
Gosport silt loam, 18 to 35 percent slopes	6,850	1.8
Gosport soils, 14 to 18 percent slopes, severely eroded	1,875	.5
Grundy silty clay loam, 2 to 5 percent slopes	7,200	2.0
Gullied land-Ely-Colo complex, 2 to 5 percent slopes	7,200	2.0
Humeston silt loam, 0 to 2 percent slopes	275	.1
Judson silty clay loam, 2 to 6 percent slopes	525	.1
Kennebec silt loam, 0 to 2 percent slopes	3,575	1.0
Keswick loam, 9 to 14 percent slopes	630	.2
Ladoga silt loam, 2 to 5 percent slopes	5,925	1.6
Ladoga silt loam, 5 to 9 percent slopes	1,900	.5
Ladoga silt loam, 5 to 9 percent slopes, moderately eroded	15,400	4.2
Ladoga silt loam, 9 to 14 percent slopes, moderately eroded	4,200	1.2
Ladoga silt loam, benches, 2 to 5 percent slopes	3,850	1.1
Ladoga silt loam, benches, 5 to 9 percent slopes, moderately eroded	1,360	.4
Ladoga-Chelsea complex, 5 to 9 percent slopes, moderately eroded	275	.1
Ladoga-Chelsea complex, 9 to 14 percent slopes, moderately eroded	515	.1
Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	12,255	3.4
Lamoni soils, 9 to 14 percent slopes, severely eroded	565	.2
Lindley loam, 9 to 14 percent slopes	250	.1
Lindley loam, 14 to 18 percent slopes	2,120	.6
Lindley loam, 18 to 25 percent slopes	2,205	.6
Lindley loam, 25 to 40 percent slopes	1,000	.3
Lindley soils, 14 to 18 percent slopes, severely eroded	595	.2
Macksburg silty clay loam, 0 to 2 percent slopes	10,700	2.9
Macksburg silty clay loam, 2 to 5 percent slopes	11,400	3.1
Macksburg silty clay loam, benches, 1 to 3 percent slopes	530	.1
Muscatine silty clay loam, 0 to 2 percent slopes	280	.1
Muscatine silty clay loam, benches, 0 to 2 percent slopes	150	(1)
Mystic silt loam, 5 to 9 percent slopes, moderately eroded	770	.2
Mystic silt loam, 9 to 14 percent slopes, moderately eroded	1,490	.4
Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded	4,800	1.3
Mystic-Caleb complex, 14 to 18 percent slopes, moderately eroded	750	.2

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

Mapping unit	Acres	Percent
Nevin silty clay loam, 0 to 2 percent slopes	2,650	.7
Nevin silty clay loam, 2 to 5 percent slopes	440	.1
Nira silty clay loam, 2 to 5 percent slopes	350	.1
Nira silty clay loam, 5 to 9 percent slopes, moderately eroded	2,100	.6
Nodaway silt loam, 0 to 2 percent slopes	4,450	1.2
Nodaway silt loam, channeled, 0 to 2 percent slopes	2,505	.7
Olmitz loam, 2 to 5 percent slopes	470	.1
Olmitz loam, 5 to 9 percent slopes	1,000	.3
Pershing silt loam, 2 to 5 percent slopes	415	.1
Pershing silt loam, 5 to 9 percent slopes, moderately eroded	4,160	1.1
Pershing silt loam, 9 to 14 percent slopes, moderately eroded	475	.1
Sharpsburg silty clay loam, 0 to 2 percent slopes	1,000	.3
Sharpsburg silty clay loam, 2 to 5 percent slopes	14,455	4.0
Sharpsburg silty clay loam, 5 to 9 percent slopes	1,800	.5
Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded	22,500	6.2
Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded	2,970	.8
Sharpsburg silty clay loam, benches, 0 to 2 percent slopes	350	.1
Sharpsburg silty clay loam, benches, 2 to 5 percent slopes	2,800	.8
Sharpsburg silty clay loam, benches, 5 to 9 percent slopes	1,745	.5
Shelby clay loam, 9 to 14 percent slopes, moderately eroded	500	.1
Shelby clay loam, 14 to 18 percent slopes, moderately eroded	1,155	.3
Shelby clay loam, 18 to 25 percent slopes, moderately eroded	605	.2
Sperry silt loam, 0 to 1 percent slopes	175	(1)
Steep rock land	375	.1
Strip mines	240	.1
Tama silty clay loam, 0 to 2 percent slopes	245	.1
Tama silty clay loam, 2 to 5 percent slopes	2,560	.7
Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	3,015	.8
Tama silty clay loam, 9 to 14 percent slopes, moderately eroded	1,210	.3
Tama silty clay loam, benches, 2 to 5 percent slopes	915	.2
Vesser silt loam, 0 to 2 percent slopes	430	.1
Vesser silt loam, 2 to 5 percent slopes	380	.1
Wabash silty clay loam, 0 to 2 percent slopes	5,900	1.6
Wabash silty clay, 0 to 2 percent slopes	1,700	.5
Watkins silt loam, 1 to 4 percent slopes	380	.1
Weller silt loam, 2 to 5 percent slopes	135	(1)
Weller silt loam, 5 to 9 percent slopes, moderately eroded	535	.1
Winterset silty clay loam, 0 to 2 percent slopes	9,050	2.5
Wiota silt loam, 0 to 2 percent slopes	520	.1
Wiota silt loam, 2 to 5 percent slopes	395	.1
Zook silty clay loam, 0 to 2 percent slopes	21,880	6.0
Gravel pit	50	(1)
Made land	120	(1)
Water[2]	275	.1
Total	365,980	100.0

[1] Less than 0.05 percent.
[2] Bodies of water 20 acres or larger.

loam subsoil extends to a depth of 42 inches; it is brown and reddish brown in the upper part, brown in the middle part, and yellowish brown in the lower part. The substratum is yellowish brown clay loam.

Permeability is slow, and available water capacity is moderate to high. The subsoil is very low in available phosphorus and potassium.

Adair soils are used mainly for row crops and pasture. The major hazard is erosion, and the major limitation is wetness.

Representative profile of Adair clay loam, 9 to 14 percent slopes, moderately eroded, on a ridge shoulder in a cultivated field, 500 feet east of the southwest corner of sec. 16, T. 76 N., R. 25 W.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) clay loam; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

B1t—7 to 11 inches; brown (10YR 4/3) clay loam; few fine prominent yellowish red (5YR 4/8) mottles; weak fine subangular blocky structure; friable; thin discontinuous clay films; slightly acid; clear smooth boundary.

B21t—11 to 16 inches; mixed brown (10YR 4/3) and reddish brown (5YR 4/4) clay loam; moderate fine subangular blocky structure; firm; thick continuous clay films; pebble band at a depth of 14 inches; slightly acid; clear smooth boundary.

IIB22t—16 to 23 inches; mixed dark reddish brown (2.5YR 3/4) and brown (10YR 5/3) heavy clay loam; moderate fine subangular blocky structure; firm; thick continuous clay films; slightly acid; clear smooth boundary.

IIB23t—23 to 26 inches; brown (10YR 5/3) heavy clay loam; many fine prominent, reddish brown (5YR 4/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; thin continuous clay films; slightly acid; gradual smooth boundary.

IIB24t—26 to 32 inches; brown (10YR 5/3) clay loam; light brownish gray (10YR 6/2) veins; common fine prominent reddish brown (5YR 4/4) mottles and few fine distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; thin discontinuous clay films; slightly acid; gradual smooth boundary.

IIB3—32 to 42 inches; yellowish brown (10YR 5/6) clay loam; common fine prominent gray (10YR 6/1) mottles and few fine prominent reddish brown (5YR 4/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; slightly acid; gradual smooth boundary.

IIC—42 to 60 inches; yellowish brown (10YR 5/4) clay loam; gray (10YR 6/1) veins; common fine and medium distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; firm; slightly acid.

The solum ranges from 40 to 65 inches in thickness. The A horizon is black (10YR 2/1) or very dark gray (10YR 3/1). It is generally clay loam, but ranges to light silty clay loam, silt loam, or loam. The A horizon is 6 to 10 inches thick. It is neutral to medium acid.

The IIB2t horizon is brown (10YR 4/3 and 5/3) and dark reddish brown (2.5YR 3/4) to yellowish red (5YR 4/6) and dark brown (7.5YR 4/4) in the upper part and is brown (10YR 4/3) to yellowish brown (10YR 5/6) in the lower part. It dominantly has mottles of dark red (2.5YR 3/6), reddish brown (5YR 4/4) to yellowish red (5YR 4/8), and yellowish brown (10YR 5/6 and 5/8), but it also has mottles of dark grayish brown (10YR 4/2), grayish brown (2.5Y 5/2), gray (5Y 5/1), and olive gray (5Y 5/2). The IIB2t horizon is 16 to 32 inches thick and is slightly acid to strongly acid. The IIB3 horizon is dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) and has reddish brown (5YR 4/4), grayish brown (10YR 5/2 or 2.5Y 5/2), or olive gray (5Y 5/2) mottles. The IIB3t horizon is 6 to 25 inches thick and is neutral or slightly acid.

The C horizon is dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6). It has yellowish brown (10YR 5/8 or 5/6), grayish brown (10YR 5/2 or 2.5Y 5/2), or olive gray (5Y 5/2) mottles. It is neutral or slightly acid.

In all mapping units the Adair soils have a thinner surface layer than is defined in the range of characteristics of the Adair series, but this does not significantly alter their use and management.

Adair soils are associated on the landscape with Grundy, Sharpsburg, Shelby, and Tama soils. They have more clay and are redder than Grundy, Sharpsburg, and Tama soils, which are upslope and formed in loess. They have more clay and are redder than Shelby soils, which are downslope and formed in less weathered glacial till.

192D2—Adair clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on narrow, convex ridgetops and shoulders on uplands. Areas are long and narrow or irregular in shape and small in size. They commonly are thin bands on the upper part of the side slopes. The profile of this soil is the one described as representative of the series. In about 40 percent of the mapped areas, the surface layer is 10 to 20 inches thick.

Included with this soil in mapping are areas of moderately sloping soils and areas where loess as thick as 24 inches overlies the reddish subsoil. Also included are spots of severely eroded soils and spots of gray clay, which are indicated on the soil map by special symbols.

This Adair soil is poorly suited to row crops; it is better suited to small grain, hay, and pasture than to most other uses. It is susceptible to erosion. During wet seasons, seeps occur near the contact of the loess and till along the upper edge of areas. The organic matter content is moderate to low. Capability unit IVe–2; environmental planting group 1.

93D2—Adair-Shelby clay loams, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on convex side slopes on uplands. This complex is about 50 percent Adair clay loam and about 50 percent Shelby clay loam. The Adair soil is upslope from the Shelby soil. Areas of this complex are long or are irregular in shape. They range from a few acres to 80 in size.

Included with these soils in mapping are small areas of Lamoni soils. Also included are spots of severely eroded soils, spots of gray clay, rock outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

These soils are poorly suited to row crops; they are better suited to small grain, hay, or pasture than to most other uses. They are susceptible to erosion, and during wet seasons seeps occur near the contact of the loess and till along the upper edge of areas. The organic matter content is moderate. Capability unit IVe–3; environmental planting group 1.

93E2—Adair-Shelby clay loams, 14 to 18 percent slopes, moderately eroded. These moderately steep soils are on convex side slopes on uplands. This complex is about 50 percent Adair clay loam and about 50 percent Shelby clay loam. The Adair soil is upslope from the Shelby soil. Areas of this complex are long or are irregular in shape. They range from a few acres to 30 acres in size.

Included with these soils in mapping are small areas of Lamoni soils. Also included are spots of severely eroded soils, spots of gray clay, and shale outcrop, all of which are indicated on the soil map by special symbols.

These soils are generally unsuited to cultivated crops; they are better suited to hay or pasture than to most other uses. They are susceptible to erosion, and during wet seasons seeps occur near the contact of the loess and till along the upper edge of areas. The organic matter content is moderate. Capability unit VIe–1; environmental planting group 1.

93E3—Adair-Shelby clay loams, 14 to 18 percent slopes, severely eroded. These moderately steep soils are on convex side slopes on uplands. This complex is about 50 percent severely eroded Adair clay loam and about 50 percent severely eroded Shelby clay loam. The Adair soil is upslope from the Shelby soil. Areas of this complex are long or are irregular in shape and range from a few acres to about 30 acres in size. These soils have profiles similar to the ones described as representative of their respective series, but the original surface layer has been almost completely removed by erosion and the plow layer is mainly material from the subsoil.

Included with these soils in mapping are small areas of Lamoni soils. Also included are small areas of shale

outcrop, which are indicated on the soil map by a special symbol.

These soils are not suited to row crops; they are better suited to hay or pasture than to most other uses. They are susceptible to erosion, and during wet seasons seeps occur near the contact of the loess and till along the upper edge of areas. These soils are low in fertility, and they are cloddy when plowed. A good seedbed is difficult to prepare, and the survival rate of seedlings commonly is low. The sparse plant cover increases the hazard of erosion and runoff. The organic matter content is very low. Capability unit VIIe–1; environmental planting group 1.

Alluvial land

315—Alluvial land. These soils consist of recently deposited silty, loamy, and sandy alluvium. They are nearly level and are on first bottoms along frequently flooded streams. In most places, the soils are stratified and are silty, loamy, or sandy. They are variable in permeability, available water capacity, and drainage.

Included in mapping are sand spots and wet spots, which are indicated on the soil map by special symbols. Also included are areas of Nodaway and Kennebec soils that are frequently flooded.

Alluvial land is better suited to woodland and pasture than to most other uses because of flooding. Most areas are suited to row crops if they are cleared of trees, adequately drained, and protected from flooding. The organic matter content is low to moderate. Capability unit IIIw–4; environmental planting group 1.

Alluvial land, channeled

C315—Alluvial land, channeled. These soils consist of recently deposited silty, loamy, and sandy alluvium. They are nearly level and are on first bottoms that are severely dissected by abandoned stream channels and present stream meanders. They are near the present channels of major streams and along small streams that flow out of the uplands. They are wet and are frequently flooded. In most places these soils are stratified and are silty, loamy, or sandy. The soils are variable in permeability, available water capacity, and drainage.

These soils are poorly suited to row crops; they are better suited to woodland, pasture, and wildlife than to most other uses. Because of the flooding and severe dissection, most areas are in woodland and pasture or are idle. Major reclamation is required for use for crops. The organic matter content is low to moderate. Capability unit Vw–1; environmental planting group 1.

Amana series

The Amana series consists of deep, nearly level, somewhat poorly drained soils. These soils are on first bottoms, generally near the former stream channels. They formed in silty alluvium under a native vegetation of mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown and very dark grayish brown silt loam about 16 inches thick. The subsoil extends to a depth of 44 inches; it is dark grayish brown silt loam mottled with dark yellowish brown. The substratum is dark grayish brown and brown loam.

Permeability is moderate, and available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium.

Amana soils are used mainly for row crops. The major hazard is flooding.

Representative profile of Amana silt loam, 0 to 2 percent slopes, on a cultivated first bottom, 800 feet west and 20 feet north of the southeast corner of sec. 21, T. 76 N., R. 25 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A3—8 to 16 inches; very dark grayish brown (10YR 3/2) silt loam; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.

B2—16 to 30 inches; dark grayish brown (10YR 4/2) silt loam high in sand; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate fine and medium subangular blocky structure; friable; strongly acid; diffuse smooth boundary.

B3—30 to 44 inches; dark grayish brown (10YR 4/2) silt loam high in sand; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C—44 to 60 inches; dark grayish brown (10YR 4/2) and brown (10YR 4/3) loam; massive; friable; neutral.

The solum ranges from 30 to 60 inches in thickness.

The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is heavy silt loam or light silty clay loam. The A horizon is 10 to 20 inches thick and is neutral to strongly acid.

The B2 horizon is dark grayish brown (10YR to 2.5Y 4/2) or grayish brown (10YR to 2.5Y 5/2) silt loam or light silty clay loam. It is 10 to 20 inches thick and is slightly acid to strongly acid. The B3 horizon is dark grayish brown (10YR 4/2) to grayish brown (2.5Y 5/2). It is 10 to 20 inches thick and is slightly acid to strongly acid.

The C horizon is dark grayish brown (10YR 4/2) and brown (10YR 4/3) to olive gray (5Y 5/2).

Amana soils formed in parent material similar to that of Colo, Kennebec, and Nodaway soils. They have less clay in the surface layer and subsoil than Colo soils have at a comparable depth. They have a browner subsoil than Kennebec soils have at a comparable depth. They have a thicker surface layer than Nodaway soils and do not have the stratification of Nodaway soils.

422—Amana silt loam, 0 to 2 percent slopes. This nearly level soil is on first bottoms, generally near former stream channels. Areas are irregular in shape and range from a few acres to 100 acres in size.

Included with this soil in mapping are wet spots,

which are indicated on the soil map by a special symbol.

This Amana soil is well suited to intensive row crops. In many places it is underlain by material that is moderately rapidly permeable. Crops are more quickly affected by moisture stress in dry periods on this soil than on surrounding soils. The soil is susceptible to flooding. The organic matter content is high. Capability unit I–2; environmental planting group 1.

Arbor series

The Arbor series consists of deep, strongly sloping, well drained and moderately well drained soils. These soils are on foot slopes. They formed in loamy sediment and the underlying glacial till under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is about 18 inches thick; it is very dark brown loam in the upper part and very dark grayish brown clay loam in the lower part. The clay loam subsoil extends to a depth of 43 inches; it is light olive brown in the upper part, yellowish brown in the middle part, and olive gray in the lower part. The substratum is yellowish brown clay loam.

Permeability is moderate to moderately slow, and available water capacity is high. The subsoil is low in available phosphorus and medium in available potassium.

Arbor soils are used mainly for pasture. Some areas are in row crops. The major hazard is erosion. The soils receive runoff from adjacent slopes.

Representative profile of Arbor loam, 9 to 14 percent slopes, on a cultivated foot slope, 1,420 feet east and 130 feet north of the southwest corner of sec. 14, T. 74 N., R. 25 W.:

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam; weak fine and medium granular structure; friable; medium acid; abrupt smooth boundary.

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

A3—14 to 18 inches; dark brown (10YR 3/3) medium clay loam; very dark grayish brown (10YR 3/2) faces of peds; weak very fine and fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B21—18 to 24 inches; light olive brown (2.5Y 5/4) medium clay loam; brown (10YR 4/3) faces of peds; weak very fine and fine subangular blocky structure; friable; medium acid; clear smooth boundary.

IIB22t—24 to 29 inches; light olive brown (2.5Y 5/4) medium clay loam; olive brown (2.5Y 4/4) faces of peds; few fine faint yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; thin continuous clay films; strongly acid; clear smooth boundary.

IIB23t—29 to 35 inches; yellowish brown (10YR 5/4) medium clay loam; grayish brown (2.5Y 5/2) faces of peds; few fine faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; strongly acid; gradual smooth boundary.

IIB3t—35 to 43 inches; olive gray (5Y 5/2) medium clay loam; many fine prominent dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles and few fine prominent strong brown (7.5YR 5/6) and reddish yellow (7.5YR 6/6) mottles; weak coarse subangular blocky structure; firm; slightly acid; gradual smooth boundary.

IIC—43 to 63 inches; yellowish brown (10YR 5/4) light clay loam; many fine prominent olive gray (5Y 4/2) and gray (5Y 5/1) mottles; few coarse prominent dark brown (7.5YR 4/4), yellowish brown (10YR 5/6), and brownish yellow (10YR 6/6) mottles, and few fine prominent reddish brown (5YR 4/4) and strong brown (7.5YR 5/6) mottles; massive; firm; neutral.

The solum is typically more than 40 inches thick, but it ranges from 36 to 48 inches in thickness.

The upper part of the A horizon is black (10YR 2/1) or very dark brown (10YR 2/2), and the lower part is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). The A horizon is heavy loam or clay loam 15 to 22 inches thick. It is slightly acid or medium acid.

The B21 horizon is brown (10YR 4/3) to light olive brown (2.5Y 5/4). It is light or medium clay loam 4 to 10 inches thick. It is slightly acid or medium acid. The IIB3t horizon is brown (10YR 4/3) to olive gray (5Y 5/2). It is light or medium clay loam 4 to 15 inches thick.

Arbor soils typically are downslope from Shelby and Gara soils. They formed in parent material similar to that of Olmitz soils. They have a thicker surface layer than Shelby and Gara soils. They have a subsoil that formed in firm glacial till, whereas the subsoil of Olmitz soils formed in loamy sediment.

434D—Arbor loam, 9 to 14 percent slopes. This strongly sloping soil is on foot slopes. Most areas are downslope from Shelby or Gara soils. Areas are small in size and irregular in shape.

Included with this soil in mapping are small areas of Gara soils. Also included are spots of red clay, which are indicated on the soil map by a special symbol.

This Arbor soil is moderately well suited to row crops where it is accessible to farm equipment. Most areas are in pasture. This soil is susceptible to erosion and to runoff from upslope. The organic matter content is high. Capability unit IIIe–3; environmental planting group 1.

Arispe series

The Arispe series consists of deep, moderately slop-

ing, somewhat poorly drained to moderately well drained soils. These soils are on the upper and middle parts of side slopes adjacent to the upland flats. They formed in loess under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is very dark gray silty clay loam about 10 inches thick. The silty clay loam subsoil extends to a depth of 50 inches; the upper part is brown, the middle part is dark grayish brown, and the lower part is grayish brown. The substratum is grayish brown silty clay loam.

Permeability is moderately slow, and available water capacity is high. The subsoil is very low to low in available phosphorus and low to medium in available potassium.

Arispe soils are used mainly for row crops. The major hazard is erosion.

Representative profile of uneroded Arispe soil in an area of Arispe silty clay loam, 5 to 9 percent slopes, moderately eroded, in a cultivated field, 500 feet east and 75 feet north of the southwest corner of sec. 6, T. 74 N., R. 22 W.:

Ap—0 to 10 inches; very dark gray (10YR 3/1) light silty clay loam; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

B21t—10 to 16 inches; brown (10YR 4/3) heavy silty clay loam; very dark grayish brown (10YR 3/2) faces on some peds; few fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate very fine and fine subangular blocky structure; friable; very few very fine dark oxides; thin discontinuous clay films; neutral; gradual smooth boundary.

B22t—16 to 21 inches; dark grayish brown (10YR 4/2) heavy silty clay loam; common fine faint grayish brown (10YR 5/2) and distinct yellowish brown (10YR 5/8) mottles; moderate fine and very fine subangular blocky structure; friable; very few very fine dark oxides; thin continuous clay films; medium acid; gradual smooth boundary.

B23t—21 to 30 inches; dark grayish brown (10YR 4/2) medium silty clay loam; common fine faint grayish brown (10YR 5/2) and distinct yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; few fine dark oxides; thick continuous clay films; medium acid; gradual smooth boundary.

B24t—30 to 36 inches; grayish brown (10YR 5/2) medium silty clay loam; dark grayish brown (10YR 4/2) faces on some peds; common fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; firm; common fine dark oxides; thick continuous clay films; slightly acid; gradual smooth boundary.

B31t—36 to 43 inches; grayish brown (2.5Y 5/2) medium silty clay loam; dark grayish brown faces on some peds; common fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure parting to weak fine subangular blocky; firm; common fine dark oxides; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B32t—43 to 50 inches; grayish brown (2.5Y 5/2) medium silty clay loam; dark grayish brown (10YR 4/2) coatings on vertical faces; many fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure parting to weak fine subangular blocky; firm; few fine dark oxides; thin discontinuous clay films on vertical faces; neutral; gradual smooth boundary.

C—50 to 60 inches; grayish brown (2.5Y 5/2) light silty clay loam; many fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; firm; few fine dark oxides; thin discontinuous clay films on vertical faces; neutral.

The solum ranges from 36 to 60 inches in thickness. The Ap or A1 horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) light or medium silty clay loam. The A horizon is 10 to 12 inches thick except in eroded areas. It is neutral to medium acid.

A B1 horizon is present in some profiles. It is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) medium silty clay loam 3 to 6 inches thick. The B2t horizon is mottled. It is brown (10YR 4/3) to grayish brown (2.5Y 5/2) heavy silty clay loam or light silty clay in the upper part and grayish brown (10YR 5/2) to gray (5Y 5/1 and 6/1) medium or light silty clay loam in the lower part. The B3t horizon has the same range of colors as the lower part of the B2t horizon, but mottles are more numerous. The B3t horizon is medium or light silty clay loam.

The C horizon is light silty clay loam or heavy silt loam. A grayish, clayey paleosol is at a depth of 4 to 6 feet in places.

Because of erosion, the dark colored surface layer in mapping unit 23C2 is thinner than is defined in the range of the Arispe series.

Arispe soils are associated on the landscape with Grundy and Clearfield soils and formed in loess as did those soils. Arispe soils are more clayey in the upper 20 inches of the profile and less clayey below that depth than Grundy and Clearfield soils. They are better drained than Clearfield soils.

23C—Arispe silty clay loam, 5 to 9 percent slopes. This moderately sloping soil is on short, convex ridges and the upper part of side slopes on uplands. Areas are long or are irregular in shape. They range from a few acres to 15 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are spots of red clay and wet spots, which are indicated on the soil map by special symbols.

This soil is moderately well suited to row crops, but it is commonly used for hay or pasture with adjoining

soils that formed in glacial till. The soil is susceptible to erosion. The organic matter content is high. Capability unit IIIe–1; environmental planting group 1.

23C2—Arispe silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on short convex ridges and the upper part of side slopes on uplands. Areas are long or are irregular in shape. Typically, they are about 5 to 15 acres in size. This soil has a profile similar to the one described as representative of the series, but erosion has removed part of the dark colored surface layer and in most places some material from the brown, finer textured subsoil has been mixed into the plow layer.

Included with this soil in mapping are a few areas of strongly sloping Arispe soils. Also included are some spots of reddish, clayey soil and wet soils, which are indicated on the soil map by special symbols.

This soil is moderately well suited to row crops. Many areas however are used mainly for hay or pasture, because they are formed with adjoining soils that are less well suited to row crops. If this soil is used for row crops, maintaining good tilth is a concern because material from the subsoil has been mixed into the plow layer. This soil is susceptible to further erosion. The content of organic matter is moderate. Capability unit IIIe–1; environmental planting group 1.

Armstrong series

The Armstrong series consists of deep, strongly sloping and moderately steep, moderately well drained to somewhat poorly drained soils. These soils are on convex ridgetops and the upper part of side slopes on uplands. They formed mainly in reddish, clayey glacial till under a native vegetation of mixed prairie grasses and trees. The upper part of the profile formed in 1 to 2 feet of loamy material that overlies the clayey glacial till.

In a representative profile the surface layer is very dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown and brown silt loam about 3 inches thick. The subsoil extends to a depth of 60 inches; it is dark yellowish brown clay loam in the upper part, brown clay in the middle part, and yellowish brown clay loam in the lower part.

Permeability is slow, and available water capacity is moderate to high. The subsoil is very low in available phosphorus and potassium.

Armstrong soils are used mainly for pasture. The major hazard is erosion, and the major limitation is seasonal wetness.

Representative profile of uneroded Armstrong soil in an area of Armstrong loam, 9 to 14 percent slopes, moderately eroded, in a bluegrass pasture, 75 feet south and 1,240 feet west of the northeast corner of sec. 17, T. 75 N., R. 24 W.:

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) loam; grayish brown (10YR 5/2) dry; weak fine granular structure; friable; thin discontinuous gray silt coatings; slightly acid; abrupt smooth boundary.

A2—6 to 9 inches; dark grayish brown (10YR 4/2) and brown (10YR 5/3) silt loam, light gray (10YR 7/2) and very pale brown (10YR 7/3) dry; weak thin platy structure; friable; thick continuous gray silt coatings; medium acid; abrupt smooth boundary.

B1—9 to 14 inches; dark yellowish brown (10YR 4/4) clay loam; weak fine subangular blocky structure; friable; thick discontinuous gray silt coatings; strongly acid; clear smooth boundary.

IIB21t—14 to 18 inches; brown (7.5YR 4/4) clay; few fine distinct grayish brown (10YR 5/2) mottles and common fine distinct yellowish red (5Y 4/6) mottles; moderate fine angular and subangular blocky structure; firm; thin continuous clay films; thick discontinuous gray silt coatings; medium acid; clear smooth boundary.

IIB22t—18 to 25 inches; brown (7.5YR 4/4) clay; many fine prominent dark red (2.5YR 3/6) and red (2.5YR 4/6) mottles and common fine distinct grayish brown (10YR 5/2) mottles; moderate very fine and fine subangular blocky structure; very firm; thick continuous clay films; medium acid; gradual smooth boundary.

IIB23t—25 to 32 inches; mixed brown (7.5YR 4/4) and dark yellowish brown (10YR 4/4) light clay; few fine prominent red (2.5YR 4/6) mottles and few fine distinct grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; very firm; thick discontinuous clay films; medium acid; gradual smooth boundary.

IIB31t—32 to 44 inches; yellowish brown (10YR 5/6) clay loam; few fine distinct grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to weak fine subangular blocky structure; firm; thin discontinuous clay films; medium acid; gradual smooth boundary.

IIB32t—44 to 60 inches; yellowish brown (10YR 5/6) clay loam; common fine and medium distinct grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky structure; firm; thin discontinuous clay films; common fine and medium dark oxides; slightly acid.

The solum is typically more than 48 inches thick, and it ranges from 40 to 80 inches in thickness.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) loam, silt loam, or light clay loam 6 to 10 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 5/3) loam or silt loam 2 to 6 inches thick. It is medium acid or strongly acid.

The IIB2t horizon is reddish brown (5YR 4/3) to strong brown (7.5YR 5/6) clay or heavy clay loam 16 to 32 inches thick. It is medium acid to very strongly acid. The IIB3t horizon is brown (10YR 4/3) to yellowish brown (10YR 5/6). It is slightly acid or medium acid.

The severely eroded Armstrong soil in mapping unit

993E3 does not have a dark colored surface layer thick enough to be within the defined range of the series, but in other ways it is similar.

Armstrong soils are associated on the landscape with Grundy, Ladoga, and Pershing soils, and they formed in parent material similar to that of Gara soils. They have more clay and are redder than Grundy, Ladoga, and Pershing soils, which are upslope and formed in loess, and Gara soils, which are downslope and formed in less weathered glacial till.

792D2—Armstrong loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex ridgetops and the upper part of side slopes on uplands. It is in narrow bands between soils that are upslope and formed in loess and soils that are downslope and formed in glacial till. Areas are long and narrow or irregular in shape and range from a few acres to 20 acres in size. This soil has the profile described as representative of the series. In many places, the subsurface layer and some material from the subsoil have been mixed into the plow layer.

Included with this soil in mapping are spots of severely eroded soils, spots of gray clay, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are areas of slightly eroded soils and areas of moderately sloping soils.

This Armstrong soil is poorly suited to row crops; it is better suited to small grain, hay, and pasture than to most other uses. It is susceptible to erosion. During wet seasons, seeps occur near the contact of the loess and till along the upper edge of areas. The organic matter content is low. Capability unit IVe–2; environmental planting group 1.

993D2—Armstrong-Gara loams, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on convex side slopes on uplands. This complex is about 50 percent Armstrong loam and about 50 percent Gara loam. The Armstrong soil is upslope from the Gara soil. Areas of this complex are long and narrow or are irregular in shape. These soils have profiles similar to the ones described as representative of their respective series, but in most places the dark grayish brown and brown subsurface layer is mixed into the plow layer. In many areas plowing has mixed material from the subsoil into the surface layer.

Included with these soils in mapping are spots of severely eroded soils, spots of gray clay, and shale outcrop, all of which are indicated on the soil map by special symbols.

These soils are generally unsuited to row crops; they are better suited to small grain, hay, and pasture than to most other uses. They are susceptible to erosion. During wet seasons, seeps occur near the contact of the loess and till along the upper edge of areas. The organic matter content is moderately low to low. Capability unit IVe–3; environmental planting group 1.

993E2—Armstrong-Gara loams, 14 to 18 percent slopes, moderately eroded. These moderately steep soils are on convex side slopes on uplands. This complex is about 50 percent Armstrong loam and about 50 percent Gara loam. The Armstrong soil is upslope from the Gara soil. Areas are long and narrow or irregular in shape. These soils have profiles similar to the ones described as representative of their respective series, but in cultivated areas the dark grayish brown and brown subsurface layer has been mixed into the plow layer. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with these soils in mapping are spots of severely eroded soils, spots of gray clay, and shale outcrop, all of which are indicated on the soil map by special symbols.

These soils are poorly suited to cultivated crops; they are better suited to hay, pasture, and woodland than to most other uses. These soils are susceptible to erosion. During wet seasons seeps occur near the contact of the loess and till along the upper edge of areas. The organic matter content is moderately low to low. Capability unit VIe–1; environmental planting group 1.

993E3—Armstrong-Gara clay loams, 14 to 18 percent slopes, severely eroded. These moderately steep soils are on convex side slopes on uplands. This complex is about 50 percent severely eroded Armstrong clay loam and about 50 percent severely eroded Gara clay loam. The Armstrong soil is upslope from the Gara soil. Areas are long and narrow or are irregular in shape. In many areas both the surface layer and subsurface layer have been removed by erosion and the plow layer is mainly material from the subsoil.

Included with these soils in mapping are areas of soils that have a loam or clay surface layer. Also included are small areas of shale outcrop, spots of gray clay, and seepy wet spots, all of which are indicated on the soil map by special symbols.

These soils are generally unsuited to row crops; they are better suited to pasture, hay, and woodland than to most other uses. They are susceptible to erosion. During wet seasons, seeps occur near the contact of the loess and till along the upper edge of areas. These soils are low in fertility, and they become cloddy when plowed. A good seedbed is difficult to prepare, and the survival rate of seedlings commonly is low. The sparse plant cover increases the hazard of erosion and runoff. The organic matter content is very low. Capability unit VIIe–1; environmental planting group 1.

Bauer series

The Bauer series consists of strongly sloping and moderately steep, well drained to moderately well drained soils that are underlain by shale at a depth of 1 to 2 feet. These soils are on convex side slopes on uplands. They formed in silty sediment over acid shale under a native vegetation of prairie grasses.

In a representative profile the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsoil extends to a depth of 16 inches. It is brown silty clay loam in the upper part and yellowish brown silty clay shale in the lower part. The substratum is gray and yellowish brown clay shale.

Permeability is very slow, and available water capacity is moderate. The subsoil is very low in available phosphorus and low in available potassium.

Bauer soils are used mainly for pasture and row crops. The major hazard is erosion, and the major limitations are the unfavorable textures for root growth and the limited available water capacity.

Representative profile of Bauer silt loam, 9 to 14 percent slopes, moderately eroded, in a cultivated

field, 300 feet west and 1,120 feet north of the southeast corner of the SW¼ sec. 13, T. 76 N., R. 24 W.:

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

B21—7 to 13 inches; brown (10YR 4/3) silty clay loam; few fine distinct yellowish brown (10YR 5/8) mottles; weak fine and medium subangular blocky structure; friable; medium acid; clear smooth boundary.

IIB22—13 to 16 inches; yellowish brown (10YR 5/4) silty clay shale; common fine and medium faint yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

IIC1—16 to 29 inches; gray (10YR 6/1) clay shale; common fine and coarse prominent yellowish brown (10YR 5/6) mottles; coarse platy rock structure; firm; strongly acid; gradual smooth boundary.

IIC2—29 to 46 inches; 60 percent gray (10YR 6/1) and 40 percent yellowish brown (10YR 5/6) clay shale; thick platy rock structure; firm; strongly acid; abrupt smooth boundary.

IIC3—46 to 51 inches; black (N 2/0) carboniferous shale; few coarse prominent yellowish brown (10YR 5/8) mottles; thick platy rock structure; friable; strongly acid.

IIC4—51 to 60 inches; gray (10YR 6/1) clay shale; thick platy rock structure; firm; strongly acid.

The solum ranges from 14 to 28 inches in thickness.

The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) silt loam or silty clay loam. The Ap horizon is silty clay in some severely eroded areas. The A horizon is 6 to 12 inches thick. It is neutral to strongly acid.

The B horizon is dark grayish brown (10YR 4/2) to yellowish brown (10YR 5/4). It is 8 to 16 inches thick. It is medium acid or strongly acid.

The IIC horizon is dark brown (7.5YR 4/4) to olive yellow (2.5Y 6/8), olive (5Y 5/3), and gray (10YR 6/1). Thin strata of highly contrasting colors are in the range of the series.

In mapping unit 185E3, the surface layer is thinner than is defined in the range for the series because it is severely eroded.

Bauer soils are associated on the landscape with Ladoga, Sharpsburg, and Shelby soils, and they formed in parent material similar to that of Gosport soils. They have a less developed B horizon and contain more clay than Ladoga and Sharpsburg soils, which developed in loess, or Shelby soils, which developed in glacial till. They have a thicker surface layer than Gosport soils.

185D2—Bauer silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes on uplands. Areas are long and narrow or are irregular in shape. The profile of this soil is the one described as representative of the series; however, in many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are areas of Bauer soils that have a 7 to 10 inch thick surface layer and some areas where slopes are less than 9 percent. Also included are spots of red clay, spots of gray clay, glacial till outcrops, sand spots, seepy wet spots, and spots of severely eroded soils, all of which are indicated on the soil map by special symbols.

This Bauer soil is generally unsuited to cultivated crops; it is better suited to hay and pasture than to most other uses. It is susceptible to erosion. The organic matter content is moderate. Capability unit VIe–1; environmental planting group 1.

185E2—Bauer silt loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on convex side slopes on uplands. Areas are long and narrow or are irregular in shape. This soil has a profile similar to the one described as representative of the series, but in many areas plowing has mixed material from the upper part of the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, and glacial till outcrops, all of which are indicated on the soil map by special symbols.

This Bauer soil is generally unsuited to cultivated crops; it is better suited to hay and pasture than to most other uses. It is susceptible to erosion. The organic matter content is moderate. Capability unit VIIe–1; environmental planting group 1.

185E3—Bauer soils, 14 to 18 percent slopes, severely eroded. These moderately steep soils are on convex side slopes on uplands. Areas are long and narrow or are irregular in shape. These soils have a silty clay or silty clay loam plow layer that is mainly material from the subsoil. In most areas, most of the surface layer and subsurface layer have been removed by erosion. Shale is at a shallower depth than in less eroded Bauer soils. The surface layer of this soil is lower in organic matter content and in fertility and it is more clayey than less sloping, less eroded Bauer soils.

Included with these soils in mapping are small areas of glacial till outcrop and spots of red clay that are indicated on the soil map by special symbols.

These soils are not suited to cultivated crops; they are better suited to hay and pasture than to most other uses. They are susceptible to erosion. Because a good seedbed is hard to establish, stands of grass, legumes, or other crops are thin, and the hazard of erosion increases. The depth to shale decreases the available water capacity and the rooting depth for trees and other plants. The organic matter content is low to very low. Capability unit VIIe–1; environmental planting group 1.

Bremer series

The Bremer series consists of deep, nearly level, poorly drained soils. These soils are on second bottoms along the major streams. They formed in moderately fine textured alluvium under a native vegetation of prairie grasses.

In a representative profile the surface layer is black

silty clay loam about 18 inches thick. The subsoil extends to a depth of 47 inches. It is very dark gray silty clay loam in the upper part, dark gray silty clay in the middle part, and gray silty clay in the lower part. The substratum is grayish brown silty clay loam.

Permeability is slow, and available water capacity is high. The subsoil is low in available phosphorus and potassium.

Bremer soils are used mainly for row crops. Some areas are in hay and pasture. The major limitation is wetness.

Representative profile of Bremer silty clay loam, 0 to 2 percent slopes, in a cultivated field, 2,140 feet west and 440 feet south of the northeast corner of sec. 15, T. 77 N., R. 23 W.:

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A12—8 to 18 inches; black (10YR 2/1) medium silty clay loam, dark gray (10YR 4/1) dry; moderate fine and very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21tg—18 to 24 inches; very dark gray (10YR 3/1) heavy silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and very fine subangular blocky structure; firm; thin discontinuous clay films; medium acid; gradual smooth boundary.

B22tg—24 to 34 inches; dark gray (10YR 4/1) light silty clay; common fine distinct yellowish brown (10YR 5/6) mottles and few fine faint grayish brown (2.5Y 5/2) mottles; strong fine and very fine subangular blocky and angular blocky structure; firm; thin discontinuous clay films; few fine dark oxides; slightly acid; gradual smooth boundary.

B3tg—34 to 47 inches; gray (10YR 5/1) light silty clay; few fine distinct strong brown (7.5YR 5/6) mottles and common fine faint grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous clay films; few fine dark oxides; slightly acid; gradual smooth boundary.

C—47 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; many fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; few fine and medium dark oxides; slightly acid.

The solum ranges from 40 to 60 inches in thickness.

The A horizon is black (10YR 2/1 or N 2/0) or very dark gray (N 3/0) silty clay loam or silt loam. It is 14 to 20 inches thick. It is slightly acid or medium acid.

The B2t horizon is 12 to 24 inches thick. It is slightly acid or medium acid.

The C horizon is dark gray (10YR 4/1 to 5Y 4/1) to olive gray (5Y 5/2). It is slightly acid or medium acid.

Bremer soils are associated on the landscape with Colo, Wabash, Zook, and Nevin soils, and they formed in parent material similar to those soils. They have a thinner surface layer than Colo, Wabash, and Zook soils. They have more clay and a grayer subsoil than Nevin soils.

43—Bremer silty clay loam, 0 to 2 percent slopes. This nearly level soil is on second bottoms along the major streams. Areas are broad and irregular in shape. They range from a few acres to many acres in size.

Included with this soil in mapping are small areas of Humeston soils, which are indicated on the soil map by a wet spot symbol.

This Bremer soil is well suited to intensive row crops if it is adequately drained. Artificial drainage is needed. The soil is susceptible to wetness. The organic matter content is high. Capability unit IIw–2; environmental planting group 2.

Caleb series

The Caleb series consists of deep, strongly sloping to moderately steep, moderately well drained soils. These soils are on convex side slopes that grade to river valleys and on side slopes of benches. They formed in old alluvium derived from glacial till material under a native vegetation of mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil extends to a depth of 60 inches. It is brown clay loam in the upper part, dark yellowish brown clay loam in the middle part, and yellowish brown clay loam, sandy clay loam, and sandy loam in the lower part.

Permeability is moderately rapid to moderate, and available water capacity is moderate to high. The subsoil is very low in available phosphorus and potassium.

Caleb soils are used mainly for pasture, hay, and row crops. The major hazard is erosion.

Representative profile of Caleb loam, 9 to 14 percent slopes, moderately eroded, on a low ridge in a pasture, 2,400 feet east and 1,420 feet south of the northwest corner of sec. 32, T. 74 N., R. 24 W.:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) dry; some peds in the lower part are brown (10YR 4/3); weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

B1—8 to 13 inches; brown (10YR 4/3) clay loam; dark brown (10YR 3/3) faces of peds; moderate fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

B21t—13 to 19 inches; brown (10YR 4/3) medium clay loam; moderate fine subangular blocky structure; firm; thin continuous clay films; medium acid; gradual smooth boundary.

B22t—19 to 27 inches; dark yellowish brown (10YR 4/4) medium clay loam; weak medium prismatic structure parting to moderate fine subangular blocky and

angular blocky; firm; thin continuous clay films; few fine dark oxides; medium acid; clear smooth boundary.

B23t—27 to 33 inches; yellowish brown (10YR 5/6) light clay loam; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films; thin discontinuous gray silt coatings; few fine dark oxides; medium acid; clear smooth boundary.

B31t—33 to 39 inches; yellowish brown (10YR 5/6) sandy clay loam; yellowish brown (10YR 5/4) faces of peds; few fine distinct gray (5Y 5/1) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous clay films on vertical faces of peds; thick continuous gray silt coatings; few fine dark oxides; medium acid; clear smooth boundary.

B32—39 to 45 inches; yellowish brown (10YR 5/6) sandy loam; yellowish brown (10YR 5/4) faces of peds; weak medium prismatic structure; very friable; some clay bridging of sand grains; thin continuous gray silt coatings; medium acid; abrupt smooth boundary.

B33—45 to 49 inches; yellowish brown (10YR 5/6) fine and medium sandy loam; weak coarse prismatic structure; very friable; some clay bridging of sand grains; strongly acid; abrupt smooth boundary.

B34—49 to 52 inches; yellowish brown (10YR 5/6) very coarse sandy loam; single grained; loose; few fine dark oxides; strongly acid; abrupt smooth boundary.

B35—52 to 54 inches; yellowish brown (10YR 5/6) fine and medium sandy loam; single grained; loose; few fine dark oxides; strongly acid; abrupt smooth boundary.

B36—54 to 60 inches; mixed yellowish brown (10YR 5/6) and gray (5Y 5/1) sandy clay loam; massive; very friable; few fine dark oxides; very strongly acid.

The solum is 5 feet or more thick.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) loam, light clay loam, or silt loam. It is 6 to 10 inches thick. It is slightly acid to medium acid.

The B horizon is brown (10YR 4/3) to yellowish brown (10YR 5/6) clay loam to sandy loam, but ranges to loamy sand in some pedons below a depth of 36 inches. The B horizon is slightly acid to very strongly acid.

Caleb soils are associated on the landscape with Ladoga and Sharpsburg soils, and they formed in parent material similar to that of Mystic soils. They have more sand than Ladoga and Sharpsburg soils. They have less red hue than Mystic soils.

451D2—Caleb loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes that grade to river valleys and on side slopes of benches. Areas are long and narrow or are irregular in shape. The profile of this soil is the one described as representative of the series; however, in many places plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, wet spots, sand spots, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Caleb soil is better suited to small grain, hay, and pasture than to row crops. It is susceptible to erosion, and it tends to be droughty. The organic matter content is low to very low. Capability unit IVe–3; environmental planting group 1.

Chelsea series

The Chelsea series consists of deep, moderately sloping to moderately steep, excessively drained soils. These soils are on upland side slopes and ridgetops adjacent to the major streams. They formed in windblown sand under a native vegetation of trees.

In a representative profile the surface layer is very dark grayish brown loamy fine sand about 5 inches thick. The subsurface layer is brown and dark yellowish brown loamy fine sand about 12 inches thick. The next layer is yellowish brown loamy fine sand that has thin, dark brown, horizontal bands at varied intervals.

Permeability is rapid, and available water capacity is low. The subsoil is very low in available phosphorus and potassium.

Chelsea soils are used mainly for pasture. The major hazard is erosion, and the major limitations are low natural fertility and low available water capacity.

Representative profile of uneroded Chelsea soil in an area of Chelsea loamy fine sand, 5 to 9 percent slopes, moderately eroded, 2,240 feet west and 640 feet north of the southeast corner of sec. 8, T. 77 N., R. 22 W.:

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) loamy fine sand, brown (10YR 5/3) dry; single grained; loose; neutral; gradual smooth boundary.

A2—5 to 17 inches; brown (10YR 4/3) and dark yellowish brown (10YR 4/4) loamy fine sand, pale brown (10YR 6/3) dry; single grained; loose; slightly acid; clear smooth boundary.

A&B—17 to 63 inches; yellowish brown (10YR 5/4) loamy fine sand, very pale brown (10YR 7/4) dry; single grained; very friable; discontinuous dark brown (7.5YR 3/2) ½ inch horizontal bands of B horizon material at various depths below 20 inches; medium acid.

The solum ranges from 4 feet to many feet in thickness.

The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 2 to 6 inches thick. It is medium acid to neutral. The Ap horizon is dark grayish brown (10YR 4/2), dark brown (10YR 3/3), or brown (10YR 4/3). The A2 horizon is dark grayish brown (10YR 4/2), brown (10YR 4/3), or dark yellowish brown (10YR 4/4).

