Issued February 1971

SOIL SURVEY
Wayne County, Iowa

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

Major fieldwork for this soil survey was done in the period 1958–63. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1963. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agriculture Experiment Station; it is part of the technical assistance furnished to the Wayne County Soil Conservation District.
Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers or can be purchased, on individual order, from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit and woodland group.

Interpretations not included in this survey can be developed by using information in the text to group the soils according to their suitability or limitations for a particular use. 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 woodland groups and capability units.

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

Engineers and builders will find under "Engineering Properties of Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

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

Newcomers in Wayne County may be especially interested in the section "General Soil Map," where broad patterns of soils are described.

Cover picture.—A typical landscape of Edina silt loam. Soybeans frequently are grown in rotation with corn on this soil.

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SOIL SURVEY OF WAYNE COUNTY, IOWA

BY L. DALE LOCKRIDGE, SOIL CONSERVATION SERVICE

FIELDWORK BY L. DALE LOCKRIDGE, WAYNE P. DIEZ, AND ROY W. SMITH, SOIL CONSERVATION SERVICE

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

WAYNE COUNTY is in the south-central part of Iowa (fig. 1). It has a total land area of about 532 square miles. Corydon, the county seat and largest town, is about 60 miles south of Des Moines, the State capital.

Most of the acreage in the county is in farms, and the population is mostly rural. Corn, soybeans, oats, hay, and pasture are the main crops, and corn is the principal grain crop. Most of the grain and forage that is grown on the farms is fed to the hogs, turkeys, and beef cattle that are raised in the county.

Most of the soils in Wayne County formed under a prairie vegetation. The climate is subhumid and continental. Winters are cold, summers are warm, and the growing season is long enough for the crops grown in the county to mature.

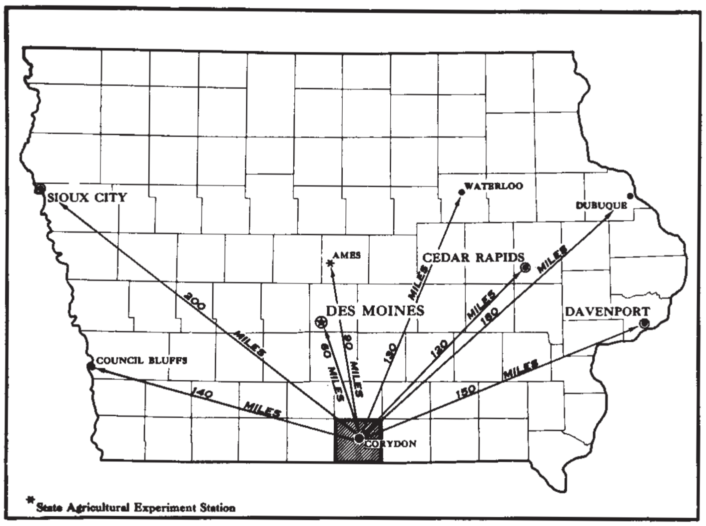

Figure 1.—Location of Wayne County in Iowa.

How This Survey Was Made

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

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug 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 roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Adair and Caleb, 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 go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

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

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Shelby loam, 9 to 14 percent slopes, is one of several phases of Shelby loam, a soil type that ranges from sloping to steep.

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 greatly help in drawing boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs.

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

In preparing some detailed maps the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Adair-Shelby complex.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, foresters, farm managers, and engineers. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil surveys. On the basis of the yield tables and other data, the soil scientists set up trial groups, and test these by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists 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 present methods of use and management.

The Climate of Wayne County [1]

Wayne County, in the most southern tier of counties in Iowa, is generally rolling to hilly. The climate at Corydon, which is centrally located, is representative of the county, though precipitation varies locally in the showers that fall mostly in summer. Variations in temperature are greatest during calm, clear nights. Table 1 is based on the temperature and precipitation recorded at Corydon and Millerton in the 30-year period from 1931 through 1960.