The A&B horizon mainly is dark grayish brown

(10YR 4/2) to light yellowish brown (10YR 6/4), but ranges to darker colors in the horizontal bands. The A&B horizon is fine sand or loamy fine sand. It is medium acid or slightly acid.

The horizontal bands are higher in the profile than is defined in the range of the Chelsea series, but this does not significantly affect use and behavior.

Chelsea soils are associated on the landscape with Clinton, Fayette, and Ladoga soils. They have more sand than Clinton, Fayette, and Ladoga soils, which formed in loess.

63C2—Chelsea loamy fine sand, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on upland side slopes and ridgetops adjacent to the major streams. Areas are small in size and irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are areas of soils that have a thicker, darker colored surface layer.

This Chelsea soil is poorly suited to row crops. Most areas are in pasture. The soil is susceptible to erosion and to soil blowing. The low available water capacity and low natural fertility restrict uses. The organic matter content is low. Capability unit IVs–1; environmental planting group 3.

63D2—Chelsea loamy fine sand, 9 to 18 percent slopes, moderately eroded. This strongly sloping and moderately steep soil is on upland side slopes and ridgetops adjacent to major streams. Areas are small and irregular in shape.

Included with this soil in mapping are areas of soils that have a thicker, darker colored surface layer. Also included are small areas of glacial till outcrop and shale outcrop, which are indicated on the soil map by special symbols.

This Chelsea soil is not suited to row crops. Most areas are in permanent vegetation. This soil is susceptible to erosion and soil blowing. The low available water capacity and low natural fertility restrict uses. The organic matter content is low. Capability unit VIIs–1; environmental planting group 3.

Clarinda series

The Clarinda series consists of deep, moderately sloping and strongly sloping, poorly drained soils. These soils are in coves at the heads of drainageways and on the upper part of side slopes on uplands. They formed mainly in gray, highly weathered glacial till, commonly referred to as gumbotil, under a native vegetation of prairie grasses. The upper 1 to 2 feet of the profile formed in moderately fine textured material overlying the gumbotil.

In a representative profile the surface layer is very dark gray silty clay loam about 14 inches thick. The subsoil extends to a depth of 60 inches. It is dark gray silty clay in the upper part and gray silty clay in the lower part.

Permeability is very slow, and available water capacity is moderate to high. The subsoil is low in available phosphorus and low to medium in available potassium.

Clarinda soils are used mainly for pasture. The major limitation is poor internal drainage, and the major hazard is erosion.

Representative profile of Clarinda silty clay loam, 5 to 9 percent slopes, in an upland bowl-shaped cove in a pasture, 1,740 feet west and 210 feet south of the northeast corner of sec. 16, T. 75 N., R. 25 W.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam; moderate fine granular and weak very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A3—7 to 14 inches; very dark gray (10YR 3/1) and some mixing of dark grayish brown (10YR 4/2) silty clay loam; moderate fine subangular blocky structure; firm; medium acid; gradual smooth boundary.

IIB21tg—14 to 25 inches; dark gray (10YR 4/1) silty clay; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; thin discontinuous clay films; few fine dark oxides; strongly acid; gradual smooth boundary.

IIB22tg—25 to 32 inches; gray (10YR 5/1) silty clay; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very firm; thick continuous clay films; many fine dark oxides; medium acid; clear smooth boundary.

IIB23tg—32 to 42 inches; gray (5Y 5/1) silty clay; many coarse distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; very firm; thick continuous clay films; few fine dark oxides; few fine sand grains; medium acid; clear smooth boundary.

IIB3tg—42 to 60 inches; gray (5Y 6/1) silty clay; few coarse faint light olive gray (5Y 6/2) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; very firm; thick continuous clay films; few fine dark oxides; slightly acid.:

The solum is generally more than 60 inches thick.

The A horizon is black (10YR 2/1) or very dark gray (10YR 3/1) light or medium silty clay loam. It is 10 to 18 inches thick. It is slightly acid or medium acid.

The IIB2 horizon ranges from dark gray (10YR 4/1) to gray (5Y 5/1). It is silty clay or clay and is 15 to 25 inches thick. It is slightly acid to strongly acid. The IIB3 horizon is gray (5Y 5/1 and 6/1) to olive gray (5Y 5/2). It is silty clay or clay and is 15 to 20 inches thick. It ranges from neutral to medium acid.

Because of erosion, mapping units 222C2 and 222D2 have a thinner, dark colored surface layer than is defined in the range of the series.

Clarinda soils are associated on the landscape with Clearfield soils, and they formed in parent material similar to that of Lamoni soils. They are shallower to gray silty clay or clay than Clearfield soils, which formed in about 40 inches of loess over gray clay. They

have a grayer, more developed subsoil than Lamoni soils.

222C—Clarinda silty clay loam, 5 to 9 percent slopes. This moderately sloping soil is on short upland side slopes and in coves at the heads of drainageways on uplands. Areas are small and bowl shaped. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Clearfield and Lamoni soils.

This Clarinda soil is poorly suited to row crops; it is better suited to small grain or hay than to most other uses. Most areas are managed with adjacent soils. The soil is susceptible to wetness and erosion. The organic matter content is high. Capability unit IVw–1; environmental planting group 2.

222C2—Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is in coves at the heads of drainageways on uplands. It extends laterally in thin bands along side slopes. Most areas are small and bowl shaped. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are small areas of Clearfield and Lamoni soils.

This Clarinda soil is poorly suited to row crops; it is better suited to small grain or hay than to most other uses. Most areas are managed with adjacent soils. The soil is susceptible to wetness and erosion. The clayey subsoil is within plow depth in many places, and because of this poor tilth is a concern. Also, the subsoil is much less favorable for root growth than the original surface layer. The organic matter content is moderate. Capability unit IVw–1; environmental planting group 2.

222D2—Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on side slopes below the heads of drainageways on uplands. Areas are small in size and irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are small areas of Lamoni soils.

This Clarinda soil is poorly suited to row crops; it is better suited to small grain and hay than to most other uses. Most areas are in pasture. The soil is susceptible to erosion and wetness. The clayey subsoil is within plow depth in many places, and because of this poor tilth is a concern. Also, the subsoil is much less favorable for root growth than the original surface layer. The organic matter content is low to moderate. Capability unit IVe–2; environmental planting group 2.

Clearfield series

The Clearfield series consists of deep, moderately sloping, somewhat poorly drained and poorly drained soils. These soils are in coves at the heads of drainageways on uplands. They formed in loess under a native vegetation of tall water-tolerant prairie grasses.

In a representative profile the surface layer is silty clay loam about 18 inches thick; it is black in the upper part and very dark gray in the lower part. The subsoil extends to a depth of 41 inches; it is dark gray silty clay loam in the upper part, dark gray silty clay in the middle part, and dark gray silty clay loam in the lower part. Below this is buried, dark gray silty clay derived from highly weathered glacial till or gumbotil.

Permeability is moderately slow in the upper part of the profile, and very slow in the lower part. Available water capacity is high. The subsoil is low in available phosphorus and potassium.

Clearfield soils are used mainly for row crops, and they are commonly managed with adjacent Sharpsburg soils. The major hazard is erosion, and the major limitation is wetness.

Representative profile of Clearfield silty clay loam, 5 to 9 percent slopes, on a gently sloping side slope in a pasture, 600 feet south and 150 feet east of the northwest corner of sec. 5, T. 75 N., R. 22 W.:

Ap—0 to 6 inches; black (10YR 2/1) medium silty clay loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A12—6 to 13 inches; black (10YR 2/1) medium silty clay loam; weak very fine subangular blocky structure parting to moderate fine and medium granular; friable; neutral; clear smooth boundary.

A3—13 to 18 inches; very dark gray (10YR 3/1) medium silty clay loam, very dark grayish brown (10YR 3/2) kneaded; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate very fine subangular blocky structure; friable; few very fine dark oxides; neutral; gradual smooth boundary.

B21tg—18 to 23 inches; dark gray (10YR 4/1) heavy silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles and many fine and medium distinct olive brown (2.5Y 4/4) mottles; weak medium prismatic structure parting to moderate very fine subangular blocky; friable; thin discontinuous clay films; few fine and medium dark oxides; neutral; gradual smooth boundary.

B22tg—23 to 32 inches; dark gray (10YR 4/1) light silty clay; many fine distinct yellowish brown (10YR 5/4 and 5/6) mottles and many fine and medium distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; thin discontinuous clay films; very fine and fine dark oxides; neutral; gradual smooth boundary.

B23tg—32 to 41 inches; dark gray (5Y 4/1) heavy silty clay loam; many fine distinct yellowish brown (10YR 5/4, 5/6, and 5/8) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous

clay films; very fine dark oxides; neutral; gradual smooth boundary.

IIB1b—41 to 46 inches; dark gray (5Y 4/1) silty clay; many fine distinct dark brown (7.5YR 4/4) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak coarse subangular blocky; firm; very fine dark oxides; neutral; abrupt smooth boundary.

IIB2b—46 to 60 inches; dark gray (10YR 4/1) silty clay; common fine distinct dark brown (7.5YR 4/4) mottles; very firm; neutral.

The solum is typically about 48 inches thick, and it ranges from 36 to 60 inches in thickness.

The A horizon is black (N 2/0) to very dark grayish brown (10YR 3/2). It is 10 to 20 inches thick and is neutral or slightly acid.

The B2 horizon is dark gray (10YR 4/1) to dark gray (5Y 4/1). The B2tg horizon is heavy silty clay loam or light silty clay. It is 15 to 25 inches thick and is neutral or slightly acid. The IIBb horizon is very dark gray (10YR 3/1) to gray (5Y 5/1). It is neutral or slightly acid.

Clearfield soils are associated on the landscape with Clarinda soils, and they formed in parent material similar to that of Macksburg and Sharpsburg soils. They have less clay in the subsoil than Clarinda soils. They have a thinner surface layer and a grayer and more clayey subsoil than Macksburg soils. They have a thicker surface layer and a grayer subsoil than Sharpsburg soils.

69C—Clearfield silty clay loam, 5 to 9 percent slopes. This moderately sloping soil is in coves at the heads of drainageways on uplands. Areas are small and bowl shaped. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are spots of gray clay, which are indicated on the soil map by a special symbol. Also included are small areas of Nira soils.

This Clearfield soil is moderately well suited to row crops. It is susceptible to wetness and erosion. The organic matter content is high. Capability unit IIIw–1; environmental planting group 2.

69C2—Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is in coves at the heads of drainageways on uplands. Areas are small and bowl shaped. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of gray clay, spots of red clay, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are small areas of Nira soils.

This Clearfield soil is moderately well suited to row crops. It is susceptible to wetness and to erosion. The loss of as much as 1 foot or more of the original surface layer has increased the hazard of wetness. The depth to the clayey layer, which causes seepage, has been reduced by the erosion. The organic matter content is high. Capability unit IIIw–1; environmental planting group 2.

Clinton series

The Clinton series consists of deep, gently sloping to strongly sloping, moderately well drained soils. These soils are on convex ridgetops and side slopes on uplands. They formed in loess under a native vegetation of trees.

In a representative profile the surface layer is very dark grayish brown silt loam about 5 inches thick. The subsurface layer is brown silt loam about 10 inches thick. The subsoil extends to a depth of 60 inches; it is dark yellowish brown silty clay loam in the upper part, yellowish brown silty clay in the middle part, and yellowish brown silty clay loam in the lower part.

Permeability is moderately slow, and available water capacity is high. The subsoil is high in available phosphorus and very low in available potassium.

Clinton soils are used mainly for row crops, hay, and pasture (fig. 13). The major hazard is erosion.

Representative profile of Clinton silt loam, 2 to 5 percent slopes, on a gently sloping upland ridge in timber, 2,300 feet east and 450 feet north of the southwest corner of sec. 2, T. 75 N., R. 23 W.:

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; very friable; neutral; clear smooth boundary.

A21—5 to 9 inches; brown (10YR 5/3) silt loam; very pale brown (10YR 7/3) dry; moderate thin platy structure; friable; slightly acid; clear smooth boundary.

A22—9 to 15 inches; brown (10YR 4/3) heavy silt loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B1t—15 to 19 inches; dark yellowish brown (10YR 4/4) medium silty clay loam; strong fine subangular and angular blocky structure; firm; thin discontinuous clay films on faces of peds; continuous gray silt coatings; few dark oxides; medium acid; clear smooth boundary.

B21t—19 to 27 inches; yellowish brown (10YR 5/4) light silty clay; dark yellowish brown (10YR 4/4) faces of peds; strong fine angular and subangular blocky structure; firm; thin continuous clay films; discontinuous gray silt coatings; few dark oxides; medium acid; gradual smooth boundary.

B22t—27 to 38 inches; yellowish brown (10YR 5/4) light silty clay; dark yellowish brown (10YR 4/4) faces of peds; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to strong medium angular blocky; firm; thin continuous clay films; discontinuous gray silt coatings; com-

Figure 13.—**An area of a Clinton soil in the foreground that has been cleared of native trees and sown to improved grasses for pasture. Trees in the background are on infertile Gosport soils.**

mon fine dark oxides; medium acid; gradual smooth boundary.

B23t—38 to 46 inches; yellowish brown (10YR 5/4) medium silty clay loam; brown (10YR 4/3) faces of peds; few fine distinct light brownish gray (2.5Y 6/2) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to strong fine angular blocky; firm; thin continuous clay films on vertical faces of peds; common fine dark oxides; medium acid; gradual smooth boundary.

B3—46 to 60 inches; yellowish brown (10YR 5/4) light silty clay loam; few fine distinct light olive gray (5Y 6/2) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak fine angular blocky; friable; thin discontinuous clay films on vertical faces of peds; common fine dark oxides; medium acid.

The solum ranges from 42 to 84 inches in thickness. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 2 to 5 inches thick and is neutral to strongly acid.

The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 5/3). It is 6 to 10 inches thick and is slightly acid to strongly acid.

The B2t horizon is dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4) light silty clay to medium silty clay loam 18 to 36 inches thick. It is medium acid or strongly acid.

Clinton soils are associated on the landscape with Keswick and Lindley soils, and they formed in parent material similar to that of Ladoga soils. They have less reddish hue than Keswick soils. Clinton soils contain less sand and pebbles than Keswick and Lindley soils, which are downslope and formed in glacial till. They have a thinner surface layer than Ladoga soils.

80B—Clinton silt loam, 2 to 5 percent slopes. This gently sloping soil is on convex ridgetops on uplands. Areas are long and narrow or irregular in shape. They range from a few acres to 20 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small sand

spots, which are indicated on the soil map by a special symbol. Also included are some areas that are somewhat poorly drained.

This Clinton soil is well suited to row crops. It is susceptible to erosion. The organic matter content is low. Capability unit IIe–2; environmental planting group 1.

80C2—Clinton silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on long, convex ridgetops and side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are areas that are slightly eroded. Also included are some spots of red clay, spots of gray clay, and sand spots, all of which are indicated on the soil map by special symbols.

This Clinton soil is moderately well suited to row crops if erosion is controlled. It is susceptible to erosion. The organic matter content is low. Capability unit IIIe–2; environmental planting group 1.

80D2—Clinton silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on long, narrow, convex ridgepoints and side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of red clay, small areas of shale outcrop, and some areas of severely eroded Clinton soils, all of which are indicated on the soil map by special symbols.

This Clinton soil is moderately well suited to row crops. Most areas are in permanent pasture and woodland. The soil is susceptible to erosion. The organic matter content is low. Capability unit IIIe–2; environmental planting group 1.

Colo series

The Colo series consists of deep, nearly level to gently sloping, poorly drained soils. These soils are on broad bottom lands and narrow drainageways on uplands. They formed in alluvium under a native vegetation of mixed prairie grasses and trees tolerant to wetness.

In a representative profile the surface layer is black silty clay loam about 25 inches thick. The next layer is very dark gray silty clay loam that extends to a depth of 40 inches. The substratum is very dark gray and dark gray silty clay loam.

Permeability is moderately slow, and available water capacity is high. The subsoil is medium in available phosphorus and potassium.

Colo series are used mainly for row crops and pasture. The major limitation is wetness.

Representative profile of Colo silty clay loam, 2 to 5 percent slopes, in a cultivated field, 720 feet south and 60 feet west of the northeast corner of sec. 1, T. 74 N., R. 25 W.:

Ap—0 to 8 inches; black (N 2/0) silty clay loam; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—8 to 13 inches; black (N 2/0) silty clay loam; moderate fine angular blocky structure; friable; neutral; gradual smooth boundary.

A13—13 to 19 inches; black (10YR 2/1) silty clay loam; weak fine and medium prismatic structure parting to weak fine subangular blocky; friable; neutral; diffuse smooth boundary.

A14—19 to 25 inches; black (10YR 2/1) silty clay loam; few fine distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; few dark oxides; neutral; gradual smooth boundary.

ACg—25 to 40 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; firm; few fine dark oxides; neutral; diffuse smooth boundary.

C1g—40 to 46 inches; very dark gray (10YR 3/1) silty clay loam; dark gray (10YR 4/1) faces of peds; few fine distinct yellowish brown (10YR 5/6) and dark brown (10YR 3/3) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; firm; few fine dark oxides; neutral; gradual smooth boundary.

C2g—46 to 60 inches; dark gray (10YR 4/1) and some very dark gray (10YR 3/1) silty clay loam; common fine distinct yellowish brown (10YR 5/6) and dark brown (10YR 3/3) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; few fine dark oxides; neutral.

The solum ranges from 36 to 54 inches in thickness. The A horizon is black (N 2/0) to very dark gray (10YR 3/1). It is 25 to 40 inches thick and is alkaline to medium acid. The AC horizon is black (10YR 2/1) or very dark gray (10YR 3/1). It is 0 to 15 inches thick, and is mildly alkaline to slightly acid.

The C horizon is very dark gray (10YR 3/1) or dark gray (10YR 4/1). It is mildly alkaline or neutral.

Colo soils are associated on the landscape with Ely soils, and they formed in parent material similar to that of Kennebec, Wabash, and Zook soils. They have a thicker dark colored surface layer than Ely soils. They contain more clay than Kennebec soils and have less clay than Wabash and Zook soils.

133—Colo silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad bottom lands. Areas range from a few acres to several hundred acres in size.

Included with this soil in mapping are sand spots and wet spots, which are indicated on the soil map by special symbols. Also included are areas of Colo soils that have 8 to 12 inches of silty, stratified overwash.

This Colo soil is well suited to row crops. It is susceptible to wetness. The organic matter content is high. Capability unit IIw–2; environmental planting group 2.

133B—Colo silty clay loam, 2 to 5 percent slopes. This gently sloping soil is on foot slopes adjacent to upland side slopes and in small valleys. Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are wet spots, which are indicated on the soil map by a special symbol. Also included are some soils that are similar to this Colo soil but are sandier.

This Colo soil is well suited to row crops. Most areas are managed with adjacent soils, and many areas are in pasture. The soil is susceptible to wetness and gully erosion. The organic matter content is high. Capability unit IIw–3; environmental planting group 2.

11B—Colo-Ely silty clay loams, 2 to 5 percent slopes. These gently sloping soils are in upland drainageways. The Colo soil is near the stream, and the Ely soil is on foot slopes. This complex is about 60 percent Colo silty clay loam and 40 percent Ely silty clay loam. Areas of this complex are long and narrow.

Included with these soils in mapping are areas of soils that have 8 to 18 inches of silty, stratified overwash.

These soils are well suited to row crops. Some areas are used for grassed waterways, and many areas are in pasture. The soils are susceptible to wetness and gully erosion. The organic matter content is high. Capability unit IIw–3; environmental planting group 2.

Downs series

The Downs series consists of deep, nearly level to strongly sloping, well drained soils. These soils are on upland ridgetops and side slopes and on benches adjacent to the major streams. They formed in loess under a native vegetation of mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil extends to a depth of 48 inches; it is brown silt loam in the upper part, brown and dark yellowish brown silty clay loam in the middle part, and yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam.

Permeability is moderate, and available water capacity is high. The subsoil is medium in available phosphorus and very low in available potassium.

Downs soils are used mainly for row crops and pasture. Some areas are in woodland. The major hazard is erosion.

Representative profile of Downs silt loam, 2 to 5 percent slopes, in a cultivated field, 1,425 feet west and 115 feet south of the northeast corner of the SE¼ sec. 16, T. 77 N., R. 22 W.:

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; moderate very fine granular structure; friable; medium acid; clear smooth boundary.

A2—7 to 12 inches; dark grayish brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) faces of peds, grayish brown (10YR 5/2) dry; weak medium platy structure parting to moderate very fine granular; friable; medium acid; clear smooth boundary.

B1—12 to 19 inches; brown (10YR 4/3) heavy silt loam; dark brown (10YR 3/3) and dark yellowish brown (10YR 3/4) faces of peds; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; thin discontinuous clay films; thin discontinuous silt coatings; medium acid; gradual smooth boundary.

B21t—19 to 29 inches; brown (10YR 4/3) light silty clay loam; weak medium subangular blocky structure parting to moderate fine subangular and angular blocky; friable; thin continuous clay films; thin discontinuous silt coatings; strongly acid; gradual smooth boundary.

B22t—29 to 40 inches; dark yellowish brown (10YR 4/4) light silty clay loam; weak medium prismatic structure parting to strong fine subangular and angular blocky; friable; thin discontinuous clay films; thin continuous silt coatings; very strongly acid; gradual smooth boundary.

B3—40 to 48 inches; yellowish brown (10YR 5/4) light silty clay loam; few fine faint light brownish gray (10YR 6/2) mottles, many fine distinct grayish brown (2.5Y 5/2) mottles, and common fine faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine and very fine subangular blocky; friable; thin discontinuous clay films; thin discontinuous silt coatings; few fine dark oxides; strongly acid; gradual smooth boundary.

C—48 to 60 inches; light brownish gray (2.5Y 6/2) light silty clay loam; brown (10YR 4/3) faces of peds; many fine prominent yellowish brown (10YR 5/8) mottles; weak medium prismatic structure; friable; thin discontinuous clay films and dark organic stains on faces of prisms; thin discontinuous silt coatings; few fine dark oxides; strongly acid.

The solum ranges from 36 to 72 inches in thickness. The Ap horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick and is slightly acid or medium acid.

The B2t horizon is dark brown (10YR 3/3) to yellowish brown (10YR 5/4) light or medium silty clay loam. It is 12 to 25 inches thick and is medium acid to very strongly acid. The B3 horizon is dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) heavy silt loam or light silty clay loam. It is 10 to 30 inches thick and is medium acid or strongly acid.

Downs soils are associated on the landscape with Gara soils, and they formed in parent material similar

to that of Fayette and Tama soils. They have less sand and fewer pebbles in the solum than Gara soils, which are downslope and formed in glacial till. They have a thicker surface layer than Fayette soils. They have an A2 horizon and Tama soils do not.

162—Downs silt loam, 0 to 2 percent slopes. This nearly level soil is on broad upland ridgetops. Areas are small in size and irregular in shape. This soil has a profile similar to the one described as representative of the series, but the subsoil contains more gray mottles.

Included with this soil in mapping are areas of somewhat poorly drained soils that are susceptible to wetness.

This Downs soil is well suited to intensive row crops. The organic matter content is high. Capability unit I–1; environmental planting group 1.

162B—Downs silt loam, 2 to 5 percent slopes. This gently sloping soil is on upland ridgetops. Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are areas of moderately eroded soils. In these areas, the surface layer is thinner and in some places plowing has mixed material from the subsoil into the surface layer. Also included are sand spots, which are indicated on the soil map by a special symbol.

This Downs soil is well suited to row crops. It is susceptible to erosion. The organic matter content is moderate. Capability unit IIe–1; environmental planting group 1.

162C2—Downs silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on long, convex ridgetops and side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are areas of slightly eroded soils. Also included are spots of severely eroded soils, seepy wet spots, sand spots, spots of red clay, and glacial till outcrop, all of which are indicated on the soil map by special symbols.

This Downs soil is moderately well suited to row crops. It is susceptible to erosion. The organic matter content is moderate to low. Capability unit IIIe–1; environmental planting group 1.

162D2—Downs silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, spots of gray clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Downs soil is moderately well suited to row crops. Some areas are in pasture. The soil is susceptible to erosion. The organic matter content is moderate to very low. Capability unit IIIe–1; environmental planting group 1.

T162B—Downs silt loam, benches, 2 to 5 percent slopes. This gently sloping soil is on long, convex benches along major streams. Areas are long and narrow or irregular in shape. Slopes are typically short.

Included with this soil in mapping are sand spots, which are indicated on the soil map by a special symbol. Also included are some areas of moderately sloping Downs soils, which are indicated on the soil map by a special symbol for short, steep slopes.

This Downs soil is well suited to row crops. It is susceptible to erosion. The organic matter content is moderate. Capability unit IIe–1; environmental planting group 1.

Ely series

The Ely series consists of deep, gently sloping, somewhat poorly drained soils. These soils are on narrow foot slopes and alluvial fans. They formed in alluvium from adjacent slopes under a native vegetation of prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown silty clay loam about 22 inches thick. The silty clay loam subsoil extends to a depth of 55 inches; it is mostly very dark grayish brown in the upper part, brown in the middle part, and dark grayish brown in the lower part. The substratum is grayish brown silt loam.

Permeability is moderate, and available water capacity is high. The subsoil is very low in available phosphorus and potassium.

Ely soils are used mainly for row crops. The major hazard is erosion. Areas are too small to be managed separately and are generally managed with the adjacent soils.

Representative profile of Ely silty clay loam, 2 to 5 percent slopes, on a cultivated foot slope, 1,205 feet west and 520 feet north of the southeast corner of sec. 5, T. 76 N., R. 22 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) light silty clay loam; moderate fine granular structure; friable; medium acid; abrupt smooth boundary.

A12—8 to 17 inches; very dark brown (10YR 2/2) medium silty clay loam; black (10YR 2/1) faces of peds; moderate fine granular structure; friable; medium acid; clear smooth boundary.

A13—17 to 22 inches; very dark grayish brown (10YR 3/2) medium silty clay loam; very dark gray (10YR 3/1) faces of peds; moderate fine subangular blocky structure parting to moderate fine granular; friable; medium acid; clear smooth boundary.

B1—22 to 32 inches; very dark grayish brown (10YR 3/2) medium silty clay loam; few fine faint dark yellowish brown (10YR 3/4) mottles; moderate very fine and fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21—32 to 39 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) and dark gray (10YR 4/1) faces of peds; common fine faint dark brown (10YR 3/3) mottles and few fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; few fine dark oxides; medium acid; gradual smooth boundary.

B22—39 to 47 inches; brown (10YR 4/3) silty clay loam; dark grayish brown (10YR 4/2) faces of peds; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles and few fine distinct strong brown (7.5YR 5/6) and grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine dark oxides; slightly acid; gradual smooth boundary.

B3—47 to 55 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) and strong brown (7.5YR 5/6) mottles and few fine distinct grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine dark oxides; slightly acid; gradual smooth boundary.

C—55 to 84 inches; grayish brown (2.5Y 5/2) silt loam; common fine distinct dark yellowish brown (10YR 4/4) and strong brown (7.5YR 5/6) mottles; massive; friable; few fine dark oxides; slightly acid.

The solum is generally more than 48 inches thick, but it ranges from 40 to 66 inches in thickness.

The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) silt loam to medium silty clay loam. It is 15 to 25 inches thick and is neutral to medium acid.

The B2 horizon is brown (10YR 4/3) to dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2). It is 10 to 20 inches thick and is slightly acid or medium acid. The B3 horizon is dark grayish brown (10YR 4/2) to brown (10YR 5/3) and is 5 to 10 inches thick.

The C horizon is grayish brown (2.5Y 5/2) or brown (10YR 5/3) and is neutral or slightly acid.

Ely soils are associated on the landscape with Colo soils and formed in parent material similar to that of Judson soils. They are better drained and have a thinner surface layer than Colo soils. They have a grayer subsoil than Judson soils.

428B—Ely silty clay loam, 2 to 5 percent slopes. This gently sloping soil is on foot slopes and alluvial fans. Areas are small in size and irregular in shape. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Colo soils.

This Ely soil is well suited to intensive row crops. It is generally managed with adjacent soils. It is susceptible to erosion and overflow from the adjoining uplands. The organic matter content is high. Capability unit IIe–3; environmental planting group 1.

Fayette series

The Fayette series consists of deep, gently sloping to steep, well drained soils. These soils are on convex upland ridgetops and side slopes. They formed in loess under a native vegetation of trees.

In a representative profile the surface layer is very dark gray silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 7 inches thick. The subsoil extends to a depth of 45 inches; it is brown silt loam in the upper part, dark yellowish brown silty clay loam in the middle part, and yellowish brown silty clay loam in the lower part. The substratum is yellowish brown silt loam.

Permeability is moderate, and available water capacity is high. The subsoil is high in available phosphorus and very low in available potassium.

Fayette soils are used mainly for row crops and pasture. Some areas are in woodland. The major hazard is erosion.

Representative profile of Fayette silt loam, 2 to 5 percent slopes, in timber, 1,800 feet north and 800 feet east of the southwest corner of sec. 11, T. 77 N., R. 22 W.:

A1—0 to 4 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A2—4 to 11 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak thin platy structure; friable; slightly acid; clear smooth boundary.

B1t—11 to 17 inches; brown (10YR 4/3) heavy silt loam; weak medium platy structure parting to weak very fine subangular blocky; friable; thin discontinuous clay films; thin continuous gray silt coatings; slightly acid; clear smooth boundary.

B21t—17 to 25 inches; dark yellowish brown (10YR 4/4) light silty clay loam; strong fine and medium angular and subangular blocky structure; firm; thin continuous clay films; thin continuous gray silt coatings; slightly acid; gradual smooth boundary.

B22t—25 to 36 inches; dark yellowish brown (10YR 4/4) medium silty clay loam; moderate medium angular and subangular blocky structure; firm; thin continuous clay films; thin discontinuous gray silt coatings; few fine dark oxides; slightly acid; gradual smooth boundary.

B3t—36 to 45 inches; yellowish brown (10YR 5/4) light silty clay loam; dark yellowish brown (10YR 4/4) faces of peds; weak medium prismatic structure parting to weak fine subangular blocky; friable;

thin discontinuous clay films; thin discontinuous gray silt coatings; few fine dark oxides; medium acid; gradual smooth boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4) medium silt loam; massive; friable; medium acid.

The solum ranges from 36 to 60 inches in thickness. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 1 inch to 4 inches thick and is neutral or slightly acid.

The B2t horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4) light or medium silty clay loam. It is 10 to 25 inches thick and is slightly acid to very strongly acid. The B3t horizon is dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) heavy silt loam or light silty clay loam. It is 9 to 18 inches thick and is medium acid or strongly acid.

Fayette soils are associated on the landscape with Chelsea and Gosport soils, and they formed in parent material similar to that of Downs soils. They contain less sand than Chelsea soils. They contain less clay than Gosport soils, which are downslope and formed in shale. They have a thinner surface layer than Downs soils.

163B—Fayette silt loam, 2 to 5 percent slopes. This gently sloping soil is on upland ridgetops. Areas are small and irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are sand spots, which are indicated on the soil map by a special symbol.

This Fayette soil is well suited to row crops. It is susceptible to erosion. The organic matter content is low. Capability unit IIe–2; environmental planting group 1.

163C2—Fayette silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on upland ridgetops and side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, sand spots, and wet spots, all of which are indicated on the soil map by special symbols.

This Fayette soil is moderately well suited to row crops and pasture. Some areas are in woodland. The soil is susceptible to erosion. The organic matter content is low to very low. Capability unit IIIe–2; environmental planting group 1.

163D2—Fayette silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer. The subsoil is exposed at the surface in some areas.

Included with this soil in mapping are spots of severely eroded soils, sand spots, spots of red clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Fayette soil is moderately well suited to row crops. Some areas are in woodland. The soil is susceptible to erosion. Erosion is more difficult to control on this soil than on moderately sloping Fayette soils. The organic matter content is low to very low. Capability unit IIIe–2; environmental planting group 1.

163E2—Fayette silt loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed subsoil material with the surface layer.

Included with this soil in mapping are spots of severely eroded soil, sand spots, spots of red clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are soils that have a thicker surface layer.

This Fayette soil is poorly suited to row crops; it is better suited to small grain and hay than to most other uses. Many areas are in pasture and woodland. Farm equipment can be used. The soil is susceptible to erosion. The organic matter content is very low. Capability unit IVe–1; environmental planting group 1.

163F2—Fayette silt loam, 18 to 25 percent slopes, moderately eroded. This steep soil is on upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner.

Included with this soil in mapping are small sand spots, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Fayette soil is generally unsuited to cultivated crops. Most areas are in woodland and pasture. The use of farm machinery requires caution because of the steepness of slopes, but in most places it can be used to improve pasture. The soil is susceptible to erosion. The organic matter content is very low. Capability unit VIe–1; environmental planting group 1.

Gara series

The Gara series consists of deep, strongly sloping to very steep, moderately well drained and well drained soils. These soils are on convex side slopes of uplands. They formed in glacial till under a native vegetation of prairie grasses and trees.

In a representative profile the surface layer is very dark gray loam about 8 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The clay loam subsoil extends to a depth of 40 inches; it is brown in the upper part and yellowish brown in the lower part. The substratum is yellowish brown clay loam.

Permeability is moderately slow, and available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium.

Gara soils are used mainly for pasture and woodland. The major hazard is erosion.

Representative profile of Gara loam, 25 to 40 percent

slopes, in a pasture, 1,120 feet west and 150 feet north of the southeast corner of sec. 3, T. 74 N., R. 23 W.:

A1—0 to 8 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak thin platy structure parting to weak fine granular; very friable; thin continuous gray silt coatings; neutral; clear smooth boundary.

A2—8 to 14 inches; dark grayish brown (10YR 4/2) loam, brown (10YR 5/3) dry; weak thin platy structure parting to weak fine granular; very friable; thin continuous gray silt coatings; neutral; clear smooth boundary.

B21t—14 to 19 inches; brown (10YR 4/3) clay loam; moderate fine subangular blocky structure; friable; thin continuous clay films; thin continuous gray silt coatings; slightly acid; gradual smooth boundary.

B22t—19 to 28 inches; yellowish brown (10YR 5/4) clay loam; moderate fine subangular blocky structure; friable; thin continuous clay films; thin discontinuous gray silt coatings; medium acid; gradual smooth boundary.

B3t—28 to 40 inches; yellowish brown (10YR 5/4) clay loam; common moderate distinct yellowish brown (10YR 5/8) mottles; moderate fine subangular blocky structure; firm; thin discontinuous clay films; very strongly acid; clear smooth boundary.

C—40 to 60 inches; yellowish brown (10YR 5/4) clay loam; gray (10YR 6/1) veins; common fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; firm; thin discontinuous clay films on vertical faces of peds; numerous carbonate concretions; strong effervescence; mildly alkaline.

The solum is typically 40 to 48 inches thick, but it ranges from 36 to 70 inches in thickness.

The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) loam or silt loam. It is 6 to 10 inches thick and is neutral to medium acid. The A2 horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3) and is 4 to 8 inches thick.

The B2t horizon is brown (10YR 4/3) to yellowish brown (10YR 5/4). It is 14 to 34 inches thick and is slightly acid to very strongly acid.

The C horizon is dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) and is strongly acid to mildly alkaline.

The Gara soil in mapping unit 993E3 has a thinner or lighter colored surface layer than the defined range for the series, but this difference does not alter the usefulness or behavior of the soil.

Gara soils are associated on the landscape with Armstrong, Gosport, Grundy, Ladoga, and Pershing soils. They formed in parent material similar to that of Lindley soils. They lack the reddish hue of the Armstrong soils and contain less clay than Armstrong soils. They have less clay and a thicker surface layer than Gosport soils, which are downslope and formed in shale. They contain more sand in the subsoil than Grundy, Ladoga, and Pershing soils, which are upslope and formed in loess. They have a thicker surface layer than Lindley soils.

179D2—Gara loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex ridges and side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and the subsoil is thicker. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are areas of slightly eroded soils.

This Gara soil is poorly suited to row crops; it is better suited to small grain, hay, and pasture than to most other uses. Row crops can be grown occasionally as the first step in improving grass and legume stands. The soil is susceptible to erosion. The organic matter content is moderately low to low. Capability unit IVe–3; environmental planting group 1.

179E2—Gara loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on convex side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and the subsoil is thicker. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, spots of gray clay, sand spots, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are areas of slightly eroded soils.

This Gara soil is generally unsuited to cultivated crops; it is better suited to hay and pasture than to most other uses. Farm machinery can be used safely in most areas to improve stands of grass and legumes. Some areas are in woodland. The soil is susceptible to erosion. The organic matter content is moderately low to low. Capability unit VIe–1; environmental planting group 1.

179F2—Gara loam, 18 to 25 percent slopes, moderately eroded. This steep soil is on convex side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and the subsoil is thicker.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, spots of gray clay, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Gara soil is not suited to row crops or hay; it is better suited to pasture or woodland than to most other uses. Caution is needed if farm machinery is used. Many areas are in woodland. The soil is susceptible to erosion. The organic matter content is moderately low to low. Capability unit VIIe–2; environmental planting group 1.

179G—Gara loam, 25 to 40 percent slopes. This very steep soil is on convex side slopes on uplands.

Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are spots of severely eroded soils. Also included is shale outcrop that causes vertical escarpments. These areas are indicated on the soil map by a special symbol for rock outcrop.

This Gara soil is not suited to row crops or hay; it is better suited to pasture and woodland than to most other uses. Most areas are too steep to safely use farm machinery. Many areas are in woodland. The soil is susceptible to erosion. The organic matter content is moderately low to low. Capability unit VIIe–2; environmental planting group 1.

Givin series

The Givin series consists of deep, nearly level, somewhat poorly drained soils. These soils are on broad upland ridgetops. They formed in loess under a native vegetation of mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The silty clay loam subsoil extends to a depth of 53 inches; it is dark grayish brown in the upper part and grayish brown in the lower part. The substratum is mixed grayish brown and light brownish gray silty clay loam.

Permeability is moderately slow, and available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium.

Givin soils are used mainly for row crops. The major limitation is wetness.

Representative profile of Givin silt loam, 0 to 2 percent slopes, in a cultivated field, 118 feet north and 122 feet east of the southwest corner of sec. 11, T. 75 N., R. 23 W.:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A2—7 to 11 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak thin platy structure; friable; thin continuous gray silt coatings; medium acid; clear smooth boundary.

B1—11 to 17 inches; dark grayish brown (10YR 4/2) light silty clay loam; few fine faint yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; friable; thick continuous gray silt coatings; strongly acid; clear smooth boundary.

B21t—17 to 22 inches; dark grayish brown (10 YR 4/2) medium silty clay loam; few fine faint yellowish brown (10YR 5/4) mottles and few fine distinct brown (7.5YR 5/4) mottles; strong fine and medium subangular and angular blocky structure; firm; thin continuous clay films; thin discontinuous gray silt coatings; few fine dark oxides; strongly acid; gradual smooth boundary.

B22t—22 to 29 inches; dark grayish brown (10YR 4/2) and grayish brown (2.5Y 5/2) heavy silty clay loam; common fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to strong fine angular and subangular blocky; firm; thin continuous clay films; few fine and medium dark oxides; strongly acid; gradual smooth boundary.

B23t—29 to 39 inches; grayish brown (2.5Y 5/2) medium silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to strong fine angular blocky; firm; thin discontinuous clay films; common fine and medium dark oxides; medium acid; gradual smooth boundary.

B3t—39 to 53 inches; grayish brown (2.5Y 5/2) medium silty clay loam; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; firm; thin discontinuous clay films on vertical faces of peds; few fine and medium dark oxides; medium acid; gradual smooth boundary.

C—53 to 60 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) light silty clay loam; common fine distinct strong brown (7.5YR 5/8) and yellowish brown (10YR 5/6) mottles; massive; friable; few fine dark oxides; medium acid.

The solum is typically more than 48 inches thick, but it ranges from 40 to 60 inches in thickness.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 6 to 9 inches thick. It is neutral to medium acid. The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) and is 2 to 6 inches thick.

The B2t horizon is dark grayish brown (10YR 4/2) to grayish brown (2.5Y 5/2) medium or heavy silty clay loam. It is 5 to 15 inches thick and is medium acid or strongly acid.

These Givin soils are grayer below the surface layer than is typical for the Givin series, but this does not significantly affect use and behavior.

Givin soils are associated on the landscape with Ladoga and Macksburg soils. They also formed in parent material similar to that of those soils. They have a grayer subsoil and more mottles than Ladoga soils. They have a thinner surface layer than Macksburg soils.

75—Givin silt loam, 0 to 2 percent slopes. This nearly level soil is on broad upland ridgetops. Areas are small in size and irregular in shape.

Included with this soil in mapping are areas of soils that have a thinner surface layer and a more clayey subsoil. Also included are some areas of Ladoga soil that are better drained than this Givin soil.

This Givin soil is well suited to intensive row crops. It is susceptible to wetness, but this is a slight limita-

tion. The organic matter content is moderate. Capability unit I–1; environmental planting group 1.

Gosport series

The Gosport series consists of strongly sloping to very steep, moderately well drained soils that have a clayey, shaley subsoil at a depth of about 1 foot. These soils are on convex side slopes on uplands. They formed in residuum weathered from gray and brown acid shale under a native vegetation of trees.

In a representative profile the surface layer is very dark gray silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The silty clay subsoil extends to a depth of 23 inches; it is yellowish brown in the upper part, light olive brown in the middle part, and olive brown in the lower part. The substratum is olive gray clay.

Permeability is very slow, and available water capacity is low to moderate. The subsoil is very low in available phosphorus and low in available potassium.

Gosport soils are used mainly for woodland and pasture (fig. 14). The major hazard is erosion, and the major limitation is poor fertility.

Representative profile of Gosport silt loam, 18 to 35 percent slopes, in timber, 400 feet west and 500 feet north of the southeast corner of sec. 15, T. 74 N., R. 22 W.:

A1—0 to 4 inches; very dark gray (10YR 3/1) heavy silt loam, gray (10YR 5/1) dry; weak thin platy structure parting to weak very fine and fine granular; friable; slightly acid; clear smooth boundary.

A2—4 to 8 inches; dark grayish brown (10YR 4/2) heavy silt loam, light brownish gray (10YR 6/2) dry; weak thin platy structure; friable; slightly acid; clear smooth boundary.

B1—8 to 11 inches; yellowish brown (10YR 5/4) light silty clay; moderate fine subangular blocky structure; friable; thin continuous gray silt coatings; strongly acid; clear smooth boundary.

B2—11 to 18 inches; light olive brown (2.5Y 5/4) medium silty clay; moderate medium angular blocky structure; firm; thick continuous gray silt coatings; strongly acid; gradual smooth boundary.

B3—18 to 23 inches; olive brown (2.5Y 4/4) heavy silty clay; few fine faint strong brown (7.5YR 5/6) mottles; weak fine

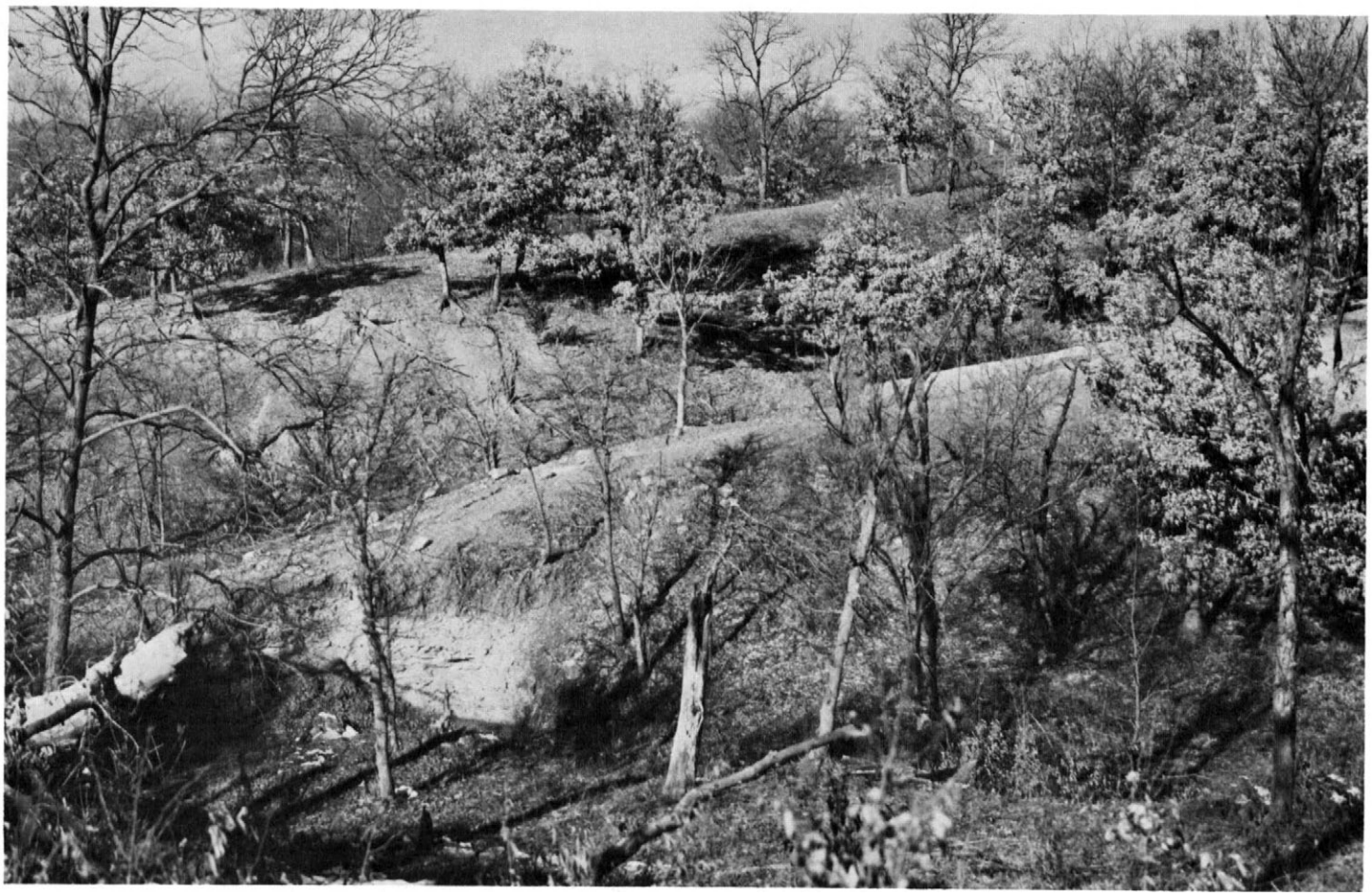

Figure 14.—Typical area of Gosport soils in woodland.

and medium angular blocky and subangular blocky structure; firm; thin discontinuous gray silt coatings; strongly acid; gradual smooth boundary.

C—23 to 60 inches; olive gray (5Y 5/2) clay; common medium distinct brownish yellow (10YR 6/6) mottles; weak medium platy structure; extremely firm; strongly acid.

The solum is typically 20 to 30 inches thick, but it ranges to 40 inches in thickness.

The A1 horizon is very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). It typically is silty clay loam, silt loam, loam, sandy loam, or clay loam, but in severely eroded areas it is silty clay or clay. The A1 horizon is 0 to 5 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 5/3) silty clay loam, silt loam, loam, sandy loam, or clay loam. It is 3 to 8 inches thick and is slightly acid to strongly acid.

The B horizon is brown (10YR 5/3) and light olive brown (2.5Y 5/4) to light yellowish brown (10YR or 2.5Y 6/4) silty clay or clay. It is 12 to 28 inches thick and is strongly acid to extremely acid.

The C horizon varies widely in color. Hue ranges from 7.5YR to 5Y, value ranges from 2 to 8, and chroma ranges from 4 to 6. The C horizon is clay that has thin strata of siltstone, sandstone, and lignite. It ranges from strongly acid to extremely acid.