Average annual precipitation ranges from about 33 inches in the northwestern part of the county to nearly 34 inches in the southeastern part. Nearly 70 percent of the annual rainfall normally falls during the warm half of the year (April through September). On about 20 days per year, and almost entirely during the warm half, a half inch or more of rain falls. Nearly half of the heavy rainfalls are in spring and early in summer, and in this period the hazard of erosion is high because the soils are not protected by adequately rooted plants. Rainfalls of about 6 to 8 inches in 24 hours seldom occur at any one point, though they have been recorded in the county. Rainfalls of 2 to 3 inches in 24 hours generally may be expected each year at any locality, and they are most

[1] By Paul Waite, State climatologist.

Table 1.—*Temperature and precipitation*

Month	Temperature (° F.)				Precipitation (inches)		
	Average daily maximum	Average daily minimum	Average monthly maximum	Average monthly minimum	Average	One year in 10 will have— Less than—	One year in 10 will have— More than—
January	33	14	56	−12	1.3	0.4	2.6
February	37	18	58	−2	1.0	.4	1.8
March	47	27	71	6	2.4	.6	4.6
April	63	40	83	24	3.0	1.0	4.8
May	73	51	88	35	4.1	1.2	6.9
June	82	61	93	48	4.8	1.6	8.4
July	87	65	97	54	3.5	.4	7.3
August	86	64	96	51	4.0	1.3	7.7
September	79	55	92	38	3.6	.6	8.3
October	68	44	84	27	2.2	.3	5.5
November	50	29	70	11	1.2	.2	3.5
December	38	20	59	−1	1.2	.3	2.3
Year	62	41	99	−14	32.3	24.3	44.5

frequent in June. Snow averages 25 to 30 inches per year and accounts for about a fourth of the precipitation that falls in winter. The snow cover normally does not last long, though occasionally it lasts for a few weeks.

At planting time it is desirable for the soil to have a relatively dry surface layer and a subsoil containing ample moisture, and for the planting of crops to be followed by timely and gentle showers that continue throughout the growing season. In Wayne County, however, May and June normally are the rainiest months. During these months rainfalls are excessive and areas are eroded more frequently, but late in July and early in August dry periods are more frequent. In May and June corn and other plants may be damaged by erosion, and later in the growing season enough moisture for good growth of plants may not be available. For ample growth well-developed corn requires about an inch of available moisture per week. About one in four or five is the probability of an inch of rain per week from late in June through the early part of August. It is likely, however, that an inch of rain will fall during each week in the first half of June. Consequently, moisture is excessive early in the growing season and is insufficient later, except in those places where there is a reserve in the subsoil. In some places, however, moisture is excessive for long periods and drainage is needed before the soils can be tilled.

Temperature on calm, clear nights is as much as 10° F. lower in the rural lowlands than in the uplands and in towns. Maximum temperature, at those levels above the ground where temperature is normally observed, seldom varies more than 1 or 2° throughout the county. Corn normally does not make optimum growth at a temperature higher than 90°, a temperature that generally is equalled or exceeded on about 32 days during the growing seasons. Plant growth is usually limited when temperature is higher than 90° because evapotranspiration is then high. Evapotranspiration is the loss of water from soils both by evaporation and by transpiration through plants.

On the average the limiting temperature of 32° occurs on April 25 in spring and on October 14 in fall. The normal growing season is 172 days. Soils are generally frozen from early in December until early in March.

Farming

Unless otherwise stated, the statistics in this section are from the 1964 Census of Agriculture.

Farms and farm tenure.—The county had 1,254 farms in 1964. Total land in farms amounted to 320,066 acres, and the average size of the farms was 255.2 acres. Of the land in farms, full owners operated 130,463 acres; part owners, 131,490 acres; managers, 630 acres; and tenants, 57,483 acres. The trend since 1942 has been away from tenant-operated farms.

In 1964 there were 561 livestock farms, 197 cash grain farms, 179 general farms, 87 dairy farms, 18 poultry farms, and 212 miscellaneous and unclassified farms in Wayne County.