Gosport soils are associated on the landscape with Gara and Lindley soils. They have more clay than Gara and Lindley soils, which are upslope and formed in glacial till.

313D—Gosport silt loam, 9 to 14 percent slopes. This strongly sloping soil is on convex side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the subsoil is thicker and more friable and has stronger structure.

Included with this soil in mapping are spots of red clay, glacial till outcrop, and sand spots, all of which are indicated on the soil map by special symbols. Also included are areas of moderately eroded soils.

This Gosport soil is generally unsuited to cultivated crops; it is better suited to hay, pasture, and woodland than to most other uses. Mechanized equipment can be used safely on most areas of the soil. Many areas are in woodland. The soil is susceptible to erosion. The organic matter content is low. Capability unit VIe–1; environmental planting group 1.

313E—Gosport silt loam, 14 to 18 percent slopes. This moderately steep soil is on convex side slopes on uplands. Areas are long and narrow or irregular in shape.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, sand spots, and glacial till outcrop, all of which are indicated on the soil map by special symbols. Also included are areas south of the South River between Squaw and Otter Creeks where this Gosport soil is underlain at a shallow depth by soft, fractured sandstone.

This Gosport soil is generally unsuited to row crops or hay; it is better suited to pasture and woodland than to most other uses. Mechanized equipment can be used for pasture improvement or timber operations. Most areas are in woodland. The soil is susceptible to erosion. The organic matter content is low. Capability unit VIIe–1; environmental planting group 1.

313F—Gosport silt loam, 18 to 35 percent slopes. This steep to very steep soil is on convex side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of glacial till outcrop and spots of severely eroded soils, both of which are indicated on the soil map by special symbols.

This Gosport soil is not suited to row crops or hay; it is better suited to woodland, wildlife habitat, and pasture than to most other uses. Mechanized equipment can be used in a few places, but it is hazardous because of slope. Most areas are in woodland. The soil is susceptible to erosion. The organic matter content is low. Capability unit VIIe–2; environmental planting group 1.

313E3—Gosport soils, 14 to 18 percent slopes, severely eroded. These moderately steep soils are on convex side slopes on uplands. Areas are long and narrow or irregular in shape. These soils have profiles similar to the one described as representative of the Gosport series, but erosion has removed the surface layer and most or all of the subsurface layer. In cultivated areas, material from the subsoil has been mixed into the remaining original subsurface layer. The surface layer is silty clay loam or silty clay in most places.

Included with these soils in mapping are spots of gray clay and glacial till outcrop, both of which are indicated on the soil map by special symbols. Also included are areas of strongly sloping soils. South of the South River between Squaw and Otter creeks are areas where these Gosport soils are underlain at a shallow depth by soft, fractured sandstone.

These Gosport soils are generally unsuited to row crops or hay; they are better suited to pasture and woodland than to most other uses. Mechanized equipment can be used safely in most areas. The soils are susceptible to erosion. The surface layer is more clayey than that of less eroded Gosport soils. These soils also are less favorable for plant growth because shale is at a shallower depth. The organic matter content is very low. Capability unit VIIe–1; environmental planting group 1.

Grundy series

The Grundy series consists of deep, gently sloping, somewhat poorly drained soils. These soils are on high upland rounded divides and the upper part of side slopes adjacent to broad upland flats. They formed in loess under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is silty clay loam about 13 inches thick; it is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil extends to a depth of 46 inches; it is very dark grayish brown silty clay loam and brown silty clay in the upper part, dark grayish brown silty clay loam in the middle part, and grayish brown silty clay loam in the lower part. The substratum is grayish brown silty clay loam.

Permeability is slow, and available water capacity is high. The subsoil is very low to low in available phosphorus and is low to medium in available potassium.

Grundy soils are used mainly for row crops. The major hazard is erosion, and the major limitation is wetness.

Representative profile of Grundy silty clay loam, 2 to 5 percent slopes, on a side slope in a pasture, 400 feet east and 360 feet south of the northwest corner of sec. 23, T. 75 N., R. 22 W.:

Ap—0 to 9 inches; very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) faces of peds; moderate medium granular structure parting to moderate fine granular; friable; slightly acid; abrupt smooth boundary.

A12—9 to 13 inches; very dark grayish brown (10YR 3/2) medium silty clay loam; black (10YR 2/1) faces of peds; weak fine subangular blocky structure parting to moderate very fine and fine granular structure; friable; few very fine dark oxides; medium acid; clear smooth boundary.

B1t—13 to 18 inches; very dark grayish brown (10YR 3/2) heavy silty clay loam; moderate very fine subangular blocky structure; friable; few very fine dark oxides; medium acid; gradual smooth boundary.

B21t—18 to 23 inches; brown (10YR 4/3) light silty clay; dark grayish brown (10YR 4/2) faces of peds; few fine faint yellowish brown (10YR 5/4 and 5/6) mottles; weak medium prismatic structure parting to strong very fine and fine subangular blocky; firm; thin continuous clay films; few very fine dark oxides; medium acid; gradual smooth boundary.

B22t—23 to 30 inches; dark grayish brown (10YR 4/2) heavy silty clay loam; few fine prominent yellowish red (5YR 4/6) mottles and few fine distinct brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to strong very fine and fine subangular blocky; firm; thin continuous clay films; few very fine and fine dark oxides; slightly acid; gradual smooth boundary.

B23t—30 to 39 inches; grayish brown (10YR 5/2) medium silty clay loam; common fine and medium distinct strong brown (7.5YR 5/6) and dark yellowish brown (10YR 4/4) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; thin continuous clay films; common very fine and fine and few medium dark oxides; slightly acid; gradual smooth boundary.

B3t—39 to 46 inches; grayish brown (2.5Y 5/2) medium silty clay loam; common fine distinct strong brown (7.5YR 5/6), yellowish brown (10YR 5/6), and dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films; organic coatings in root channels; common very fine and fine and few medium dark oxides; slightly acid; gradual smooth boundary.

C—46 to 60 inches; grayish brown (2.5Y 5/2) light silty clay loam; many medium prominent strong brown (7.5YR 5/8) mottles and few fine faint light yellowish brown (10YR 6/4) mottles; massive; firm; common fine dark oxides; slightly acid.

The solum ranges from 40 to 60 inches in thickness. The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) heavy silt loam or light silty clay loam. It is 10 to 15 inches thick and is neutral to medium acid.

The B horizon is very dark grayish brown (10YR 3/2) to dark brown (10YR 4/3) in the upper part and dark grayish brown (10YR 4/2) to grayish brown (2.5Y 5/2) in the lower part. It is heavy silty clay loam or light silty clay. The B horizon is 30 to 45 inches thick and is strongly acid to slightly acid.

The C horizon is dark grayish brown (2.5Y 4/2) to olive (5Y 5/3) light or medium silty clay loam. It is slightly acid to strongly acid.

Grundy soils in this county have slightly less clay than defined for the range of the series. This difference, however, does not significantly affect use and behavior.

Grundy soils formed in parent material similar to that of Pershing and Weller soils. Grundy soils do not have a subsurface layer, which those soils have, and they have a thicker, darker colored surface layer than Pershing and Weller soils.

864B—Grundy silty clay loam, 2 to 5 percent slopes. This gently sloping soil is on ridgetops and the upper part of side slopes that surround nearly level upland flats. Areas are long and narrow or irregular in shape. They range from a few acres to several hundred acres in size.

Included with this soil in mapping are wet spots, which are indicated on the soil map by a special symbol.

This Grundy soil is well suited to intensive row crops. It is susceptible to erosion. The organic matter content is high. Capability unit IIe–1; environmental planting group 1.

Gullied land

Gullied land consists of soils in which a large gully has formed. The width and depth of the gully is as much as 20 to 25 feet. Major landforming is needed to reclaim these soils for crop production.

980B—Gullied land-Ely-Colo complex, 2 to 5 percent slopes. These gently sloping soils are in upland drainageways. Colo soils are near the stream, and Ely soils are on foot slopes. Areas are long and narrow. This complex is 50 percent gullies 10 to 25 feet deep, 20 percent Colo soils, and 30 percent Ely soils (fig. 15). The soils have profiles similar to the ones described as representative of their respective series.

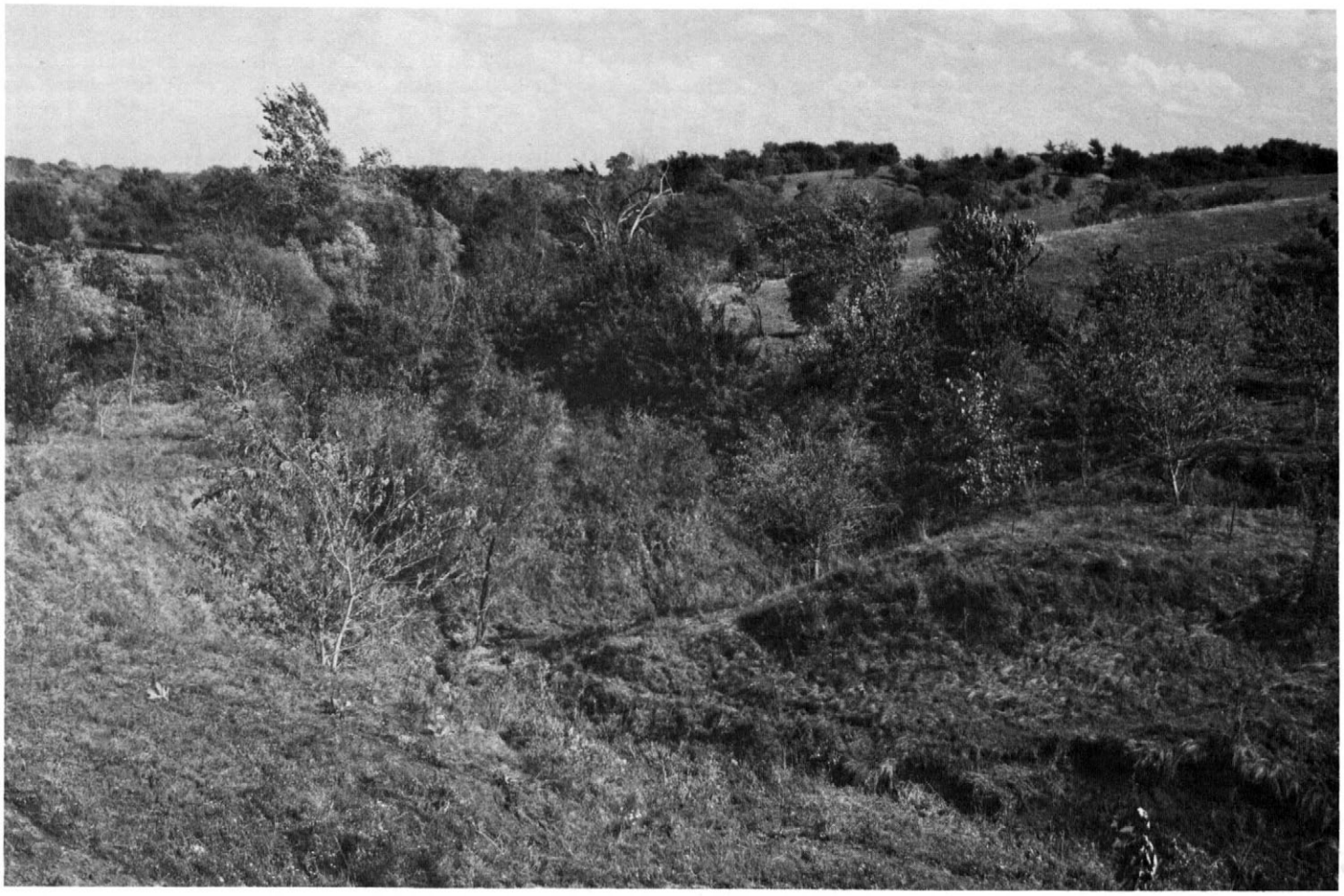

Figure 15.—An area of Gullied land-Ely-Colo complex, 2 to 5 percent slopes. The gully occupies a large part of the mapped area. Landforming for cultivationis not economically feasible.

Included in mapping are small areas of shale outcrop, which are indicated on the soil map by a special symbol.

These soils are not suited to row crops. Most areas are in pasture or woodland. The soils are susceptible to continuing gully erosion. Capability unit VIIe–3; environmental planting group 1.

Humeston series

The Humeston series consists of deep, nearly level, poorly drained to very poorly drained soils. These soils are on first and second bottoms. They formed in moderately fine textured to fine textured alluvium under a native vegetation of trees and grasses.

In a representative profile the surface layer is very dark gray silt loam about 12 inches thick. The subsurface layer is dark gray silt loam about 9 inches thick. The subsoil extends to a depth of 60 inches; it is black silty clay loam and silty clay in the upper part, very dark gray silty clay in the middle part, and dark gray silty clay and silty clay loam in the lower part.

Permeability is very slow, and available water capacity is high. The subsoil is medium to low in available phosphorus and very low in available potassium.

Humeston soils are used mainly for row crops. The major limitation is wetness. Some areas are subject to flooding.

Representative profile of Humeston silt loam, 0 to 2 percent slopes, on a cultivated second bottom, 2,420 feet west and 1,310 feet north of the southeast corner of sec. 25, T. 77 N., R. 24 W.:

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—8 to 12 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; medium acid; abrupt smooth boundary.

A21—12 to 16 inches; dark gray (10YR 4/1) silt loam, light gray (10YR 7/1) dry; weak thin platy structure; friable; thin discontinuous gray silt coatings; medium acid; abrupt smooth boundary.

A22—16 to 21 inches; dark gray (10YR 4/1) silt loam; few black (10YR 2/1) faces of peds, light gray (10YR 7/1) dry; weak thin platy structure parting to weak very fine subangular blocky; friable; thin discontinuous gray silt coatings; strongly acid; clear smooth boundary.

B1—21 to 26 inches; black (10YR 2/1) silty clay loam; moderate fine subangular blocky structure; firm; thin discontinuous clay films; many discontinuous gray silt coatings; strongly acid; gradual smooth boundary.

B21t—26 to 34 inches; black (10YR 2/1) silty clay; moderate fine and medium subangular blocky structure; firm; thin continuous clay films; few fine dark oxides; strongly acid; gradual smooth boundary.

B22t—34 to 40 inches; very dark gray (10YR 3/1) silty clay; few fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; few fine dark oxides; strongly acid; gradual smooth boundary.

B31t—40 to 46 inches; dark gray (10YR 4/1) silty clay; common fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; few fine dark oxides; medium acid; gradual smooth boundary.

B32t—46 to 60 inches; dark gray (10YR 4/1) heavy silty clay loam; few fine distinct brown (7.5YR 5/4) mottles and common fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films; medium acid.

The solum is typically more than 60 inches thick. The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1) silt loam or light silty clay loam. It is 10 to 16 inches thick and is slightly acid or medium acid. The A2 horizon is dark gray (10YR 4/1) or gray (10YR 5/1) and is 6 to 14 inches thick. It is slightly acid to very strongly acid.

The B2 horizon is black (N 2/0) to very dark gray (10YR 3/1) silty clay or heavy silty clay loam. It is 14 to 32 inches thick and is slightly acid to very strongly acid.

Humeston soils are associated on the landscape with Bremer, Nevin, Vesser, and Zook soils. They also formed in parent material similar to that of those soils. They have an A2 horizon, which Bremer, Nevin, and Zook soils do not have. They have more clay in the B horizon than Vesser soils.

269—Humeston silt loam, 0 to 2 percent slopes. This nearly level soil is on first and second bottoms. Areas are irregular in shape and range from a few acres to about a hundred acres in size.

Included with this soil in mapping are small areas of soils that have a thinner surface layer and a grayer subsoil.

This Humeston soil is moderately well suited to row crops. It is susceptible to wetness. Some areas are subject to flooding. The organic matter content is high. Capability unit IIIw–2; environmental planting group 2.

Judson series

The Judson series consists of deep, gently sloping, well drained to moderately well drained soils. These soils are on foot slopes. They formed in alluvium from adjacent slopes under a native vegetation of prairie grasses.

In a representative profile the surface layer is very dark brown, very dark grayish brown, and dark brown silty clay loam about 27 inches thick. The silty clay loam subsoil extends to a depth of 49 inches. It is dark brown in the upper part and brown in the lower part. The substratum is brown silty clay loam.

Permeability is moderate, and available water capacity is high. The subsoil is low in available phosphorus and potassium.

Judson soils are used mainly for row crops. The major hazards are erosion and overflow from adjacent side slopes.

Representative profile of Judson silty clay loam, 2 to 6 percent slopes, on a cultivated foot slope, 600 feet north and 100 feet west of the southeast corner of NE¼ sec. 30, T. 77 N., R. 24 W.:

A11—0 to 14 inches; very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) faces of peds; weak fine granular structure; friable; neutral; gradual smooth boundary.

A12—14 to 21 inches; very dark grayish brown (10YR 3/2) light silty clay loam; very dark brown (10YR 2/2) faces of peds; moderate very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

A3—21 to 27 inches; dark brown (10YR 3/3) light silty clay loam; very dark grayish brown (10YR 3/2) faces of peds; moderate very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B2—27 to 36 inches; dark brown (10YR 3/3) medium silty clay loam; weak fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B3—36 to 49 inches; brown (10YR 4/3) medium silty clay loam; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) mottles; weak medium and coarse subangular blocky structure; friable; slightly acid; diffuse smooth boundary.

C—49 to 63 inches; brown (10YR 4/3 and 5/3) light silty clay loam; few fine faint grayish brown (10YR 5/2) mottles and com-

mon fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; few fine dark oxides; slightly acid.

The solum ranges from 40 to 60 inches in thickness.

The A horizon is black (10YR 2/1) to very dark brown (10YR 2/2) in the upper part to very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3) in the lower part. It is heavy silt loam or light silty clay loam. The A horizon is 20 to 36 inches thick and is medium acid to neutral.

The B horizon is dark brown (10YR 3/3) to yellowish brown (10YR 5/4). It is 20 to 34 inches thick and is medium acid or slightly acid.

The C horizon is heavy silt loam or light silty clay loam. It is medium acid or slightly acid.

Judson soils formed in parent material similar to that of Ely soils. They have better natural drainage and a more yellow subsoil than Ely soils.

8B—Judson silty clay loam, 2 to 6 percent slopes. This gently sloping soil is on foot slopes. Areas are small in size and irregular in shape.

Included with this soil in mapping are small areas of Ely soils.

This Judson soil is well suited to intensive row crops. It is susceptible to erosion. In some places, runoff from adjacent soils is a concern. The organic matter content is high. Capability unit IIe–3; environmental planting group 1.

Kennebec series

The Kennebec series consists of deep, nearly level, moderately well drained soils. These soils are on first bottoms near the stream channel. They formed in alluvium under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is black silt loam about 31 inches thick. The next layer extends to a depth of 41 inches. It is very dark grayish brown silt loam. The substratum is very dark grayish brown silt loam.

Permeability is moderate, and available water capacity is high. The subsoil is low in available phosphorus and low to very low in available potassium.

Kennebec soils are used mainly for row crops. The major hazard is flooding.

Representative profile of Kennebec silt loam, 0 to 2 percent slopes, in a cultivated field, 2,520 feet south and 1,920 feet east of the northwest corner of sec. 3, T. 75 N., R. 24 W.:

Ap—0 to 8 inches; black (10YR 2/1) silt loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A12—8 to 17 inches; black (10YR 2/1) silt loam; weak fine granular and subangular blocky structure; friable; slightly acid; diffuse smooth boundary.

A13—17 to 31 inches; black (10YR 2/1) silt loam; weak fine subangular blocky structure; friable; slightly acid; diffuse smooth boundary.

AC—31 to 41 inches; very dark grayish brown (10YR 3/2) heavy silt loam; very dark gray (10YR 3/1) faces of peds; weak fine subangular blocky structure; friable; slightly acid; diffuse smooth boundary.

C—41 to 60 inches; very dark grayish brown (10YR 3/2) silt loam; massive; friable; slightly acid.

The solum is typically more than 36 inches thick, and it ranges from 36 to 60 inches in thickness.

The A horizon is black (10YR 2/1) or very dark gray (10YR 3/1) and is 30 to 45 inches thick.

The AC horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is 6 to 15 inches thick and is medium acid or slightly acid.

The C horizon is very dark grayish brown (10YR 3/2) or dark grayish brown (10YR 4/2). It is silt loam to medium silty clay loam. The C horizon is slightly acid or neutral.

Kennebec soils are associated on the landscape with Colo, Nodaway, and Zook soils. They also formed in parent material similar to that of those soils. They contain less clay than Colo and Zook soils. They lack stratification and have a darker surface layer than Nodaway soils.

212—Kennebec silt loam, 0 to 2 percent slopes. This nearly level soil is on first bottoms near the stream channel. Areas are irregular in shape and range from 5 to 100 acres in size.

Included with this soil in mapping are sand spots and wet spots, which are indicated on the soil map by special symbols.

This Kennebec soil is well suited to intensive row crops. It is susceptible to flooding. The organic matter content is high. Capability unit I–2; environmental planting group 1.

Keswick series

The Keswick series consists of deep, strongly sloping, moderately well drained soils. These soils are at the ends of convex ridges and on the upper part of side slopes on uplands. They formed mainly in reddish, clayey glacial till under a native vegetation of trees. The upper 1 to 2 feet of the profile formed in loamy material overlying the till.

In a representative profile the surface layer is black and very dark gray loam about 4 inches thick. The subsurface layer is dark grayish brown loam about 7 inches thick. The subsoil extends to a depth of 60 inches. It is brown clay loam and clay in the upper part, yellowish brown clay loam in the middle part, and strong brown sandy clay loam and yellowish brown and light brownish gray clay loam in the lower part.

Permeability is slow, and available water capacity is moderate to high. The subsoil is very low in available phosphorus and potassium.

Keswick soils are used mainly for pasture and woodland. The major hazard is erosion.

Representative profile of Keswick loam, 9 to 14 percent slopes, at the end of a convex ridge in timber, 1,200 feet north and 285 feet west of the southeast corner of sec. 18, T. 74 N., R. 22 .W:

A11—0 to 2 inches; black (10YR 2/1) loam, dark gray (10R 4/1) dry; weak thin platy

structure; very friable; thin continuous gray silt coatings; neutral; clear smooth boundary.

A12—2 to 4 inches; very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) dry; weak thin platy structure; very friable; thin continuous and thick discontinuous gray silt coatings; very strongly acid; clear smooth boundary.

A2—4 to 11 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) faces of peds, grayish brown (10YR 5/2) dry; weak thin platy structure; very friable; thick continuous gray silt coatings; very strongly acid; gradual smooth boundary.

B21t—11 to 20 inches; brown (10YR 4/3) clay loam; dark brown (10YR 3/3) faces of peds; moderate fine subangular blocky structure; friable; thin continuous clay films; thin discontinuous gray silt coatings; strongly acid; clear smooth boundary.

IIB22t—20 to 28 inches; brown (7.5YR 4/4) clay; many medium prominent dark red (2.5YR 3/6) and red (2.5YR 4/8) mottles and few fine distinct grayish brown (2.5Y 5/2) mottles; moderate very fine subangular blocky structure; friable; thick continuous clay films; thin discontinuous gray silt coatings; medium acid; gradual smooth boundary.

IIB23t—28 to 32 inches; brown (7.5YR 5/4) clay; many fine prominent red (2.5YR 4/8) and reddish brown (5YR 4/4) mottles; moderate very fine subangular blocky structure; firm; thin continuous clay films; medium acid; gradual smooth boundary.

IIB24t—32 to 43 inches; yellowish brown (10YR 5/4) heavy clay loam; many fine faint grayish brown (10YR 5/2), brown (10YR 5/3), and yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure parting to moderate very fine subangular blocky; firm; thin continuous clay films; few fine dark oxides; medium acid; abrupt smooth boundary.

IIB31t—43 to 49 inches; strong brown (7.5YR 5/6) sandy clay loam; few medium faint yellowish red (5YR 5/8) mottles and few fine faint strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; very friable; slightly acid; abrupt smooth boundary.

IIB32t—49 to 60 inches; yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) clay loam; common fine faint yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure parting to weak fine subangular blocky; friable; few fine dark oxides; neutral.

The solum ranges from 42 to 72 inches in thickness.

The A1 horizon is black (10YR 2/1), very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), or very dark brown (10YR 2/2) loam or silt loam. It is 1 to 5 inches thick and is neutral to very strongly acid.

The B2t horizon commonly has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. If the matrix has hue of 7.5YR, it has mottles that have hue of 5YR or 2.5YR. The B2t horizon is heavy clay loam or clay.

Keswick soils are associated on the landscape with Clinton and Weller soils. They formed in parent material similar to that of Lindley soils. They have redder hue and more sand than Clinton and Weller soils, which are upslope and formed in loess. They have more clay and a redder hue than Lindley soils, which are downslope.

425D—Keswick loam, 9 to 14 percent slopes. This strongly sloping soil is at the ends of convex ridges and on the upper part of side slopes below soils that formed in loess and above soils that formed in glacial till and shale. Areas are irregular in shape and range from a few acres to about 10 acres in size. In cultivated areas, the surface layer and subsurface layer and in many areas the upper part of the subsoil are mixed into the plow layer.

Included with this soil in mapping are spots of severely eroded soils, sand spots, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are small areas that are moderately sloping.

This Keswick soil is poorly suited to row crops; it is better suited to small grain, pasture, hay, or woodland than to most other uses. It is susceptible to erosion. The organic matter content is low. Capability unit IVe–2; environmental planting group 1.

Ladoga series

The Ladoga series consists of deep, gently sloping to strongly sloping, moderately well drained soils. These soils are on upland ridgetops and side slopes and on benches adjacent to the major streams. They formed in loess under a native vegetation of prairie grasses and trees.

In a representative profile the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil extends to a depth of 42 inches and is brown silty clay loam. The substratum is mixed grayish brown and brown silty clay loam.

Permeability is moderately slow, and available water capacity is high. The subsoil is medium in available phosphorus and very low in available potassium.

Ladoga soils are used mainly for row crops and pasture. Some areas are in woodland. The major hazard is erosion.

Representative profile of Ladoga silt loam, 2 to 5 percent slopes, in a pasture, 20 feet south and 50 feet west of the northeast corner of NW¼SE¼ sec. 11, T. 75 N., R. 24 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak very fine subangular blocky; friable; thin discontinuous

gray silt coatings; neutral; clear smooth boundary.

B1t—9 to 16 inches; brown (10YR 4/3) light silty clay loam; dark brown (10YR 3/3) faces of peds; moderate fine subangular blocky structure; friable; thin discontinuous clay films; thin discontinuous gray silt coatings; neutral; gradual smooth boundary.

B21t—16 to 21 inches; brown (10YR 4/3) heavy silty clay loam; dark brown (10YR 3/3) faces of peds; few fine distinct yellowish brown (10YR 5/8) mottles; moderate fine subangular blocky structure; firm; thin continuous clay films; thin discontinuous gray silt coatings; neutral; gradual smooth boundary.

B22t—21 to 29 inches; brown (10YR 4/3) heavy silty clay loam; dark brown (10YR 3/3) faces of peds; few fine distinct yellowish brown (10YR 5/8) mottles; moderate fine and medium subangular blocky structure; firm; thin continuous clay films; few fine dark oxides; neutral; gradual smooth boundary.

B23t—29 to 36 inches; brown (10YR 4/3) medium silty clay loam; few fine distinct grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/8) mottles; moderate fine and medium subangular blocky structure; firm; thin continuous clay films; few fine dark oxides; slightly acid; gradual smooth boundary.

B3t—36 to 42 inches; brown (10YR 4/3) medium silty clay loam; common fine distinct grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films; few fine dark oxides; slightly acid; gradual smooth boundary.

C1—42 to 48 inches; mixed grayish brown (2.5Y 5/2) and brown (10YR 4/3) medium silty clay loam; common fine distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure; firm; thin discontinuous clay films and dark organic stains on vertical faces of prisms; common fine dark oxides; medium acid; gradual smooth boundary.

C2—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; brown (10YR 4/3) vertical faces of peds; many fine prominent yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; friable; dark organic stains on vertical faces of prisms; common fine dark oxides; medium acid.

The solum ranges from 36 to 72 inches in thickness. The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 6 to 10 inches thick. An A2 horizon that is 2 to 6 inches thick is in uncultivated areas.

The B2t horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4) and is 16 to 32 inches thick. It is neutral to strongly acid.

The C horizon is brown (10YR 4/3), dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/4), or grayish brown (10YR 5/2) and is 16 to 32 inches thick. It is neutral to strongly acid.

Ladoga soils formed in parent material similar to that of the Clinton and Sharpsburg soils. They have a thicker surface layer than Clinton soils and a thinner surface layer than Sharpsburg soils.

76B—Ladoga silt loam, 2 to 5 percent slopes. This gently sloping soil is on upland ridgetops. Areas are small in size and irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are sand spots, which are indicated on the soil map by a special symbol.

This Ladoga soil is well suited to row crops. It is susceptible to erosion. The organic matter content is moderate. Capability unit IIe–1; environmental planting group 1.

76C—Ladoga silt loam, 5 to 9 percent slopes. This moderately sloping soil is on convex, upland ridgetops and side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but in uncultivated areas it has a dark grayish brown subsurface layer.

Included with this soil in mapping are small areas that are moderately eroded.

This Ladoga soil is moderately well suited to row crops. It is susceptible to erosion. The organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

76C2—Ladoga silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on convex upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, seepy spots, sand spots, spots of red clay, and glacial till outcrop, all of which are indicated on the soil map by special symbols.

This Ladoga soil is moderately well suited to row crops. Some areas are in pasture. The soil is susceptible to erosion. Most of the original surface layer has been removed by erosion, and only a thin layer remains above the heavy silty clay loam subsoil. As a result, a good seedbed is difficult to prepare and plant growth is retarded. The organic matter content is moderate to low. Capability unit IIIe–1; environmental planting group 1.

76D2—Ladoga silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on upland side slopes. Areas are small in size and irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of

severely eroded soils, seepy wet spots, sand spots, spots of red clay, spots of gray clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Ladoga soil is moderately well suited to row crops. Some areas are in pasture. The soil is susceptible to erosion. Most of the original surface layer has been removed by erosion and only a thin layer remains over the heavy silty clay loam subsoil. As a result, a good seedbed is difficult to prepare and plant growth is retarded. The organic matter content is moderate to low. Capability unit IIIe–1; environmental planting group 1.

T76B—Ladoga silt loam, benches, 2 to 5 percent slopes. This gently sloping soil is on benches adjacent to the major streams. Areas are small in size and irregular in shape. Slopes are typically short.

Included with this soil in mapping are wet spots, which are indicated on the soil map by a special symbol. Also included are areas of nearly level Ladoga soils and gently sloping Grundy and Clinton soils.

This Ladoga soil is well suited to row crops. It is susceptible to erosion. In most areas, the loess is underlain by stratified alluvium instead of glacial till. Commonly, the alluvium is sand and is rapidly permeable, which creates a hazard for farm ponds and other uses that require water retention. The organic matter content is moderate. Capability unit IIe–1; environmental planting group 1.

T76C2—Ladoga silt loam, benches, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on benches adjacent to major streams. Areas are long and narrow or irregular in shape. Slopes are typically short. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of red clay and seepy wet spots, both of which are indicated on the soil map by special symbols. Also included are areas of Arispe and Clinton soils on benches.

This Ladoga soil is moderately well suited to row crops. Some areas are in pasture. The soil is susceptible to erosion. In most areas, the loess is underlain by stratified alluvium instead of glacial till. Commonly, the alluvium is rapidly permeable, which creates a hazard for farm ponds and other uses that require water retention. The organic matter content is moderate to low. Capability unit IIIe–1; environmental planting group 1.

427C2—Ladoga-Chelsea complex, 5 to 9 percent slopes, moderately eroded. These moderately sloping soils are on long, convex ridges and the upper part of side slopes on uplands southeast of and within 1 to 2 miles of the major streams. This complex is about 60 percent Ladoga soils and 40 percent Chelsea soils. Areas of this complex are irregular in shape. They range from a few acres to 60 acres in size. The soils have profiles similar to the ones described as representative of their respective series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with these soils in mapping are spots of severely eroded soils, which are indicated on the soil map by a special symbol.

These soils are moderately well suited to row crops, but many areas are in pasture, hay, or woodland. The soils are susceptible to erosion, and the Chelsea soils are susceptible to drought. The organic matter content is low to moderate. Capability unit IIIe–1; environmental planting group 1.

427D2—Ladoga-Chelsea complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are at the ends of long, convex ridges and the upper part of side slopes on uplands southeast of and within 1 to 2 miles of the major streams. This complex is about 60 percent Ladoga soils and 40 percent Chelsea soils. Areas are irregular in shape and range from a few acres to 30 acres in size. These soils have profiles similar to the ones described as representative of their respective series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with these soils in mapping are spots of severely eroded soils and spots of red clay, both of which are indicated on the soil map by special symbols. Also included are areas that are moderately steep.

These soils are poorly suited to row crops; they are better suited to small grain, pasture, hay, or woodland than to most other uses. They are susceptible to erosion, and the Chelsea soils are susceptible to drought. The organic matter content is low to moderate. Capability unit IVe–1; environmental planting group 1.

Lamoni series

The Lamoni series consists of deep, strongly sloping, somewhat poorly drained soils. These soils are in coves at the upper reaches of drainageways and in bands on the shoulders of slopes. They formed in gray, highly weathered glacial till under a native vegetation of prairie grasses. The upper 1 to 2 feet of the profile formed in loess or other less clayey material.

In a representative profile the surface layer is black silty clay loam about 11 inches thick. The subsoil extends to a depth of 50 inches; it is very dark gray, dark gray, and dark grayish brown clay loam in the upper part and yellowish brown and olive gray clay loam in the lower part. The substratum is yellowish brown and strong brown clay loam.

Permeability is slow to very slow, and available water capacity is high. The subsoil is low in available phosphorus and low to medium in available potassium.

Lamoni soils are used mainly for row crops, hay, and pasture. The major hazard is erosion, and the major limitation is seasonal wetness.

Representative profile of uneroded Lamoni soil in an area of Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded, in a cove at the head of a drainageway in a pasture, 1,600 feet east and 600 feet north of the southwest corner of sec. 3, T. 76 N., R. 25 W.:

A1—0 to 7 inches; black (10YR 2/1) light silty clay loam; moderate very fine subangular blocky structure parting to moderate very fine granular; friable; medium acid; clear smooth boundary.

A3—7 to 11 inches; black (10YR 2/1) and very dark grayish brown (10YR 3/2) medium silty clay loam; moderate very fine

subangular blocky structure; friable; medium acid; gradual smooth boundary.

IIB21t—11 to 18 inches; very dark gray (10YR 3/1), dark gray (10YR 4/1), and dark grayish brown (10YR 4/2) medium clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate very fine and fine subangular blocky structure; friable; thin continuous clay films; medium acid; gradual smooth boundary.

IIB22t—18 to 26 inches; dark grayish brown (10YR 4/2) heavy clay loam; dark gray (10YR 4/1) and dark grayish brown (10YR 4/2) faces of peds; many fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate fine subangular blocky structure; firm; thin continuous clay films; few fine dark oxides; slightly acid; gradual smooth boundary.

IIB23t—26 to 38 inches; yellowish brown (10YR 5/6) heavy clay loam; few fine faint dark grayish brown (10YR 4/2) mottles and common fine distinct gray (10YR 5/1) and grayish brown (10YR 5/2) mottles; weak coarse prismatic structure parting to moderate fine subangular blocky; firm; thin discontinuous clay films; few fine dark oxides; neutral; gradual smooth boundary.

IIB3t—38 to 50 inches; yellowish brown (10YR 5/6) and olive gray (5Y 5/2) medium clay loam; weak coarse prismatic structure; firm; few fine dark oxides; neutral; gradual smooth boundary.

IIC—50 to 60 inches; yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) medium clay loam; common fine distinct grayish brown (2.5Y 5/2) mottles; massive; firm; few fine dark oxides; neutral.

The solum ranges from 48 to 64 inches in thickness. The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2). It generally is silty clay loam, but it ranges to silt loam, clay loam, or silty clay. The A horizon is 10 to 18 inches thick and is neutral to strongly acid.

The B horizon is very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2) in the upper part and is yellowish brown (10YR 5/6) to olive gray (5Y 5/2) in the lower part. The finest texture in the B horizon is heavy clay loam or clay. The B horizon is 38 to 46 inches thick and is medium acid to neutral.

The C horizon is clay loam or loam.

In mapping unit 822D3, the surface layer is thinner than is defined in the range for the series, but this difference does not affect the other properties of this soil.

Lamoni soils formed in parent material similar to that of Clarinda soils. They are downslope from Clarinda soils and have a less clayey, less gray subsoil than Clarinda soils.

822D2—Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is in coves at the upper reaches of drainageways and in bands on the shoulders of slopes. Areas are long or irregular in shape. They range from a few acres to 60 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, sand spots, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Lamoni soil is poorly suited to row crops; it is better suited to small grain, hay, or pasture than to most other uses. It is susceptible to erosion and wetness. The organic matter content is moderate. Capability unit IVe–2; environmental planting group 1.

822D3—Lamoni soils, 9 to 14 percent slopes, severely eroded. These strongly sloping soils are in coves at the upper reaches of drainageways and in bands at the shoulders of slopes. Areas are long or irregular in shape. They range from a few acres to 40 acres in size. These soils have profiles similar to the one described as representative of the series, but all or most of the original surface layer has been removed by erosion. The surface layer is silty clay loam, silty clay, or clay loam.

Included with these soils in mapping are spots of gray clay, which are indicated on the soil map by a special symbol.

These Lamoni soils are generally unsuited to cultivated crops; they are better suited to pasture or hay than to most other uses. They are susceptible to erosion and wetness. The surface layer is more clayey and contains less organic matter than less eroded Lamoni soils. Thus, a good seedbed is difficult to prepare and plant growth is retarded. Capability unit VIe–1; environmental planting group 1.

Lindley series

The Lindley series consists of deep, strongly sloping to very steep, well drained to moderately well drained soils. These soils are on upland side slopes. They formed in glacial till under a native vegetation of trees.

In a representative profile the surface layer is very dark grayish brown loam about 2 inches thick. The subsurface layer is dark grayish brown and brown loam and clay loam about 6 inches thick. The clay loam subsoil extends to a depth of 47 inches and is mostly yellowish brown. The substratum is mixed yellowish brown and gray clay loam.

Permeability is moderately slow, and available water capacity is high. The subsoil is medium in available phosphorus and very low in available potassium.

Lindley soils are used mainly for pasture and woodland. The major hazard is erosion.

Representative profile of Lindley loam, 14 to 18 percent slopes, in a wooded pasture, 1,660 feet east and 220 feet north of the southwest corner of sec. 26, T. 75 N., R. 24 W.:

A1—0 to 2 inches; very dark grayish brown (10YR 3/2) loam; very dark gray (10YR 3/1) faces of peds, dark grayish brown (10YR 4/2) dry; weak thin platy

structure; very friable; neutral; clear smooth boundary.

A21—2 to 5 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) faces of peds, grayish brown (10YR 5/2) and brown (10YR 5/3) dry; weak thin platy structure; very friable; thin continuous gray silt coatings; slightly acid; clear smooth boundary.

A22—5 to 8 inches; brown (10YR 5/3) light clay loam; dark grayish brown (10YR 4/2) faces of peds, grayish brown (10YR 5/2), and brown (10YR 5/3) dry; weak thin platy structure parting to weak fine granular; very friable; thin continuous gray silt coatings; slightly acid; clear smooth boundary.

B21t—8 to 11 inches; brown (10YR 4/3) clay loam; weak fine subangular blocky structure; friable; thin discontinuous clay films; thin continuous gray silt coatings; medium acid; clear smooth boundary.

B22t—11 to 18 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct yellowish brown (10YR 5/8) mottles; moderate fine and medium subangular blocky structure; firm; thin continuous clay films; thin discontinuous gray silt coatings; strongly acid; gradual smooth boundary.

B23t—18 to 29 inches; yellowish brown (10YR 5/4) clay loam; few fine faint yellowish brown (10YR 5/8) mottles; moderate fine and medium subangular blocky structure; firm; thick continuous clay films; few fine dark oxides; strongly acid; gradual smooth boundary.

B24t—29 to 39 inches; yellowish brown (10YR 5/4) clay loam; brown (10YR 5/3) faces of peds; common fine faint yellowish brown (10YR 5/8) and distinct light gray (10YR 7/1) mottles; moderate fine and medium subangular blocky structure; firm; thin continuous clay films; few fine dark oxides; very strongly acid; gradual smooth boundary.

B3t—39 to 47 inches; yellowish brown (10YR 5/4) clay loam; common fine faint yellowish brown (10YR 5/8) and distinct light gray (10YR 7/1) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin continuous clay films on vertical faces of prisms; few fine dark oxides; neutral; gradual smooth boundary.

C1—47 to 56 inches; mixed yellowish brown (10YR 5/4) and gray (10YR 6/1) clay loam; common fine faint yellowish brown (10YR 5/8) mottles; weak medium prismatic structure; firm; thin discontinuous grayish brown (10YR 5/2) clay films on vertical faces of prisms; few fine dark oxides; mildly alkaline; gradual smooth boundary.

C2—56 to 60 inches; yellowish brown (10YR 5/6) clay loam; common fine distinct gray (10YR 6/1) mottles; massive; firm; common fine dark oxides; strong effervescence; mildly alkaline.

The solum ranges from 30 to 60 inches in thickness. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is silt loam to light clay loam. It is 1 to 4 inches thick and is neutral to strongly acid.

The B2t horizon is brown (10YR 4/3) to strong brown (7.5YR 5/6) light to heavy clay loam. It is 12 to 32 inches thick and is strongly acid to extremely acid in the most acid part. The B3 horizon is yellowish brown (10YR 5/4 or 5/6). It is 8 to 22 inches thick and is neutral to medium acid.

Lindley soils formed in parent material similar to that of Gara soils. They have a thinner surface layer than Gara soils.

65D—Lindley loam, 9 to 14 percent slopes. This strongly sloping soil is on upland side slopes. Areas are small in size and irregular in shape. In cultivated areas, the surface and subsurface layers and, in places, material from the subsoil are mixed into the plow layer.

Included with this soil in mapping are spots of severely eroded soils and spots of red clay, both of which are indicated on the soil map by special symbols.

This Lindley soil is generally unsuited to row crops. It is moderately well suited to small grain and hay, but most areas are in pasture and woodland. It is susceptible to erosion. The organic matter content is low. Capability unit IVe–3; environmental planting group 1.

65E—Lindley loam, 14 to 18 percent slopes. This moderately steep soil is on upland side slopes. Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series. In cultivated areas, the plow layer is a mixture of the original surface layer and subsurface layer and, in places, material from the subsoil.

Included with this soil in mapping are small spots of red clay, sand spots, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are areas that are moderately eroded.

This Lindley soil is generally unsuited to cultivated crops. Most areas are in pasture and woodland. The soil is susceptible to erosion. The organic matter content is low to very low. Capability unit VIe–1; environmental planting group 1.

65F—Lindley loam, 18 to 25 percent slopes. This steep soil is on upland side slopes. Areas are long and narrow or irregular in shape.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Lindley soil is not suited to row crops or hay. Most areas are in pasture and woodland. Mechanized equipment can be used in most areas, although the steepness of slopes makes it hazardous. The soil is susceptible to erosion. The organic matter content is low to very low. Capability unit VIIe–2; environmental planting group 1.

65G—Lindley loam, 25 to 40 percent slopes. This

very steep soil is on upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer and the subsoil are thinner.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Lindley soil is not suited to row crops or hay. The use of farm machinery is hazardous or impractical. Most areas are in pasture and woodland. The soil is susceptible to erosion. The organic matter content is very low. Capability unit VIIe–2; environmental planting group 1.

65E3—Lindley soils, 14 to 18 percent slopes, severely eroded. These moderately steep soils are on upland side slopes. Areas are small in size and irregular in shape. These soils have profiles similar to the one described as representative of the series, but the surface layer is loam or clay loam because erosion has removed most of the original surface layer and has exposed the subsoil at the surface.

Included with these soils in mapping are shale outcrop and spots of red clay, both of which are indicated on the soil map by special symbols.

These Lindley soils are not suited to row crops. Most areas are in pasture and woodland. The soils are susceptible to erosion. The surface layer is more clayey and lower in content of organic matter than the surface layer of less eroded Lindley soils. As a result, the survival rate of seedlings, trees, and other plants is often reduced. The organic matter content is very low. Capability unit VIIe–1; environmental planting group 1.

Macksburg series

The Macksburg series consists of deep, nearly level and gently sloping, somewhat poorly drained soils. These soils are on broad upland divides, on the upper part of side slopes adjacent to the upland divides, and on loess covered stream benches. They formed in loess under a native vegetation of prairie grasses.

In a representative profile the surface layer is black and very dark brown silty clay loam about 18 inches thick. The silty clay loam subsoil extends to a depth of 50 inches. It is very dark grayish brown in the upper part, dark grayish brown and grayish brown in the middle part, and olive gray in the lower part.

Permeability is moderately slow, and available water capacity is high. The subsoil is low in available phosphorus and medium in available potassium.

Macksburg soils are used mainly for row crops. Erosion is a hazard on the gently sloping soils. Wetness is a slight limitation.

Representative profile of Macksburg silty clay loam, 0 to 2 percent slopes, in a cultivated field, 1,520 feet west and 2,530 feet north of the southeast corner of sec. 22, T. 76 N., R. 24 W.:

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak fine granular; friable; strongly acid; abrupt smooth boundary.

A12—7 to 12 inches; very dark brown (10YR 2/2) medium silty clay loam; black (10YR 2/1) faces of peds, dark gray (10YR 4/1) dry; moderate very fine granular structure; friable; strongly acid; clear smooth boundary.

A13—12 to 18 inches; very dark brown (10YR 2/2) medium silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine and fine subangular blocky structure parting to moderate fine granular; friable; strongly acid; gradual smooth boundary.

B1—18 to 25 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) medium silty clay loam; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate very fine subangular blocky structure; friable; few very fine dark oxides; strongly acid; gradual smooth boundary.

B21t—25 to 34 inches; dark grayish brown (10YR 4/2) heavy silty clay loam; few fine distinct yellowish brown (10YR 5/6) and brown (7.5YR 5/4) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; common fine dark oxides; strongly acid; gradual smooth boundary.

B22t—34 to 42 inches; grayish brown (2.5Y 5/2) medium silty clay loam; few fine prominent strong brown (7.5YR 5/6) mottles and common fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous clay films; few fine dark oxides; medium acid; clear smooth boundary.

B3—42 to 50 inches; olive gray (5Y 5/2) light silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles and many fine prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; few fine dark oxides; medium acid.

The solum ranges from 48 to 70 inches in thickness.

The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) light or medium silty clay loam. It is 16 to 24 inches thick and is slightly acid to strongly acid.

The B2t horizon is dark grayish brown (10YR 4/2) to olive gray (5Y 5/2) medium or heavy silty clay loam. It is 14 to 24 inches thick and is medium acid or strongly acid.

The C horizon is not described in the representative profile, but it is grayish brown (2.5Y 5/2) or olive gray (5Y 5/2) medium or light silty clay loam. It is neutral to medium acid.

Macksburg soils are associated on the landscape with Sharpsburg, Sperry, and Winterset soils. They also formed in parent material similar to that of those soils.

They have a thicker, darker colored surface layer than Sharpsburg soils. They do not have a subsurface layer and have less clay in the subsoil than Sperry soils. They have a thinner surface layer, have fewer mottles, and have a browner subsoil than Winterset soils.

368—Macksburg silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad upland divides. Areas are long and broad or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Winterset and Sperry soils, which are indicated on the soil map by a wet spot symbol.

This Macksburg soil is well suited to intensive row crops. The organic matter content is high. Capability unit I–1; environmental planting group 1.