Crops and pasture.—Most of the cropland in Wayne County is used for corn, soybeans, and small grains. These crops usually are grown in rotation with hay or pasture. About 52 percent of the farmland in the county is cropland, 36 percent is pasture, and 8 percent is woodland. The remaining 4 percent is in farmsteads and lots. A few acres in the county are used for row crops grown continuously, but row crops can be grown continuously only on flatlands that are not subject to serious erosion. Many areas of woodland are in pasture.

Most of the permanent pasture in the county is on the rolling land along the major stream valleys. Areas of unimproved bluegrass and brushy pasture are grazed in many places, but many farmers are using improved pasture that is seeded to mixtures of grasses and legumes. The most common pasture seeding is alfalfa mixed with bromegrass, orchardgrass, or timothy. According to local sources mixtures of birdsfoot trefoil and grass were grown on about 20,000 acres in Wayne County in 1963 and have increased in popularity.

Livestock and livestock products.—A significant part of Wayne County is rolling and well suited to permanent pasture or rotations in which forage crops are grown much of the time. The raising of cattle and sheep therefore has become important in the county.

The leading livestock enterprise in the county is the raising of beef. In 1964, there were about 27,565 beef cows and heifers that had calved, and the general trend, then and now, is toward increased numbers. Most of the beef cows are in the rougher parts of the county where there are large acreages of permanent pasture.

The number of dairy cows in Wayne County has declined from 8,647 in 1954 to 5,243 in 1964. Dairy herds are usually kept in the gently rolling areas where they are fed hay and are grazed on rotation of improved pasture.

Hogs are raised throughout the county but are dominantly in areas of level to gently rolling soils. The number of litters farrowed each year ranges from 10,000 to 12,000.

The number of sheep and lambs in the county has declined from 18,559 in 1935 to 11,623 in 1964.

Poultry also is important in Wayne County. In 1964, 5,001 turkey hens were kept for breeding, and in 1962 about 200,000 turkeys were raised. The number of chickens 4 months old and over was 82,891.

General Soil Map

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

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The five soil associations in Wayne County are described in the following pages.

1. Seymour-Edina Association

Dark or moderately dark colored, somewhat poorly drained and poorly drained, nearly level to moderately sloping soils on loess in the uplands

This association consists of nearly level soils on flats and gently sloping to moderately sloping soils on ridgetops and the sides of ridges. In some places these soils are dissected by moderately wide, slightly concave drainageways that originate in this association and are less entrenched than they are in other associations (fig. 2). A few scattered trees grow in the drainageways and along fences. The soils in this association are higher lying than those in adjacent associations. This association occupies about 26 percent of the county and is the most extensive loessal area.

The Seymour soils make up 70 percent of the association; the Edina soils, 25 percent; and minor soils, the remaining 5 percent.

The Seymour soils are on slopes of 2 to 9 percent and are somewhat poorly drained. Their surface layer is very dark gray silt loam grading to silty clay loam with depth. The subsoil is dark grayish-brown and dark-gray silty clay and olive-gray silty clay to silty clay loam. Typically it extends to a depth of about 64 inches and is underlain by a gray, clayey buried soil.

The Edina soils occur on upland flats and are poorly drained. They developed in loess 6 to 8 feet thick. The surface layer is very dark gray friable silt loam about 10 inches thick. The subsoil is gray to very dark gray in color and silt loam, silty clay, or silty clay loam in texture.

The minor soils in this association are the Clarinda, Lamoni, and Lineville. The Clarinda soils developed from highly weathered glacial till, and the Lineville soils developed from loess underlain by other sediments and weathered glacial till.

This association is the most important grain-producing area in the county. Most of the soils are well suited to cultivated crops, but crop rotations and contour tillage, terracing, or stripcropping are needed on the moderately sloping Seymour soils. The nearly level Edina soils are used extensively for row crops (fig. 3). A large part of most soils in the association is used for corn and soybeans. Many farmers also raise livestock and feed the grain grown to hogs, cattle, or both. Nearly all farmsteads are occupied and in good repair. Farms vary in size, but many are between 160 and 240 acres.

The fertility of most soils is moderate, and additions of nitrogen, phosphorus, potassium, and lime are needed. Response to added fertilizer and lime is good.