368B—Macksburg silty clay loam, 2 to 5 percent slopes. This gently sloping soil is mainly on the upper part of side slopes adjacent to upland divides. In the southwest part of the county it is on long, narrow upland ridges. Areas are small in size and irregular in shape.

Included with this soil in mapping are small areas of Winterset and Sperry soils, which are indicated on the soil map by a wet spot symbol.

This Macksburg soil is well suited to intensive row crops. It is susceptible to erosion. The organic matter content is high. Capability unit IIe–1; environmental planting group 1.

T368—Macksburg silty clay loam, benches, 1 to 3 percent slopes. This nearly level soil is on benches adjacent to major streams. Areas are small in size and irregular in shape.

Included with this soil in mapping are small areas of Winterset and Sperry soils, which are indicated on the soil map by a wet spot symbol.

This Macksburg soil is well suited to intensive row crops. The most sloping parts of the soil have a slight hazard of erosion. In most areas, the loess is underlain by stratified alluvium instead of glacial till. Typically the alluvium is sandy and is rapidly permeable, which affects the use of this soil for farm ponds and other uses that require water retention. The organic matter content is high. Capability unit I–1; environmental planting group 1.

Muscatine series

The Muscatine series consists of deep, nearly level, somewhat poorly drained soils. These soils are on broad upland flats and on benches adjacent to major streams. They formed in loess under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is very dark brown silty clay loam about 17 inches thick. The silty clay loam subsoil extends to a depth of 50 inches; it is mainly dark grayish brown, but the upper 8 inches is very dark grayish brown.

Permeability is moderate, and available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium.

Muscatine soils are used mainly for row crops. There are no serious limitations to use for crops.

Representative profile of Muscatine silty clay loam, 0 to 2 percent slopes, on a broad upland flat, 1,925 feet west and 180 feet south of the northeast corner of sec. 1, T. 76 N., R. 23 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) faces of peds; weak medium subangular blocky structure parting to moderate fine granular; friable; strongly acid; abrupt smooth boundary.

A12—8 to 17 inches; very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) faces of peds; moderate fine and very fine subangular blocky and moderate fine granular structure; friable; strongly acid; gradual smooth boundary.

B1—17 to 25 inches; very dark grayish brown (10YR 3/2) medium silty clay loam; moderate fine and very fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B21t—25 to 31 inches; dark grayish brown (10YR 4/2) medium silty clay loam; common fine faint dark yellowish brown (10YR 4/4) mottles and few fine distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure parting to moderate very fine subangular blocky; friable; thin discontinuous clay films; strongly acid; gradual smooth boundary.

B22t—31 to 41 inches; dark grayish brown (2.5Y 4/2) medium silty clay loam; common fine distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; friable; thin discontinuous clay films; strongly acid; gradual smooth boundary.

B3t—41 to 50 inches; dark grayish brown (2.5Y 4/2) light silty clay loam; common medium distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; weak fine prismatic structure; friable; thin continuous clay films on vertical faces of peds; medium acid.

The solum is typically about 48 inches thick, and it ranges from 40 to 60 inches in thickness.

The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) and is 11 to 20 inches thick. It is medium acid or strongly acid.

The B2t horizon is dark grayish brown (10YR 4/2 or 2.5Y 4/2) light or medium silty clay loam. It is 15 to 25 inches thick and is medium acid or strongly acid. The B3t horizon is dark grayish brown (10YR 4/2) to light olive gray (5Y 6/2) heavy silt loam or light silty clay loam. It is 5 to 10 inches thick and is neutral to medium acid.

Muscatine soils are associated on the landscape with Tama soils, and formed in parent material similar to that of Tama soils. They have a thicker surface layer and a grayer subsoil than Tama soils.

119—Muscatine silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad upland flats. Areas are small in size and irregular in shape. The profile

of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Sperry soils, which are indicated on the soil map by a wet spot symbol.

This Muscatine soil is well suited to intensive row crops. The organic matter content is high. Capability unit I–1; environmental planting group 1.

T119—Muscatine silty clay loam, benches, 0 to 2 percent slopes. This nearly level soil is on benches adjacent to major streams. Areas are small in size and irregular in shape.

Included with this soil in mapping are small areas of Sperry soils, which are indicated on the soil map by a wet spot symbol.

This Muscatine soil is well suited to intensive row crops. In most areas the loess is underlain by stratified alluvium rather than glacial till. The alluvium is sandy and is rapidly permeable in some places. This affects uses that require good water retention. The organic matter content is high. Capability unit I–1; environmental planting group 1.

Mystic series

The Mystic series consists of deep, moderately sloping to moderately steep, moderately well drained to somewhat poorly drained soils. These soils are on long, low side slopes and ends of low convex ridges that grade to river valleys. They formed in weathered old alluvium derived from glacial till material under a native vegetation of mixed prairie grasses and trees.

In a representative profile the surface layer is very dark gray silt loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 2 inches thick. The subsoil extends to a depth of 40 inches; it is brown silty clay and clay in the upper part and dark grayish brown and brown clay loam in the lower part. The substratum is light gray and strong brown clay loam.

Permeability is slow, and available water capacity is moderate to high. The subsoil is very low in available phosphorus and potassium.

Mystic soils are used mainly for pasture or hay. The major hazard is erosion, and the major limitation is seasonal wetness.

Representative profile of uneroded Mystic soil in an area of Mystic silt loam, 5 to 9 percent slopes, moderately eroded, on a low ridge in a pasture, 1,240 feet south and 680 feet west of the northeast corner of the SE¼ sec. 31, T. 76 N., R. 25 W.:

Ap—0 to 6 inches; very dark gray (10YR 3/1) heavy silt loam, grayish brown (10YR 5/2) dry; weak thin platy and weak fine granular structure; friable; neutral; clear smooth boundary.

A2—6 to 8 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak thin platy and weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21t—8 to 12 inches; brown (10YR 4/3) silty clay; dark grayish brown (10YR 4/2) faces of peds; moderate fine angular blocky structure; friable; thin continuous clay films; strongly acid; gradual smooth boundary.

B22t—12 to 23 inches; brown (10YR 4/3) clay; many fine prominent dark red (2.5YR 3/6) mottles and few fine faint grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) mottles; moderate fine angular blocky structure; friable; thick continuous clay films; few fine dark oxides; strongly acid; gradual smooth boundary.

B23t—23 to 32 inches; dark grayish brown (10YR 4/2) and brown (10YR 4/3) heavy clay loam; many fine prominent yellowish red (5YR 4/6) and yellowish brown (10YR 5/8) mottles and common fine distinct light brownish gray (2.5Y 6/2) mottles; moderate fine subangular blocky structure; firm; thick continuous clay films; common fine dark oxides; strongly acid; gradual smooth boundary.

B3—32 to 40 inches; dark grayish brown (10YR 4/2) heavy clay loam; common fine distinct strong brown (7.5YR 5/8) mottles and few fine distinct grayish brown (10YR 5/2) mottles; moderate fine and medium subangular blocky structure; firm; thin continuous clay films; common fine dark oxides; very strongly acid; gradual smooth boundary.

C—40 to 60 inches; light gray (10YR 7/1) and strong brown (7.5YR 5/8) heavy clay loam; thin strata of sandy loam and sandy clay loam less than 1 inch thick; massive; firm; common fine dark oxides; slightly acid.

The solum ranges from 40 to 60 inches in thickness.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) silt loam, loam, or light clay loam. The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 5/3) silt loam or loam.

The B horizon is very dark grayish brown (10YR 3/2) to brown (7.5YR 5/4) and has many reddish mottles. It is heavy clay loam, clay, or silty clay and is 30 to 45 inches thick.

The C horizon contains moderately coarse textured to fine textured, stratified sediment that is high in content of quartz.

Mystic soils formed in parent material similar to that of Caleb soils. They are more weathered, are higher in content of clay, and have redder hues than Caleb soils.

592C2—Mystic silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on the ends of low convex ridges near the major streams. Areas are long and narrow or irregular in shape. They range from a few acres to about 20 acres in size. This soil has a profile similar to the one described as representative of the series, but in most areas it does not have a dark grayish brown subsurface layer. In many areas, plowing has mixed the material from the subsoil with the surface and subsurface layers.

Included with this soil in mapping are areas that

are slightly eroded and small areas of Caleb soils. Also included are spots of severely eroded soils and shale outcrop, both of which are indicated on the soil map by special symbols.

This Mystic soil is moderately well suited to row crops; it is better suited to pasture or hay than to most other uses. It is susceptible to erosion, and during wet seasons it is seepy. The organic matter content is low to very low. Capability unit IIIe–3; environmental planting group 1.

592D2—Mystic silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on long, low side slopes and ends of low convex ridges near the major streams. Areas are long and narrow or irregular in shape. They range from a few acres to about 40 acres in size. This soil has a profile similar to the one described as representative of the series, but in most areas it does not have a dark grayish brown subsurface layer. In many areas, plowing has mixed the material from the subsoil with the surface and subsurface layers.

Included with this soil in mapping are spots of severely eroded soils, spots of gray clay, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are small areas of Caleb soils.

This Mystic soil is poorly suited to row crops; it is better suited to small grain, pasture, or hay than to most other uses. It is susceptible to erosion, and during wet seasons it is seepy. The organic matter content is low to very low. Capability unit IVe–2; environmental planting group 1.

94D2—Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on long, low side slopes and ends of low convex ridges near the major streams. This complex is about 50 percent Mystic silt loam and about 50 percent Caleb loam. The Mystic soil is upslope from the Caleb soil. Areas are long and narrow or irregular in shape. They range from a few acres to about 60 acres in size. These soils have profiles similar to the ones described as representative of their respective series, but in most places the Mystic soil does not have a dark grayish brown subsurface layer. In many areas, plowing has mixed material from the subsoil with the surface and subsurface layers.

Included with these soils in mapping are spots of severely eroded soils, spots of gray clay, and shale outcrop, all of which are indicated on the soil map by special symbols.

These soils are poorly suited to row crops; they are better suited to small grain, pasture, or hay than to most other uses. They are susceptible to erosion, and during wet seasons they are seepy. The organic matter content is low to very low. Capability unit IVe–3; environmental planting group 1.

94E2—Mystic-Caleb complex, 14 to 18 percent slopes, moderately eroded. These moderately steep soils are on convex side slopes of low ridges near the major streams. This complex is about 50 percent Mystic silt loam and about 50 percent Caleb loam. The Mystic soil is upslope from the Caleb soil. Areas are long and narrow or irregular in shape. They range from a few acres to about 20 acres in size. These soils have profiles similar to the ones described as representative of their respective series, but in most places the Mystic soil does not have a dark grayish brown subsurface layer. In many areas, plowing has mixed the material from the subsoil with the surface layer.

Included with these soils in mapping are severely eroded spots and shale outcrop, both of which are indicated on the soil map by special symbols.

These soils are generally unsuited to cultivated crops; they are better suited to pasture or hay than to most other uses. They are susceptible to erosion. The organic matter content is low to very low. Capability unit VIe–1; environmental planting group 1.

Nevin series

The Nevin series consists of deep, nearly level and gently sloping, somewhat poorly drained soils. These soils are on low stream benches or second bottoms above the flood plain of major streams. They formed in silty alluvium under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is black, very dark brown, and very dark grayish brown silty clay loam about 22 inches thick. The silty clay loam subsoil extends to a depth of 50 inches; it is dark grayish brown in the upper part and grayish brown in the lower parts.

Permeability is moderate to moderately slow, and available water capacity is high. The subsoil is medium in available phosphorus and high in available potassium.

Nevin soils are used mainly for row crops. These soils are seldom flooded. Erosion is a hazard on the gently sloping soils. Wetness is a slight limitation.

Representative profile of Nevin silty clay loam, 0 to 2 percent slopes, in a cultivated field, 1,115 feet south and 730 feet east of the northwest corner of sec. 29, T. 77 N., R. 24 W.:

Ap—0 to 7 inches; black (10YR 2/1) light silty clay loam; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—7 to 11 inches; black (10YR 2/1) light silty clay loam; weak fine subangular blocky structure parting to moderate very fine granular; friable; neutral; gradual smooth boundary.

A13—11 to 16 inches; very dark brown (10YR 2/2) light silty clay loam; weak fine subangular blocky structure parting to moderate very fine granular; friable; medium acid; gradual smooth boundary.

A3—16 to 22 inches; very dark grayish brown (10YR 3/2) light silty clay loam; weak very fine and fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21t—22 to 34 inches; dark grayish brown (2.5Y 4/2) light silty clay loam; common fine faint grayish brown (2.5Y 5/2) mottles; weak fine and medium subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B22t—34 to 43 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct

dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4 and 5/6) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; neutral; gradual smooth boundary.

B3t—43 to 50 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium distinct brown (7.5YR 4/4) mottles and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; firm; neutral.

The solum is typically more than 40 inches thick, and it ranges from 36 to 60 inches in thickness.

The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) light silty clay loam or silt loam. It is 18 to 30 inches thick and is medium acid to neutral.

The B2t horizon is dark grayish brown (10YR to 2.5Y 4/2) and grayish brown (10YR to 2.5Y 5/2) to brown (10YR 5/3 and 4/3). It is 10 to 21 inches thick and is medium acid to neutral.

The C horizon is not described in the representative profile, but it is dark grayish brown (10YR to 2.5Y 4/2) or grayish brown (10YR to 2.5Y 5/2) to brown (10YR 5/3 and 4/3).

The B2t horizon has only a slightly higher content of clay than the A horizon. For this reason the Nevin soils in this county are not within the range of the series, but this does not significantly affect their use and behavior.

Nevin soils formed in parent material similar to that of Bremer and Wiota soils. Nevin soils have higher chroma and are not so olive in hue as Bremer soils. They have higher value and lower chroma than Wiota soils.

88—Nevin silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad second bottoms and low stream benches a few feet above the flood plain. Areas are broad and irregular in shape. They range from a few acres to several hundred acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of poorly drained Bremer and Humeston soils, which are indicated on the soil map by a wet spot symbol. Also included are some soils that have a less clayey subsoil and soils that have a silt loam surface layer.

This Nevin soil is well suited to intensive row crops. The organic matter content is high. Capability unit I–1; environmental planting group 1.

88B—Nevin silty clay loam, 2 to 5 percent slopes. This gently sloping soil is along the edges of broad second bottoms and on small dissected second bottoms and low stream benches a few feet above the flood plain. Areas are long and narrow or irregular in shape. They range from a few acres to 15 acres in size.

Included with this soil in mapping are areas of soils that have a silt loam surface layer.

This Nevin soil is well suited to row crops. Most areas are managed with surrounding soils. The soil is susceptible to erosion. The organic matter content is high to moderate. Capability unit IIe–1; environmental planting group 1.

Nira series

The Nira series consists of deep, gently sloping and moderately sloping, moderately well drained soils. These soils are on short, convex upper parts of side slopes and on slopes bordering coves of drainageways on uplands and benches adjacent to the major streams. They formed in loess under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is very dark gray silty clay loam about 14 inches thick. The silty clay loam subsoil extends to a depth of 44 inches; it is brown in the upper part, olive gray in the middle part, and light olive gray in the lower part. The silty clay loam substratum is similar in color to the lower part of the subsoil.

Permeability is moderately slow, and available water capacity is high. The subsoil is very low in available phosphorus and potassium.

Nira soils are used mainly for row crops. The major hazard is erosion.

Representative profile of Nira silty clay loam, 2 to 5 percent slopes, on a side slope, 1,350 feet north and 1,350 feet west of the southeast corner of sec. 17, T. 76 N., R. 23 W.:

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay loam; weak fine granular structure; friable; neutral; clear smooth boundary.

A3—9 to 14 inches; very dark gray (10YR 3/1) silty clay loam; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

B21t—14 to 21 inches; brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; friable; thin discontinuous clay films; few very fine dark oxides; slightly acid; clear smooth boundary.

B22tg—21 to 28 inches; olive gray (5Y 5/2) silty clay loam; many fine prominent yellowish red (5YR 4/6) and yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; thin discontinuous clay films; few very fine dark oxides; neutral; gradual smooth boundary.

B31g—28 to 37 inches; olive gray (5Y 5/2) silty clay loam; few fine prominent reddish brown (5YR 4/4) mottles and common fine prominent yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; common very fine dark oxides; neutral; gradual smooth boundary.

B32g–37 to 44 inches; light olive gray (5Y 6/2) silty clay loam; few fine prominent dark reddish brown (2.5YR 2/4) mottles and many fine and medium prominent yellowish red (5YR 4/8) and yellowish brown (10YR 5/8) mottles; weak medium and coarse prismatic structure; fri-

able; dark organic stains; common very fine dark oxides; neutral; gradual smooth boundary.

Cg—44 to 60 inches; light olive gray (5Y 6/2) silty clay loam; common fine prominent yellowish red (5YR 4/8) and yellowish brown (10YR 5/8) mottles; massive; friable; common very fine dark oxides; mildly alkaline.

The solum ranges from 30 to 50 inches in thickness. The A horizon is black (10YR 2/1) or very dark gray (10YR 3/1) and is 10 to 15 inches thick.

All but the upper 6 or 8 inches of the B horizon is gray (5Y 5/1) to light olive gray (5Y 6/2) and light brownish gray (2.5Y 6/2).

The C horizon is gray (5Y 5/1) to light olive gray (5Y 6/2) and light brownish gray (2.5Y 6/2).

Nira soils are associated on the landscape with Clearfield, Grundy, Macksburg, and Sharpsburg soils. They also formed in parent material similar to that of those soils. They are shallower to the maximum clay layer than the associated soils. Nira soils are better drained than Clearfield, Grundy, and Macksburg soils. The upper part of their subsoil is brown as is the subsoil of Sharpsburg soils, but the lower part is gray.

570B—Nira silty clay loam, 2 to 5 percent slopes. This gently sloping soil is at the heads of drainageways and is downslope from the adjacent, nearly level Macksburg soils on the divides of uplands and benches adjacent to the major streams. Areas are irregular in shape, and they range from a few acres to 30 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of wet soils in waterways.

This Nira soil is well suited to intensive row crops. It is susceptible to erosion. The organic matter content is moderately high. Capability unit IIe–1; environmental planting group 1.

570C2—Nira silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on short, convex, upper parts of side slopes and on slopes bordering and in coves of drainageways in the uplands and on benches adjacent to the major streams. Areas are irregular in shape, and they range from a few acres to 40 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and the depth to gray colors is less. In many areas, plowing has mixed subsoil material with the surface layer.

Included with this soil in mapping are areas that are slightly eroded and small areas of Sharpsburg soils. Also included are spots of severely eroded soils, seepy wet spots, spots of red clay, and sand spots, all of which are indicated on the soil map by special symbols.

This Nira soil is well suited to row crops. It is susceptible to erosion. The organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

Nodaway series

The Nodaway series consists of deep, nearly level, moderately well drained soils. These soils are on first bottoms near the original stream channels. They formed in silty alluvium under a native vegetation of trees.

In a representative profile the surface layer is very dark grayish brown silt loam about 5 inches thick. Below this, to a depth of 60 inches, is stratified very dark grayish brown, dark grayish brown, and grayish brown silt loam.

Permeability is moderate, and available water capacity is high. The subsoil is medium in available phosphorus and potassium.

Nodaway soils are used mainly for row crops. The major hazard is flooding.

Representative profile of Nodaway silt loam, 0 to 2 percent slopes, on a flood plain of Middle River, 690 feet south and 180 feet west of the northeast corner of the SE¼ of sec. 21, T. 77 N., R. 23 W.:

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

C—5 to 60 inches; stratified, very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), and grayish brown (10YR 5/2) silt loam; weak thick platy structure; very friable; neutral.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2).

The stratified C horizon generally is many feet thick. Strata range from very dark grayish brown (10YR 3/2) to yellowish brown (10YR 5/4) and in places contain very thin very fine sand layers. In places a dark colored buried soil is below a depth of about 3 feet.

Nodaway soils are associated on the landscape with Amana, Colo, Kennebec, and Ackmore soils. They also formed in parent material similar to that of those soils. They have a thinner surface layer than Amana, Colo, and Kennebec soils and are stratified, whereas those soils are not. Nodaway soils formed in recent, stratified alluvium as did Ackmore soils, but do not have a dark buried soil at a depth of 20 to 40 inches as do Ackmore soils.

220—Nodaway silt loam, 0 to 2 percent slopes. This nearly level soil is on first bottoms near the original stream channels. Areas are long or irregular in shape. They range from a few acres to several hundred acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are sand spots and wet spots, both of which are indicated on the soil map by special symbols. Also included are areas of stratified soils that are darker colored than this Nodaway soil.

This Nodaway soil is well suited to intensive row crops if cleared of trees and protected from flooding. It is susceptible to flooding. The organic matter content is low to moderate. Capability unit I–2; environmental planting group 1.

C220—Nodaway silt loam, channeled, 0 to 2 percent slopes. This nearly level soil is on first bottoms near the original stream channels in areas that are cut by bayous and old meander channels. Areas are long or irregular in shape. They range from a few acres to a hundred acres or more in size.

Included with this soil in mapping are areas that

are not channeled. They are suited to cultivation but have not been cleared of trees.

This Nodaway soil is generally unsuited to row crops; it is better suited to trees or pasture than to most other uses. The soil can be used for row crops if trees are cleared, old channels are filled, and drainage and protection from flooding are adequate. The soil is susceptible to flooding. The organic matter content is low to moderate. Capability unit Vw–1; environmental planting group 1.

Olmitz series

The Olmitz series consists of deep, gently sloping and moderately sloping, well drained to moderately well drained soils. These soils are on alluvial fans and foot slopes. They formed in alluvium from adjacent slopes under a native vegetation of prairie grasses.

In a representative profile the surface layer is about 29 inches thick; it is very dark brown loam in the upper part and very dark grayish brown clay loam in the lower part. The clay loam subsoil extends to a depth of 60 inches; it is very dark grayish brown in the upper part, dark brown in the middle part, and brown in the lower part.

Permeability is moderate to moderately slow, and available water capacity is high. The subsoil is very low in available phosphorus and potassium.

Olmitz soils are used mainly for row crops, hay, and pasture. The major hazards are erosion and overflow from adjacent slopes.

Representative profile of Olmitz loam, 5 to 9 percent slopes, in a cultivated field, 200 feet west and 270 feet north of the southeast corner of sec. 8, T. 75 N., R. 25 W.:

A11—0 to 12 inches; very dark brown (10YR 2/2) loam; moderate fine granular structure; friable; medium acid; gradual smooth boundary.

A12—12 to 21 inches; very dark grayish brown (10YR 3/2) light clay loam; very dark brown (10YR 2/2) faces of peds; moderate very fine and fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

A13—21 to 29 inches; very dark grayish brown (10YR 3/2) light clay loam; moderate fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B1—29 to 37 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) medium clay loam; weak medium prismatic structure parting to moderate fine subangular blocky; friable; slightly acid; gradual smooth boundary.

B21—37 to 48 inches; dark brown (10YR 3/3) medium clay loam; weak medium prismatic structure parting to moderate medium subangular blocky; friable; slightly acid; gradual smooth boundary.

B22—48 to 60 inches; brown (10YR 4/3) medium clay loam; dark brown (10YR 3/3) faces of peds; weak medium prismatic structure parting to weak medium subangular blocky; friable; medium acid.

The solum is typically more than 40 inches thick.

The A11 horizon is black (10YR 2/1) or very dark brown (10YR 2/2) loam or light clay loam. It is 5 to 15 inches thick and is slightly acid to strongly acid.

The B1 horizon is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3) light or medium clay loam. It is 6 to 12 inches thick and is slightly acid or medium acid. The B2 horizon is dark brown (10YR 3/3) or brown (10YR 4/3) light or medium clay loam. It is slightly acid or medium acid.

Olmitz soils are associated on the landscape with Gara and Lindley soils, and they formed in parent material similar to that of Arbor soils. They are deeper to firm glacial till than Arbor soils, which have firm glacial till at a depth of less than 40 inches. They have a thicker surface layer than Gara and Lindley soils, which formed upslope in glacial till.

273B—Olmitz loam, 2 to 5 percent slopes. This gently sloping soil is on foot slopes. Areas are small in size and are long and narrow or irregular in shape.

Included with this soil in mapping are small areas of Arbor soils. Also included are small areas of glacial till outcrop, which are indicated on the soil map by a special symbol.

This Olmitz soil is well suited to row crops. It is generally managed with the more dominant soils of the adjacent bottom land. It is susceptible to erosion and to runoff from adjacent side slopes. The organic matter content is high. Capability unit IIe–3; environmental planting group 1.

273C—Olmitz loam, 5 to 9 percent slopes. This moderately sloping soil is on alluvial fans and foot slopes. Areas are small in size and irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Arbor soils and areas of gently sloping Olmitz soils. Also included are sand spots and small areas of glacial till outcrop, both of which are indicated on the soil map by special symbols.

This Olmitz soil is well suited to row crops. It is generally managed with adjacent soils. It is susceptible to erosion and to runoff from adjacent side slopes. The organic matter content is high. Capability unit IIIe–3; environmental planting group 1.

Pershing series

The Pershing series consists of deep, gently sloping to strongly sloping, moderately well drained to somewhat poorly drained soils. These soils are on upland ridges and the upper part of side slopes. They formed in loess under a native vegetation of mixed prairie grasses and trees.

In a representative profile the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 6 inches thick. The subsoil extends to a depth of 60 inches; it is dark grayish brown silty clay loam and silty clay in the upper part, grayish brown silty clay and silty clay loam in the middle part, and olive gray silty clay loam in the lower part.

Permeability is slow, and available water capacity is high. The subsoil is high in available phosphorus and very low in available potassium.

Pershing soils are used mainly for row crops, hay, and pasture. Some areas are in woodland. The major hazard is erosion.

Representative profile of Pershing silt loam, 2 to 5 percent slopes, on a broad ridge in an improved pasture, 1,965 feet west and 360 feet south of the northeast corner of sec. 22, T. 74 N., R. 22 W.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, some mixing of dark grayish brown (10YR 4/2), grayish brown (10YR 5/2) dry; weak very thin platy structure; friable; thick discontinuous gray silt coatings; neutral; abrupt smooth boundary.

A2—7 to 13 inches; dark grayish brown (10YR 4/2) silt loam, some mixing of grayish brown (10YR 5/2), pale brown (10YR 6/3) dry; weak thin platy structure; friable; thick discontinuous gray silt coatings; few very fine dark oxides; medium acid; clear smooth boundary.

B21t—13 to 18 inches; dark grayish brown (10YR 4/2) heavy silty clay loam; weak coarse prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; thick continuous gray silt coatings; few very fine dark oxides; medium acid; gradual smooth boundary.

B22t—18 to 25 inches; dark grayish brown (10YR 4/2) light silty clay; common fine distinct yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) mottles; weak coarse prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; few fine dark oxides; strongly acid; gradual smooth boundary.

B23t—25 to 31 inches; grayish brown (2.5Y 5/2) light silty clay; dark grayish brown (10YR 4/2) faces of peds; common fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; common fine dark oxides; strongly acid; gradual smooth boundary.

B24t—31 to 37 inches; grayish brown (2.5Y 5/2) heavy silty clay loam; dark grayish brown (10YR 4/2) faces of peds; many fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; common fine dark oxides; medium acid; gradual smooth boundary.

B31t—37 to 43 inches; olive gray (5Y 5/2) heavy silty clay loam; many fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; firm; thin continuous clay films on vertical faces of prisms; common fine dark oxides; medium acid; gradual smooth boundary.

B32t—43 to 60 inches; olive gray (5Y 5/2) silty clay loam; black (10YR 2/1) stains on vertical faces of prisms; many fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; firm; thin continuous and thick discontinuous clay films on vertical faces of prisms; thin discontinuous gray silt coatings; common fine dark oxides; slightly acid.

The solum ranges from 50 to 80 inches in thickness. The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick and is neutral to medium acid.

The B horizon is dark grayish brown (10YR to 2.5Y 4/2) to brown (10YR 5/3) in the upper part and dark grayish brown (2.5Y 4/2) to gray (5Y 6/1) in the lower part. The B horizon is heavy silty clay loam or light silty clay. It is 40 to 70 inches thick and is medium acid to strongly acid in the most acid part.

The B horizon is grayer than defined in the range of the Pershing series, but this difference does not significantly affect the use and behavior.

Pershing soils formed in parent material similar to that of Grundy and Weller soils. They have an A2 horizon that Grundy soils do not have. They have a thicker A1 or Ap horizon than Weller soils.

131B—Pershing silt loam, 2 to 5 percent slopes. This gently sloping soil is on upland ridgetops. Areas are long and narrow or irregular in shape. They range from a few acres to about 40 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are some areas of Pershing soils that are moderately eroded and some that are nearly level.

This Pershing soil is well suited to row crops. It is susceptible to erosion. The organic matter content is moderate to low. Capability unit IIe–1; environmental planting group 1.

131C2—Pershing silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on long, convex ridgetops and the upper part of side slopes on uplands. Areas are long and narrow or irregular in shape. They range from a few acres to 50 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed the surface layer and subsurface layer and, in places, material from the subsoil into the plow layer.

Included with this soil in mapping are areas of slightly eroded soils. Also included are spots of severely eroded soils, spots of red clay, spots of gray clay, glacial till outcrop, and seepy wet spots, all of which are indicated on the soil map by special symbols.

This Pershing soil is moderately well suited to row crops, but it is commonly used for hay and pasture with Armstrong and Gara soils that are downslope. It is susceptible to erosion. The organic matter content is moderate to low. Capability unit IIIe–1; environmental planting group 1.

131D2—Pershing silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on the end of long, convex ridges and the upper part of side slopes on uplands. Areas are long or irregular in shape.

They range from a few acres to 10 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed the surface and subsurface layers and, in places, material from the subsoil into the plow layer.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Pershing soil is poorly suited to row crops; it is better suited to small grain, pasture, hay, or woodland than to most other uses. It is susceptible to erosion. The organic matter content is moderate to low. Capability unit IVe–1; environmental planting group 1.

Sharpsburg series

The Sharpsburg series consists of deep, nearly level to strongly sloping, moderately well drained soils. These soils are on convex ridgetops, on the upper part of side slopes adjacent to upland ridges, and on loess covered stream benches. They formed in loess under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown silty clay loam about 16 inches thick. The silty clay loam subsoil extends to a depth of 50 inches; it is brown in the upper part and dark yellowish brown and yellowish brown in the lower part.

Permeability is moderately slow, and available water capacity is high. The subsoil is low in available phosphorus and medium in available potassium.

Sharpsburg soils are used mainly for row crops, hay, and pasture. The major hazard is erosion.

Representative profile of Sharpsburg silty clay loam, 5 to 9 percent slopes, in a cultivated field, 1,675 feet north and 140 feet east of the southwest corner of sec. 23, T. 76 N., R. 24 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) silty clay loam; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—8 to 11 inches; very dark brown (10YR 2/2) medium silty clay loam; weak very fine subangular blocky structure parting to moderate fine granular; friable; slightly acid; gradual smooth boundary.

A3—11 to 16 inches; very dark grayish brown (10YR 3/2) medium silty clay loam; moderate very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21t—16 to 24 inches; brown (10YR 4/3) heavy silty clay loam; dark brown (10YR 3/3) faces of peds; weak medium prismatic structure parting to moderate fine and very fine subangular blocky; firm; thin discontinuous clay films; strongly acid; gradual smooth boundary.

B22t—24 to 32 inches; brown (10YR 4/3) medium silty clay loam; few fine faint grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; firm; thin discontinuous clay films; few fine dark oxides; medium acid; gradual smooth boundary.

B23t—32 to 41 inches; dark yellowish brown (10YR 4/4) light silty clay loam; common fine distinct grayish brown (2.5Y 5/2) mottles and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; thin discontinuous clay films; common fine dark oxides; medium acid; gradual smooth boundary.

B3t—41 to 50 inches; yellowish brown (10YR 5/4) light silty clay loam; common fine and medium distinct grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; friable; thin discontinuous clay films on vertical faces of peds; few fine dark oxides; medium acid.

The solum is typically about 48 inches thick, and it ranges from 42 to 72 inches in thickness.

The A horizon is black (10YR 2/1) to dark brown (10YR 3/3) light or medium silty clay loam. It is 10 to 20 inches thick and is slightly acid to strongly acid.

The B2t horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). The finest textured part of this horizon is heavy silty clay loam or light silty clay. The B2t horizon is 22 to 37 inches thick and is slightly acid to strongly acid. The B3t horizon is dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4) light or medium silty clay loam. It is 8 to 15 inches thick and is slightly acid or medium acid.

The C horizon is not described in the representative profile, but it ranges from yellowish brown (10YR 5/4) to grayish brown (2.5Y 5/2). It is neutral or slightly acid.

Sharpsburg soils are associated on the landscape with Adair and Shelby soils, and they formed in parent material similar to that of Macksburg soils. They have less clay and less red hue in the subsoil than Adair soils. They have less sand than Shelby soils. They have a thinner surface layer and fewer gray mottles than Macksburg soils.

370—Sharpsburg silty clay loam, 0 to 2 percent slopes. This nearly level soil is on convex, upland ridgetops. Some areas are small in size and irregular in shape; others are long and 500 to 600 feet wide. This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker.

Included with this soil in mapping are wet spots, which are indicated on the soil map by a special symbol.

This Sharpsburg soil is well suited to intensive row crops. The organic matter content is high. Capability unit I–1; environmental planting group 1.

370B—Sharpsburg silty clay loam, 2 to 5 percent slopes. This gently sloping soil is on upland ridgetops. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but in places the surface layer is thicker.

Included with this soil in mapping are some areas of moderately eroded soils that have a thinner, lighter colored surface layer. Also included are sand spots and wet spots, both of which are indicated on the soil map by special symbols.

This Sharpsburg soil is well suited to intensive row crops. It is susceptible to erosion. The organic matter content is high. Capability unit IIe–1; environmental planting group 1.

370C—Sharpsburg silty clay loam, 5 to 9 percent slopes. This moderately sloping soil is on convex, upland ridgetops and side slopes. Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of shale outcrop, spots of red clay, spots of gray clay, seepy wet spots, and sand spots, all of which are indicated on the soil map by special symbols.

This Sharpsburg soil is well suited to row crops. It is susceptible to erosion. The organic matter content is high. Capability unit IIIe–1; environmental planting group 1.

370C2—Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on convex ridgetops and side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and lighter colored.

Included with this soil in mapping are spots of severely eroded soils, wet spots, sand spots, spots of gray clay, spots of red clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Sharpsburg soil is well suited to row crops. It is susceptible to erosion. Preparing a good seedbed is more difficult on this soil than on less eroded Sharpsburg soils. The organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

370D2—Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, seepy wet spots, spots of gray clay, spots of red clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Sharpsburg soil is moderately well suited to row crops. Some areas are in pasture. The soil is susceptible to erosion. The organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

T370—Sharpsburg silty clay loam, benches, 0 to 2 percent slopes. This nearly level soil is on loess covered stream benches. Areas are small in size and irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker.

Included with this soil in mapping are small areas of Macksburg soils, which are indicated on the soil map by a wet spot symbol.

This Sharpsburg soil is well suited to intensive row crops. In most areas, the loess is underlain by stratified alluvium rather than glacial till. In places the alluvium is sandy and is rapidly permeable. This porous substratum is a hazard for such uses as landfills. Capability unit I–1; environmental planting group 1.

T370B—Sharpsburg silt clay loam, benches, 2 to 5 percent slopes. This gently sloping soil is on convex benches along major streams. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker.

Included with this soil in mapping are sand spots, which are indicated on the soil map by a special symbol.

This Sharpsburg soil is well suited to intensive row crops. It is susceptible to erosion. In most areas, the loess is underlain by stratified alluvium rather than glacial till. In places, the alluvium is sandy and is rapidly permeable. This porous substratum is a hazard for such uses as farm ponds. The organic matter content is high. Capability unit IIe–1; environmental planting group 1.

T370C—Sharpsburg silty clay loam, benches, 5 to 9 percent slopes. This moderately sloping soil is on convex benches adjacent to major streams. Areas are long and narrow or irregular in shape. Slopes are typically short. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner.

Included with this soil in mapping are some areas of moderately eroded soils where plowing has mixed material from the subsoil into the surface layer. Also included are sand spots and seepy wet spots, both of which are indicated on the soil map by special symbols.

This Sharpsburg soil is well suited to row crops. It is susceptible to erosion. In most areas, the loess is underlain by stratified alluvium rather than glacial till. In places the alluvium is sandy and is rapidly permeable. This porous substratum is a hazard for such uses as farm ponds. Capability unit IIIe–1; environmental planting group 1.

Shelby series

The Shelby series consists of deep, strongly sloping to steep, moderately well drained soils. These soils are on convex side slopes on uplands. They formed in glacial till under a native vegetation of prairie grasses.

In a representative profile the surface layer is very dark brown clay loam about 7 inches thick. The clay loam subsoil extends to a depth of 44 inches; it is dark brown and dark yellowish brown in the upper part and mixed dark yellowish brown, olive gray, and light olive gray in the lower part. The substratum is mixed dark yellowish brown, olive gray, and light olive gray, calcareous clay loam.

Permeability is moderately slow, and available water capacity is high. The subsoil is low in available phosphorus and high in available potassium.

Shelby soils are used mainly for hay, pasture, and row crops. The major hazard is erosion.

Representative profile of Shelby clay loam, 14 to 18

percent slopes, moderately eroded, in a bluegrass pasture, 1,990 feet east and 120 feet south of the northwest corner of sec. 25, T. 76 N., R. 25 W.:

A1—0 to 7 inches; very dark brown (10YR 2/2) light clay loam; moderate medium granular structure parting to weak fine granular; friable; neutral; clear smooth boundary.

B1—7 to 11 inches; dark brown (10YR 3/3) clay loam; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) faces of peds; moderate very fine subangular blocky structure; friable; neutral; clear smooth boundary.

B21t—11 to 16 inches; dark yellowish brown (10YR 4/4) heavy clay loam; dark brown (10YR 3/3) faces of peds; moderate very fine subangular blocky structure; friable; thin continuous clay films; slightly acid; clear smooth boundary.

B22t—16 to 25 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure parting to weak very fine subangular blocky; firm; thin continuous clay films; medium acid; clear smooth boundary.

B23t—25 to 35 inches; dark yellowish brown (10YR 4/4) clay loam; brown (10YR 4/3) faces of peds; common medium distinct olive gray (5Y 5/2) mottles and few fine and medium distinct strong brown (7.5YR 5/6 and 5/8) mottles; moderate medium and coarse subangular blocky structure; firm; thin discontinuous clay films on vertical faces of peds; many dark oxides; slightly acid; gradual smooth boundary.

B3t—35 to 44 inches; mixed dark yellowish brown (10YR 4/4), olive gray (5Y 5/2), and light olive gray (5Y 6/2) clay loam; common fine and medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak medium and coarse subangular blocky structure; firm; thin discontinuous clay films on vertical faces of peds; many dark oxides; neutral; clear smooth boundary.

C—44 to 60 inches; mixed dark yellowish brown (10YR 4/4), olive gray (5Y 5/2), and light olive gray (5Y 6/2) light clay loam; common medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; massive; firm; many dark oxides; many soft carbonates; strong effervescence; mildly alkaline.

The solum is typically 40 to 50 inches thick, and it ranges from 30 to 75 inches in thickness.

The A horizon is very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2) light clay loam or loam. It is 10 to 18 inches thick in uneroded areas, and it is neutral to strongly acid.

The B2t horizon is brown (10YR 4/3), dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/6). It is medium to heavy clay loam. It is 10 to 24 inches thick and is slightly acid to strongly acid.

The C horizon is brown (10YR 4/3) to yellowish brown (10YR 5/6) mixed with grayish brown (2.5Y 5/2) to light olive gray (5Y 6/2).

The B2t horizon is finer textured than defined in the range of the Shelby series, but this difference does not alter the usefulness or behavior of the soil.

Shelby soils formed in parent material similar to that of Gara soils. They have a thicker surface layer than Gara soils.

24D2—Shelby clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes on uplands. Areas are long or irregular in shape. They range from a few acres to 20 acres in size. This soil has a profile similar to the one described as representative of the series, but in many places material from the subsoil is mixed into the plow layer.

Included with this soil in mapping are areas that are slightly eroded. Also included are spots of severely eroded soils, spots of gray clay, spots of red clay, rock outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Shelby soil is moderately well suited to row crops, but it is commonly used for hay or pasture. It is susceptible to erosion. The organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

24E2—Shelby clay loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on convex side slopes on uplands. Areas are long or are irregular in shape. They range from a few acres to 30 acres in size. The profile of this soil is the one described as representative of the series. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, spots of gray clay, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Shelby soil is poorly suited to row crops; it is better suited to small grain, hay, or pasture. It is susceptible to erosion. The organic matter content is moderate. Capability unit IVe–3; environmental planting group 1.

24F2—Shelby clay loam, 18 to 25 percent slopes, moderately eroded. This steep soil is on convex side slopes on uplands. Areas are long or irregular in shape. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of red clay, which are indicated on the soil map by a special symbol.

This Shelby soil is generally unsuited to cultivated crops. Most areas are in pasture, and some are in hay. Farm machinery can be used in most areas, but caution is required because of the steepness of slopes. The soil is susceptible to erosion. The organic matter content is moderate. Capability unit VIe–1; environmental planting group 1.

Sperry series

The Sperry series consists of deep, nearly level,

poorly drained to very poorly drained soils. These soils are in depressional areas on broad upland flats. They formed in loess under a native vegetation of tall prairie grasses tolerant to wetness.

In a representative profile the surface layer is black silt loam about 10 inches thick. The subsurface layer is very dark gray and dark gray silt loam about 11 inches thick. The subsoil extends to a depth of 56 inches; it is dark gray silty clay loam and silty clay in the upper part and dark gray and gray silty clay in the lower part. The substratum is olive gray silty clay loam.

Permeability is slow to very slow, and available water capacity is high. The subsoil is very low in available phosphorus and potassium.

Sperry soils are used mainly for row crops. The major limitation is wetness.

Representative profile of Sperry silt loam, 0 to 1 percent slopes, on a broad upland flat, 1,780 feet north and 455 feet east of the southwest corner of sec. 9, T. 76 N., R. 23 W.:

Ap—0 to 10 inches; black (10YR 2/1) silt loam; weak fine granular structure; friable; strongly acid; abrupt smooth boundary.

A21—10 to 14 inches; very dark gray (10YR 3/1) silt loam, light gray (10YR 6/1) dry; moderate medium platy structure; friable; medium acid; clear smooth boundary.

A22—14 to 21 inches; dark gray (10YR 4/1) silt loam, light gray (10YR 6/1 and 7/1) dry; weak medium platy structure parting to weak very fine subangular blocky; friable; medium acid; abrupt smooth boundary.

B21tg—21 to 27 inches; dark gray (10YR 4/1) heavy silty clay loam; very dark gray (10YR 3/1) faces of peds; moderate fine subangular blocky structure; firm; thin continuous clay films; few dark oxides; medium acid; clear smooth boundary.

B22tg—27 to 35 inches; dark gray (10YR 4/1) medium silty clay; very dark gray (10YR 3/1) faces of peds; moderate fine subangular and angular blocky structure; firm; thin continuous clay films; few dark oxides; slightly acid; gradual smooth boundary.

B23tg—35 to 43 inches; dark gray (5Y 4/1) medium silty clay; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous clay films; few dark oxides; neutral; gradual smooth boundary.

B3tg—43 to 56 inches; gray (5Y 5/1) light silty clay; common fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky; firm; thin discontinuous clay films on vertical faces of peds; few dark oxides; neutral; gradual smooth boundary.

Cg—56 to 60 inches; olive gray (5Y 5/2) heavy silty clay loam; common medium prominent strong brown (7.5YR 5/6) mottles; massive; firm; few dark oxides; neutral.

The solum ranges from 40 to 68 inches in thickness.

The Ap horizon is black (10YR 2/1) or very dark gray (10YR 3/1). It is 6 to 10 inches thick and is neutral to strongly acid. The A2 horizon is very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). It is 6 to 11 inches thick and is medium acid or strongly acid.

The B2t horizon is dark gray (10YR 4/1) to dark gray (5Y 4/1) heavy silty clay loam to medium silty clay.

The change in texture from the A2 horizon to the B2 horizon is not as abrupt as required in the range of the Sperry series. This difference, however, does not have a significant effect on the use and behavior of the soils.

Sperry soils are near Winterset soils. Sperry soils have a grayish subsurface layer that Winterset soils lack.

122—Sperry silt loam, 0 to 1 percent slopes. This nearly level soil is in small depressional areas on broad flats. Areas are small in size and elliptical in shape.

Included with this soil in mapping are small areas of adjacent Winterset soils. Also included in areas of the Grundy-Arispe-Winterset association are Sperry soils that have a higher than typical content of clay in the subsoil.

This Sperry soil is moderately well suited to row crops if drainage is adequate. It is susceptible to wetness. Artificial drainage is required for optimum crop production. The organic matter content is moderate to high. Capability unit IIIw–2; environmental planting group 2.

Steep rock land

478—Steep rock land. This mapping unit consists of shale and sandstone in areas where slopes are 25 to 50 percent and, in a few places, escarpments of sandstone. It is on convex side slopes on uplands. The vegetation is mainly trees. The surface layer ranges from silt loam to sandy loam and is about 8 inches thick. The substratum is mixed shale, siltstone, and soft sandstone. Permeability is very slow, and available water capacity is low.

Included in mapping are small areas of glacial till outcrop, which are indicated on the soil map by a special symbol. Also included are areas of Gosport soils.

Steep rock land is not suited to row crops, hay, or pasture; it is better suited to woodland and to wildlife habitat than to most other uses (fig. 16). Most areas are in woodland, but some areas are in pasture. The major hazard is erosion, and the major limitations are low fertility, low available water capacity, and the very steep slopes. The organic matter content is low. Capability unit VIIe–2; environmental planting group 4.

Strip mines

502—Strip mines. This mapping unit consists of abandoned coal mines. The coal mines are stripped areas, some of which contain bodies of water, and

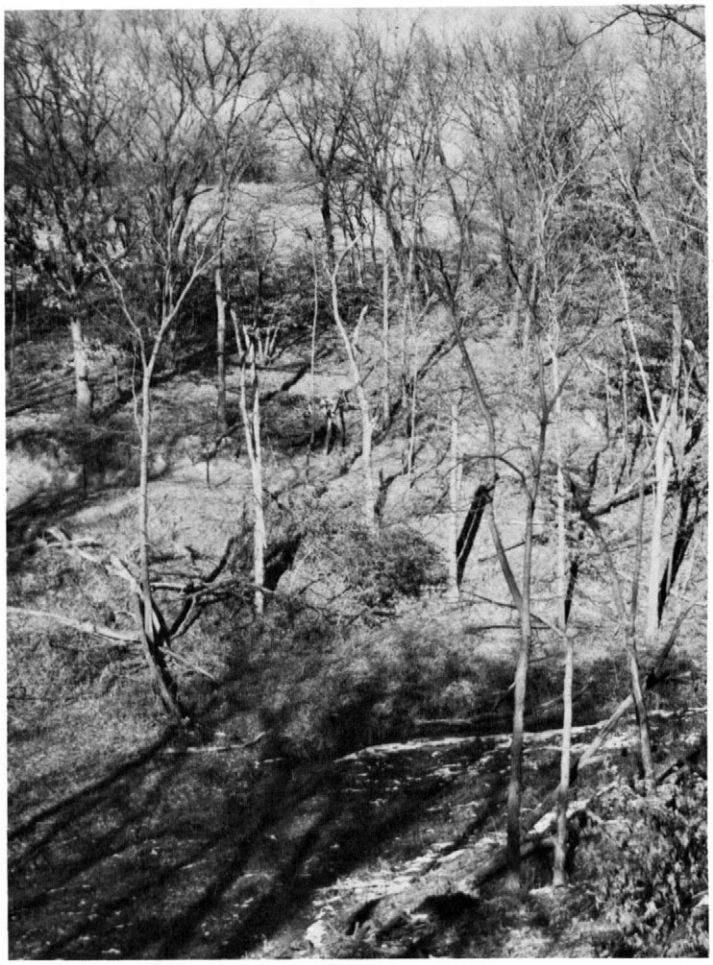

Figure 16.—Typical area of Steep rock land in woods. Areas that are used for pasture are generally not managed.

areas where spoil was deposited. Most areas range from depressional to very steep and are about 5 to 160 acres in size. The vegetation usually consists of widely spaced weeds and tufts of grass. A few small trees are in the most favorable parts of some of the areas. This material is mainly raw shale or material weathered from shale or other sedimentary rock. It is very infertile and mostly extremely acid. Permeability commonly is very slow, and available water capacity is low.

Strip mine areas are not suited to row crops, and major reclamation is necessary for the soil to be used for hay, pasture, woodland, or wildlife habitat. The low fertility and low available water capacity are serious limitations. Erosion is a hazard in the sloping areas. The organic matter content is very low. Capability unit VIIs–2; environmental planting group 4.

Tama series

The Tama series consists of deep, nearly level to strongly sloping, well drained soils. These soils are on convex ridgetops and side slopes on uplands and on benches adjacent to major streams. They formed in loess under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is very dark brown light silty clay loam about 13 inches thick. The silty clay loam subsoil extends to a depth of 50 inches; it is mainly dark yellowish brown but is dark brown in the upper 6 inches.

Permeability is moderate, and available water capacity is high. The subsoil is medium in available phosphorus and very low in available potassium.

Tama soils are used mainly for row crops, hay, and pasture. The major hazard is erosion.

Representative profile of Tama silty clay loam, 2 to 5 percent slopes, on an upland ridgetop, 400 feet south and 80 feet east of the northwest corner of sec. 28, T. 77 N., R. 22 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) light silty clay loam; weak very fine granular structure; friable; strongly acid; abrupt smooth boundary.

A12—8 to 13 inches; very dark brown (10YR 2/2) light silty clay loam; weak very fine subangular blocky structure parting to moderate very fine and fine granular; friable; medium acid; gradual smooth boundary.

B1—13 to 19 inches; dark brown (10YR 3/3) silty clay loam; very dark grayish brown (10YR 3/2) faces of peds; weak medium subangular blocky structure parting to moderate very fine subangular blocky; friable; medium acid; gradual smooth boundary.

B21t—19 to 30 inches; dark yellowish brown (10YR 4/4) silty clay loam; brown (10YR 4/3) faces of peds; weak medium subangular blocky structure parting to moderate fine and very fine subangular blocky; friable; thin discontinuous clay films; medium acid; gradual smooth boundary.

B22t—30 to 40 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine faint grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; friable; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B3t—40 to 50 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine faint grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous clay films on vertical faces of peds; medium acid.

The solum is typically about 48 inches thick, but it ranges from 36 to 60 inches in thickness.

The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) heavy silt loam or light silty clay loam. It is 10 to 20 inches thick and is medium acid or strongly acid.

The B2t horizon is dark brown (10YR 4/3) to yellowish brown (10YR 5/4) light or medium silty clay loam. It is 8 to 20 inches thick and is slightly acid to strongly acid.

The C horizon is not described in the representative profile, but it is from dark brown (10YR 4/3) to yellowish brown (10YR 5/6).

Tama soils formed in parent material similar to that of Downs and Muscatine soils. They have a thicker surface layer than Downs soils. They have a browner subsoil and a thinner surface layer than Muscatine soils.

120—Tama silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad upland flats. Areas are small in size and irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker.

Included with this soil in mapping are small areas of Muscatine soils.

This Tama soil is well suited to intensive row crops. The organic matter content is high. Capability unit I–1; environmental planting group 1.

120B—Tama silty clay loam, 2 to 5 percent slopes. This gently sloping soil is on convex, upland ridgetops. Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are some areas of moderately eroded soils.

This Tama soil is well suited to intensive row crops. It is susceptible to erosion. The organic matter content is high. Capability unit IIe–1; environmental planting group 1.

120C2—Tama silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on upland ridgetops and side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, seepy wet spots, spots of red clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are some areas of slightly eroded soils.

This Tama soil is moderately well suited to row crops. It is susceptible to erosion. The organic matter content is high. Capability unit IIIe–1; environmental planting group 1.

120D2—Tama silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are sand spots, shale outcrop, glacial till outcrop, spots of red clay, and spots of gray clay, all of which are indicated on the soil map by special symbols.

This Tama soil is moderately well suited to row crops. It is susceptible to erosion. The organic matter content is high. Capability unit IIIe–1; environmental planting group 1.

T120B—Tama silty clay loam, benches, 2 to 5 percent slopes. This gently sloping soil is on benches adjacent to major streams. Areas are long and narrow or irregular in shape. Slopes are typically short.

Included in mapping are some areas of moderately sloping Tama soils, which are indicated on the soil map by a special symbol for short, steep slopes.

This Tama soil is well suited to intensive row crops. It is susceptible to erosion. In most areas, the loess is underlain by stratified alluvium rather than glacial till. In places, the alluvium is sandy and rapidly permeable, and it is a hazard for such uses as farm ponds or landfills. Capability unit IIe–1; environmental planting group 1.

Vesser series

The Vesser series consists of deep, nearly level and gently sloping, somewhat poorly drained to poorly drained soils. These soils are on bottom lands and foot slopes. They formed in alluvium under a native vegetation of mixed prairie grasses and trees tolerant of wetness.

In a representative profile the surface layer is very dark gray silt loam about 12 inches thick. The subsurface layer is gray, dark gray, and very dark gray silt loam about 14 inches thick. The silty clay loam subsoil extends to a depth of 60 inches; it is very dark gray in the upper part, dark grayish brown and dark gray in the middle part, and mixed grayish brown and yellowish brown in the lower part.

Permeability is moderate to moderately slow, and available water capacity is high. The subsoil is medium in available phosphorus and low in available potassium.

Vesser soils are used mainly for row crops. The major limitation is wetness and, in places, flooding.

Representative profile of Vesser silt loam, 2 to 5 percent slopes, in a cultivated field, 1,025 feet west and 250 feet north of the southeast corner of the NW¼ sec. 33, T. 76 N., R. 25 W.:

Ap—0 to 8 inches; very dark gray (10YR 3/1) heavy silt loam; black (10YR 2/1) faces of peds, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; medium acid; clear smooth boundary.

A12—8 to 12 inches; very dark gray (10YR 3/1) heavy silt loam; black (10YR 2/1) faces of peds, very dark gray (10YR 3/1) and some dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

A21—12 to 19 inches; gray (10YR 5/1) and some dark gray (10YR 4/1) and gray (10YR 6/1) heavy silt loam, gray (10YR 5/1 and 6/1) and light gray (10YR 7/1) dry; few fine prominent dark brown (7.5YR 3/2) and brown (7.5YR 5/4) mottles; weak medium platy structure parting to weak very fine subangular blocky; friable; medium acid; clear smooth boundary.

A22—19 to 26 inches; very dark gray (10YR 3/1) and some dark gray (10YR 4/1) and gray (10YR 5/1 and 6/1) heavy silt loam; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium

platy structure parting to weak very fine subangular blocky; friable; medium acid; clear smooth boundary.

B21t—26 to 31 inches; very dark gray (10YR 3/1) medium silty clay loam; few fine distinct dark brown (7.5YR 3/2 and 4/4) mottles; moderate fine and medium prismatic structure parting to moderate medium and fine subangular blocky; friable; thin continuous clay films; slightly acid; gradual smooth boundary.

B22t—31 to 40 inches; dark grayish brown (10YR 4/2) medium silty clay loam; very dark gray (10YR 3/1) faces of peds; common fine distinct dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; firm; thin continuous clay films; slightly acid; gradual smooth boundary.

B23t—40 to 48 inches; dark gray (5Y 4/1) medium silty clay loam; many fine prominent yellowish brown (10YR 5/6) mottles and few fine faint dark gray (10YR 4/1) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin continuous clay films; few fine dark oxides; neutral; gradual smooth boundary.

B3g—48 to 60 inches; grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) light silty clay loam; few fine faint dark gray (10YR 4/1) and grayish brown (10YR 5/2) mottles; weak medium prismatic and yellowish brown (10YR 5/6) light structure; firm; common fine and medium dark oxides; friable; neutral.

The solum is commonly more than 60 inches thick. The A1 horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) silt loam or light silty clay loam. It is 12 to 20 inches thick and is neutral to medium acid. The A2 horizon is very dark gray (10YR 3/1) to grayish brown (10YR 5/2). It is 12 to 24 inches thick and is neutral to strongly acid.

The B2t horizon is very dark gray (10YR 3/1) to olive gray (5Y 5/2) light or medium silty clay loam. It is 15 to 30 inches thick and is neutral or slightly acid. The B3 horizon has mixed colors that range from yellowish brown (10YR 5/6) to grayish brown (2.5Y 5/2). It is light or medium silty clay loam 10 to 20 inches thick and is neutral or slightly acid.

Vesser soils are associated on the landscape with Colo and Zook soils. They formed in parent material similar to that of Humeston soils. They have a subsurface layer that Colo and Zook soils do not have. They have a thicker subsurface layer and less clay in the subsoil than Humeston soils.

51—Vesser silt loam, 0 to 2 percent slopes. This nearly level soil is on bottom lands. Areas are small in size and irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker.

Included with this soil in mapping are small areas of Humeston soils.

This Vesser soil is moderately well suited to row crops. It is susceptible to wetness and to flooding. The organic matter content is high. Capability unit IIw–2; environmental planting group 2.

51B—Vesser silt loam, 2 to 5 percent slopes. This gently sloping soil is on foot slopes. Areas are small in size and irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of soils that have a thinner surface layer.

This Vesser soil is moderately well suited to row crops. It is susceptible to wetness, and many areas receive runoff from soils upslope. The organic matter content is high. Capability unit IIw–3; environmental planting group 2.

Wabash series

The Wabash series consists of deep, nearly level, very poorly drained soils. These soils are on broad bottom lands. They formed in fine textured alluvium under a native vegetation of mixed prairie grasses and trees tolerant to excessive wetness.

In a representative profile the surface layer is about 36 inches thick; it is black silty clay loam in the upper part and black silty clay in the lower part. The subsoil extends to a depth of 52 inches and is dark gray silty clay. The substratum is dark gray silty clay.

Permeability is very slow, and available water capacity is moderate. The subsoil is high in available phosphorus and medium in available potassium.

Wabash soils are used mainly for row crops and pasture. The major limitation is wetness and flooding.

Representative profile of Wabash silty clay loam, 0 to 2 percent slopes, in a cultivated bottom land, 740 feet west and 620 feet north of the southeast corner of sec. 29, T. 76 N., R. 25 W.:

Ap—0 to 9 inches; black (10YR 2/1) medium silty clay loam; weak medium subangular blocky structure parting to weak fine granular; friable; mildly alkaline; abrupt smooth boundary.

A12—9 to 14 inches; black (10YR 2/1) light silty clay; moderate very fine subangular blocky structure; friable; neutral; clear smooth boundary.

A13—14 to 20 inches; black (N 2/0) medium silty clay; moderate medium subangular blocky structure parting to moderate fine and very fine subangular blocky; firm; few fine dark oxides; medium acid; gradual smooth boundary.

A3—20 to 36 inches; very dark gray (10YR 3/1) heavy silty clay; black (10YR 2/1) faces of peds; few fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate fine subangular and angular blocky structure; firm; few fine dark oxides; medium acid; gradual smooth boundary.

Bg—36 to 52 inches; dark gray (10YR 4/1) heavy silty clay; few fine distinct yellowish brown (10YR 5/6) mottles; moderate

medium subangular blocky structure; firm; few fine dark oxides; neutral; gradual smooth boundary.

Cg—52 to 60 inches; dark gray (5Y 4/1) medium silty clay; common fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; massive; firm; few fine dark oxides; neutral.

The solum ranges from 40 to more than 60 inches in thickness.

The upper 6 to 15 inches of the A1 horizon ranges from medium silty clay loam to silty clay. The A1 horizon is 20 to 30 inches thick and ranges from medium acid to mildly alkaline.

The Bg horizon is very dark gray (10YR 3/1) to gray (5Y 5/1) light to heavy silty clay. It is 15 to 30 inches thick and is medium acid to neutral.

Wabash soils are associated on the landscape with Colo and Zook soils and formed in parent material similar to that of those soils. They contain more clay than Colo and Zook soils.

248—Wabash silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad bottom lands, generally at low elevations next to foot slopes or stream benches. Areas vary greatly in shape. They range from a few acres to more than 100 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Zook soils and soils that have a silty clay surface layer. Also included are sand spots and small areas of marsh, both of which are indicated on the soil map by special symbols.

This Wabash soil is moderately well suited to row crops. Some areas are in pasture. The soil is susceptible to wetness and to flooding. Ponding of water after rain is common. Artificial drainage is needed. Maintaining good tilth is a concern. The organic matter content is high. Capability unit IIIw–3; environmental planting group 2.

172—Wabash silty clay, 0 to 2 percent slopes. This nearly level soil is on broad bottom lands, generally at low elevations next to foot slopes or stream benches. Areas vary greatly in shape. They range from a few acres to more than 100 acres in size.

Included with this soil in mapping are small areas of Zook soils and soils that have a silty clay loam surface layer. Also included are small areas that pond water, which are indicated on the soil map by a wet spot symbol.

This Wabash soil is moderately well suited to row crops. Some areas are in pasture. The soil is susceptible to wetness and flooding. Maintaining good tilth is a concern. Ponding of water after rain is common. Artificial drainage is needed. The organic matter content is high. Capability unit IIIw–3; environmental planting group 2.

Watkins series

The Watkins series consists of deep, nearly level to gently sloping, well drained to moderately well drained soils. These soils are on second bottoms. They formed in silty alluvium under a native vegetation of mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil extends to a depth of 49 inches; it is brown silt loam in the upper part, brown silty clay loam in the middle part, and dark yellowish brown and yellowish brown silty clay loam in the lower part. The substratum is yellowish brown and grayish brown silty clay loam.

Permeability is moderate, and available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium.

Watkins soils are used mainly for row crops. The major hazard is erosion.

Representative profile of Watkins silt loam, 1 to 4 percent slopes, on a second bottom, 1,110 feet north and 130 feet west of the southeast corner of sec. 28, T. 76 N., R. 25 W.:

A1—0 to 6 inches; very dark grayish brown (10YR 3/2) heavy silt loam, grayish brown (10YR 5/2) dry; moderate very thin platy structure parting to weak very fine granular; friable; neutral; clear smooth boundary.

A2—6 to 11 inches; dark grayish brown (10YR 4/2) heavy silt loam, grayish brown (10YR 5/2) dry; weak platy structure parting to moderate fine subangular blocky; friable; neutral; gradual smooth boundary.

B1—11 to 15 inches; brown (10YR 4/3) heavy silt loam; very dark grayish brown (10YR 3/2) faces of peds; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

B21t—15 to 22 inches; brown (10YR 4/3) medium silty clay loam; dark grayish brown (10YR 4/2) faces of peds; moderate medium subangular blocky structure parting to moderate fine angular and subangular blocky; friable; thin discontinuous clay films; thin continuous gray silt coatings; few fine dark oxides; neutral; gradual smooth boundary.

B22t—22 to 29 inches; brown (10YR 4/3) meium silty clay loam; moderate coarse subangular blocky structure; friable; thin discontinuous clay films; thin discontinuous gray silt coatings; few fine dark oxides; medium acid; gradual smooth boundary.

B23t—29 to 36 inches; dark yellowish brown (10YR 4/4) medium silty clay loam; moderate coarse subangular blocky structure; thin discontinuous clay films; many fine dark oxides; medium acid; gradual smooth boundary.

B3t—36 to 49 inches; yellowish brown (10YR 5/4) light silty clay loam; common fine distinct grayish brown (2.5Y 5/2) mottles and few fine faint yellowish brown (10YR 5/6) mottles; weak coarse sub-

angular blocky structure; thin discontinuous clay films; many fine dark oxides; medium acid; gradual smooth boundary.

C—49 to 60 inches; yellowish brown (10YR 5/4) and grayish brown (2.5Y 5/2) light silty clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; many fine dark oxides; medium acid.

The solum ranges from 30 to 60 inches in thickness. The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick and is neutral to medium acid.

The B2t horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4) light or medium silty clay loam. It is 12 to 25 inches thick and is neutral to medium acid. The B3t horizon is brown (10YR 4/3) to yellowish brown (10YR 5/4) light or medium silty clay loam. It is 6 to 18 inches thick and is slightly acid or medium acid.

Watkins soils are associated on the landscape with Colo and Zook soils. They formed in parent material similar to that of Nevin soils. They have a thinner surface layer than Colo and Zook soils. They have a thinner surface layer and fewer gray mottles than Nevin soils.

687B—Watkins silt loam, 1 to 4 percent slopes. This nearly level to gently sloping soil is on second bottoms. Areas are small in size and irregular in shape.

Included with this soil in mapping are sand spots, which are indicated on the soil map by a special symbol. Also included are small areas of somewhat poorly drained soils, which are indicated on the soil map by a wet spot symbol.

This Watkins soil is well suited to intensive row crops. Gently sloping areas are susceptible to erosion; the nearly level areas have no serious hazards or limitations. The organic matter content is moderate. Capability unit IIe–1; environmental planting group 1.

Weller series

The Weller series consists of deep, gently sloping and moderately sloping, moderately well drained soils. These soils are on upland ridges and the upper part of side slopes. They formed in loess under a native vegetation of trees.

In a representative profile the surface layer is very dark grayish brown silt loam about 3 inches thick. The subsurface layer is dark grayish brown silt loam about 6 inches thick. The subsoil extends to a depth of 49 inches; it is dark yellowish brown and yellowish brown silty clay loam in the upper part, yellowish brown silty clay in the middle part, and yellowish brown and grayish brown silty clay loam in the lower part. The substratum is yellowish brown and grayish brown silty clay loam.

Permeability is slow, and available water capacity is high. The subsoil is medium in available phosphorus and very low in available potassium.

Weller soils are used mainly for hay, pasture, and woodland. The major hazard is erosion.

Representative profile of uneroded Weller soil in an area of Weller silt loam, 5 to 9 percent slopes, moderately eroded, in a pasture, 2,050 feet east and 290 feet north of the southwest corner of sec. 36, T. 74 N., R. 22 W.:

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak thin platy structure parting to weak fine granular; neutral; abrupt smooth boundary.

A2—3 to 9 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; weak thin platy structure; friable; thin discontinuous gray silt coatings; neutral; clear smooth boundary.

B1—9 to 14 inches; dark yellowish brown (10YR 4/4) medium silty clay loam; moderate fine subangular and angular blocky structure; friable; thin continuous gray silt coatings; medium acid; clear smooth boundary.

B21t—14 to 19 inches; yellowish brown (10YR 5/4) heavy silty clay loam; dark yellowish brown (10YR 4/4) faces of peds; moderate fine and medium angular blocky structure; firm; thin continuous clay films; thin discontinuous gray silt coatings; medium acid; gradual smooth boundary.

B22t—19 to 25 inches; yellowish brown (10YR 5/4) light silty clay; few fine distinct grayish brown (2.5Y 5/2) mottles; strong fine angular blocky structure; firm; thin continuous clay films; thin discontinuous gray silt coatings; few very fine dark oxides; strongly acid; gradual smooth boundary.

B23t—25 to 37 inches; yellowish brown (10YR 5/4) light silty clay; few medium distinct dark brown (7.5YR 4/4) mottles and common fine and medium distinct grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure parting to strong fine angular blocky; firm; thin discontinuous clay films; few fine dark oxides; strongly acid; gradual smooth boundary.

B3t—37 to 49 inches; grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) medium silty clay loam; few fine distinct dark brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; thin continuous clay films on vertical faces of peds; common fine dark oxides; medium acid; gradual smooth boundary.

C—49 to 60 inches; grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) light silty clay loam; few fine distinct dark brown (7.5YR 4/4) mottles; massive; friable; common fine dark oxides; slightly acid.

The solum ranges from 48 to 80 inches in thickness. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The Ap horizon is dark grayish brown (10YR 4/2), grayish brown

(10YR 5/2), or brown (10YR 5/3). The A2 horizon is neutral to very strongly acid.

The B2t horizon is dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4) heavy silty clay loam or light silty clay. It is medium acid to very strongly acid.

Weller soils in this county lack mottles of chroma 2 or less in the upper part of the B horizon as defined in the range of the series. Also, the B horizon is slightly lower in content of clay than defined in the range. These differences, however, do not significantly affect the use and behavior of the soils.

Weller soils formed in parent material similar to that of Grundy and Pershing soils. They have a thinner surface layer than Grundy and Pershing soils.

132B—Weller silt loam, 2 to 5 percent slopes. This gently sloping soil is on upland ridgetops. Areas are long and narrow or irregular in shape. They range from a few acres to 60 acres or more in size. In plowed areas, the surface and subsurface layers and, in places, material from the subsoil are mixed into the plow layer.

Included with this soil in mapping are wet spots, which are indicated on the soil map by a special symbol.

This Weller soil is moderately well suited to row crops. It is susceptible to erosion. The organic matter content is low to moderately low. Capability unit IIIe–2; environmental planting group 1.

132C2—Weller silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on long, convex ridges and the upper part of side slopes on uplands. Areas are long and narrow or irregular in shape. They range from a few acres to 90 acres in size. This soil has a profile similar to the one described as representative of the series, but in most places the surface and subsurface layers are thinner. In cultivated areas, the surface layer and subsurface layer and, in many places, material from the subsoil are mixed into the plow layer.

Included with this soil in mapping are areas that are slightly eroded and small areas that are strongly sloping. Also included are spots of severely eroded soils and spots of red clay, both of which are indicated on the soil map by special symbols.

This Weller soil is moderately well suited to row crops, but most areas are in hay, pasture, or woodland with Gosport, Keswick, and Lindley soils downslope. The soil is susceptible to erosion. The organic matter content is low to moderately low. Capability unit IIIe–2; environmental planting group 1.

Winterset series

The Winterset series consists of deep, nearly level, poorly drained soils. These soils are on broad upland flats. They formed in loess under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is black silty clay loam about 19 inches thick. The subsoil extends to a depth of 60 inches; it is very dark gray silty clay loam in the upper part, olive gray silty clay and silty clay loam in the middle part, and gray and olive gray silty clay loam in the lower part.

Permeability is moderately slow to slow, and available water capacity is high. The subsoil is low to medium in available phosphorus and medium in available potassium.

Winterset soils are used mainly for row crops. The major limitation is wetness.

Representative profile of Winterset silty clay loam, 0 to 2 percent slopes, on an upland flat in a pasture, 205 feet west and 250 feet south of the northeast corner of the NW¼ sec. 16, T. 76 N., R. 23 W.:

A11—0 to 8 inches; black (10YR 2/1) light silty clay loam; moderate fine granular structure; friable; strongly acid; gradual smooth boundary.

A12—8 to 19 inches; black (10YR 2/1) silty clay loam; moderate very fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B1t—19 to 26 inches; very dark gray (10YR 3/1) heavy silty clay loam; moderate and strong fine and very fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B21tg—26 to 34 inches; olive gray (5Y 5/2) light silty clay; very dark gray (10YR 3/1) faces of peds; common fine distinct olive brown (2.5Y 4/4) mottles; weak medium prismatic structure parting to strong fine subangular blocky; firm; thin continuous clay films; few fine dark oxides; medium acid; gradual smooth boundary.

B22tg—34 to 43 inches; olive gray (5Y 5/2) heavy silty clay loam; very dark grayish brown (2.5Y 3/2) faces of prisms; common fine distinct yellowish brown (10YR 5/4) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; common fine dark oxides; medium acid; gradual smooth boundary.

B23t—43 to 50 inches; gray (5Y 5/1) medium silty clay loam; common fine distinct yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous clay films on vertical faces of peds; common fine dark oxides; slightly acid; gradual smooth boundary.

B3t—50 to 60 inches; olive gray (5Y 5/2) light silty clay loam; common fine distinct yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; few dark oxides; slightly acid.

The solum is typically more than 60 inches thick, and it ranges from 48 to 72 inches in thickness.

The A horizon is 15 to 25 inches thick. It is strongly acid to neutral.

The B2t horizon is grayish brown (2.5Y 5/2) or olive gray (5Y 5/2) to dark gray (5Y 4/1) medium silty clay loam to light silty clay. The B2t horizon is 16 to 28 inches thick and is strongly acid to slightly acid.

The C horizon is not described in the representative profile, but it is gray (5Y 5/1) or olive gray (5Y 5/2) light silty clay loam or heavy silt loam.

Winterset soils are associated on the landscape with Macksburg, Sharpsburg, and Sperry soils. They also formed in parent material similar to that of those soils. They have a grayer subsoil than Macksburg and Sharpsburg soils. They have a lower clay content in the subsoil than Sperry soils.

369—Winterset silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad upland flats. Areas are irregular in shape. They are large on the major divides and small on the smaller divides.

Included with this soil in mapping are small areas of Macksburg soils. Also included are small areas of Sperry soils, which are indicated on the soil map by a wet spot symbol.

This Winterset soil is well suited to intensive row crops. It is susceptible to wetness. The organic matter content is high. Capability unit IIw–1; environmental planting group 1.

Wiota series

The Wiota series consists of deep, nearly level and gently sloping, well drained to moderately well drained soils. These soils are on second bottoms and stream benches above the present flood plain. They formed in silty alluvium under a native vegetation of prairie grasses.

In a representative profile the upper 8 inches of the surface layer is very dark brown silt loam, and the lower 14 inches is very dark grayish brown and dark brown silty clay loam. The subsoil extends to a depth of 50 inches; it is dark brown silty clay loam in the upper part and dark yellowish brown silty clay loam in the lower part.

Permeability is moderate, and available water capacity is high. The subsoil is low in available phosphorus and potassium.

Wiota soils are used mainly for row crops. The major hazard is erosion on the gently sloping soils.

Representative profile of Wiota silt loam, 0 to 2 percent slopes, in a cultivated field, 700 feet south and 135 feet east of the northwest corner of sec. 29, T. 77 N., R. 24 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) heavy silt loam; weak fine subangular blocky structure parting to weak very fine granular; friable; strongly acid; clear smooth boundary.

A12—8 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak fine subangular blocky structure parting to moderate fine granular; friable; strongly acid; gradual smooth boundary.

A3—14 to 22 inches; dark brown (10YR 3/3) light silty clay loam; very dark grayish brown (10YR 3/2) faces of peds; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; strongly acid; clear smooth boundary.

B21t—22 to 30 inches; dark brown (10YR 4/3) silty clay loam; weak medium subangular blocky structure parting to moderate very fine and fine subangular blocky; friable; strongly acid; gradual smooth boundary.

B22t—30 to 38 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine dark oxides; strongly acid; gradual smooth boundary.

B3—38 to 50 inches; dark yellowish brown (10YR 4/4) light silty clay loam; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine dark oxides; strongly acid.

The solum is typically more than 40 inches thick, and it ranges from 36 to 60 inches in thickness.

The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) silty clay loam or silt loam. It is 18 to 30 inches thick and is slightly acid to strongly acid.

The B horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). It is 18 to 26 inches thick and is slightly acid to strongly acid.

The C horizon is not described in the representative profile, but it is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). It is slightly acid to strongly acid.

Wiota soils formed in parent material similar to that of Bremer and Nevin soils. They have a more yellow subsoil than Bremer and Nevin soils.

7—Wiota silt loam, 0 to 2 percent slopes. This nearly level soil is on convex stream benches and terraces above the flood plain. Areas are long and narrow or irregular in shape. They range from a few acres to nearly 100 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are soils that are silt loam throughout the surface layer and subsoil. These soils are in the Des Moines River bottom east of Carlisle. Also included are small areas of Wiota soils that are underlain by alluvial sand at a shallow depth. Sand spots, which are indicated on the soil map by a special symbol, are also included.

This Wiota soil is well suited to intensive row crops. The organic matter content is high. Capability unit I–1; environmental planting group 1.

7B—Wiota silt loam, 2 to 5 percent slopes. This gently sloping soil is on convex stream benches and terraces above the flood plain. Areas are long and narrow or irregular in shape. They range from a few acres to about 10 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil are thinner.

Included with this soil in mapping are sand spots, which are indicated on the soil map by a special symbol.

This Wiota soil is well suited to intensive row crops if erosion is controlled. It is susceptible to erosion. The organic matter content is high. Capability unit IIe–1; environmental planting group 1.

Zook series

The Zook series consists of deep, nearly level, poorly drained soils. These soils are on bottom lands. They formed in fine textured and moderately fine textured alluvium under a native vegetation of mixed prairie grasses that tolerate excessive wetness.

In a representative profile the surface layer is black silty clay loam in the upper 7 inches and black silty clay in the lower 29 inches. The subsoil extends to a depth of 50 inches; it is very dark gray silty clay in the upper part and very dark gray silty clay loam in the lower part. The substratum is dark gray silty clay loam.

Permeability is slow, and available water capacity is moderate to high. The subsoil is low in available phosphorus and potassium.

Zook soils are used mainly for row crops. The major hazard is flooding, and the major limitation is wetness.

Representative profile of Zook silty clay loam, 0 to 2 percent slopes, on a cultivated first bottom, 300 feet north and 300 feet east of the southwest corner of the NE¼ sec. 23, T. 76 N., R. 25 W.:

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium angular blocky structure parting to moderate fine angular blocky; friable; neutral; abrupt smooth boundary.

A12—7 to 15 inches; black (N 2/0) light silty clay; moderate medium subangular blocky structure parting to moderate fine and very fine subangular blocky; friable; neutral; gradual smooth boundary.

A13—15 to 22 inches; black (N 2/0) light silty clay; moderate medium subangular blocky structure parting to moderate fine and very fine subangular blocky; friable; sheen on faces of peds; neutral; gradual smooth boundary.

A14—22 to 30 inches; black (N 2/0) light silty clay, very dark gray (N 3/0) dry; moderate fine and very fine subangular blocky structure; friable; sheen on faces of peds; neutral; gradual smooth boundary.

A3—30 to 36 inches; black (10YR 2/1) light silty clay; moderate fine subangular blocky structure; firm; sheen on faces of peds; neutral; gradual smooth boundary.

B21g—36 to 43 inches; very dark gray (10YR 3/1) light silty clay; moderate fine subangular blocky structure; firm; sheen on faces of peds; slightly acid; gradual smooth boundary.

B22g—43 to 50 inches; very dark gray (10YR 3/1) heavy silty clay loam; weak medium prismatic structure parting to moderate fine subangular blocky; firm; sheen on faces of peds; slightly acid; gradual smooth boundary.

Cg—50 to 60 inches; dark gray (10YR 4/1) light silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; slightly acid.

The solum ranges from 36 to 64 inches in thickness.

The A horizon is black (10YR 2/1 or N 2/0). It is 26 to 44 inches thick and is neutral to medium acid.

The Bg horizon is very dark gray (10YR 3/1) to dark gray (10YR to 5Y 4/1) to gray (5Y 5/1) heavy silty clay loam or light silty clay. It is 10 to 20 inches thick and is slightly acid or medium acid.

The C horizon ranges from dark gray (10YR 4/1) to gray (5Y 5/1). It is slightly acid to medium acid.

Zook soils are associated on the landscape with Colo and Wabash soils, and formed in parent material similar to that of those soils. They contain more clay than Colo soils. They have less clay in the subsoil than Wabash soils.

54—Zook silty clay loam, 0 to 2 percent slopes. This nearly level soil is on bottom lands. Areas are irregular in shape and range from a few acres to several hundred acres in size.

Included with this soil in mapping are small areas of marsh, which are indicated on the soil map by a special symbol. Also included are areas of Colo silty clay loam and Wabash silty clay loam. The Colo soil makes up as much as 20 percent of some mapped areas, and the Wabash soil as much as 30 percent of other areas. Areas of a soil that is similar to this Zook soil but that is lighter colored are also included.

This Zook soil is well suited to intensive row crops if drainage and protection from flooding are adequate. It is susceptible to flooding and wetness. Maintaining good tilth is difficult. The organic matter content is high. Capability unit IIw–2; environmental planting group 2.

Use and management of the soils

This section discusses the use and management of the soils for crops and pasture. It explains the use of the soils for environmental plantings, for town and country planning, for recreational development, and for wildlife habitat. It also describes the uses of the soils for engineering purposes and shows tables of estimates and interpretations of soil properties.

Crops and pasture

The soils of Warren County are used mainly for farming. Approximately 75 percent of the land is in crops or pasture. Some of the factors that affect management of soils in Warren County are described in this section. This section shows predicted yields for the principal crops grown in the county. It also explains the system of capability classification commonly used by the Soil Conservation Service and discusses management of the soils by capability units.

Management of crops and pasture

About 45 percent of the acreage in the county is used for cultivated crops, and about 30 percent is used for pasture.

Crops.—Corn is the major crop. It normally makes up about 45 to 50 percent of the total acreage in crops. Soybeans, oats, and hay are the other crops that are planted extensively. Sorghum, wheat, rye, and other

minor crops total only about 1,000 acres in most years.

Controlling erosion is an important consideration in management of the sloping soils. Contour tillage and methods of tillage that leave crop residue on the surface reduce erosion. Cropping systems that include grasses and legumes are also helpful. Other measures used in controlling erosion are terraces, diversions, grassed waterways, and ponds.

Most of the terraces in Warren County are built on soils that formed in loess. Generally, these are the main soils used for cultivated crops. Also, these soils have a subsoil that can be raised to a reasonable level of productivity over a period of a few years by large applications of manure and fertilizer. This is especially true of such soils as Tama, Downs, and Fayette soils, which have a less clayey subsoil than most other soils of the county. However, stockpiling topsoil during construction and spreading it over the areas of exposed subsoil is a good practice on all soils. It is essential on such soils as Bauer, Gosport, Adair, Clarinda, and Lamoni soils, which have a clayey, infertile subsoil.

Diversions are used to protect soils on bottom lands and foot slopes from being flooded by water from the adjoining hillsides. Many of the soils on bottom lands, such as Colo, Zook, and Wabash soils, are poorly drained or very poorly drained. Run-on water from upslope increases the concern of disposing of excess water. In addition, rilling and gullying occur on Judson, Olmitz, Ely, and other soils on foot slopes if the water from the hills is not intercepted. Sedimentation is another hazard. Young plants are sometimes buried and killed under silt washed off the hillsides.

Grassed waterways are used to prevent the formation of gullies in watercourses. The major soils on which waterways are built are Colo, Ely, Ackmore, Vesser, and Zook soils. These soils support good plant growth if they are properly drained and fertilized. Lines of tile generally are used to reduce wetness. Grassed waterways are not needed in fields where terraces with tile inlets have been installed.

Farm ponds help prevent gully erosion, keep excess water off bottom lands, and provide water for livestock. They also are used for recreation and for farm water supplies. Most ponds are in areas of Bauer, Clarinda, Gara, Gosport, Lamoni, Lindley, and Shelby soils. These soils and the material derived from them for construction of the dam generally are relatively impervious. Onsite investigation is needed to avoid pockets of sand or other porous material.

Maintaining fertility and good tilth is a consideration in management. Including grasses and legumes in the cropping system and using manure, crop residue, and commercial fertilizers are common practices in the county.

The soils on the bottom lands generally can be used for intensive row crops if drainage is adequate and if flooding is controlled. Flooding is most common from March to June. The floods that occur in spring after the crops are planted are the most damaging. Building levees, improving stream channels, and installing conservation practices upstream are methods commonly used in the county to control flooding. Some soils are subject to flooding when the level of the water is raised in the Red Rock Reservoir to reduce flooding downstream. In some years water stands for fairly long periods on these soils.

Rainfall is adequate in most years for the production of the crops generally grown in the county. The distribution of rainfall during the growing season is seldom ideal, so supplemental irrigation can generally improve yields. However, the cost of an irrigation system, the availability of an adequate supply of water, and other factors must be considered. To date, irrigation has been a very minor practice in the county.

Many soils in the county need artificial drainage to improve timeliness of operations and to increase production. Clearfield, Grundy, Macksburg, Sperry, and Winterset soils are on uplands, and they benefit from tile drainage. In places, tile drains installed in Sperry soils do not function adequately, and surface drains are needed to remove ponded water. Interceptor tile help to prevent sidehill seeps in some areas of sloping soils that formed in loess, such as Arispe, Clearfield, Clinton, Ladoga, Nira, Pershing, Sharpsburg, and Weller soils. The interceptor tile are placed at the contact between these soils and Adair, Armstrong, Clarinda, Lamoni, and Keswick soils, which lie downslope.

Soils on bottom lands that benefit from tile drains are Bremer, Colo, Nevin, Ackmore, Vesser, and Zook soils. Tile drains in Wabash soils and in Zook soils in places do not function adequately, so surface drains are needed. Suitable outlets for surface drains and tile are available in most places, but some low lying areas lack good outlets.

Pasture.—Most of the pasture in the county is on strongly sloping to very steep soils. Some is on soils on bottom lands that are frequently flooded.

The main consideration in management is to establish and maintain desirable plant species. This includes controlling the woody plants that readily invade pasture. Farm machinery can be used on most pasture; therefore, reseeding, fertilizing, and other cultural practices are practical. Overgrazing increases the hazard of erosion and encourages the invasion of weeds.

Woodland in the county is used mainly for grazing, rather than for wood products. Production from these areas is quite limited.

Predicted yields

The predicted average yields of the principal crops in Warren County are given in table 2 for each soil in the county. The estimates and ratings are based on corn yield studies made jointly by Iowa State University and the Soil Conservation Service and on observations made by soil scientists and other agricultural workers who are familiar with the soils.

The yields in table 2 are for a high level of management. A high level of management is attained when all approved practices and measures are used to attain highest possible yields over an extended period of time. A variation in yields of about 20 percent can be expected from 1 year to another and between different areas of the county in any particular year. This variation in yields results from kinds of management used, variations in the amount and timeliness of rainfall, amount of insect damage, types of disease, and other factors.

The yield values stated in table 2 may be outdated after several years, but the yields of individual soils

TABLE 2.—*Predicted average acre yields of principal crops under a high level of management*

[Dashes indicate the soil is not suited to the crop or that the crop is ordinarily not grown]

Soil	Corn	Soybeans	Oats	Alfalfa-grass	Pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD*[1]
Ackmore silt loam, 0 to 2 percent slopes	106	40	64	4.5	225
Adair clay loam, 9 to 14 percent slopes, moderately eroded	54	20	30	2.3	115
Adair-Shelby clay loams, 9 to 14 percent slopes, moderately eroded	67	25	37	2.8	140
Adair-Shelby clay loams, 14 to 18 percent slopes, moderately eroded	53	20	29	2.2	110
Adair-Shelby clay loams, 14 to 18 percent slopes, severely eroded				1.3	65
Alluvial land	(2)	(2)	(2)	(2)	(2)
Alluvial land, channeled					(2)
Amana silt loam, 0 to 2 percent slopes	110	42	66	4.6	230
Arbor loam, 9 to 14 percent slopes	88	33	48	3.7	185
Arispe silty clay loam, 5 to 9 percent slopes	104	39	57	4.3	215
Arispe silty clay loam, 5 to 9 percent slopes, moderately eroded	99	38	54	4.1	205
Armstrong loam, 9 to 14 percent slopes, moderately eroded	50	19	28	2.0	100
Armstrong-Gara loams, 9 to 14 percent slopes, moderately eroded	62	23	34	2.7	135
Armstrong-Gara loams, 14 to 18 percent slopes, moderately eroded				1.7	85
Armstrong-Gara clay loams, 14 to 18 percent slopes, severely eroded				1.1	55
Bauer silt loam, 9 to 14 percent slopes, moderately eroded				2.5	125
Bauer silt loam, 14 to 18 percent slopes, moderately eroded				1.5	75
Bauer soils, 14 to 18 percent slopes, severely eroded				1.0	50
Bremer silty clay loam, 0 to 2 percent slopes	106	40	64	4.5	225
Caleb loam, 9 to 14 percent slopes, moderately eroded	66	25	36	2.8	140
Chelsea loamy fine sand, 5 to 9 percent slopes, moderately eroded	50	19	27	1.8	90
Chelsea loamy fine sand, 9 to 18 percent slopes, moderately eroded				1.4	70
Clarinda silty clay loam, 5 to 9 percent slopes	63	24	35	2.6	130
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	55	21	30	2.2	110
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	46	17	25	1.8	90
Clearfield silty clay loam, 5 to 9 percent slopes	91	35	55	3.6	180
Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded	88	33	53	3.5	175
Clinton silt loam, 2 to 5 percent slopes	107	41	68	4.5	225
Clinton silt loam, 5 to 9 percent slopes, moderately eroded	99	38	60	4.2	210
Clinton silt loam, 9 to 14 percent slopes, moderately eroded	90	34	54	3.8	190
Colo silty clay loam, 0 to 2 percent slopes	104	40	65	4.2	210
Colo silty clay loam, 2 to 5 percent slopes	102	39	62	4.0	200
Colo-Ely silty clay loams, 2 to 5 percent slopes	102	39	62	4.0	200
Downs silt loam, 0 to 2 percent slopes	123	46	74	5.0	250
Downs silt loam, 2 to 5 percent slopes	117	44	70	5.0	250
Downs silt loam, 5 to 9 percent slopes, moderately eroded	108	41	65	4.6	230
Downs silt loam, 9 to 14 percent slopes, moderately eroded	100	38	60	4.1	205
Downs silt loam, benches, 2 to 5 percent slopes	117	44	70	5.0	250
Ely silty clay loam, 2 to 5 percent slopes	124	47	74	5.3	265
Fayette silt loam, 2 to 5 percent slopes	111	42	67	4.7	235
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	102	38	62	4.3	215
Fayette silt loam, 9 to 14 percent slopes, moderately eroded	92	34	55	3.9	195
Fayette silt loam, 14 to 18 percent slopes, moderately eroded	76	28	46	3.2	160
Fayette silt loam, 18 to 25 percent slopes, moderately eroded				3.0	150

TABLE 2.—*Predicted average acre yields of principal crops under a high level of management*—Continued

Soil	Corn	Soybeans	Oats	Alfalfa-grass	Pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD*[1]
Gara loam, 9 to 14 percent slopes, moderately eroded	75	28	41	3.1	155
Gara loam, 14 to 18 percent slopes, moderately eroded				2.2	110
Gara loam, 18 to 25 percent slopes, moderately eroded				1.5	75
Gara loam, 25 to 40 percent slopes					40
Givin silt loam, 0 to 2 percent slopes	118	45	70	5.0	250
Gosport silt loam, 9 to 14 percent slopes	15				40
Gosport silt loam, 14 to 18 percent slopes					30
Gosport silt loam, 18 to 35 percent slopes					30
Gosport soils, 14 to 18 percent slopes, severely eroded					30
Grundy silty clay loam, 2 to 5 percent slopes	109	42	60	4.6	230
Gullied land-Ely-Colo complex, 2 to 5 percent slopes					(2)
Humeston silt loam, 0 to 2 percent slopes	88	33	48	3.7	185
Judson silty clay loam, 2 to 6 percent slopes	114	43	68	4.8	240
Kennebec silt loam, 0 to 2 percent slopes	122	46	73	5.1	255
Keswick loam, 9 to 14 percent slopes	44	17	24	1.8	190
Ladoga silt loam, 2 to 5 percent slopes	113	43	68	4.7	235
Ladoga silt loam, 5 to 9 percent slopes	108	41	65	4.5	225
Ladoga silt loam, 5 to 9 percent slopes, moderately eroded	105	40	63	4.4	220
Ladoga silt loam, 9 to 14 percent slopes, moderately eroded	96	36	58	4.0	200
Ladoga silt loam, benches, 2 to 5 percent slopes	113	43	68	4.7	235
Ladoga silt loam, benches, 5 to 9 percent slopes, moderately eroded	105	40	63	4.4	220
Ladoga-Chelsea complex, 5 to 9 percent slopes, moderately eroded	80	30	48	3.1	155
Ladoga-Chelsea complex, 9 to 14 percent slopes, moderately eroded				2.7	135
Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	61	23	33	2.6	130
Lamoni soils, 9 to 14 percent slopes, severely eroded				1.5	75
Lindley loam, 9 to 14 percent slopes	72	27	40	3.0	150
Lindley loam, 14 to 18 percent slopes				2.0	100
Lindley loam, 18 to 25 percent slopes				1.0	50
Lindley loam, 25 to 40 percent slopes					40
Lindley soils, 14 to 18 percent slopes, severely eroded				1.0	50
Macksburg silty clay loam, 0 to 2 percent slopes	121	46	72	5.1	225
Macksburg silty clay loam, 2 to 5 percent slopes	117	44	70	4.9	245
Macksburg silty clay loam, benches, 1 to 3 percent slopes	121	46	72	5.1	255
Muscatine silty clay loam, 0 to 2 percent slopes	131	50	79	5.5	275
Muscatine silty clay loam, benches, 0 to 2 percent slopes	131	50	79	5.5	275
Mystic silt loam, 5 to 9 percent slopes, moderately eroded	60	23	33	2.5	125
Mystic silt loam, 9 to 14 percent slopes, moderately eroded	51	19	28	2.0	100
Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded	62	23	34	2.7	135
Mystic-Caleb complex, 14 to 18 percent slopes, moderately eroded				1.7	85
Nevin silty clay loam, 0 to 2 percent slopes	114	43	68	4.8	240
Nevin silty clay loam, 2 to 5 percent slopes	110	41	66	4.7	235
Nira silty clay loam, 2 to 5 percent slopes	110	42	66	4.7	235
Nira silty clay loam, 5 to 9 percent slopes, moderately eroded	104	39	62	4.4	220
Nodaway silt loam, 0 to 2 percent slopes	111	42	67	4.7	235
Nodaway silt loam, channeled, 0 to 2 percent slopes				(2)	(2)
Olmitz loam, 2 to 5 percent slopes	100	38	60	4.2	210
Olmitz loam, 5 to 9 percent slopes	95	36	57	4.0	200
Pershing silt loam, 2 to 5 percent slopes	104	39	57	4.2	210
Pershing silt loam, 5 to 9 percent slopes, moderately eroded	93	36	51	3.8	190
Pershing silt loam, 9 to 14 percent slopes, moderately eroded	81	31	45	3.5	175
Sharpsburg silty clay loam, 0 to 2 percent slopes	115	44	69	4.8	240
Sharpsburg silty clay loam, 2 to 5 percent slopes	113	43	68	4.7	235
Sharpsburg silty clay loam, 5 to 9 percent slopes	108	41	65	4.5	225
Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded	105	40	63	4.4	220

TABLE 2.—*Predicted average acre yields of principal crops under a high level of management*—Continued

Soil	Corn	Soybeans	Oats	Alfalfa-grass	Pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD*[1]
Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded	96	36	58	4.0	200
Sharpsburg silty clay loam, benches, 0 to 2 percent slopes	115	44	69	4.8	240
Sharpsburg silty clay loam, benches, 2 to 5 percent slopes	113	43	68	4.7	235
Sharpsburg silty clay loam, benches, 5 to 9 percent slopes	105	40	63	4.4	220
Shelby clay loam, 9 to 14 percent slopes, moderately eroded	81	31	44	3.4	170
Shelby clay loam, 14 to 18 percent slopes, moderately eroded	66	25	36	2.7	135
Shelby clay loam, 18 to 25 percent slopes, moderately eroded				1.8	90
Sperry silt loam, 0 to 1 percent slopes	97	37	58	3.5	175
Steep rock land					
Strip mines					
Tama silty clay loam, 0 to 2 percent slopes	129	49	77	5.4	270
Tama silty clay loam, 2 to 5 percent slopes	122	47	73	5.2	260
Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	113	41	68	4.8	240
Tama silty clay loam, 9 to 14 percent slopes, moderately eroded	102	36	61	4.2	210
Tama silty clay loam, benches, 2 to 5 percent slopes	122	47	73	5.2	260
Vesser silt loam, 0 to 2 percent slopes	95	36	57	4.0	200
Vesser silt loam, 2 to 5 percent slopes	93	35	56	3.9	195
Wabash silty clay loam, 0 to 2 percent slopes	86	33	47	2.5	125
Wabash silty clay, 0 to 2 percent slopes	68	26	37	1.8	90
Watkins silt loam, 1 to 4 percent slopes	104	39	62	4.4	220
Weller silt loam, 2 to 5 percent slopes	97	36	53	4.0	200
Weller silt loam, 5 to 9 percent slopes, moderately eroded	87	32	48	3.3	165
Winterset silty clay loam, 0 to 2 percent slopes	117	44	70	4.9	245
Wiota silt loam, 0 to 2 percent slopes	110	42	66	4.6	230
Wiota silt loam, 2 to 5 percent slopes	108	41	65	4.5	225
Zook silty clay loam, 0 to 2 percent slopes	96	36	58	3.8	190

[1] Animal Unit Days (AUD) based on the assumption that one mature animal consumes 40 pounds of dry matter per pasture day. Yields based on alfalfa-grass except for those soils where no hay yields are given. For these soils the yields are based on permanent bluegrass pasture.