2. Grundy-Haig Association

Dark-colored, poorly drained to moderately well drained, nearly level to moderately sloping soils on loess in the uplands

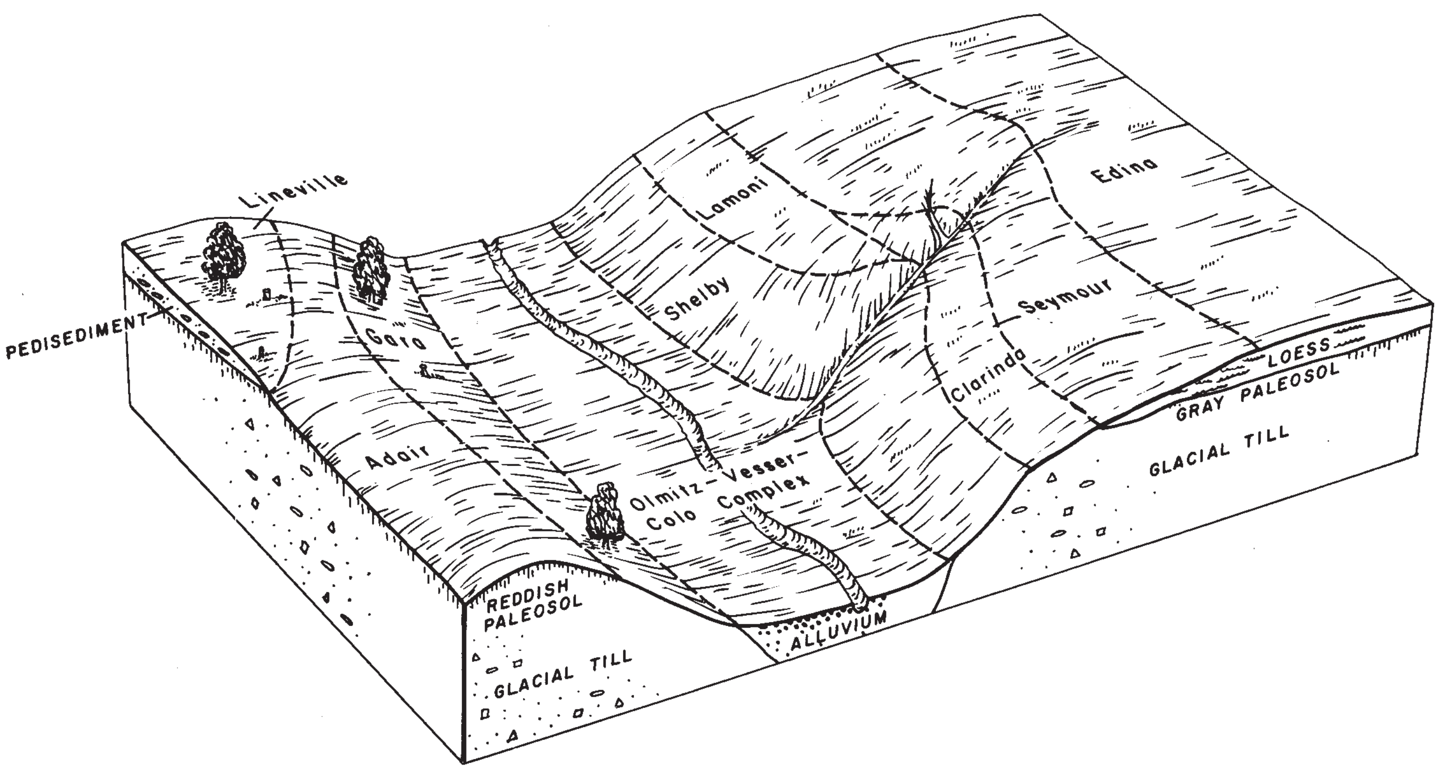

***Figure 2.*—Relationship of slope, vegetation, and parent material to soils of the Seymour-Edina and the Clarinda-Shelby-Adair associations.**

Figure 3.—**A typical landscape in the Seymour-Edina association. The soybeans are on nearly level Edina silt loam.**

This association consists of nearly level soils on flats and gently sloping to moderately sloping soils on ridgetops and side slopes. It occurs in an irregularly shaped area along and near the northern boundary of the county, mostly in the western half. In some places the soils are dissected by moderately wide, slightly concave drainageways that originate in this association and are less entrenched than they are in other associations. The soils in this association are higher lying than those in adjacent associations. A few scattered trees grow in the drainageways and along fences in some places. This association occupies 4.5 percent of the county.