[2] Variable, depending on frequency of overflow.

can be expected to maintain about the same relationship to each other.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

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

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

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat.

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

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

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes. (No class VIII soils in Warren County.)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in some parts of the United States but not in Warren County, shows that the chief limitation is climate that is too cold or too dry.

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

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–1 or IIIe–3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Warren County are described and suggestions for the use and management of the soils are given. To determine the soils in a capability unit or the capability unit of a specified soil, refer to the "Guide to mapping units" at the back of this survey.

Capability unit I–1

This unit consists of deep, nearly level soils. These soils are well drained to somewhat poorly drained and are on uplands and stream benches. They have a surface layer of silt loam or silty clay loam and a subsoil of silty clay loam. Permeability is moderate or moderately slow, and available water capacity is high. Organic matter content is moderate to high.

These soils are easy to till and are readily penetrated by roots to a depth of several feet. They are among the most productive soils in the county. Artificial drainage commonly is not needed in most years on these soils.

The soils in this unit are well suited to cultivated crops. Corn and soybeans can be grown intensively. The soils respond well to fertilizer. Where these soils are on stream benches, diversions placed at the base of adjacent side slopes help to prevent runoff overflow.

Capability unit I–2

This unit consists of deep, nearly level, moderately well drained and somewhat poorly drained soils. These soils formed in recent alluvium near current stream channels and in the old stream meanders. They have a surface layer of silt loam and a subsoil of silt loam. Permeability is moderate, and available water capacity is high. Organic matter content is low to high.

These soils are easy to till and are readily penetrated by roots to a depth of several feet. They are highly productive. Artificial drainage commonly is not needed in most years on these soils. The soils are subject to flooding if they are not protected. Areas inside the Red Rock Flood Pool are flooded for extended periods in some years.

The soils in this unit are well suited to cultivated crops. Corn and soybeans can be grown intensively. The soils respond well to fertilizer. Where flooding is frequent, dikes or levees are beneficial.

Capability unit IIe–1

This unit consists of deep, gently sloping soils. These soils are well drained to somewhat poorly drained and are on uplands and stream benches. They have a surface layer of silt loam or silty clay loam and a subsoil of silty clay loam or silty clay. Permeability is moderate to slow, and available water capacity is high. Organic matter content is moderate to high. The hazard of erosion is slight.

These soils are easy to till, and most are readily penetrated by roots to a depth of several feet. The soils that have a silty clay subsoil have a narrower range of workability and inhibited root penetration. These soils are highly productive. Artificial drainage commonly is not needed in most years.

The soils in this unit are well suited to cultivated crops. Corn and soybeans can be grown intensively if the soils are protected from erosion. Farming on the contour, grassed waterways, and minimum tillage are effective erosion-control practices. These soils respond well to fertilizer. Where the soils are on stream benches, diversions placed at the base of adjacent side slopes help to prevent runoff overflow.

Capability unit IIe–2

This unit consists of deep, gently sloping soils. These soils are well drained and moderately well drained and are on uplands. They have a surface layer and subsurface layer of silt loam and a subsoil of silty clay loam or silty clay. Permeability is moderate or moderately slow, and available water capacity is high. Organic matter content is low. Runoff is a hazard. Erosion is especially harmful because the surface layer is thin.

These soils are easy to till and are readily penetrated

by roots to a depth of several feet. Artificial drainage is not needed.

The soils in this unit are well suited to cultivated crops, but they require special management because of the low organic matter content, the thin surface layer, and the structure of the subsurface layer. These soils are susceptible to puddling and crusting after rain. Row crops should be grown in rotation with legumes and grasses to increase organic matter content and to decrease erosion. Farming on the contour, terraces, grassed waterways, and minimum tillage are other effective erosion-control practices. These soils respond well to fertilizer.

Capability unit IIc–3

This unit consists of deep, gently sloping soils. These soils are well drained to somewhat poorly drained and are on foot slopes at the base of uplands along major streams and in drainageways. They have a surface layer of silty clay loam or loam and a subsoil of silty clay loam or clay loam. Permeability is moderate or moderately slow, and available water capacity is high. Organic matter content is high. The hazard of erosion is slight.

These soils are easy to till and are readily penetrated by roots to a depth of several feet. They are highly productive. Artificial drainage is needed on the somewhat poorly drained soils for optimum production.

The soils in this unit are well suited to intensive row crops if they are protected from erosion. Farming on the contour, grassed waterways, terraces, and minimum tillage are effective erosion control practices. Diversions placed at the base of adjacent upland side slopes are beneficial in preventing runoff overflow. These soils respond well to fertilizer.

Capability unit IIw–1

Winterset silty clay loam, 0 to 2 percent slopes, is the only soil in this unit. It is poorly drained and is on uplands. It has a surface layer of silty clay loam and a subsoil of silty clay loam or silty clay. Permeability is moderately slow to slow, and available water capacity is high. The organic matter content is high.

This soil is easy to till and is readily penetrated by roots to a depth of several feet. In the southeastern part of the county, however, the subsoil is finer textured than typical, so adequate drainage and good tilth are more difficult to obtain than in other parts of the county and the subsoil is more restrictive to root growth. This soil is highly productive if properly drained. It has a seasonal high water table and requires artificial drainage for optimum production. Tile drains commonly function satisfactorily.

This soil is well suited to cultivated crops. Corn and soybeans can be grown intensively. This soil responds well to fertilizer.

Capability unit IIw–2

This unit consists of deep, nearly level soils. These soils are poorly drained and somewhat poorly drained and are on flood plains or second bottoms of the major streams. They have a surface layer of silt loam or silty clay loam and a subsoil of silt loam, silty clay loam, or silty clay. Permeability is moderate to slow, and available water capacity is high. Organic matter content is high to moderate.

These soils have a narrow range of workability. They commonly are plowed in fall when they are drier. This allows clods to break up during winter, producing a better seedbed. Root growth is inhibited in the soils that have a silty clay subsoil. These soils are highly productive if properly drained. They have a seasonal high water table and require artificial drainage for optimum production. Tile drains commonly function satisfactorily if suitable outlets are available. Seasonal flooding is a hazard on the flood plains, but flooding generally is only of short duration. Where overflow occurs, sedimentation is a hazard.

The soils in this unit are well suited to moderately well suited to cultivated crops. Corn and soybeans can be grown intensively. Where flooding is frequent, dikes or levees are beneficial. These soils respond well to fertilizer.

Capability unit IIw–3

This unit consists of deep, gently sloping soils. These soils are poorly drained and somewhat poorly drained and are along narrow upland drainageways and on gently sloping foot slopes adjacent to uplands. They have a surface layer of silty clay loam or silt loam and a subsoil of silty clay loam. Permeability is moderate or moderately slow, and available water capacity is high. Organic matter content is high.

These soils are relatively easy to till and are readily penetrated by roots to a depth of several feet. In some places, the poorly drained soils are difficult to till and fall plowing is practiced to improve tilth. The soils are highly productive if properly drained. They have a seasonal high water table and require artificial drainage for optimum production. Tile drains commonly function satisfactorily if suitable outlets are available. Flooding by runoff is common for short periods. Gully erosion and silt deposition from adjacent slopes are hazards.

The soils in this unit are well suited to moderately well suited to cultivated crops. Because areas are small or the soils are in intricate patterns, the cropping system is determined by the dominant surrounding soils. These soils respond well to fertilizer. Grassed waterways are beneficial in preventing gully erosion. Where these soils are on foot slopes, diversions placed at the base of adjacent upland soils are beneficial in preventing runoff overflow.

Capability unit IIIe–1

This unit consists of deep, moderately sloping and strongly sloping soils. These soils are well drained to somewhat poorly drained and are on uplands and high stream benches. They have a surface layer of silt loam or silty clay loam and a subsoil of silty clay loam or silty clay. Permeability is moderate to slow, and available water capacity is high. Organic matter content ranges from high to moderate. The hazard of erosion is severe. Included in this unit are small areas of a soil that has a surface layer and subsoil of loamy fine sand. This soil is excessively drained. Permeability is rapid, and available water capacity is low. Organic matter content is low.

Most soils in this unit are easy to till and are readily penetrated by roots to a depth of several feet, but the soils in the southeastern part of the county have a narrower range of workability and a fine textured subsoil that inhibits deep root penetration. These soils are highly productive to moderately productive if properly managed.

The soils in this unit are well suited to moderately well suited to cultivated crops. Corn and soybeans can be grown frequently if the soils are protected from erosion. Farming on the contour, terraces, stripcropping, grassed waterways, and cropping systems that include grasses and legumes are effective erosion-control practices. These soils respond well to fertilizer. Where the soils are on stream benches, diversions placed at the base of adjacent side slopes help to prevent runoff overflow.

Capability unit IIIe–2

This unit consists of deep, gently sloping to strongly sloping soils. These soils are well drained and moderately well drained and are on uplands. They have a surface layer and subsurface layer of silt loam and a subsoil of silty clay loam or silty clay. Permeability is moderate to slow, and available water capacity is high. Organic content is low to very low. The hazard of erosion is severe.

Most soils in this unit are easy to till and are readily penetrated by roots to a depth of several feet, but the soils in the southeastern part of the county have a narrower range of workability because of the fine textured subsoil, which also inhibits deep root penetration. These soils are highly productive to moderately productive.

The soils in this unit are well suited to moderately well suited to cultivated crops. They require special management because of the low organic matter content, the thin surface layer, and the structure of the subsurface layer. They are susceptible to puddling and crusting after rain. Row crops should be grown in rotation with legumes and grasses to increase organic matter content and decrease erosion. Farming on the contour, terraces, stripcropping, grassed waterways, and minimum tillage are other effective erosion-control practices. These soils respond well to fertilizer.

Capability unit IIIe–3

This unit consists of deep, moderately sloping and strongly sloping soils. These soils are well drained to somewhat poorly drained and are on upland side slopes and foot slopes. They have a surface layer of silt loam, loam, or clay loam and a subsoil of clay loam or clay. Permeability is moderate to slow, and available water capacity is moderate to high. Organic matter content is mainly high to moderate. The hazard of erosion is moderate or severe.

These soils are easy to till and are readily penetrated by roots to a depth of several feet. Root growth is inhibited to some extent in the soils that have a heavy clay loam or clay subsoil. Also, where topsoil has been eroded from those soils, tillage is difficult. These soils are highly productive to moderately productive. Artificial drainage commonly is not needed in most years.

The soils in this unit are well suited to moderately well suited to cultivated crops. Corn and soybeans can be grown frequently if erosion is controlled. Terraces are not suitable where the clay or heavy clay loam subsoil is exposed, because it is difficult to obtain good plant growth on the exposed subsoil. Farming on the contour, stripcropping, and grassed waterways are effective erosion-control practices. The soils respond well to fertilizer. Where these soils are on foot slopes, diversions placed at the base of adjacent side slopes are beneficial in preventing runoff overflow. Areas of the soils on foot slopes are generally small in size, and use and management are generally dictated by the dominant surrounding soils.

Capability unit IIIw–1

This unit consists of deep, moderately sloping poorly drained to somewhat poorly drained soils at the heads of drainageways on uplands. They have a surface layer of silty clay loam and a subsoil of silty clay loam or silty clay. Permeability is moderately slow in the upper part of the profile and very slow in the substratum. Available water capacity is high. Organic matter content is high to moderate. Erosion is a hazard.

These soils are difficult to till, and root penetration is inhibited by a clayey layer at a depth of about 40 inches. The clayey layer causes the soils to have a perched water table and to be seepy. Artificial drainage is required for optimum production. Tile drains placed as interceptor tile commonly function satisfactorily. Tillage must be done at the proper moisture content to maintain good tilth.

The soils in this unit are moderately well suited to cultivated crops if they are properly drained. Corn and soybeans can be grown intensively if the soils are protected from erosion. The soils respond well to fertilizer. Farming on the contour, terraces, and grassed waterways are effective erosion-control practices. Areas are generally small in size, and use and management are commonly dictated by the dominant surrounding soils.

Capability unit IIIw–2

This unit consists of deep, nearly level to depressional soils. These soils are poorly drained to very poorly drained and are in depressions on second bottoms and upland flats. They have a surface layer of silt loam and a subsoil of silty clay or silty clay loam. Permeability is slow or very slow, and available water capacity is high. Organic matter content is moderate or high.

These soils are difficult to till. The fine textured subsoil inhibits deep root penetration and causes a seasonal high water table. Ponding occurs after rain. Artificial drainage is required for optimum crop production. Tile drains do not drain all areas satisfactorily, and surface drains are needed. In wet years these areas are commonly idle while surrounding soils are cultivated. Alfalfa and other legumes are frequently drowned or winterkilled.

The soils in this unit are moderately well suited to cultivated crops if they are adequately drained. Corn and soybeans can be grown intensively. The soils respond well to fertilizer. Most areas are small, and their use and management are dictated by the dominant

surrounding soils. A few areas are large enough to be managed separately.

Capability unit IIIw–3

This unit consists of deep, very poorly drained soils on flood plains of major streams. They have a surface layer of silty clay loam or silty clay and a subsoil of silty clay. Permeability is very slow, and available water capacity is moderate. Organic matter content is high.

These soils are difficult to till. The high seasonal water table and the fine textured subsoil inhibit deep root penetration. The soils are at lower elevations than other surrounding soils on bottom lands, and ponding occurs for several days after rain. The soils are commonly idle during wet years. They must be tilled within a narrow moisture range, or they become compacted, cloddy, and hard. Artificial drainage is required for optimum crop production. Tile drains commonly do not function satisfactorily, and surface drains are required. Landshaping and bedding help to remove excess surface water. Alfalfa and other legumes often are drowned out, and in some years damage to crops is extensive.

The soils in this unit are only moderately well suited to cultivated crops. Corn and soybeans can be grown intensively if the soils are adequately drained. The soils respond well to fertilizer.

Capability unit IIIw–4

Deep, nearly level miscellaneous areas of Alluvial land make up this unit. These soils are near the current streambed or in old stream meanders on the flood plains of streams. They are variable and require onsite investigation to determine properties. In some places the soils are medium textured, and the thickness of sandy overwash is variable. In other places the soils differ widely within such short distances, and it is not practical to separate them in mapping. Permeability and organic matter content are variable.

Most areas of these soils are in woodland or pasture. Some areas are well suited to cultivated crops if cleared of trees and protected from flooding. If cultivated, the soils require artificial drainage. Tile drains function satisfactorily in some areas. The soils are frequently flooded. All areas require onsite investigation to determine the kinds of use and management.

Capability unit IVe–1

This unit consists of deep, strongly sloping and moderately steep soils. These soils are mainly well drained to somewhat poorly drained and are on uplands. Most of these soils have a surface layer of silt loam or silty clay loam, a subsoil of silty clay loam or silty clay. Permeability is mainly moderate to slow. One soil is excessively drained, is loamy fine sand throughout, and is rapidly permeable. Organic matter content ranges from moderate to very low. The hazard of erosion is severe.

Most of these soils are easy to till and are readily penetrated by roots to a depth of several feet; but the soils in the southeastern part of the county have a narrower range of workability, and their fine textured subsoil inhibits deep root penetration. Artificial drainage is not needed.

These soils are poorly suited to row crops because of steepness of slope or degree of erosion. They are better suited to small grain, hay, and pasture than to most other uses. Corn and soybeans should be grown only at intervals to reestablish legume stands or to renovate pasture. Farming on the contour, cropping system of mostly legumes, terraces where they are suitable, grassed waterways, and pasture renovation with controlled grazing are effective erosion-control measures. The soils respond well to fertilizer.

Capability unit IVe–2

This unit consists of deep, strongly sloping soils. These soils are moderately well drained to poorly drained and are on uplands. They have a surface layer of silt loam, silty clay loam, loam, or clay loam and a subsoil of clay loam, silty clay, or clay. Permeability is slow or very slow, and available water capacity is high or moderately high. Organic matter content is high to low. The hazard of erosion is severe.

These soils are difficult to till, and the clayey subsoil inhibits deep root penetration. If worked when too wet, these soils become cloddy and hard. Water moves horizontally on top of the clayey subsoil and seep areas form on sidehills at the upper boundary at the contact of the loess and till. Interceptor tile placed at the base of the loess and on top of the clayey till are beneficial in removing water and controlling these seeps. In places, deep gullies interfere with the use of farm equipment.

The soils in this unit are poorly suited to row crops; they are better suited to small grain, hay, pasture, or woodland than to most other uses. These soils commonly are in small areas or in narrow bands on hillsides, and their use and management is dictated by the dominant surrounding soils. If the surrounding soils are cultivated, the soils of this unit are often left in grass. Terraces are not suitable because construction exposes the clayey subsoil, on which plant cover is difficult to establish. Farming on the contour, stripcropping, cropping systems of mostly legumes, and pasture renovation with controlled grazing are effective erosion-control measures. Many areas of these soils have sites suitable for farm ponds. These soils respond only moderately well to fertilizer.

Capability unit IVe–3

This unit consists of deep, strongly sloping to moderately steep soils. These soils are well drained to somewhat poorly drained and are on side slopes on uplands. They have a surface layer of silt loam, loam, or clay loam and a subsoil of sandy loam, sandy clay loam, clay loam, or clay. Permeability is moderately rapid to slow, and available water capacity is high. The organic matter content is high to low. The hazard of erosion is severe.

These soils are difficult to till. If tilled when wet, they become cloddy and hard. Artificial drainage commonly is not needed, except in those soils that have a clayey subsoil that prevents the downward movement of water. Water flows laterally on the clayey subsoil, and seep areas form on sidehills at the upper boundary

of this horizon. Properly placed interceptor tiles are beneficial in controlling these sidehill seeps. In places, deep gullies interfere with use of farm equipment.

The soils in this unit are poorly suited to row crops; they are better suited to small grain, hay, pasture, and woodland than to most other uses. Corn and soybeans should be grown only at intervals to reestablish legume stands or to renovate pasture. Where ground cover is removed, the soils erode rapidly. In eroded areas, fertility is poor and vegetation is difficult to reestablish. Terraces are only moderately satisfactory on the soils, because construction exposes the firm, clayey subsoil. Where seepage is a concern the soils are in narrow bands on hillsides and their use and management are dictated by the adjoining soils. Farming on the contour, stripcropping, cropping systems of mostly legumes, grassed waterways, and pasture renovation with controlled grazing are effective erosion-control measures. Many areas of the soils are suitable for farm ponds. These soils respond only moderately well to fertilizer.

Capability unit IVs–1

Chelsea loamy fine sand, 5 to 9 percent slopes, moderately eroded, is the only soil in this unit. It is excessively drained and is loamy fine sand throughout. It is on uplands bordering major streams. Permeability is rapid, and available water capacity is low. Organic matter content is low. The hazard of erosion is severe.

This soil is poorly suited to row crops; it is better suited to small grain, hay, pasture, or woodland than to most other uses. If ground cover is removed, the soil erodes readily and is also subject to soil blowing.

This soil commonly is too droughty to grow corn or soybeans. It should be seeded to drought-tolerant grasses, and grazing should be controlled to prevent plant mortality. The soil responds poorly to fertilizer.

Capability unit IVw–1

This unit consists of deep, poorly drained soils at the heads of drainageways on uplands. They have a surface layer of silty clay loam and a subsoil of silty clay. Permeability is very slow, and available water capacity is moderate to high. Organic matter content is high. The hazard of erosion is severe.

These soils are difficult to till, and root penetration is inhibited by the clayey subsoil. Water flows laterally across the top of the clayey subsoil and seep areas form on hillsides at the upper boundary of this horizon. Properly placed interceptor tile are beneficial in controlling these sidehill seeps. Tillage must be done at the proper moisture content to maintain tilth. If worked when too wet, these soils become cloddy and hard.

These soils are poorly suited to row crops; they are better suited to small grain, hay, and pasture than to most other uses. Most areas are small in size, and the use and management of the soils is dictated by the dominant surrounding soils. If the surrounding soils are cultivated, the Clarinda soils are commonly left in grass. Terraces are not suitable on these soils because construction exposes the clayey subsoil, on which plant cover is difficult to establish. Farming on the contour, stripcropping, cropping systems that include grasses and legumes, and pasture renovation are effective erosion-control practices. These soils respond poorly to fertilizer.

Capability unit Vw–1

This unit consists of deep, nearly level soils. They are on flood plains that are dissected by abandoned stream channels or that are adjacent to current meandering streams (fig. 17). Soil properties vary widely. Most areas are covered by trees. Some areas are used as unimproved pasture, and others are idle. Organic matter content is low to high.

Some areas are well suited to cultivated crops if they are cleared of trees, the old stream meanders are filled in, and the soils are protected from flooding. Some soils do not need artificial drainage, but others do if the soils are to be cultivated. Tile drains do not function satisfactorily in all areas.

Without major reclamation, the soils of this unit are better suited to pasture, woodland, or wildlife habitat than to most other uses. Flooding is a major hazard and stagnant water stands in abandoned oxbows and bayous for several months during the year.

Capability unit VIe–1

This unit consists of strongly sloping to steep soils. These soils are mostly deep. Some of the soils are shaly at a depth of about 2 feet; in these soils, root growth is restricted. The soils in this unit are well drained to somewhat poorly drained and are on upland side slopes. They have a surface layer of silt loam, silty clay loam, loam, clay loam, or, in a few places, silty clay and a subsoil of silty clay loam, silty clay,

Figure 17.—**Typical area in capability unit Vw–1. Piles of driftwood and recent deposits of sand and silt along this meandering stream indicate this soil is frequently flooded. The soil is Nodaway silt loam, channeled, 0 to 2 percent slopes.**

clay, clay loam, sandy loam, or sandy clay loam. Permeability is moderately rapid to very slow, and available water capacity is low to high. Organic matter content is moderate to very low. The hazard of erosion is severe.

These soils are difficult to till. If tilled when wet they become cloddy and hard. Artificial drainage is not needed on these soils. Interceptor tile can help to control sidehill seeps in the wet soils. In places deep gullies interfere with the use of farm equipment (fig. 18).

These soils are generally unsuited to cultivated crops. They are better suited to hay, pasture, and woodland than to most other uses. The soils erode rapidly if the ground cover is removed. Where eroded these soils have poor fertility, and plant cover is difficult to establish. Terraces are not satisfactory because of the steep slopes and because construction exposes the firm, clayey, and infertile subsoil. The wet soils are in narrow bands on side slopes, and their use and management are determined by use and management of the adjoining soils. Farming on the contour, grassed waterways, legumes and grasses in the cropping system, and pasture renovation with controlled grazing are effective erosion-control measures. Many areas of these soils have sites suitable for farm ponds. These soils respond moderately well to poorly to fertilizer.

Capability unit VIIe–1

This unit consists of moderately steep soils. These soils are mostly deep. Some of the soils are shaly at a depth of about 2 feet; in these soils root growth is restricted. The soils in this unit are well drained to somewhat poorly drained and are on upland side slopes. They are mainly severely eroded, and the texture of the surface layer is the same as the texture of the subsoil. The subsoil is silty clay loam, silty clay, clay loam, or clay. One soil in this unit is less eroded and has a thin surface layer of silt loam. Permeability is moderately slow to very slow, and available water capacity ranges from high to low. Organic matter content is low or very low. The hazard of erosion is severe.

Figure 18.—**A deep gully on a soil in capability unit VIe–1. The gully restricts farming, but it provides a good site for a water impounding structure.**

These soils are difficult to till. If tilled when wet they become cloddy and hard. Artificial drainage is not needed on these soils. Interceptor tile can help to control sidehill seeps. In places deep gullies interfere with the use of farm equipment.

These soils are not suited to cultivated crops. They are better suited to hay, pasture, and woodland than to most other uses. These soils erode rapidly if the ground cover is removed. Plant cover is difficult to establish, and natural vegetation is often undesirable or of poor quality. Terraces are not suitable because of the steep slopes and the firm, clayey subsoil. The soils that are subject to seepage are in narrow bands on side slopes, and their use and management are determined by the use and management of adjoining soils. Legumes and grasses in the cropping system and pasture renovation with controlled grazing are effective erosion-control measures. Many areas of these soils have sites suitable for farm ponds. The soils respond poorly to fertilizer.

Capability unit VIIe–2

This unit consists of deep to shallow, steep and very steep soils. These soils generally are moderately well drained. They are on upland side slopes. They have a surface layer of silt loam, loam, or sandy loam and a subsoil of silty clay or clay loam or a substratum of sandstone. Permeability is moderately slow to very slow, and available water capacity is high or low. Organic matter content is low. The hazard of erosion is severe.

These soils are not suited to cultivated crops. They are better suited to pasture, woodland, or wildlife habitat than to most other uses. Where ground cover is removed, these soils erode rapidly. Plant cover is difficult to establish. Pasture renovation with controlled grazing is an effective erosion-control practice. However, it is not practical to use farm machinery on most of the very steep soils in this unit. Some areas of these soils have sites suitable for farm ponds. These soils respond poorly to fertilizer.

Capability unit VIIe–3

Only Gullied land-Ely-Colo complex, 2 to 5 percent slopes, is in this unit. These soils are poorly drained and somewhat poorly drained and are in small waterways and drainageways. They have a surface layer of silty clay loam and a subsoil of silty clay loam. Permeability is moderate or moderately slow. Organic matter content is high.

The soils of this unit are not suited to cultivated crops. They are better suited to pasture, woodland, and wildlife than to most other uses. Large gullies, 10 to 25 feet deep, have destroyed soils in half the acreage of this unit. Shaping these gullies into waterways would result in steep slopes and exposing of glacial till or shale material along the sides and at the base of the upland side slopes. Gully erosion is a severe hazard. Some areas of these soils have sites suitable

for farm ponds. Farm ponds and other water-control structures can help to control gully erosion and the cutting back of the overfall or gully head into the upland.

Capability unit VIIs–1

Only Chelsea loamy fine sand, 9 to 18 percent slopes, moderately eroded, is in this unit. This deep, excessively drained soil is on uplands bordering the major streams. It is loamy fine sand throughout. Permeability is rapid, and available water capacity is low. Organic matter content is low. The hazard of erosion is severe.

This soil is not suited to cultivated crops. It is better suited to pasture or woodland than to most other uses. Where the ground cover is removed, these soils erode rapidly. The soils should be seeded to drought-tolerant grasses, and grazing should be controlled to prevent plant mortality. These soils respond poorly to fertilizer.

Capability unit VIIs–2

This unit consists of Strip mines. Most areas range from depressional to very steep. The soil material generally is shallow, very slowly permeable, and dominantly clayey. Organic matter content is very low.

These areas are not suited to row crops, and extensive soil amendments are necessary to establish any kind of desirable plant cover. Reclaimed areas could be used for wildlife habitat, pasture, woodland, or recreation. Some areas have been acquired by public agencies and developed for wildlife habitat.

Environmental plantings

In this section the soils of Warren County are placed into four groups according to their suitability for growing trees and shrubs. Some of the important soil characteristics for each group are given, and hazards are discussed (fig. 19).

In table 3 suggested tree and shrub species are given for the following uses: shade trees, street trees, hedges and screens, woodland planting, windbreak planting, and wildlife planting. The lists are not intended to be complete, and the plants are not listed in any particular order. Individual taste and the advice of specialists will determine which species will be used.

Soils have been placed in four environmental planting groups as follows:

ENVIRONMENTAL PLANTING GROUP 1.—In this group are fertile soils that have properties generally favorable to good plant growth. Erosion is a hazard on the sloping soils, and flooding is a hazard on the bottom

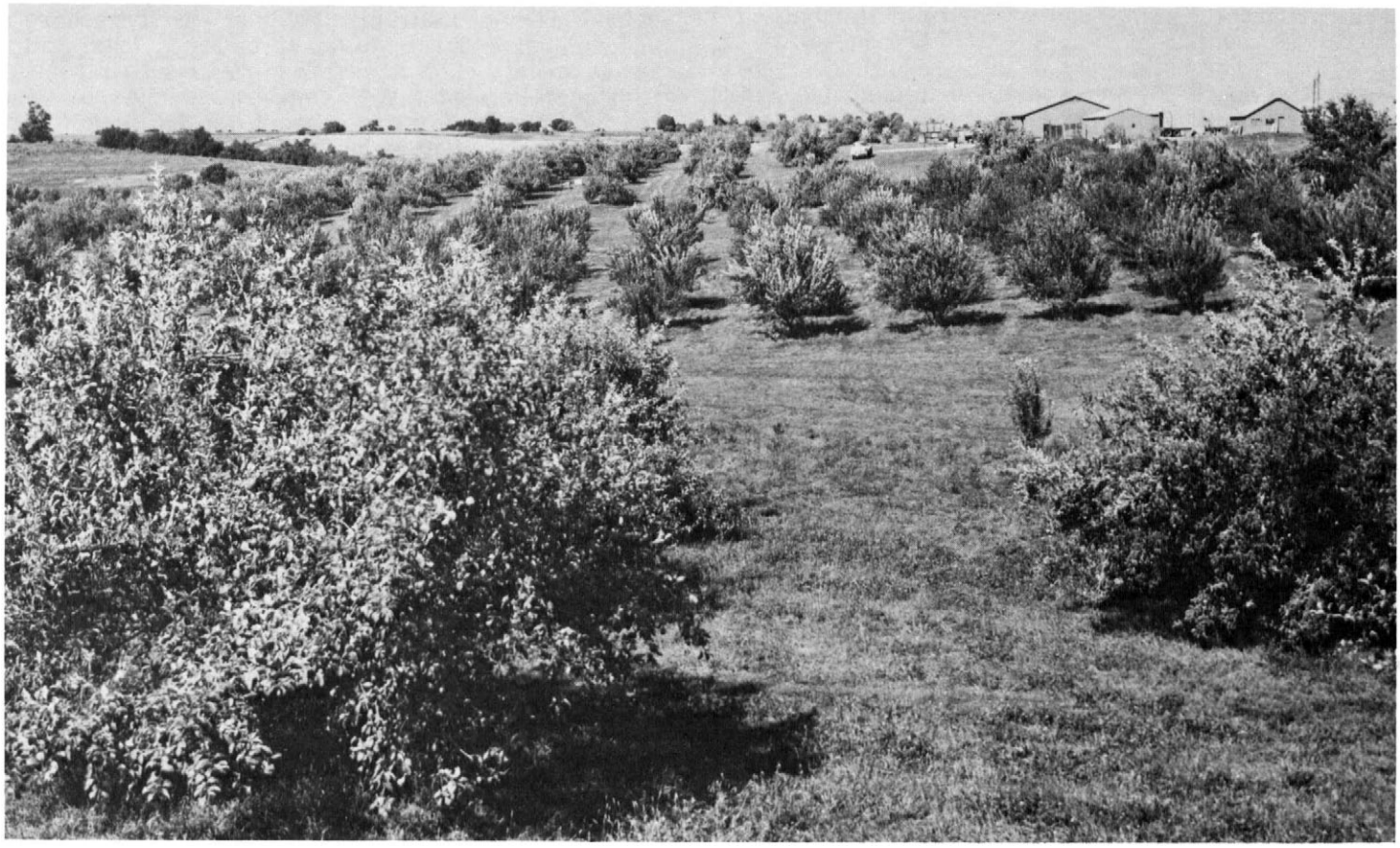

Figure 19.—An area used for the production of fruit. Nearly all of the commercial apple orchards in Warren County are on Sharpsburg soils, which are in environmental planting group 1.

land soils. Cultural operations are limited on the steep and very steep soils. The water available to plants is sometimes less than optimum, especially on the steep and very steep soils and on south- and southwest-facing slopes. Available water capacity is lower in the Chelsea soils in the Ladoga-Chelsea complex and in Bauer, Caleb, and Gosport soils than in other soils of this group. Permeability is mainly moderate or moderately slow, but it is rapid in Chelsea soils and is slow or very slow in Bauer and Gosport soils. The surface layer of most of the soils is slightly acid or medium acid.

ENVIRONMENTAL PLANTING GROUP 2.—In this group are wet soils and some that are subject to ponding or flooding. Maximum duration of standing water is a few days to about a week, except during unusually wet periods. Artificial drainage systems have been installed in many places. Poor tilth is a concern at times, especially on soils that have a fine textured surface layer. Erosion is a hazard on the sloping soils. Permeability is moderately slow to very slow. The surface layer of these soils is mainly slightly acid or medium acid, but it ranges to strongly acid or mildly alkaline.

ENVIRONMENTAL PLANTING GROUP 3.—In this group are droughty soils. Plant growth is limited by lack of adequate available water during dry periods. Erosion and soil blowing are hazards. Permeability is rapid. The surface layer typically is neutral.

ENVIRONMENTAL PLANTING GROUP 4.—In this group, soil conditions generally are unfavorable for plant growth. The soils included in these areas normally are low in fertility and are shallow to shale, sandstone, or limestone. Available water capacity typically is low. Cultural operations are difficult because of steep or very steep slopes, rock outcrop, or clayey texture.

Much of Warren County was in prairie grasses when it was settled. Trees grew mainly in belts on bottom land and along streams on uplands. The trees on uplands were mostly hardwoods and included bur oak, white oak, black oak, red oak, shagbark hickory, green ash, and elm. The trees on bottom lands were mostly soft maple, willow, cottonwood, green ash, and elm.

Most of the original timber has been cut over or cleared for use for crops and pasture. Most present timber is regrowth. Some areas of dominantly virgin timber remain, mostly on steep soils bordering major streams. Most of the existing trees on uplands are on Gara, Lindley, Gosport, Clinton, Ladoga, Fayette, Downs, Weller, and Pershing soils. Wooded areas on bottom lands are on Nodaway soils and Alluvial land.

Landowners can get help from the Warren County Soil Conservation District to determine the best use of their land. Local SCS conservationists and State Conservation Commission foresters can assist the landowner in developing a complete conservation plan that includes management of woodland.

Town and country planning

Residential, commercial, industrial, and institutional developments in Warren County are increasing in number as the suburbs of Des Moines and the towns in the county expand into the rural areas. The increase in these developments has led to many problems, which clearly show need for careful planning and for broad understanding of the physical and economic aspects involved when the use of land is changed.

This soil survey helps in planning these developments and in solving problems that result when use of the land is changed. Planning officials and developers, as well as homeowners and others, can find useful information on the soil maps, in the text, and in the tables in this survey. The detailed soil map in the back of the survey is useful because it shows the location of each of the soils in the county. The colored general soil map that precedes the detailed soil map shows the pattern of the major soils within the county. All of the soils are discussed in detail in the section "Descriptions of the soils."

The section "Environmental plantings" is a guide for persons who are interested in planting trees and shrubs.

The detailed soil map can be used with information from tables in the sections "Engineering uses of the soil" and "Recreational development." Colored maps can be compiled for any area in the county to show the pattern of hazards and limitations for specified uses.

Recreation

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 4 the soils of Warren County are rated according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails.

In table 4 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of plants can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they can easily be overcome. A *moderate* limitation means that limitations can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intensive maintenance, or a combination of these, is required.

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

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

Playgrounds are areas used intensively for baseball,

TABLE 3.—*Environmental planting groups of*

Environmental planting group	Shade trees	Street trees
Group 1: 7, 7B, 8B, 23C, 23C2, 24D2, 24E2, 24F2, 65D, 65E, 65E3, 65F, 65G, 75, 76B, 76C, 76C2, 76D2, T76B, T76C2, 80B, 80C2, 80D2, 88, 88B, 93D2, 93E2, 93E3, 94D2, 94E2, 119, T119, 120, 120B, 120C2, 120D2, T120B, 131B, 131C2, 131D2, 132B, 132C2, 162, 162B, 162C2, 162D2, T162B, 163B, 163C2, 163D2, 163E2, 163F2, 179D2, 179E2, 179F2, 179G, 185D2, 185E2, 185E3, 192D2, 212, 220, C220, 273B, 273C, 313D, 313E, 313F, 313E3, 315, C315, 368, 368B, T368, 369, 370, 370B, 370C, 370C2, 370D2, T370, T370B, T370C, 422, 425D, 427C2, 427D2, 428B, 430, 434D, 451D2, 570B, 570C2, 592C2, 592D2, 687B, 792D2, 822D2, 822D3, 864B, 980B, 993D2, 993E2, 993E3.	American basswood, honey locust, green ash, hackberry, sugar maple, silver maple.	Green ash, hackberry, pin oak, sugar maple.
Group 2: 11B, 43, 51, 51B, 54, 69C, 69C2, 122, 133, 133B, 172, 222C, 222C2, 222D2, 248, 269.	Silver maple, hackberry, sycamore, green ash.	Hackberry, sycamore, green ash.
Group 3: 63C2, 63D2	Scarlet oak, bur oak, hackberry, green ash, silver maple.	Hackberry, green ash
Group 4: 478, 502	Green ash, hackberry	Green ash, hackberry

[1] Not well suited to very poorly drained soils.

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

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

Wildlife[3]

Wildlife habitat is a product of the soil, and there is a direct relationship between soil fertility and the kinds and numbers of wildlife in a given area. Also, such factors as slope, permeability, and drainage, and the kinds of plants that will grow affect wildlife habitat, help to determine the kind of wildlife habitat available, and help to determine the potential of areas for developing certain kinds of habitat.

In Warren County many factors affect development of wildlife habitat and the resulting wildlife populations. In intensively farmed areas, personal preferences mainly determine the types of crops planted and other uses of the soils. The resulting type of vegetation or lack of it determines the kinds of wildlife that inhabit an area.

Wildlife generally require three things from the habitat for survival: food, cover for protection from enemies and weather, and a suitable site to produce young. Fortunately, most farm crops provide food, cover, or a place to produce young for some types of wildlife. Sometimes proper habitat is not enough. Other factors such as disease, extreme weather conditions, predation, and hunting pressure affect wildlife populations; therefore, good wildlife habitat is not a guarantee for abundant wildlife populations.

Table 5 shows the potential of each soil in Warren County to produce seven habitat elements: grain and seed crops, grasses and legumes, wild herbaceous plants, hardwood trees and shrubs, coniferous trees and shrubs, wetland plants, and shallow water areas.

Grain and seed crops include corn, oats, soybeans, barley, and rye. These plants provide food for many kinds of wildlife.

Grasses and legumes include bromegrass, switchgrass, indiangrass, big bluestem, alfalfa, red clover, and wild sweet clover. Such vegetation is important to birds for nesting as well as for providing cover and protection.

Wild herbaceous plants provide both food and cover for many forms of wildlife. Examples of these plants include goldenrod, sunflower, pigweed, dock, and ragweed.

Hardwood trees and shrubs lose their leaves each

[3] BILL D. WELKER, biologist, Soil Conservation Service, helped to prepare this section.

soils and suited trees and shrubs for planting

Hedges and screens	Woodland planting	Windbreak planting	Wildlife planting
Lilac, American cranberrybush, Tatarian honeysuckle, silky dogwood, arrowwood viburnum, hawthorn.	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, selected poplars.	Eastern white pine, red pine, Colorado blue spruce, Norway spruce, Scotch pine, white spruce, European larch, eastern redcedar, green ash, hackberry, eastern dogwood, Douglas-fir, Tatarian honeysuckle, pin oak, Russian-olive, silver maple, lilac.	Blackhaw, lilac, gray dogwood, alternate-leaf dogwood, autumn-olive, Tatarian honeysuckle, midwest Manchurian crabapple.
Northern white-cedar, silky dogwood, American cranberrybush, Lombardy poplar.	Eastern cottonwood	Silver maple, selected poplars, laurel willow, sycamore, green ash, hackberry [1], northern white-cedar, eastern redcedar [1], white spruce [1], Norway spruce. [1]	Red-osier dogwood, eastern redcedar, northern white-cedar, silky dogwood, American cranberrybush.
Eastern redcedar, Russian-olive, honeysuckle, lilac, Siberian peashrub.	Eastern white pine, Scotch pine, European larch, eastern redcedar.	Red pine, eastern white pine, Scotch pine, eastern redcedar, green ash, hackberry, Siberian peashrub.	Blackhaw, lilac, gray dogwood, alternate-leaf dogwood, autumn-olive.
Eastern redcedar, lilac, honeysuckle, arrowwood viburnum, hawthorn.	(2)	Eastern redcedar, green ash, hackberry, jack pine, American plum.	Eastern redcedar, gray dogwood, blackhaw, lilac, honeysuckle, autumn-olive, American plum.

[2] Woodland plantings are not recommended for environmental planting group 4.

winter. Examples include oak, maple, elm, basswood, walnut, hickory, honeysuckle, dogwood, and ninebark. Their leaves, buds, or seeds provide important food and cover for squirrels, deer, and birds.

Coniferous trees and shrubs retain their leaves throughout the year. These include eastern white pine, eastern red cedar, Austrian pine, Norway spruce, Scotch pine, jack pine, and pfitzer juniper. These plants furnish important winter cover for wild birds and mammals.

Wetland plants include smartweed, bulrush, cattail, and arrowhead. These plants provide both food and cover for the many kinds of waterfowl in Warren County.

Shallow water areas refers to the capacity of a soil to retain water in water areas that have a maximum depth of 5 feet.

The ratings in table 5 are good, fair, poor, or very poor. Generally, soils producing the most abundant crop of grain, grass or legumes, are rated *good.* Soils providing the best conditions for growing conifers, hardwoods, wild herbaceous plants, and wetland plants or for holding water for impoundment are also rated *good.*

Soils that are artificially drained can produce different vegetation than soils that are naturally poorly drained. Artificially drained soils in Warren County are used to produce grain and seed crops or grasses and legumes. In table 5, the poorly drained soils are given two ratings for drained and undrained conditions, respectively.

Various combinations of habitat elements are evaluated in table 5 for their potential to develop habitat for three general kinds of wildlife: open-land, woodland, and wetland.

Open-land wildlife includes pheasant, cottontail rabbit, and bobwhite quail. Their habitat is composed of cropland, pasture, road ditches, and railroad rights-of-way. Much of Warren County is composed of this type of habitat. Poorly drained soils rated for open-land wildlife are given two ratings for drained and undrained conditions, respectively.

Woodland wildlife includes white-tailed deer, eastern fox squirrel, and red fox. Their habitat is the natural timbered areas scattered throughout Warren County.

Wetland wildlife includes mink, muskrat, beaver, raccoon, and the many species of ducks and geese. Their habitat is mainly the shallow water potholes and marsh areas. Few of these areas are present in Warren County. Some of the wetland wildlife is well adapted to creeks, ponds, and other water areas in the county.

Engineering uses of the soils [4]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning com-

[4] VOLNEY SMITH, assistant State engineer and DEANE S. GLEN, civil engineer, Soil Conservation Service, helped to prepare this section.

TABLE 4.—*Use of the soils for recreational development*

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ackmore: 430	Severe: subject to flooding; somewhat poorly drained.	Severe: subject to flooding; somewhat poorly drained.	Severe: subject to flooding; somewhat poorly drained.	Moderate: somewhat poorly drained; subject to flooding.
Adair: 93D2	Moderate: moderately well drained to somewhat poorly drained; slow to moderately slow permeability; slopes of 9 to 14 percent; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent; clay loam surface layer.	Severe: slopes of 9 to 14 percent; moderately well drained to somewhat poorly drained; slow to moderately slow permeability; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; clay loam surface layer.
93E2, 93E3	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained; slow to moderately slow permeability; clay loam surface layer.	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained; clay loam surface layer.	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained; slow permeability to moderately slow permeability; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; slopes of 14 to 18 percent; clay loam surface layer.
192D2	Moderate: moderately well drained to somewhat poorly drained; slow permeability; slopes of 9 to 14 percent; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent; clay loam surface layer.	Severe: slopes of 9 to 14 percent; moderately well drained to somewhat poorly drained; slow permeability; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; clay loam surface layer.
Alluvial land: 315, C315.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Amana: 422	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Arbor: 434D	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Arispe: 23C, 23C2	Moderate: moderately well drained to somewhat poorly drained; moderately slow permeability; silty clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; silty clay loam surface layer.	Severe: slopes of 5 to 9 percent; moderately well drained to somewhat poorly drained; moderately slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
Armstrong: 792D2	Moderate: moderately well drained to somewhat poorly drained; slow permeability; slopes of 9 to 14 percent.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent; moderately well drained to somewhat poorly drained; slow permeability.	Moderate: moderately well drained to somewhat poorly drained.
993D2	Moderate: moderately well drained to somewhat poorly drained; slow permeability; slopes of 9 to 14 percent.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent; moderately well drained to somewhat poorly drained; slow permeability.	Moderate: moderately well drained to somewhat poorly drained.
993E2, 993E3	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained; moderately slow permeability to slow permeability.	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained.	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained.	Moderate: slopes of 14 to 18 percent.

TABLE 4.—*Use of the soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Bauer:				
185D2	Moderate: slow permeability to very slow permeability; slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent; slow permeability to very slow permeability.	Slight.
185E2, 185E3	Severe: slopes of 14 to 18 percent; slow permeability to very slow permeability.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent; slow permeability to very slow permeability.	Moderate: slopes of 14 to 18 percent.
Bremer: 43	Severe: poorly drained; slow permeability; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.	Severe: poorly drained; slow permeability; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.
Caleb: 451D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Chelsea:				
63C2	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Severe: slopes of 5 to 9 percent; loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.
63D2	Severe: slopes of 9 to 18 percent; loamy fine sand surface layer.	Severe: slopes of 9 to 18 percent; loamy fine sand surface layer.	Severe: slopes of 9 to 18 percent; loamy fine sand surface layer.	Moderate: slopes of 9 to 18 percent; loamy fine sand surface layer.
Clarinda: 222C, 222C2, 222D2.	Severe: poorly drained; very slow permeability.	Severe: poorly drained.	Severe: poorly drained; very slow permeability; slopes of 5 to 14 percent.	Severe: poorly drained.
Clearfield: 69C, 69C2	Severe: poorly drained; moderately slow permeability; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.	Severe: poorly drained; moderately slow permeability; slopes of 5 to 9 percent; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.
Clinton:				
80B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
80C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
80D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Colo: 11B, 133, 133B	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.
Downs:				
162	Slight	Slight	Slight	Slight.
162B, T162B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
162C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
162D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.

TABLE 4.—*Use of the soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ely: 428B	Severe: subject to flooding; somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; subject to flooding; silty clay loam surface layer.	Moderate: somewhat poorly drained; subject to flooding; slopes of 2 to 5 percent.	Moderate: somewhat poorly drained; subject to flooding; silty clay loam surface layer.
Fayette:				
163B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
163C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
163D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
163E2, 163F2	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
Gara:				
179D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
179E2, 179F2	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
179G	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.
Givin: 75	Moderate: somewhat poorly drained; moderately slow permeability.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained; moderately slow permeability.	Moderate: somewhat poorly drained.
Gosport:				
313D	Moderate: very slow permeability; slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: very slow permeability; slopes of 9 to 14 percent.	Slight.
313E	Severe: very slow permeability; slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: very slow permeability; slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.
313F, 313E3	Severe: very slow permeability; slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: very slow permeability; slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
Grundy: 864B	Moderate: somewhat poorly drained to moderately well drained; slow permeability; silty clay loam surface layer.	Moderate: somewhat poorly drained to moderately well drained; silty clay loam surface layer.	Moderate: somewhat poorly drained to moderately well drained; slow permeability; slopes of 2 to 5 percent; silty clay loam surface layer.	Moderate: somewhat poorly drained to moderately well drained; silty clay loam surface layer.
Gullied land: 980B	Severe: gully dangerous.	Severe: gully dangerous.	Severe: gully dangerous.	Severe: gully dangerous.
Humeston: 269	Severe: poorly drained to very poorly drained; subject to flooding; slow permeability to very slow permeability.	Severe: poorly drained to very poorly drained; subject to flooding.	Severe: poorly drained to very poorly drained; subject to flooding; slow permeability to very slow permeability.	Severe: poorly drained to very poorly drained; silty clay loam surface layer.
Judson: 8B	Severe: subject to flooding; silty clay loam surface layer.	Moderate: subject to flooding; silty clay loam surface layer.	Severe: subject to flooding; slopes of 2 to 6 percent; silty clay loam surface layer.	Moderate: subject to flooding; silty clay loam surface layer.

TABLE 4.—*Use of the soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Kennebec: 212	Severe: subject to flooding.	Moderate: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Keswick: 425D	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Ladoga:				
76B, T76B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
76C, 76C2, T76C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
76D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
427C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
427D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Lamoni: 822D2, 822D3	Moderate: somewhat poorly drained; slow permeability to very slow permeability; slopes of 9 to 14 percent; silty clay loam surface layer.	Moderate: somewhat poorly drained; slopes of 9 to 14 percent; silty clay loam surface layer.	Severe: somewhat poorly drained; slow permeability to very slow permeability; slopes of 9 to 14 percent; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.
Lindley:				
65D	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
65E, 65F, 65E3	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
65G	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.
Macksburg: 368, 368B, T368.	Moderate: somewhat poorly drained; moderately slow permeability; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; moderately slow permeability; slopes of 0 to 5 percent; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.
Muscatine: 119, T119	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.
Mystic:				
94D2	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent; moderately well drained to somewhat poorly drained.	Moderate: moderately well drained to somewhat poorly drained; slow permeability to moderately rapid permeability.
94E2	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained.	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained.	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained.	Moderate: moderately well drained to somewhat poorly drained; slopes of 14 to 18 percent.

TABLE 4.—*Use of the soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
592C2, 592D2	Moderate: somewhat poorly drained; slow permeability; slopes of 5 to 14 percent.	Moderate: somewhat poorly drained; slopes of 5 to 14 percent.	Severe: slopes of 5 to 14 percent; somewhat poorly drained.	Moderate: somewhat poorly drained.
Nevin: 88, 88B	Moderate: somewhat poorly drained; moderately slow permeability; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; moderately slow permeability; slopes of 0 to 5 percent; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.
Nira:				
570B	Moderate: moderately slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: moderately slow permeability; slopes of 2 to 5 percent; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
570C2	Moderate: moderately slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Severe: slopes of 5 to 9 percent; moderately slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
Nodaway: 220, C220	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Olmitz:				
273B	Severe: subject to flooding.	Moderate: subject to flooding.	Moderate: subject to flooding; slopes of 2 to 5 percent.	Moderate: subject to flooding.
273C	Severe: subject to flooding.	Moderate: subject to flooding.	Severe: slopes of 5 to 9 percent; subject to flooding.	Moderate: subject to flooding.
Pershing:				
131B	Moderate: moderately well drained to somewhat poorly drained; slow permeability.	Moderate: moderately well drained to somewhat poorly drained.	Moderate: moderately well drained to somewhat poorly drained; slow permeability; slopes of 2 to 5 percent.	Slight.
131C2, 131D2	Moderate: moderately well drained to somewhat poorly drained; slow permeability; slopes of 5 to 14 percent.	Moderate: moderately well drained to somewhat poorly drained; slopes of 5 to 14 percent.	Severe: slopes of 5 to 14 percent; moderately well drained to somewhat poorly drained; slow permeability.	Slight.
Sharpsburg:				
370, 370B, T370, T370B	Moderate: moderately slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: moderately slow permeability; slopes of 0 to 5 percent; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
370C, 370C2, 370D2, T370C.	Moderate: moderately slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer; slopes of 5 to 14 percent.	Severe: slopes of 5 to 14 percent; moderately slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.

TABLE 4.—*Use of the soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Shelby:				
24D2	Moderate: slopes of 9 to 14 percent; clay loam surface layer.	Moderate: slopes of 9 to 14 percent; clay loam surface layer.	Severe: slopes of 9 to 14 percent; clay loam surface layer.	Moderate: clay loam surface layer.
24E2, 24F2	Severe: slopes of 14 to 25 percent; clay loam surface layer.	Severe: slopes of 14 to 25 percent; clay loam surface layer.	Severe: slopes of 14 to 25 percent; clay loam surface layer.	Moderate: slopes of 14 to 25 percent; clay loam surface layer.
Sperry: 122	Severe: very poorly drained; slow permeability.	Severe: very poorly drained.	Severe: very poorly drained; slow permeability.	Severe: very poorly drained; slow permeability.
Steep rock land: 478	Severe: slopes of 25 to 50 percent.	Severe: slopes of 25 to 50 percent.	Severe: slopes of 25 to 50 percent.	Severe: slopes of 25 to 50 percent.
Strip mines: 502	Severe: very slow permeability; clay surface layer.	Severe: very slow permeability; clay surface layer.	Severe: very slow permeability; clay surface layer.	Severe: very slow permeability; clay surface layer.
Tama:				
120, 120B, T120B	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: slopes of 2 to 5 percent; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
120C2, 120D2	Moderate: silty clay loam surface layer; slopes of 5 to 14 percent.	Moderate: silty clay loam surface layer; slopes of 5 to 14 percent.	Severe: slopes of 5 to 14 percent; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
Vesser: 51, 51B	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.
Wabash: 172, 248	Severe: very poorly drained; subject to flooding; very slow permeability; silty clay or silty clay loam surface layer.	Severe: very poorly drained; subject to flooding; silty clay or silty clay loam surface layer.	Severe: very poorly drained; subject to flooding; very slow permeability; silty clay or silty clay loam surface layer.	Severe: very poorly drained; subject to flooding; silty clay or clay loam surface layer.
Watkins: 687B	Slight	Slight	Moderate: slopes of 1 to 4 percent.	Slight.
Weller:				
132B	Moderate: slow permeability.	Slight	Moderate: slow permeability; slopes of 2 to 5 percent.	Slight.
132C2	Moderate: slow permeability.	Slight	Severe: slopes of 5 to 9 percent; slow permeability.	Slight.
Winterset: 369	Severe: poorly drained; moderately slow permeability to slow permeability; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.	Severe: poorly drained; moderately slow permeability to slow permeability; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.
Wiota:				
7	Slight	Slight	Slight	Slight.
7B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
Zook: 54	Severe: poorly drained; subject to flooding; slow permeability to very slow permeability; silty clay loam surface layer.	Severe: poorly drained; subject to flooding; silty clay loam surface layer.	Severe: poorly drained; subject to flooding; slow permeability to very slow permeability; silty clay loam surface layer.	Severe: poorly drained; subject to flooding; silty clay loam surface layer.

TABLE 5.—*Potential of the*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops [1]	Grasses and legumes [1]	Wild herbaceous plants	Hardwood trees and shrubs
Ackmore: 430	Good or fair	Good or fair	Good	Good
Adair:				
93D2	Fair	Good	Good	Good
93E2, 93E3	Poor	Fair	Good	Good
192D2	Fair	Good	Good	Good
Alluvial land: 315, C315	Poor	Fair	Fair	Good
Amana: 422	Good	Good	Good	Good
Arbor: 434D	Fair	Good	Good	Good
Arispe: 23C, 23C2	Fair	Good	Good	Good
Armstrong:				
792D2	Fair	Good	Good	Good
993D2	Fair	Good	Good	Good
993E2, 993E3	Poor	Fair	Good	Good
Bauer: 185D2, 185E2, 185E3	Poor	Fair	Fair	Fair
Bremer: 43	Good or fair	Good or fair	Good	Fair
Caleb: 451D2	Fair	Good	Good	Good
Chelsea: 63C2, 63D2	Poor	Poor	Fair	Poor
Clarinda: 222C, 222C2, 222D2	Poor	Poor	Poor	Poor
Clearfield: 69C, 69C2	Fair or poor	Fair or poor	Good	Fair
Clinton:				
80B	Good	Good	Good	Good
80C2, 80D2	Fair	Good	Good	Good
Colo:				
133	Good or fair	Good or fair	Good	Fair
11B, 133B	Good	Good	Good	Fair
Downs:				
162	Good	Good	Good	Good
162B, T162B	Good	Good	Good	Good
162C2, 162D2	Fair	Good	Good	Good
Ely: 428B	Good	Good	Good	Good
Fayette:				
163B	Good	Good	Good	Good
163C2, 163D2	Fair	Good	Good	Good
163E2, 163F2	Poor	Fair	Good	Good
Gara:				
179D2	Fair	Good	Good	Good
179E2, 179F2	Poor	Fair	Good	Good
179G	Very poor	Poor	Good	Good
Givin: 75	Good	Good	Good	Good
Gosport:				
313D, 313F, 313E3	Poor	Fair	Fair	Fair
313E	Very poor	Poor	Good	Good
Grundy: 864B	Good	Good	Good	Good
Gullied land: 980B	Poor	Poor	Good	Good
Humeston: 269	Fair	Fair	Good	Fair
Judson: 8B	Good	Good	Good	Good

soils for wildlife

Elements of wildlife habitat—Continued			Kinds of wildlife habitat		
Coniferous trees and shrubs	Wetland plants	Shallow water areas	Open-land [1]	Woodland	Wetland
Good	Fair	Fair	Good or fair	Good	Fair.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Fair	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Good	Good	Good or fair	Fair	Good.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Poor	Very poor	Fair or poor	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good or fair	Fair	Good.
Poor	Poor	Very poor	Good	Fair	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Poor	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Poor	Good	Good	Fair	Fair	Good.
Good	Poor	Very poor	Good	Good	Very poor.

TABLE 5.—*Potential of the*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops[1]	Grasses and legumes[1]	Wild herbaceous plants	Hardwood trees and shrubs
Kennebec: 212	Good	Good	Good	Good
Keswick: 425D	Fair	Good	Good	Good
Ladoga:				
76B, T76B	Good	Good	Good	Good
76C, 76C2, 76D2, T76C2	Fair	Good	Good	Good
427C2, 427D2	Fair	Fair	Good	Fair
Lamoni: 822D2, 822D3	Fair	Good	Good	Good
Lindley:				
65D	Fair	Good	Good	Good
65E, 65F, 65E3	Poor	Fair	Good	Good
65G	Very poor	Poor	Good	Good
Macksburg:				
368, T368	Good	Good	Good	Good
368B	Good	Good	Good	Good
Muscatine: 119, T119	Good	Good	Good	Good
Mystic:				
94D2	Fair	Good	Good	Good
94E2	Poor	Fair	Good	Good
592C2, 592D2	Fair	Good	Good	Good
Nevin: 88, 88B	Good	Good	Good	Good
Nira:				
570B	Good	Good	Good	Good
570C2	Fair	Good	Good	Good
Nodaway:				
220	Good	Good	Good	Good
C220	Poor	Fair	Fair	Good
Olmitz:				
273B	Good	Good	Good	Good
273C	Fair	Good	Good	Good
Pershing:				
131B	Good	Good	Good	Good
131C2, 131D2	Fair	Good	Good	Good
Sharpsburg:				
370, T370	Good	Good	Good	Good
370B, T370B	Good	Good	Good	Good
370C, 370C2, 370D2, T370C	Fair	Good	Good	Good
Shelby:				
24D2	Fair	Good	Good	Good
24E2, 24F2	Poor	Fair	Good	Good
Sperry: 122	Fair	Fair	Good	Fair
Steep rockland: 478	Very poor	Very poor	Fair	Fair
Strip mines: 502	Very poor	Very poor	Very poor	Very poor
Tama:				
120	Good	Good	Good	Good
120B, T120B	Good	Good	Good	Good
120C2, 120D2	Fair	Good	Good	Good
Vesser:				
51	Good	Good	Good	Fair
51B	Good	Good	Good	Fair
Wabash: 172, 248	Fair	Fair	Poor	Very poor

soils for wildlife—Continued

Elements of wildlife habitat—Continued			Kinds of wildlife habitat		
Coniferous trees and shrubs	Wetland plants	Shallow water areas	Open-land[1]	Woodland	Wetland
Good	Fair	Fair	Good	Good	Fair.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Poor	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Good	Fair	Fair	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Poor	Good	Good	Fair	Fair	Good.
Fair	Very poor	Very poor	Poor	Fair	Very poor.
Very poor	Very poor	Good	Very poor	Very poor	Poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good	Fair	Good.
Poor	Poor	Very poor	Good	Fair	Very poor.
Very poor	Good	Good	Fair	Very poor	Good.

TABLE 5.—*Potential of the*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops[1]	Grasses and legumes[1]	Wild herbaceous plants	Hardwood trees and shrubs
Watkins: 687B	Good	Good	Good	Good
Weller:				
132B	Good	Good	Good	Good
132C2	Fair	Good	Good	Good
Winterset: 369	Good or fair	Good or fair	Good	Fair
Wiota:				
7	Good	Good	Good	Good
7B	Good	Good	Good	Good
Zook: 54	Good or fair	Good or fair	Good	Fair

[1] Dual rating in column is for drained and undrained conditions.

missions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, drainage, shrink-swell potential, grain size, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6 and 7 which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 6 and 7, and it also can be used to make other useful maps.

This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to a depth of more than that shown in the tables, generally a depth of more than 5 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have different meanings in soil science than in engineering. The Glossary defines many of these terms as they are commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*2*) used by the SCS engineers, Department of Defense, and others, and the AASHTO system (*1*) adopted by the American Association of State Highway and Transportation Officials.

In the Unified system soils are classified according to particle size distribution, plasticity, liquid limit, and organic matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL–ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups, ranging from A–1 through A–7, on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength

soils for wildlife—Continued

Elements of wildlife habitat—Continued			Kinds of wildlife habitat		
Coniferous trees and shrubs	Wetland plants	Shallow water areas	Open-land[1]	Woodland	Wetland
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good or fair	Fair	Good.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good or fair	Fair	Good.

when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The estimated AASHTO classification is shown in table 6 for all soils mapped in the survey area.

Soil properties significant to engineering

Several estimated soil properties significant in engineering are given in table 6. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 6.

Depth to seasonal high water table is distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Texture is described in table 6 in the standard terms used by the U.S. Department of Agriculture (USDA). These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic. If the moisture content is further increased, the material changes from a plastic to a liquid. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic; and the liquid limit, from a plastic to a liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 6.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 6 do not take into account lateral seepage or such transient soil features as a plowpan or a surface crust.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed as pH. The pH value and terms used to describe reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Depth to bedrock is omitted from table 6. Bedrock is normally below the depths investigated during the survey except in Bauer and Gosport soils and Steep rock land.

Engineering interpretations of the soils

The interpretations in table 7 are based on the estimated engineering properties of soils shown in table

TABLE 6.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. fully the instructions for referring to other series that appear in the first column

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
Ackmore: 430	3–5	0–25	Silt loam	ML or CL	A–4 or A–6
		25–60	Silty clay loam	CL or CH	A–7
*Adair: 93D2, 93E2, 93E3, 192D2	1–3	0–16	Clay loam	CL	A–6
		16–26	Heavy clay loam	CH or CL	A–7
For Shelby parts of 93D2, 93E2, 93E3, see Shelby series.		26–60	Clay loam	CL	A–7 or A–6
*Armstrong: 792D2, 993D2, 993E2	3–5	0–60			
Most properties too variable to estimate.					
Amana: 422	3–5	0–44	Silt loam	ML or CL	A–6
		44–60	Loam	ML or CL	A–4 or A–6
Arbor: 434D	>5	0–14	Loam or light clay loam	CL	A–6
		14–63	Clay loam	CL	A–6 or A–7
Arispe: 23C, 23C2	>5	0–10	Light silty clay loam	CL or CH	A–6 or A–7
		10–50	Silty clay loam	CL or CH	A–6 or A–7
		50–60	Light silty clay loam	CL or CH	A–6 or A–7
*Armstrong: 792D2, 993D2, 993E2, 993E3.	1–3	0–9	Loam or silt loam	CL or ML	A–4 or A–6
		9–14	Clay loam	CL	A–6 or A–7
		14–32	Clay	CH or CL	A–7
For Gara parts of 993D2, 993E2, and 993E3, see Gara series.		32–60	Clay loam	CL	A–6 or A–7
Bauer: 185D2, 185E2, 185E3	>5	0–13	Silt loam or silty clay loam	CL	A–6
		13–60	Silty clay or clay shale	CH	A–7
Bremer: 43	1–3	0–18	Silty clay loam	CL, CH or MH	A–7
		18–47	Silty clay loam or silty clay	CH	A–7
		47–60	Silty clay loam	CH or CL	A–7
Caleb: 451D2	>5	0–8	Loam	CL	A–6
		8–33	Clay loam or sandy clay loam	CL or CH	A–6 or A–7
		33–60	Sandy loam or sandy clay loam	SC or CL	A–4 or A–6
Chelsea: 63C2, 63D2	>5	0–5	Loamy fine sand	SM	A–2
		5–60	Loamy fine sand	SP or SM	A–3 or A–2
Clarinda: 222C, 222C2, 222D2	1–3	0–14	Silty clay loam	CL or ML	A–6 or A–7
		14–60	Silty clay	CH	A–7
Clearfield: 69C, 69C2	1–3	0–18	Silty clay loam	ML or CL	A–7
		18–46	Silty clay loam or silty clay	CH	A–7
		46–60	Silty clay	CH	A–7
Clinton: 80B, 80C2, 80D2	>5	0–15	Silt loam	CL, ML, or CL–ML	A–4 or A–6
		15–46	Silty clay loam or silty clay	CL or CH	A–7
		46–60	Silty clay loam	CL	A–6 or A–7
*Colo: 11B, 133, 133B	1–3	0–40	Silty clay loam	CL or CH	A–7
		40–60	Silty clay loam	CL or CH	A–7
For Ely part of 11B, see Ely series.					
Downs: 162, 162B, 162C2, 162D2 T162B.	>5	0–19	Silt loam	ML or CL	A–4 or A–6
		19–48	Silty clay loam	CL	A–7 or A–6
		48–60	Silty clay loam	CL	A–6 or A–7
Ely: 428B	3–5	0–22	Silty clay loam	CL	A–7
		22–60	Silty clay loam	CL	A–7 or A–6

significant in engineering

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-of this table. The symbol > means more than; the symbol < means less than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In per hr*	*In per in of soil*	*pH range*	
100	95–100	90–100	70–90	30–40	5–15	0.6–2.0	0.21–0.23	5.6–6.0	Moderate.
100	100	95–100	85–95	41–55	20–30	0.6–2.0	0.18–0.20	6.1–7.3	High.
95–100	95–100	90–95	70–80	30–40	11–20	0.2–0.6	0.17–0.19	6.1–6.5	Moderate.
95–100	95–100	90–100	75–90	41–55	20–35	0.06–0.2	0.15–0.17	6.1–6.5	High.
95–100	95–100	90–100	70–80	35–50	20–30	0.2–0.6	0.14–0.16	6.1–6.5	Moderate.
100	100							5.6–6.5	
100	100	90–100	70–95	30–40	11–20	0.6–2.0	0.21–0.23	5.1–7.3	Moderate.
100	100	90–100	70–90	25–40	5–15	0.6–2.0	0.17–0.19	6.6–7.3	Low.
95–100	95–100	85–95	60–75	30–40	11–20	0.6–2.0	0.19–0.21	5.6–6.5	Low.
95–100	95–100	90–100	70–80	35–45	15–25	0.2–0.6	0.15–0.17	5.1–7.3	Moderate.
100	100	100	95–100	35–40	15–25	0.2–0.6	0.21–0.23	5.6–7.3	Moderate.
100	100	100	95–100	35–50	20–30	0.06–0.2	0.15–0.17	5.6–7.3	High.
100	100	100	95–100	35–45	15–25	0.2–0.6	0.18–0.20	6.6–7.3	Moderate.
95–100	90–95	85–95	60–80	25–35	5–15	0.6–2.0	0.21–0.23	5.6–6.5	Low.
95–100	95–100	90–95	65–80	35–50	20–35	0.2–0.6	0.16–0.18	5.1–5.5	Moderate.
95–100	95–100	90–100	65–80	45–60	20–35	0.06–0.2	0.11–0.13	5.6–6.0	High.
95–100	95–100	90–95	65–80	35–45	20–30	0.2–0.6	0.14–0.16	5.6–6.5	Moderate.
100	100	95–100	85–95	30–40	15–25	0.6–2.0	0.21–0.23	5.6–6.5	Moderate.
100	100	95–100	90–95	60–85	20–35	<0.06	0.11–0.13	5.1–5.5	High.
100	100	95–100	90–100	45–60	25–40	0.2–0.6	0.21–0.23	6.1–6.5	Moderate.
100	100	95–100	90–100	50–65	25–40	0.06–0.2	0.15–0.17	5.6–6.5	High.
100	100	95–100	90–100	41–55	20–35	0.2–0.6	0.15–0.17	6.1–6.5	High.
90–100	90–100	80–90	60–80	30–40	11–20	0.6–6.0	0.20–0.22	5.6–6.5	Low.
95–100	90–100	80–90	70–80	35–55	20–35	0.6–6.0	0.15–0.19	5.1–6.5	Moderate.
90–100	90–100	80–90	35–60	25–40	5–15	0.6–6.0	0.11–0.13	4.5–6.0	Low.
100	95–100	85–95	10–35	<20	[1] NP	6.0–20	0.10–0.12	6.6–7.3	Low.
100	95–100	85–95	8–20	<20	NP	6.0–20	0.08–0.10	5.6–6.5	Low.
100	95–100	95–100	85–95	35–45	15–25	0.2–0.6	0.21–0.23	5.6–6.5	Moderate.
100	95–100	95–100	85–95	50–65	30–40	<0.06	0.11–0.13	5.1–6.5	High.
100	100	95–100	95–100	41–50	15–25	0.2–0.6	0.21–0.23	6.5–7.3	Moderate.
100	100	95–100	95–100	50–60	25–35	0.2–0.6	0.15–0.17	6.5–7.3	High.
100	95–100	95–100	90–95	50–65	30–40	<0.06	0.11–0.13	6.5–7.3	High.
100	100	95–100	95–100	25–40	5–15	0.6–2.0	0.22–0.24	5.6–7.3	Low.
100	100	95–100	95–100	41–55	20–30	0.2–0.6	0.15–0.17	5.6–6.0	High.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
100	100	95–100	85–95	41–60	20–30	0.2–0.6	0.21–0.23	6.6–7.3	High.
100	100	95–100	85–95	41–60	20–30	0.2–0.6	0.18–0.20	6.6–7.3	High.
100	100	95–100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	5.6–6.0	Low.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	5.1–5.5	Moderate.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	5.1–5.5	Moderate.
100	100	95–100	85–95	41–50	15–25	0.6–2.0	0.21–0.23	5.6–6.0	Moderate.
100	100	95–100	85–95	35–45	11–20	0.6–2.0	0.18–0.20	5.6–6.5	Moderate.

TABLE 6.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
Fayette: 163B, 163C2, 163D2, 163E2, 163F2.	>5	0–11	Silt loam	ML, CL, or CL–ML	A–4 or A–6
		11–45	Silty clay loam or heavy silt loam.	CL	A–7 or A–6
		45–60	Silt loam	CL	A–6
Gara: 179D2, 179E2, 179F2, 179G	>5	0–14	Loam	CL	A–6
		14–40	Clay loam	CL	A–7
		40–60	Clay loam	CL	A–7
Givin: 75	3–5	0–11	Silt loam	ML or CL	A–4 or A–6
		11–53	Silty clay loam	CL or CH	A–7
		53–60	Silty clay loam	CL	A–6 or A–7
Gosport: 313D, 313E, 313E3, 313F	>5	0–8	Silt loam	CL	A–6
		8–23	Silty clay	CH	A–7
		23–50	Clay shale	CH	A–7
Grundy: 864B	3–5	0–13	Silty clay loam	ML or CL	A–7
		13–18	Silty clay loam	CH or CL	A–7
		18–30	Silty clay or heavy silty clay loam.	CH	A–7
		30–60	Silty clay loam	CH or CL	A–7
*Gullied land: 980B Most properties too variable to estimate. For Ely part, see Ely series. For Colo part, see Colo series.		0–60			
Humeston: 269	1–3	0–21	Silt loam	ML or CL	A–6 or A–7
		21–60	Silty clay or silty clay loam	CH	A–7
Judson: 8B	>5	0–27	Silty clay loam	CL or ML	A–6 or A–7
		27–63	Silty clay loam	CL	A–6 or A–7
Kennebec: 212	3–5	0–41	Silt loam	CL or ML	A–6 or A–7
		41–60	Silt loam	CL	A–6 or A–7
Keswick: 425D	1–3	0–11	Loam	CL	A–6
		11–32	Clay or clay loam	CH	A–7
		32–60	Clay loam or sandy clay loam	CL	A–6 or A–7
*Ladoga: 76B, 76C, 76C2, 76D2, T76B, T76C2, 427C2, 427D2. For Chelsea part of 427C2 and 427D2, see Chelsea series.	>5	0–9	Silt loam	ML or CL	A–6 or A–4
		9–60	Silty clay loam	CH or CL	A–6 or A–7
Lamoni: 822D2, 822D3	1–3	0–11	Silty clay loam	CL	A–6 or A–7
		11–38	Clay loam	CH	A–7
		38–60	Clay loam	CL or CH	A–7
Lindley: 65D, 65E, 65F, 65G, 65E3	>5	0–5	Loam	CL–ML, CL, or ML	A–4 or A–6
		5–60	Clay loam	CL	A–6 or A–7
Macksburg: 368, 368B, T368	3–5	0–18	Silty clay loam	ML or CL	A–7
		18–42	Silty clay loam	MH or CH	A–7
		42–50	Silty clay loam	CH or CL	A–7
Muscatine: 119, T119	3–5	0–17	Silty clay loam	ML or CL	A–7
		17–41	Silty clay loam	CL	A–7
		41–50	Silty clay loam	CL	A–6 or A–7

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In per hr*	*In per in of soil*	*pH range*	
100	100	95–100	95–100	25–35	5–15	0.6–2.0	0.22–0.24	6.1–7.3	Low.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.16–0.18	5.6–6.5	Moderate.
100	100	95–100	95–100	30–40	11–20	0.6–2.0	0.20–0.22	5.6–6.0	Moderate.
95–100	95–100	85–95	75–85	30–40	11–20	0.6–2.0	0.20–0.22	6.6–7.3	Low.
95–100	95–100	90–100	75–85	41–50	20–30	0.2–0.6	0.16–0.18	4.5–6.5	Moderate.
95–100	95–100	90–100	75–85	41–50	20–30	0.2–0.6	0.14–0.16	7.4–7.8	Moderate.
100	100	95–100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	5.6–7.3	Low.
100	100	95–100	95–100	41–55	20–35	0.2–0.6	0.18–0.20	5.1–6.0	High.
100	100	95–100	95–100	35–50	15–25	0.2–0.6	0.18–0.20	5.6–6.0	Moderate.
100	100	90–100	70–90	30–40	11–20	0.6–2.0	0.22–0.24	6.1–6.5	Low.
100	100	95–100	90–95	50–65	25–35	<0.06	0.11–0.13	5.1–5.5	High.
100	100	95–100	85–95	55–70	25–35	<0.06	0.06–0.10	5.1–5.5	High.
100	100	95–100	95–100	41–50	11–20	0.6–2.0	0.21–0.23	5.6–6.5	Moderate.
100	100	95–100	95–100	45–60	25–35	0.2–0.6	0.18–0.20	5.6–6.0	Moderate.
100	100	95–100	95–100	50–65	25–35	0.06–0.2	0.15–0.17	5.6–6.5	High.
100	100	95–100	95–100	41–55	20–30	0.2–0.6	0.18–0.20	6.1–6.5	Moderate.
100	100	90–100	90–100	----------	----------	----------	0.18–0.22	5.6–7.8	
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.22–0.24	5.1–6.5	Low.
100	100	95–100	95–100	50–65	25–35	<0.06	0.16–0.18	5.1–6.0	High.
100	100	95–100	90–100	35–50	15–25	0.6–2.0	0.21–0.23	5.6–7.3	Moderate.
100	100	95–100	90–100	35–45	15–25	0.6–2.0	0.18–0.20	6.1–6.5	Moderate.
100	100	90–100	85–100	35–45	15–25	0.6–2.0	0.22–0.24	6.1–7.3	Moderate.
100	100	90–100	70–90	30–45	11–20	0.6–2.0	0.20–0.22	6.1–6.5	Moderate.
100	100	90–95	60–75	30–40	11–20	0.6–2.0	0.20–0.22	4.5–7.3	Low.
100	100	90–95	70–85	50–65	30–40	0.06–0.2	0.11–0.13	5.1–6.0	High.
100	95–100	90–95	60–80	35–45	15–25	0.2–0.6	0.14–0.16	5.6–7.3	Moderate.
100	100	95–100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	6.6–7.3	Low.
100	100	95–100	95–100	35–55	15–25	0.2–0.6	0.18–0.20	5.6–7.3	High.
100	100	95–100	75–95	35–45	11–20	0.6–2.0	0.21–0.23	5.6–6.0	Moderate.
100	100	90–100	70–85	50–65	30–40	<0.06	0.14–0.16	5.6–7.3	High.
100	100	90–100	70–80	41–55	25–35	0.2–0.6	0.14–0.16	6.6–7.3	High.
100	95–100	85–95	50–60	20–35	5–15	0.6–2.0	0.20–0.22	6.1–7.3	Low.
100	95–100	80–95	55–70	35–50	15–25	0.2–0.6	0.16–0.18	4.5–8.4	Moderate.
100	100	100	95–100	41–55	15–25	0.6–2.0	0.21–0.23	5.1–5.5	Moderate.
100	100	100	95–100	50–60	25–35	0.2–0.6	0.18–0.20	5.1–6.0	High.
100	100	100	95–100	41–55	20–30	0.2–0.6	0.18–0.20	5.6–6.0	Moderate.
100	100	95–100	95–100	41–50	15–25	0.6–2.0	0.21–0.23	5.1–5.5	Moderate.
100	100	95–100	95–100	41–50	25–35	0.6–2.0	0.18–0.20	5.1–5.5	Moderate.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.

TABLE 6.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
*Mystic: 94D2, 94E2, 592C2, 592D2 — For Caleb part of 94D2 and 94E2, see Caleb series.	1–3	0–8	Silt loam	ML or CL	A–4 or A–6
		8–60	Heavy clay loam, clay, or silty clay.	CL or CH	A–6 or A–7
Nevin: 88, 88B	3–5	0–16	Silty clay loam	ML or CL	A–6 or A–7
		16–43	Silty clay loam	CL	A–7
		43–50	Silty clay loam	CL	A–6 or A–7
Nira: 570B, 570C2	>5	0–14	Silty clay loam	ML or CL	A–6 or A–7
		14–37	Silty clay loam	CL	A–7
		37–60	Silty clay loam	CL	A–6 or A–7
Nodaway: 220, C220	3–5	0–60	Silt loam	CL–ML, ML, or CL	A–6
Olmitz: 273B, 273C	>5	0–29	Loam or light clay loam	CL	A–6 or A–7
		29–60	Clay loam	CL	A–6 or A–7
Pershing: 131B, 131C2, 131D2	3–5	0–13	Silt loam	ML or CL	A–4 or A–6
		13–43	Silty clay loam or silty clay	CH	A–7
		43–60	Silty clay loam	CL or CH	A–7
Sharpsburg: 370, 370B, 370C, 370C2, 370D2, T370, T370B, T370C.	>5	0–16	Silty clay loam	ML or CL	A–7
		16–32	Silty clay loam	CH	A–7
		32–50	Silty clay loam	CL or CH	A–7
Shelby: 24D2, 24E2, 24F2	>5	0–11	Clay loam	CL	A–6
		11–44	Clay loam	CL	A–6 or A–7
		44–60	Clay loam	CL	A–6 or A–7
Sperry: 122	0–2	0–21	Silt loam	ML or CL	A–6 or A–4
		21–56	Silty clay	CH	A–7
		56–60	Silty clay loam	CL	A–7
Steep rock land: 478 — Most properties too variable to estimate.	>5				
Strip mines: 502 — Some properties too variable to estimate.	-------	0–60	Clay or silty clay	CH	A–7
Tama: 120, 120B, 120C2, 120D2 T120B.	>5	0–13	Silty clay loam	ML or CL	A–6 or A–7
		13–50	Silty clay loam	CL	A–7 or A–6
Vesser: 51, 51B	1–3	0–26	Silt loam	ML or CL	A–6 or A–7
		26–60	Silty clay loam	CH or CL	A–7
Wabash:					
172	1–3	0–26	Silty clay	CH	A–7
		26–60	Silty clay	CH	A–7
248	1–3	0–9	Silty clay loam	CL or CH	A–7
		9–60	Silty clay	CH	A–7
Watkins: 687B	>5	0–15	Silt loam	ML or CL	A–6 or A–4
		15–36	Silty clay loam	CL or ML	A–7 or A–6
		36–60	Silty clay loam	CL	A–7 or A–6
Weller: 132B, 132C2	2–4	0–9	Silt loam	ML, CL, or CL–ML	A–4 or A–6
		9–37	Silty clay or silty clay loam	CH	A–7
		37–60	Silty clay loam	CL	A–7 or A–6

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In per hr*	*In per in of soil*	*pH range*	
100	100	95–100	90–100	30–40	5–15	0.6–2.0	0.22–0.24	6.1–7.3	Low.
100	95–100	85–95	65–80	35–55	15–30	0.06–0.2	0.13–0.15	4.5–6.5	High.
100	95–100	90–100	90–100	35–45	11–20	0.6–2.0	0.21–0.23	5.6–7.3	Moderate.
100	95–100	90–100	90–100	41–50	20–30	0.2–2.0	0.18–0.20	5.6–7.3	Moderate.
100	95–100	90–100	90–100	35–50	20–30	0.2–2.0	0.18–0.20	6.6–7.3	Moderate.
100	100	95–100	95–100	35–50	15–25	0.6–2.0	0.21–0.23	6.6–7.3	Moderate.
100	100	95–100	95–100	41–50	20–30	0.2–0.6	0.18–0.20	6.1–7.3	Moderate.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	6.6–7.8	Moderate.
100	95–100	90–100	70–90	25–40	5–15	0.6–2.0	0.20–0.22	6.6–7.3	Moderate.
100	90–100	90–95	60–80	35–45	15–25	0.2–2.0	0.19–0.21	5.1–6.0	Low.
100	90–100	90–95	60–80	35–50	15–25	0.2–2.0	0.16–0.18	5.6–6.5	Moderate.
100	100	95–100	95–100	25–40	5–15	0.6–2.0	0.22–0.24	5.6–7.3	Low.
100	100	95–100	95–100	50–65	30–40	0.06–0.2	0.14–0.16	5.1–6.0	High.
100	100	95–100	95–100	45–60	25–35	0.2–0.6	0.18–0.20	6.1–6.5	Moderate.
100	100	95–100	95–100	41–50	15–25	0.6–2.0	0.21–0.23	6.1–6.5	Moderate.
100	100	95–100	95–100	50–60	25–35	0.2–0.6	0.18–0.20	5.1–6.0	High.
100	100	95–100	95–100	41–55	20–30	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
90–100	90–100	80–90	60–80	25–40	15–25	0.6–2.0	0.17–0.19	6.6–7.3	Moderate.
90–100	90–100	80–90	60–80	35–50	20–30	0.2–0.6	0.16–0.18	5.6–7.3	Moderate.
90–100	90–100	80–90	60–80	30–45	20–30	0.2–0.6	0.14–0.16	7.4–7.8	Moderate.
100	100	95–100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	5.1–6.0	Low.
100	100	95–100	95–100	50–65	25–35	<0.06–0.2	0.11–0.13	5.6–7.3	High.
100	100	95–100	95–100	41–50	20–30	0.2–0.6	0.18–0.20	6.6–7.3	Moderate.
----------	----------	----------	----------	50–70	20–40	<0.06	0.08–0.10	4.5–6.0	
100	100	95–100	95–100	35–50	11–20	0.6–2.0	0.21–0.23	5.1–6.0	Moderate.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	5.6–6.5	Moderate.
100	100	95–100	95–100	30–45	11–20	0.6–2.0	0.22–0.24	5.6–6.0	Moderate.
100	100	95–100	95–100	41–55	20–30	0.2–2.0	0.18–0.20	6.1–7.3	High.
100	100	95–100	95–100	60–85	45–55	<0.06	0.12–0.14	5.6–7.3	High.
100	100	95–100	95–100	20–35	40–50	<0.06	0.11–0.13	5.6–7.3	High.
100	100	95–100	90–100	45–70	60–85	0.2–0.6	0.21–0.23	7.4–7.8	High.
100	100	95–100	95–100	60–85	40–55	<0.06	0.11–0.13	5.6–7.3	High.
100	100	95–100	85–95	25–40	5–15	0.6–2.0	0.22–0.24	6.6–7.3	Low.
100	100	95–100	85–95	35–45	11–20	0.6–2.0	0.18–0.20	5.6–7.3	Moderate.
100	100	95–100	85–95	35–45	15–25	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
100	100	95–100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	6.6–7.3	Low.
100	100	95–100	95–100	50–65	30–40	0.06–0.2	0.15–0.17	5.1–6.0	High.
100	100	95–100	95–100	35–45	15–25	0.2–0.6	0.18–0.20	5.6–6.5	Moderate.

TABLE 6.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
Winterset: 369	1–3	0–19	Silty clay loam	CL	A–7
		19–43	Silty clay or silty clay loam	CH	A–7
		43–60	Silty clay loam	CL or CH	A–7
Wiota: 7, 7B	>5	0–22	Silt loam or silty clay loam	CL	A–6
		22–50	Silty clay loam	CL or CH	A–6 or A–7
Zook: 54	1–3	0–7	Silty clay loam	CH or CL	A–7
		7–60	Silty clay, silty clay loam	CH	A–7

[1] NP means nonplastic.

6, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Warren County. In table 7, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for drainage or cropland and pasture, irrigation, pond reservoir areas, embankments, terraces and diversions, and grassed waterways. For these particular uses, table 7 lists those soil features not to be overlooked in planning, installation, and maintenance.

In estimating soils for engineering it must be remembered that, even though investigations during the survey were to a depth of about 5 feet, the nature of the material immediately below this depth generally can be estimated from a knowledge of the soil series or phase. For example, the bench phases of soils formed in loess are indicated by a prefix "T" on the soil symbol. These soils typically are underlain by stratified alluvium instead of glacial till. In places the alluvium is coarse textured and is at a depth as shallow as 5 feet. This should be considered in selecting sites for septic tank absorption fields, sewage lagoons, sanitary landfill, pond reservoir areas, and other uses that are affected by porous substratum. Also, the bench phases are a possible source of sand or gravel.

Soil limitations in table 7 are indicated by the ratings slight, moderate, and severe. *Slight* means that soil properties are generally favorable for the rated use, or in other words, that limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance. For some uses, the rating of severe is divided to obtain ratings of severe and very severe.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 7.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects difficulty of layout and construction and also the risk of erosion, lateral seepage, and downslope flow of effluent. Large rock or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor, and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter content, and slope, and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated the ratings in table 6 apply only to a depth of about 6 feet, and therefore limita-

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In per hr*	*In per in of soil*	*pH range*	
100	100	95–100	95–100	41–50	15–25	0.2–0.6	0.21–0.23	5.1–5.5	Moderate.
100	100	95–100	95–100	50–60	30–40	0.06–0.2	0.15–0.17	5.1–6.0	High.
100	100	95–100	95–100	41–55	20–30	0.2–0.6	0.18–0.20	6.1–6.5	Moderate.
100	100	95–100	90–100	30–40	11–20	0.6–2.0	0.21–0.23	5.1–5.5	Moderate.
100	100	95–100	90–100	35–55	15–30	0.6–2.0	0.18–0.20	5.1–5.5	Moderate.
100	100	95–100	95–100	41–55	15–25	0.2–0.6	0.21–0.23	0.6–7.3	High.
100	100	95–100	95–100	50–65	35–45	0.06–0.2	0.13–0.15	6.1–7.3	High.

tion ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. Even though reliable predictions can be made to a depth of 10 or 15 feet for some soils, every site should be investigated before it is selected.

Local roads and streets, as rated in table 7, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand.

Soil properties that most affect design and construction of roads and streets are load supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rock, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage. They also reflect the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the material, and neither do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material, or its response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability, but also considered in the ratings is damage that results at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage and piping and that has favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are unfavorable factors.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; need for drainage; and depth to water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; pres-

TABLE 7.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. fully the instructions for referring to other series

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Ackmore: 430 ------	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; susceptible to frost action; low strength.	Poor: low strength; high shrink-swell potential; susceptible to frost action; somewhat poorly drained.	Not suitable ---
*Adair: 93D2, 93E2, 93E3, 192D2. For Shelby part of 93D2, 93E2 and 93E3, see Shelby series.	Severe: seasonal high water table; slow permeability; slopes of 9 to 18 percent.	Severe: slopes of 9 to 18 percent; seasonal high water table.	Severe: seasonal high water table; moderately well drained or somewhat poorly drained; clay loam texture.	Severe: low strength; high shrink-swell potential; slopes of 9 to 18 percent.	Poor: low strength; high shrink-swell potential.	Not suitable ---
Alluvial land: 315, C315.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; variable permeability; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding.	Variable ------	Not suitable ---
Amana: 422 --------	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; susceptible to frost action; somewhat poorly drained.	Poor: low strength; susceptible to frost action; somewhat poorly drained.	Not suitable ---

interpretations

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-that appear in the first column of this table]

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Good	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Moderate permeability; seasonal high water at a depth of 3 to 5 feet; slopes of 0 to 2 percent; subject to flooding.	Slopes of 0 to 2 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; subject to flooding; moderate permeability.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.
Fair: clay loam texture; slopes of 9 to 18 percent.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Water seeps downslope along slowly permeable layer and causes perched seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Slopes of 9 to 18 percent; seasonal high water table at a depth of 1 foot to 3 feet; hazard of erosion; slow permeability.	Slopes of 9 to 18 percent; hazard of erosion; heavy clay loam subsoil; slow permeability; hard to vegetate.	Hazard of erosion; heavy clay loam subsoil at a depth of 1⅓ feet; moderately well drained to somewhat poorly drained; seeps in places.
Generally fair to good: properties variable.	Properties variable; slopes of 0 to 2 percent.	Properties variable but generally medium to low shear strength; medium compressibility; medium to low compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Variable permeability and texture; subject to frequent flooding; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; subject to flooding; variable permeability.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.
Good	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; high to medium susceptibility to piping; fair compaction characteristics.	Moderate permeability; subject to flooding and ponding; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; seasonal high water table at a depth of 3 to 5 feet; subject to flooding; moderate permeability.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Arbor: 434D	Moderate: slopes of 9 to 14 percent; moderately slow permeability.	Severe: slopes of 9 to 14 percent.	Slight	Moderate: slopes of 9 to 14 percent; moderate shrink-swell potential.	Poor: low shear strength; moderate shrink-swell potential.	Not suitable
Arispe: 23C, 23C2	Severe: moderately slow permeability.	Severe: slopes of 5 to 9 percent.	Moderate: moderately well drained to somewhat poorly drained; silty clay loam texture.	Severe: low strength; high shrink-swell potential; susceptible to frost action.	Poor: low strength; high shrink-swell potential; susceptible to frost action.	Not suitable
*Armstrong: 792D2, 993D2, 993E2, 993E3. For Gara parts of 993D2, 993E2, and 993E3, see Gara series.	Severe: slow permeability; slopes of 9 to 18 percent.	Severe: slopes of 9 to 18 percent.	Severe: moderately well drained to somewhat poorly drained; clay loam texture; seasonal high water table at a depth of 1 foot to 3 feet.	Severe: somewhat poorly drained; moderate to high shrink-swell potential.	Poor: high shrink-swell potential; low strength.	Not suitable
Bauer: 185D2, 185E2, 185E3.	Severe: very slow permeability; slopes of 9 to 18 percent.[1]	Severe: slopes of 9 to 18 percent.	Severe: less than 30 inches to rippable bedrock; silty clay or clay texture.	Severe: slopes of 9 to 18 percent; high shrink-swell potential; low strength.	Poor: low strength; high shrink-swell potential.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Fair: slopes of 9 to 14 percent.	Moderately slow permeability to moderate permeability; slopes of 9 to 14 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 9 to 14 percent; moderate permeability to moderately slow permeability.	Slopes of 9 to 14 percent; hazard of erosion.	Hazard of erosion; slopes of 9 to 14 percent.
Fair: silty clay loam texture.	Moderately slow permeability; slopes of 5 to 9 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Moderately slow permeability; slopes of 5 to 9 percent.	Slopes of 5 to 9 percent; moderately well drained to somewhat poorly drained; moderately slow permeability; hazard of erosion.	Slopes of 5 to 9 percent; hazard of erosion; silty clay loam subsoil; moderately slow permeability.	Hazard of erosion; moderately well drained to somewhat poorly drained.
Fair: clay loam texture below a depth of 9 inches; slopes of 9 to 18 percent.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Water seeps downslope along slowly permeable layer and causes perched seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Slopes of 9 to 18 percent; seasonal high water table at a depth of 1 foot to 3 feet; hazard of erosion; slow permeability.	Slopes of 9 to 18 percent; hazard of erosion; clay subsoil; slow permeability; plant cover difficult to establish.	Hazard of erosion; clay subsoil at a depth of 14 inches; moderately well drained to somewhat poorly drained; seeps in places.
Poor: silty clay or clay below a depth of 13 inches; slopes of 9 to 18 percent.	Very slow permeability; shallow to bedrock; slopes of 9 to 18 percent.	Low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; poor compaction characteristics.	Natural drainage adequate.	Moderate available water capacity; clayey shale at a depth of 13 inches; slopes of 9 to 18 percent; hazard of erosion.	Slopes of 9 to 18 percent: shallow to bedrock; hazard of erosion.	Hazard of erosion; shallow to bedrock; slopes of 9 to 18 percent.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Bremer: 43	Severe: seasonal high water table; slow permeability.	Severe: high organic matter content; seasonal high water table.	Severe: seasonal high water table; poorly drained; silty clay loam texture.	Severe: poorly drained; high shrink-swell potential; low strength.	Poor: high shrink-swell potential; low strength; poorly drained.	Not suitable
Caleb: 451D2	Severe: permeability of stratified material not predictable; slopes of 9 to 18 percent.[1]	Severe: slopes of 9 to 14 percent; permeability of stratified material not predictable.	Severe: permeability of stratified material not predictable.	Moderate if slopes are 9 to 14 percent; moderate shrink-swell potential; moderate strength. Severe if slopes are 14 to 18 percent.	Fair: moderate to high strength; moderate shrink-swell potential.	Not suitable
Chelsea: 63C2, 63D2	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 14 percent. Severe if slopes are more than 14 percent.	Severe: rapid permeability; slopes of 5 to 18 percent.	Severe: rapid permeability.	Moderate: slopes of 9 to 18 percent.	Good	Good source of poorly graded fine sand; lacks gravel.
Clarinda: 222C, 222C2, 222D2.	Severe: very slow permeability.	Severe: seasonal high water table; slopes of 5 to 14 percent; moderate to high organic matter content.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; high shrink-swell potential; slopes of 5 to 14 percent; low strength.	Poor: low strength; high shrink-swell potential; poorly drained.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: poorly drained; silty clay loam texture.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; poorly drained; seasonal high water table at a depth of 1 to 3 feet; slow permeability.	Slopes of 0 to 2 percent; on stream benches.	Slopes of 0 to 2 percent; on stream benches.
Fair: clay loam texture below a depth of 8 inches; slopes of 9 to 14 percent.	Permeability depends on texture of stratified material; seepage possible; slopes of 9 to 18 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Natural drainage adequate.	Moderate to high available water capacity; slopes of 9 to 18 percent; permeability not predictable in stratified material; hazard of erosion.	Slopes of 9 to 18 percent; subsoil and substratum sandy and gravelly in places; hazard of erosion; plant cover difficult to vegetate.	Hazard of erosion; clay loam or sandy clay loam subsoil at a depth of 8 inches; slopes of 9 to 18 percent; moderate to high available water capacity.
Poor: loamy fine sand texture; slopes of 5 to 18 percent.	Rapid permeability; slopes of 5 to 18 percent.	Medium shear strength; low to medium compressibility; medium to high compacted permeability; medium to high susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Low available water capacity; slopes of 5 to 18 percent; rapid permeability; hazard of erosion and soil blowing.	Slopes of 5 to 18 percent; hazard of soil blowing and erosion; loamy fine sand texture; plant cover difficult to vegetate.	Hazard of erosion; loamy fine sand texture; excessively drained; low available water capacity.
Poor: silty clay below a depth of 14 inches; poorly drained.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 5 to 14 percent.	Medium to low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; fair to poor compaction characteristics.	Very slow permeability; silty clay subsoil; seasonal high water table at a depth of 1 foot to 3 feet; seepage from upslope; slopes of 5 to 14 percent.	Moderate to high available water capacity; slopes of 5 to 14 percent; poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; very slow permeability; hazard of erosion.	Slopes of 5 to 14 percent; silty clay subsoil at a depth of 14 inches; very slow permeability; plant cover difficult to establish.	Hazard of erosion; hazard of seepage; silty clay subsoil at a depth of 14 inches.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Clearfield: 69C, 69C2.	Severe: moderately slow permeability above substratum; very slow permeability in substratum.	Severe: seasonal high water table; slopes of 5 to 9 percent; moderate or high organic matter content.	Severe: somewhat poorly drained to poorly drained; seasonal high water table.	Severe: somewhat poorly drained to poorly drained; high shrink-swell potential; low strength.	Poor: low strength; high shrink-swell potential; somewhat poorly drained to poorly drained.	Not suitable
Clinton: 80B, 80C2, 80D2.	Moderate: moderately slow permeability; slopes of 2 to 14 percent.	Moderate where slopes are less than 5 percent. Severe where slopes are more than 5 percent.	Moderate: silty clay loam texture.	Severe: low strength; high shrink-swell potential; slopes of 2 to 14 percent.	Poor: low strength; high shrink-swell potential.	Not suitable
*Colo: 11B, 133, 133B—For Ely part of 11B, see Ely series.	Severe: subject to flooding; moderately slow permeability.	Severe: subject to flooding; seasonal high water table; high organic matter content.	Severe: subject to flooding; seasonal high water table.	Severe: poorly drained; subject to flooding; low strength; high shrink-swell potential.	Poor: low strength; high shrink-swell potential; poorly drained; susceptible to frost action.	Not suitable
Downs: 162, 162B, 162C2, 162D2, T162B.[2]	Slight if slopes are less than 9 percent. Moderate if slopes are more than 9 percent.	Moderate if slopes are less than 9 percent. Severe if slopes are more than 9 percent; moderate permeability.	Moderate: silty clay loam texture.	Moderate: moderate shrink-swell potential; slopes of 0 to 14 percent.	Poor: low strength; moderate shrink-swell potential.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: somewhat poorly drained to poorly drained; silty clay loam texture.	Moderately slow permeability above substratum; very slow permeability in underlying material; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 5 to 9 percent.	Medium to low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; fair compaction characteristics.	Very slow permeability in underlying material; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 5 to 9 percent.	Slopes of 5 to 9 percent; somewhat poorly drained to poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; hazard of erosion.	Slopes of 5 to 9 percent; hazard of erosion; silty clay loam subsoil at a depth of 18 inches.	Hazard of erosion; hazard of seepage; silty clay or silty clay loam subsoil at a depth of 18 inches; somewhat poorly drained to poorly drained.
Good where slopes are less than 9 percent. Fair where slopes are more than 9 percent.	Moderately slow permeability; slopes of 2 to 14 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Natural drainage adequate.	Slopes of 2 to 14 percent; moderately well drained; moderately slow permeability; hazard of erosion.	Slopes of 2 to 14 percent; hazard of erosion; silty clay or silty clay loam subsoil at a depth of 15 inches.	Hazard of erosion; silty clay or silty clay loam subsoil at a depth of 15 inches.
Poor: poorly drained; silty clay loam texture.	Moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 5 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 5 percent; subject to flooding; outlets not available in some places.	Slopes of 0 to 5 percent; poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding; moderately slow permeability.	Slopes of 0 to 5 percent; on bottom lands or foot slopes; hazard of siltation.	Poorly drained; slopes of 0 to 5 percent; high potential for siltation and wetness from run-on water from upslope.
Good if slopes are less than 9 percent. Fair if slopes are more than 9 percent.	Moderate permeability; slopes of 0 to 14 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 0 to 14 percent; well drained; moderate permeability; hazard of erosion if slopes are more than 2 percent.	Slopes of 0 to 14 percent; hazard of erosion; moderate permeability.	Hazard of erosion; well drained; slopes of 0 to 14 percent.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Ely: 428B	Severe: seasonal high water table.	Moderate: moderate permeability; seasonal high water table; high organic matter content.	Severe: seasonal high water table; somewhat poorly drained; silty clay loam texture.	Moderate: somewhat poorly drained; moderate shrink-swell potential.	Poor: low strength; moderate shrink-swell potential; somewhat poorly drained; susceptible to frost action.	Not suitable
Fayette: 163B, 163C2, 163D2, 163E2, 163F2.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 14 percent. Severe if slopes are more than 14 percent.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent. Moderate permeability.	Moderate: silty clay loam texture.	Moderate if slopes are less than 14 percent. Severe if slopes are more than 14 percent; moderate shrink-swell potential.	Poor: low strength; slopes of 2 to 25 percent; moderate shrink-swell potential.	Not suitable
Gara: 179D2, 179E2, 179F2, 179G.	Severe: moderately slow permeability; slopes of 9 to 40 percent.	Severe: slopes of 9 to 40 percent.	Moderate if slopes are less than 15 percent. Severe if slopes are more than 15 percent; clay loam texture.	Severe: low strength; slopes of 9 to 40 percent.	Poor: low strength; moderate shrink-swell potential; slopes of 9 to 40 percent.	Not suitable
Givin: 75	Severe: moderately slow permeability; seasonal high water table.	Moderate: seasonal high water table; high organic matter content.	Severe: seasonal high water table; somewhat poorly drained; silty clay loam texture.	Severe: low strength; somewhat poorly drained; high shrink-swell potential.	Poor: low strength; high shrink-swell potential; somewhat poorly drained.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Fair: silty clay loam texture.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent; subject to run-on water from upslope.	Slopes of 2 to 5 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; subject to run-on water from upslope; hazard of erosion.	Slopes are 2 to 5 percent; high potential for siltation from run-on water from upslope; on foot slopes.	Somewhat poorly drained; slopes of 2 to 5 percent; high potential for siltation and wetness from run-on water from upslope.
Good if slopes are less than 9 percent. Fair if slopes are 9 to 14 percent. Poor if slopes are more than 14 percent.	Moderate permeability; slopes of 2 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 2 to 25 percent; well drained; hazard of erosion.	Slopes of 2 to 25 percent; hazard of erosion; moderate permeability.	Hazard of erosion; well drained; slopes of 2 to 25 percent.
Fair if slopes are 9 to 14 percent. Poor if slopes are more than 14 percent.	Moderately slow permeability; slopes of 9 to 40 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 9 to 40 percent; well drained to moderately well drained; hazard of erosion.	Slopes of 9 to 40 percent; hazard of erosion; moderately slow permeability.	Hazard of erosion; well drained to moderately well drained; slopes of 9 to 40 percent.
Good	Moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; moderately slow permeability.	Slopes of 0 to 2 percent; on ridgetops.	Slopes of 0 to 2 percent; on ridgetops.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Gosport: 313D, 313E, 313E3, 313F.	Severe: very slow permeability; slopes of 9 to 35 percent.	Severe: slopes of 9 to 35 percent.	Severe: silty clay or clay texture; rippable bedrock at a depth of less than 1½ feet.	Severe: high shrink-swell potential; low strength; slopes of 9 to 35 percent.	Poor: low strength; high shrink-swell potential; slopes of 9 to 35 percent.	Not suitable
Grundy: 864B	Severe: slow permeability; seasonal high water table.	Moderate: seasonal high water table; high organic matter content.	Severe: seasonal high water table; somewhat poorly drained; silty clay and silty clay loam texture.	Severe: high shrink-swell potential; low strength; somewhat poorly drained.	Poor: low strength; high shrink-swell potential; somewhat poorly drained.	Not suitable
*Gullied land: 980B—For Colo and Ely parts, see their respective series.	Severe: moderately slow permeability or moderate permeability; seasonal high water table.	Severe: seasonal high water table; high organic matter content.	Severe: seasonal high water table; silty clay loam texture.	Severe: poorly drained to somewhat poorly drained; low strength.	Poor: low strength; high shrink-swell potential; susceptible to frost action.	Not suitable
Humeston: 269	Severe: subject to flooding; very slow permeability; seasonal high water table.	Severe: subject to flooding; seasonal high water table; high organic matter content.	Severe: subject to flooding; seasonal high water table; silty clay or silty clay loam texture.	Severe: poorly drained to very poorly drained; high shrink-swell potential; subject to flooding; low strength.	Poor: low strength; high shrink-swell potential; poorly drained to very poorly drained.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: silty clay or clay texture below a depth of 8 inches; slopes of 9 to 35 percent.	Very slow permeability; shallow to bedrock; slopes of 9 to 35 percent.	Low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; poor compaction characteristics.	Natural drainage adequate.	Low to moderate available water capacity; shallow to clayey shale; moderately well drained; very slow permeability; hazard of erosion.	Slopes of 9 to 45 percent; shallow to bedrock; hazard of erosion; silty clay subsoil at a depth of 8 inches.	Hazard of erosion; silty clay subsoil at a depth of 8 inches; shallow to bedrock; low to moderate available water capacity.
Fair: silty clay loam texture.	Slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent.	Slopes of 2 to 5 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; slow permeability; hazard of erosion.	Slopes of 2 to 5 percent; hazard of erosion; silty clay or heavy silty clay loam subsoil at a depth of 18 inches.	Hazard of erosion; silty clay or heavy silty clay loam subsoil at a depth of 18 inches; slopes of 2 to 5 percent.
Fair: silty clay loam texture; poorly drained in places.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 2 to 5 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Gully generally makes drainage impractical.	Gully generally makes drainage impractical.	Hazard of gully erosion; slopes of 2 to 5 percent; on foot slopes; hazard of siltation.	Waterways impractical unless gully filled in and controlled.
Poor: poorly drained to very poorly drained.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding; outlets not available in places.	Slopes of 0 to 2 percent; poorly drained to very poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding; very slow permeability.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Judson: 8B	Moderate: moderate permeability.	Moderate: moderate permeability; slopes of 2 to 6 percent; high organic matter content.	Moderate: silty clay loam texture.	Moderate: moderate shrink-swell potential; moderate strength.	Poor: low strength; moderate shrink-swell potential.	Not suitable
Kennebec: 212	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; moderate permeability; seasonal high water table; high organic matter content.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; moderately well drained; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action; moderately well drained.	Not suitable
Keswick: 425D	Severe: slow permeability; seasonal high water table.	Severe: slopes of 9 to 14 percent; seasonal high water table.	Severe: seasonal high water table; clay or clay loam texture.	Severe: high shrink-swell potential; low strength; slopes of 9 to 14 percent.	Poor: low strength; high shrink-swell potential.	Not suitable
*Ladoga: 76B, 76C, 76C2, 76D2, T76B [2], T76C2, 427C2, 427D2. For Chelsea parts of 427C2 and 427D2, see Chelsea series.	Severe: moderately slow permeability.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent.	Moderate: silty clay loam texture.	Severe: high shrink-swell potential; low strength; slopes of 2 to 14 percent.	Poor: low strength; high shrink-swell potential.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Fair: silty clay loam texture.	Moderate permeability; slopes of 2 to 6 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 2 to 6 percent; well drained to moderately well drained; susceptible to run-on water from upslope; hazard of erosion.	Slopes of 2 to 6 percent; on foot slopes; hazard of siltation; moderate permeability.	Well drained to moderately well drained; slopes of 2 to 6 percent; hazard of siltation.
Good	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; low to medium compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent; subject to flooding.	Slopes of 0 to 2 percent; moderately well drained; seasonal high water table at a depth of 3 to 5 feet; subject to flooding.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.
Fair: slopes of 9 to 14 percent.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 14 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Water seeps downslope along slowly permeable layer and causes perched seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 14 percent.	Moderate to high available water capacity; slopes of 9 to 14 percent; slow permeability; hazard of erosion.	Slopes of 9 to 14 percent; hazard of erosion; clay or heavy clay loam subsoil at a depth of 11 inches; slow permeability; hard to vegetate.	Hazard of erosion; clay or heavy clay loam subsoil at a depth of 11 inches; moderately well drained; seeps in some places.
Good	Moderately slow permeability; slopes of 2 to 14 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Natural drainage adequate.	Slopes of 2 to 14 percent; moderately well drained; moderately slow permeability; hazard of erosion.	Slopes of 2 to 14 percent; hazard of erosion; silty clay loam subsoil at a depth of 9 inches; moderately slow permeability.	Hazard of erosion; silty clay loam subsoil at a depth of 9 inches; moderately well drained.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Lamoni: 822D2, 822D3.	Severe: slow permeability to very slow permeability; seasonal high water table.	Slopes of 9 to 14 percent; seasonal high water table.	Severe: seasonal high water table; clay loam texture.	Severe: high shrink-swell potential; low strength; slopes of 9 to 14 percent.	Poor: low strength; high shrink-swell potential; somewhat poorly drained.	Not suitable
Lindley: 65D, 65E, 65F, 65G, 65E3.	Severe: moderately slow permeability; slopes of 9 to 40 percent.	Severe: slopes of 9 to 40 percent.	Moderate if slopes are less than 14 percent. Severe if slopes are more than 40 percent; clay loam texture.	Severe: slopes of 9 to 14 percent.	Poor: low strength; moderate shrink-swell potential; slopes of 9 to 40 percent.	Not suitable
Macksburg: 368, 368B, T368.[2]	Severe: moderately slow permeability; seasonal high water table.	Moderate: moderately slow permeability; seasonal high water table.	Severe: seasonal high water table; silty clay loam texture.	Severe: high shrink-swell potential; low strength.	Poor: low strength; high shrink-swell potential; somewhat poorly drained.	Not suitable
Muscatine: 119, T119.[2]	Moderate: moderate permeability; seasonal high water table.	Moderate: moderate permeability; seasonal high water table.	Severe: seasonal high water table; silty clay loam texture.	Severe: low strength; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action; somewhat poorly drained.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: heavy clay loam below a depth of 11 inches; slopes of 9 to 14 percent.	Slow permeability to very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 14 percent.	Medium to low shear strength; high to medium compressibility; low compacted permeability; low susceptibility to piping; fair to poor compaction characteristics.	Water seeps downslope along slowly permeable to very slowly permeable layer and causes perched seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 14 percent.	Slopes of 9 to 14 percent; somewhat poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; slow permeability to very slow permeability; hazard of erosion.	Slopes of 9 to 14 percent; heavy clay loam subsoil at a depth of 11 inches; hazard of erosion; slow permeability to very slow permeability.	Hazard of erosion; heavy clay loam subsoil at a depth of 11 inches; slopes of 9 to 14 percent; somewhat poorly drained.
Fair if slopes are 9 to 14 percent. Poor if more than 14 percent.	Moderately slow permeability; slopes of 9 to 40 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 9 to 40 percent; well drained to moderately well drained; hazard of erosion.	Slopes of 9 to 40 percent; hazard of erosion.	Hazard of erosion; well drained to moderately drained; slopes of 9 to 40 percent.
Fair: silty clay loam texture.	Moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 5 percent.	Slopes of 0 to 5 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; moderately slow permeability; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 5 percent; on ridgetops and upper part of side slopes; moderately slow permeability.	Somewhat poorly drained; slopes of 0 to 5 percent; on ridgetops and upper part of side slopes.
Fair: silty clay loam texture.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet.	Slopes of 0 to 2 percent; on ridgetops or high stream benches.	Slopes of 0 to 2 percent; on ridgetops or high stream benches.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
*Mystic: 94D2, 93E2, 592C2, 592D2. For Caleb parts of 94D2 and 94E2, see Caleb series.	Severe: slow permeability; seasonal high water table.[1]	Severe: slopes of 5 to 18 percent; seasonal high water table.	Severe: seasonal high water table; slopes of 5 to 18 percent; silty clay, clay, or heavy clay loam texture.	Severe: low strength; slopes of 5 to 18 percent.	Poor: low strength; somewhat poorly drained to moderately well drained.	Not suitable
Nevin: 88, 88B	Severe: moderate permeability to moderately slow permeability; seasonal high table.	Moderate: moderate permeability to moderately slow permeability; seasonal high water table; high organic matter content.	Severe: seasonal high water table; silty clay loam texture.	Severe: low strength; moderate shrink-swell potential; somewhat poorly drained; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; somewhat poorly drained; susceptible to frost action.	Not suitable
Nira: 570B, 570C2	Severe: moderately slow permeability.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent; moderate to high organic matter content.	Moderate: silty clay loam texture.	Severe: low strength; moderate shrink-swell potential; slopes of 2 to 9 percent.	Poor: low strength; moderate shrink-swell potential.	Not suitable
Nodaway: 220, C220	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; moderate permeability; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; susceptible to frost action; moderate shrink-swell potential.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: clay, heavy clay loam, or silty clay loam texture below a depth of 8 inches; slopes of 5 to 18 percent.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; underlying material porous in places; slopes of 5 to 18 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Water seeps downslope along slowly permeable layer and causes perched seasonal high water table at a depth of 1 foot to 3 feet; slopes of 5 to 18 percent.	Slopes of 5 to 18 percent; moderately well drained to somewhat poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; hazard of erosion.	Slopes of 5 to 18 percent; hazard of erosion; clayey subsoil at a depth of 8 inches; plant cover difficult to establish.	Hazard of erosion; clayey subsoil at a depth of 8 inches; slopes of 5 to 18 percent; seeps in places; moderate to high available water capacity.
Fair: silty clay loam texture.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 5 percent.	Slopes of 0 to 5 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 5 percent; on stream benches.	Somewhat poorly drained; slopes of 0 to 5 percent; on stream benches.
Fair: silty clay loam texture.	Moderately slow permeability; slopes of 2 to 9 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 2 to 9 percent; moderately well drained; hazard of erosion.	Slopes of 2 to 9 percent; hazard of erosion.	Hazard of erosion; moderately well drained; slopes of 2 to 9 percent.
Good ----------	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; low to medium compacted permeability; high to medium susceptibility to piping; fair compaction characteristics.	Natural drainage adequate; subject to flooding.	Slopes of 0 to 2 percent; moderately well drained; seasonal high water table at a depth of 3 to 5 feet; subject to flooding.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Olmitz: 273B, 273C	Moderate: moderate permeability to moderately slow permeability.	Moderate: moderate permeability to moderately slow permeability; slopes of 2 to 9 percent.	Moderate: clay loam texture.	Severe: low strength; moderate shrink-swell potential; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action.	Not suitable
Pershing: 131B, 131C2, 131D2.	Severe: slow permeability; seasonal high water table.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent; seasonal high water table.	Severe: seasonal high water table; silty clay and silty clay loam texture.	Severe: high shrink-swell potential; low strength.	Poor: low strength; high shrink-swell potential; moderately well drained to somewhat poorly drained.	Not suitable
Sharpsburg: 370, 370B, 370C, 370C2, 370D2, T370, T370B, T370C.[2]	Moderate if slopes are less than 9 percent. Severe if slopes are more than 9 percent; moderately slow permeability.	Slight if slopes are less than 2 percent. Moderate if slopes are 2 to 5 percent. Severe if slopes are more than 5 percent.	Moderate: silty clay loam texture.	Severe: high shrink-swell potential; low strength; slopes of 0 to 14 percent.	Poor: low strength; high shrink-swell potential.	Not suitable
Shelby: 24D2, 24E2, 24F2.	Severe: moderately slow permeability; slopes of 9 to 25 percent.	Severe: slopes of 9 to 25 percent.	Moderate if slopes are less than 14 percent. Severe if slopes are more than 14 percent; clay loam texture.	Severe: low strength; slopes of 9 to 25 percent; moderate shrink-swell potential.	Poor: low strength; moderate shrink-swell potential; slopes of 9 to 25 percent.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Good	Moderate permeability to moderately slow permeability; slopes of 2 to 9 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 2 to 9 percent; well drained to moderately well drained; receives run-on water from upslope; hazard of erosion.	Slopes of 2 to 9 percent; on foot slopes; hazard of siltation.	Well drained to moderately well drained; slopes of 2 to 9 percent; on foot slopes; hazard of siltation.
Good if slopes are less than 9 percent. Fair if slopes are more than 9 percent.	Slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 14 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 14 percent.	Slopes of 2 to 14 percent; moderately well drained to somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; slow permeability; hazard of erosion.	Slopes of 2 to 14 percent; silty clay or heavy silty clay loam subsoil at a depth of 13 inches; hazard of erosion.	Hazard of erosion; silty clay or heavy silty clay loam subsoil at a depth of 13 inches; moderately well drained to somewhat poorly drained.
Fair: silty clay loam texture; slopes of 0 to 14 percent.	Moderately slow permeability; slopes of 0 to 14 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Natural drainage adequate.	Slopes of 0 to 14 percent; moderately well drained; moderately slow permeability; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 14 percent; hazard of erosion; moderately slow permeability.	Hazard of erosion; moderately well drained; slopes of 0 to 14 percent.
Fair if slopes are less than 14 percent. Poor if slopes are more than 14 percent; clay loam texture.	Moderately slow permeability; slopes of 9 to 25 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 9 to 25 percent; moderately well drained; moderately slow permeability; hazard of erosion.	Slopes of 9 to 25 percent; hazard of erosion; moderately slow permeability.	Hazard of erosion; moderately well drained; slopes of 9 to 25 percent.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Sperry: 122	Severe: slow permeability to very slow permeability; seasonal high water table.	Severe: seasonal high water table; high organic matter content.	Severe: poorly drained to very poorly drained; seasonal high water table.	Severe: poorly drained to very poorly drained; high shrink-swell potential.	Poor: low strength; high shrink-swell potential; poorly drained to very poorly drained.	Not suitable
Steep rock land: 478.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Poor: shallow to bedrock; slopes of more than 15 percent.	Not suitable
Strip mines: 502	Severe: very slow permeability.	Slight if slopes are less than 2 percent. Moderate or severe if slopes are more than 2 percent.	Severe: silty clay or clay texture.	Severe: generally very poorly drained; irregular slopes; low strength.	Poor: low strength; high shrink-swell potential; generally very poorly drained.	Not suitable
Tama: 120, 120B, 120C2, 120D2, T120B.[2]	Slight if slopes are less than 9 percent. Moderate if slopes are more than 9 percent.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent; moderate permeability.	Moderate: silty clay loam texture.	Severe: low strength; moderate shrink-swell potential; slopes of 0 to 14 percent.	Poor: low strength; moderate shrink-swell potential.	Not suitable
Vesser: 51, 51B	Severe: seasonal high water table; subject to flooding; moderate permeability to moderately slow permeability.	Severe: subject to flooding; seasonal high water table; high organic matter content.	Severe: subject to flooding; poorly drained to somewhat poorly drained; seasonal high water table.	Severe: somewhat poorly drained to poorly drained; subject to flooding; high shrink-swell potential; susceptible to frost action.	Poor: low strength; high shrink-swell potential; susceptible to frost action; somewhat poorly drained to poorly drained.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: poorly drained to very poorly drained.	Slow permeability to very slow permeability; seasonal high water table at a depth of 0 to 2 feet; slopes of 0 to 1 percent.	Medium to low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; fair to poor compaction characteristics.	Slow permeability to very slow permeability; seasonal high water table at a depth of 0 to 2 feet; slopes of 0 to 1 percent; ponding; outlets not readily available.	Slopes of 0 to 1 percent; poorly drained to very poorly drained; seasonal high water table at a depth of 0 to 2 percent; slow permeability to very slow permeability.	Slopes of 0 to 1 percent; in upland depressions.	Slopes of 0 to 1 percent; in upland depressions.
Poor: slopes of more than 15 percent.	Variable permeability; shallow to bedrock; slopes of more than 15 percent.	Shallow to bedrock.	Natural drainage adequate.	Slopes of more than 15 percent; shallow to bedrock.	Slopes of more than 15 percent; shallow to bedrock.	Slopes of more than 15 percent; shallow to bedrock.
Poor: clayey texture; generally very poorly drained; irregular slopes.	Generally very slow permeability; shallow to bedrock; irregular slopes.	Low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; poor compaction characteristics.	Very slow permeability; shallow to bedrock.	Irregular slopes; shallow to bedrock.	Irregular slopes; shallow to bedrock.	Irregular slopes; shallow to bedrock.
Fair: silty clay loam texture; slopes of 0 to 14 percent.	Moderate permeability; slopes of 0 to 14 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 0 to 14 percent; well drained; moderate permeability; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 14 percent; hazard of erosion; moderate permeability.	Hazard of erosion; well drained; slopes of 0 to 14 percent.
Poor: somewhat poorly drained to poorly drained.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding; slopes of 0 to 5 percent.	Slopes of 0 to 5 percent; somewhat poorly drained; subject to flooding; moderate permeability to moderately slow permeability; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 5 percent; on foot slopes or bottom lands; hazard of siltation.	Somewhat poorly drained to poorly drained; slopes of 0 to 5 percent; on foot slopes or bottom lands; hazard of siltation.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Wabash: 172, 248	Severe: seasonal high water table; subject to flooding; very slow permeability.	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; very poorly drained; seasonal high water table; silty clay texture.	Severe: very poorly drained; subject to flooding; low strength; high shrink-swell potential.	Poor: low strength; high shrink-swell potential; very poorly drained.	Not suitable
Watkins: 687B	Moderate: moderate permeability.	Moderate: moderate permeability; slopes of 1 to 4 percent; moderate organic matter content.	Moderate: silty clay loam texture.	Severe: low strength; susceptible to frost action; moderate shrink-swell potential.	Poor: low strength; moderate shrink-swell potential.	Not suitable
Weller: 132B, 132C2	Severe: slow permeability; seasonal high water table.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent; seasonal high water table.	Severe: seasonal high water table; silty clay or silty clay loam texture.	Severe: high shrink-swell potential; low strength; slopes of 2 to 9 percent.	Poor: low strength; high shrink-swell potential.	Not suitable
Winterset: 369	Severe: moderately slow permeability to slow permeability; seasonal high water table.	Severe: seasonal high water table; high organic matter content.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; high shrink-swell potential; low strength; susceptible to frost action.	Poor: low strength; high shrink-swell potential.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: silty clay or silty clay loam texture; very poorly drained.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; fair to poor compaction characteristics.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding; outlets not readily available.	Moderate available water capacity; slopes of 0 to 2 percent; very poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding; very slow permeability.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.
Good	Moderate permeability; slopes of 1 to 4 percent.	Medium to low shear strength; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 1 to 4 percent; well drained to moderately well drained; moderate permeability; hazard of erosion.	Slopes of 1 to 4 percent; on stream benches; moderate permeability.	Slopes of 1 to 4 percent; on stream benches; well drained to moderately well drained.
Fair: silty clay or silty clay loam texture below a depth of 9 inches.	Slow permeability; seasonal high water table at a depth of 2 to 4 feet; slopes of 2 to 9 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 2 to 4 feet; slopes of 2 to 9 percent.	Slopes of 2 to 9 percent; moderately well drained; seasonal high water table at a depth of 2 to 4 feet; slow permeability; hazard of erosion.	Slopes of 2 to 9 percent; hazard of erosion; silty clay or heavy silty clay subsoil at a depth of 9 inches; slow permeability.	Hazard of erosion; silty clay or heavy silty clay loam at a depth of 9 inches; moderately well drained; slopes of 2 to 9 percent.
Poor: poorly drained; silty clay loam texture.	Moderately slow permeability to slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Moderately slow permeability to slow permeability; seasonal high water table at a depth of 1 to 3 feet; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; moderately slow permeability to slow permeability.	Slopes of 0 to 2 percent; on ridgetops.	Slopes of 0 to 2 percent; on ridgetops.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Wiota: 7, 78	Moderate: moderate permeability.	Moderate: moderate permeability; high organic matter content.	Moderate: silty clay loam texture.	Severe: low strength; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential.	Not suitable [1]
Zook: 54	Severe: subject to flooding; slow permeability.	Severe: subject to flooding seasonal high water table; high organic matter content.	Severe: subject to flooding; poorly drained; seasonal high water table.	Severe: poorly drained; subject to flooding; high shrink-swell potential.	Poor: low strength; high shrink-swell potential; poorly drained.	Not suitable [1]

[1] Danger of pollution of ground water through porous material or through cracks in bedrock.

ence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Grassed waterways should be in areas of fertile soils on which plant cover is easy to establish. In some places, topdressing is needed. Tile drains are needed in most waterways to control seepage until the grass is established and to facilitate crossing with implements.

Formation and classification of the soils

In this section the factors that affected the formation of the soils in Warren County are discussed. Also discussed is the classification of the soils by higher categories. Detailed descriptions of profiles considered representative of the series are given in the section "Descriptions of the soils."

Factors of soil formation

Soil is produced by the action of soil-forming processes on material deposited or accumulated by geologic agencies. The characteristics of the soil are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material (*5*).

Climate and vegetation are the active factors in soil formation. They act on the parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by the relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for horizon differentiation. A long period generally is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other factors. Many of the processes of soil formation are unknown.

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Good	Moderate permeability; slopes of 0 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Natural drainage adequate.	Slopes of 0 to 5 percent; well drained to moderately well drained; moderate permeability; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 5 percent; on stream benches; moderate permeability.	Slopes of 0 to 5 percent; on stream benches; well drained to moderately well drained.
Poor: poorly drained; silty clay texture below a depth of 7 inches.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; low compacted permeability low susceptibility to piping; fair to poor compaction characteristics.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding; outlets not readily available.	Moderate to high available water capacity; slopes of 0 to 2 percent; poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; slow permeability; subject to flooding.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.

[2] Bench phases, indicated by a "T" prefix, generally are underlain by stratified alluvium instead of glacial till. In places the alluvium is coarse textured and is at a depth as shallow as 5 feet.

Parent material

The soils in Warren County formed in material weathered from shale (residual material), in glacial till (ice-laid material), in loess (windblown material), and in alluvium (water-laid material). Small areas of eolian sands are along the major streams.

Shale.—Before the glaciers covered Iowa, shale, limestone, and sandstone were exposed on the land surface. This shale bedrock consists of the Cherokee and Marmaton Groups of the Des Moines Series which is of Pennsylvanian age (*4*). Most of these materials were later covered by glacial till. In some areas geologic erosion has removed the till and reexposed the residual material. Shale is on the lower part of side slopes, and it is mainly north and east of a line drawn diagonally across Warren County from the northwest corner to the southeast corner of the county.

Soils that formed in shale residuum commonly show only minimal profile development and a B horizon that is only weakly expressed or absent. They are commonly quite acid and are low in fertility. Bauer and Gosport soils are the only soils in the county that formed in such material.

Glacial till.—Two glaciers, the Nebraskan and Kansan, left deposits in Warren County (*9*). The Kansan drift is identifiable throughout the county and is on side slopes that form an extensive part of the landscape. Nebraskan drift is not readily identifiable on the surface in Warren County.

Soils formed on the Kansan till plain during the Yarmouth and Sangamon interglacial ages. This was before the loess was deposited. On nearly level interstream divides, the soils were strongly weathered and had a gray plastic subsoil called gumbotil (*6*). This gumbotil remains; it is several feet thick and very slowly permeable. Clarinda soils formed in this gumbotil and are extensive throughout Warren County. Because the gumbotil in the Lamoni soils is partly truncated, the clay material is not so thick as in the Clarinda soils.

During late Sangamon Time, geologic erosion cut through the Yarmouth-Sangamon paleosol and into the Kansan till. At the depth to which this erosion has cut, generally there is a stone line or subjacent till that is overlain by pedisediment. A paleosol formed in this material (*7, 8*). Geologic erosion removed the loess from many slopes and exposed the paleosol on the surface. Adair soils formed in these reexposed paleosols.

Caleb and Mystic soils formed in pre-Sangamon sediments of valley fills. These sediments are of

glacial origin and vary in texture (*7*). They are on low, stepped interfluves above the present valley floor. They owe their landscape partly to valley fill, but their surface merges with the present erosional uplands. Caleb and Mystic soils are above the flood plain, but they are lower than Gara, Lindley, and Shelby soils, which formed in Kansan till on dissected slopes of late Wisconsin age.

Loess.—Loess of Wisconsin age covers most of Warren County and is an extensive parent material. It consists of particles of silt and clay deposited by wind. Variations in soils are related to the distance of the soils from the loess source. The major source of loess in Warren County was probably the Missouri River bottoms in western Iowa (*3, 11*). Some soils along the major streams in Warren County contain less clay and were probably influenced by local loess sources. On stable upland divides the loess is about 12 feet thick.

Alluvium.—Soils on bottom lands formed in alluvium. Water sorts the sediments by particle size, and the larger particles drop out first. Thus, the coarser textured soils are near the stream channel, and the clayey soils are away from the stream channel toward the base of the uplands. Nodaway and Amana soils are silty soils that are near stream channels, while Zook and Wabash soils are clayey soils that are generally separated from the stream channel by coarser textured soils.

Sediments from the hillsides that have been deposited at the foot of the slope are called local alluvium or colluvium.

Climate

Climate is an important factor in the formation of soils. The soils of Warren County differ considerably from the soils formed in the dry climate of the Great Plains States and from the soils formed in the humid climate of the southeastern states. The influence of the general climate in a region is modified by local conditions. For example, soils on south-facing slopes formed under a microclimate that is warmer and drier than the one on slopes that face north. The low-lying, poorly drained soils on bottom lands formed under a wetter and colder microclimate than soils in surrounding areas. These local differences influence the characteristics of the soil and account for some of the differences among soils in the same general climatic region.

Living organisms

Plants have been an important influence in the development of the soils of Warren County. Animals have influenced the soil to a lesser extent. Trees covered the more dissected areas along major streams, and prairie grasses dominated the gently rolling uplands. Evidence indicates a shifting of these two types of vegetation in areas of Gara, Ladoga, and Pershing soils.

In most places soils that formed under trees are lighter colored, are more acid, and have a thinner surface layer than soils that formed under grasses. Soils that formed under a shifting vegetation have properties that are intermediate between the properties of soils that formed under grasses and soils that formed under trees.

Relief

Relief indirectly influences soil formation through its effect on drainage and on geologic erosion. In Warren County soils range from level to very steep.

Most nearly level soils on bottom lands are frequently flooded. Water ponds in depressional areas, and these soils have a fluctuating water table. Nearly level soils are also on broad upland flats and have a seasonal high water table. The steepest soils in the county are along the south and east sides of major streams and their tributaries. The intricate pattern of upland drainageways indicates that in nearly all of the county the landscape has been modified by geological processes.

Generally, soils that formed where the water table is high have a subsoil that is dominantly grayish. Examples of such soils are Clearfield, Haig, Wabash, Winterset, and Zook. Macksburg and Grundy soils formed where the water table fluctuated, so they have a grayish brown subsoil. Sharpsburg and Shelby soils formed where the water table is below the subsoil, so they have a yellowish brown subsoil. Soils that are poorly drained commonly have more organic matter in the surface layer than well drained soils if all other conditions are similar. In soils that are similar but have a wide range in slope, the depth to carbonates is shallowest where slopes are steepest, are convex, or are more unstable.

Time

The length of time a soil is allowed to form affects the kind of soil that forms. An older or more strongly developed soil shows well defined genetic horizons. A less well developed soil shows no horizons or only weakly defined ones. Most soils on flood plains have not been in place long enough for distinct horizons to develop.

Material is generally removed from the steeper soils before there has been time for a thick profile with strong horizons to develop. Even though the material has been in place for a long time, the soil can still be immature because much of the water runs off the slopes rather than through the soil material. Shelby, Gara, and Lindley soils formed on recently dissected slopes of the late Wisconsin age (*7, 8*). These soils therefore are no older than 11,000 to 14,000 years and probably are much younger.

Adair, Armstrong, Clarinda, Keswick, Lamoni, and Mystic soils are among the oldest soils in the county (*7, 8*). Clarinda and Lamoni soils formed in Kansan glacial till that was strongly weathered during the Yarmouth-Sangamon time. Adair, Armstrong, Keswick, and Mystic soils formed from material deposited and weathered during the late Sangamon interglacial stage. These materials are much older than the loessal parent material of the Grundy, Winterset, Macksburg, and Sharpsburg soils. These soils are no older than 14,000 to 16,000 years and probably are considerably younger *(10)*.

Classification of the soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering works; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (*13*). This system is under continual study. Therefore, readers interested in the development of the current system should search the latest literature available.

The current system of classification has six categories. Beginning with broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 8, the soil series of Warren County are placed in four categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Moll-i-sol).

Four of the ten soil orders occur in Warren County. They are Mollisols, Alfisols, Entisols, and Inceptisols. Mollisols have a dark colored surface horizon 10 inches or more thick, high base saturation, at least 1 percent organic matter, and a genetic subsurface horizon that has some degree of development. Alfisols have a surface horizon less than 10 inches thick and commonly have an A2 horizon that is light colored. They have a clay enriched B horizon that is high in base saturation. Entisols have no natural genetic horizons or only the beginning of such horizons. Inceptisols have low base saturation.

SUBORDER: Each order is divided into suborders that are based mainly on those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquoll* (*Aqu*, meaning water or wet, and *oll*, from Mollisol).

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark red and dark brown colors associated with basic rock, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquolls (*Hapl*, meaning simple horizons, *aqu* for wetness or water, and *oll*, from Mollisols). The great group is not shown separately in table 8, because it is the last word in the name of the subgroup.

SUBGROUP: Great groups are divided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups can also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquolls (a typical Haplaquoll).

FAMILY: Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae. An example is the firm, montmorillonitic, noncalcareous, mesic family of Typic Haplaquolls.

SERIES: The series consists of a group of soils that formed from a particular kind of parent material and have genetic horizons that, except for the texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

Farming

Unless otherwise stated, the statistics in this section are from the 1970 Iowa Annual Farm Census.

Farms and farm tenure.—The county had 1,425 farms in 1970. The total acreage in farms was 334,260 acres, and the average size of the farms was 235 acres.

TABLE 8.—*Classification of soil series*

Series	Family	Subgroup	Order
Ackmore	Fine-silty, mixed, nonacid, mesic	Aeric Fluvaquents	Entisols.
Adair[1]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Amana	Fine-silty, mixed, mesic	Aquic Hapludolls	Mollisols.
Arbor	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Arispe[1]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Armstrong[1]	Fine, montmorillonitic, mesic	Aquollic Hapludalfs	Alfisols.
Bauer[1]	Fine, mixed, mesic	Typic Hapludolls	Mollisols.
Bremer	Fine, montmorillonitic, mesic	Typic Argiaquolls	Mollisols.
Caleb	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Chelsea[1]	Mixed, mesic	Alfic Udipsamments	Entisols.
Clarinda[1]	Fine, montmorillonitic, mesic	Typic Argiaquolls	Mollisols.
Clearfield	Fine, montmorillonitic, mesic, sloping	Typic Haplaquolls	Mollisols.
Clinton	Fine, montmorillonitic, mesic	Typic Hapludalfs	Alfisols.
Colo	Fine-silty, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Downs	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Ely	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Fayette	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Gara[1]	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Givin[1]	Fine, montmorillonitic, mesic	Udollic Ochraqualfs	Alfisols.
Gosport	Fine, illitic, mesic	Typic Dystrochrepts	Inceptisols.
Grundy[1]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Humeston	Fine, montmorillonitic, mesic	Argiaquic Argialbolls	Mollisols.
Judson	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Keswick	Fine, montmorillonitic, mesic	Aquic Hapludalfs	Alfisols.
Ladoga	Fine, montmorillonitic, mesic	Mollic Hapludalfs	Alfisols.
Lamoni	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Lindley	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Macksburg	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Muscatine	Fine-silty, mixed, mesic	Aquic Argiudolls	Mollisols.
Mystic	Fine, montmorillonitic, mesic	Aquollic Hapludalfs	Alfisols.
Nevin[1]	Fine-silty, mixed, mesic	Aquic Argiudolls	Mollisols.
Nira	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Nodaway	Fine-silty, mixed, nonacid, mesic	Mollic Udifluvents	Entisols.
Olmitz	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Pershing[1]	Fine, montmorillonitic, mesic	Udollic Ochraqualfs	Alfisols.
Sharpsburg	Fine, montmorillonitic, mesic	Typic Argiudolls	Mollisols.
Shelby[1]	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Sperry[1]	Fine, montmorillonitic, mesic	Typic Argialbolls	Mollisols.
Tama	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Vesser	Fine-silty, mixed, mesic	Argiaquic Argialbolls	Mollisols.
Wabash	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Watkins	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Weller[1]	Fine, montmorillonitic, mesic	Aquic Hapludalfs	Alfisols.
Winterset	Fine, montmorillonitic, mesic	Typic Argiaquolls	Mollisols.
Wiota	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Zook	Fine, montmorillonitic, mesic	Cumulic Haplaquolls	Mollisols.

[1] Some or all of the mapping units in this series are taxadjuncts to the series. For their differences, see the discussion on range of characteristics that follows the representative profile description in the section "Descriptions of the soils."

Of this acreage, owners operated 202,739 acres and tenants operated 131,521 acres. In 1962 there were 1,759 farms in Warren County, and the average size was 201 acres.

Crops and pasture.—Most of the cropland in Warren County is used for corn and soybeans. These crops are generally grown in rotation with oats, hay, or pasture. In some areas of the county, continuous row-cropping is practiced. About 46 percent of the acreage of farms in the county is in cropland, 30 percent is in pasture, and the remaining 24 percent is in woodland and used for other purposes.

Most of the permanent pasture is rolling to very steep, and it is along the major streams and in the southern half of the county. Most of the permanent pasture consists of unimproved bluegrass and is brushy. Many farmers are using improved pasture seeded to mixtures of grasses and legumes.

Livestock.—A significant part of Warren County is rolling to steep and is well suited to permanent pasture or to a cropping system in which forage crops are grown much of the time.

Beef cow herds have been increasing in importance. In 1970 there were 19,426 beef cows in Warren County as compared with 13,958 in 1962. Only 7,475 grain fed cattle were marketed in 1962, and 9,673 grain fed cattle were marketed in 1970. In 1970 Warren County farmers marketed 110,154 hogs. The number of spring and fall farrowings were 16,640 or nearly 1,000 less than in 1962. Dairy cows have decreased from 4,977 in 1962 to 2,800 in 1970. The number of lambs born declined from 4,402 in 1962 to 2,861 in 1970. The num-

ber of hens and pullets of laying age declined from 79,314 in 1962 to 28,211 in 1970. Turkeys also decreased from 33,907 to 12,016.

Climate [5]

Climate for Warren County is represented by data taken at Indianola. Temperature and precipitation are given in table 9, and the probability of freezing temperatures in spring and fall is given in table 10.

There is little gradient in the precipitation pattern across Warren County. The average annual precipitation is between 31 and 32 inches. No consistent gradient is evident for individual months. Average monthly values are given in table 9, as well as the extreme values which may be expected in 1 year in 10. June is the wettest month, and May is second wettest. Precipitation is concentrated in the warm season, and about 75 percent occurs as showers. Showers vary widely across the county; some are of sufficient intensity and duration to cause erosion. From 1951 to 1960, an average of 19 days per year had one-half inch precipitation or more, and 57 days had one tenth inch or more.

The temperatures at Indianola are representative of all of Warren County, particularly for maximum temperatures. An average of 39 days per year have a maximum temperature of 90° F or more. These temperatures are too high for optimum crop growth. Minimum temperatures are more variable. Areas that are in low positions relative to surrounding areas have

[5] This section was prepared by ROBERT H. SHAW, climatologist, Iowa State University.

TABLE 9.—*Temperature and precipitation*

[All data from Indianola]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average highest	Average lowest	Average total	One year in 10 will have—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	In	In	In	No	In
January	32	13	53	−13	1.2	0.3	2.8	19	4
February	35	16	56	− 6	1.1	.1	2.5	14	4
March	48	27	72	4	2.3	.8	4.8	7	6
April	62	40	84	24	3.2	1.6	5.7	1	3
May	73	51	89	34	4.5	2.1	7.1		
June	82	60	94	45	5.1	2.0	7.2		
July	88	64	98	52	3.5	.9	6.5		
August	86	63	97	49	3.7	.7	6.7		
September	78	55	92	35	3.4	.8	7.7		
October	66	43	85	24	2.3	.3	5.7		
November	49	29	71	10	1.5	.3	3.3	3	3
December	36	18	58	− 5	1.3	.4	2.6	10	3
Year	61	40	99	−15	33.0	24.7	45.9	54	4

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall*

[All data from Indianola]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	April 5	April 11	April 20	April 28	May 14
2 years in 10 later than	March 30	April 5	April 15	April 23	May 9
5 years in 10 later than	March 20	March 25	April 4	April 13	April 29
Fall:					
1 year in 10 earlier than	November 1	October 23	October 13	October 8	September 28
2 years in 10 earlier than	November 6	October 28	October 19	October 13	October 3
5 years in 10 earlier than	November 17	November 8	October 30	October 24	October 13

lower minimum temperatures than urban or upland areas on clear, calm nights.

The average date of the last 32° temperature in spring is April 29 and the first in fall is October 13. This gives an average growing season of 166 days.

For good crop production, warm-season rainfall and good subsoil moisture reserves are needed. On April 15, the average moisture reserve is 7 to 8 inches; there is about a 10 percent chance of having less than 5 inches in the east edge of the county and about a 25 percent chance of having less than 5 inches in the central and western parts of the county. An adequate moisture reserve in spring is 7 to 8 inches, and 5 inches is considered very low. In years of such low moisture reserve, more than normal rainfall is needed in the warm season for average crop production.

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Glossary

Acidity. See Reaction, soil.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Bench position. A high, shelflike position.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under slight pressure.

Cemented.—Hard; little affected by moistening.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Gumbotil. A massive deposit of clay-rich till that weathered into gray to dark-colored clay during the interglacial period. It is very sticky and plastic when wet and very hard and firm when dry.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

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.

Pedisediment. A sediment that covers a pediment rather thinly. A pediment is an erosion surface that lies at the foot of a receded slope, is underlain by rock or sediment of the upland, is barren or mantled with alluvium, and displays a longitudinal profile, normally concave upward.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		pH
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in the horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon; has no depth limit.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

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