The Grundy soils make up 85 percent of the association; the Haig soils, 13 percent; and minor soils, the remaining 2 percent.

The Grundy soils occur on slopes of 2 to 9 percent and are moderately well drained to somewhat poorly drained. They developed in loess 6 to 8 feet thick. The surface layer is black to very dark gray, friable silty clay loam about 15 inches thick. The subsoil extends to a depth of 4 to 5 feet. The upper part is firm silty clay that has a matrix color of grayish brown, yellowish brown, and light olive brown. The lower part is silty clay or silty clay loam that is mainly olive gray and gray. Mottling begins at a depth of about 19 inches.

The Haig soils are on upland flats and are poorly drained. Their surface layer is black, friable silt loam and silty clay loam 17 inches thick. Mottling begins at a depth of about 10 inches and extends throughout the profile. The subsoil extends to a depth of 4 feet or more. It is black to very dark gray and grayish-brown, firm silty clay in the upper part and grayish-brown to light brownish-gray, friable silty clay loam in the lower part.

The minor soils in this associations are the Edina and the Clarinda. The Edina soils are on flats and have a lighter colored surface layer than the Grundy or Haig soils. The Clarinda soils are moderately sloping and have a fine-textured, gray subsoil 3 to 5 feet thick.

Nearly all of the acreage in this association is well suited to row crops, but crop rotations and contour tillage or terracing are needed on the moderately sloping soils. The nearly level Haig and the gently sloping Grundy soils are used intensively for row crops. Much acreage in this association is used for corn and soybeans. Shallow ditches are needed for drainage. Livestock is raised on many farms, and the grain grown is fed to hogs, cattle, or both. Nearly all farmsteads are occupied and are in good repair. The farms vary in size, but many are between 200 and 300 acres. The general trend is to enlarge the farm units, and many of them are made up of tracts that do not join.

The soills in this association are moderate to high in fertility, but additions of nitrogen, phosphorus, potassium, and lime are needed. Response to applications of lime and fertilizer is good.

3. Clarinda-Shelby-Adair Association

Dark or moderately dark colored, mainly poorly drained and somewhat poorly drained, moderately sloping to strongly sloping soils derived from till

This association consists of sloping soils on narrow ridgetops and moderately sloping to strongly sloping soils on side slopes that are dissected by waterways. The main branches of upland drainageways originate in the soils of this association (see fig. 2). In many places these branches are wider, wetter, and flatter where they are underlain by a fine-textured, gray, buried soil. Farther downstream, however, where the waterway passes out of the fine-textured soil, the slope increases, the valleys become somewhat narrower, and gullies and noncrossable drains form in places. Scattered trees commonly are along fences and in waterways (fig. 4). This association occupies 53 percent of the county and is well distributed throughout.

The Clarinda soils occupy 30 percent of the association; the Shelby soils, 30 percent; the Adair soils, 20 percent; and the minor soils, the remaining 20 percent.

The Clarinda soils are moderately sloping and poorly drained. Their surface layer is very dark gray, friable silty clay loam about 11 inches thick. The subsoil extends to a depth of 3 to 5 feet and is dark-gray, firm silty clay mottled with yellowish red in the upper part and gray, very firm clay mottled with yellowish red and yellowish brown in the lower part.

The Shelby soils are sloping to strongly sloping and moderately well drained. Their surface layer is black to very dark gray, friable loam 12 inches thick. The subsoil extends to a depth of 44 inches and consists of dark-brown to yellowish-brown, firm clay loam that is mottled.

The Adair soils are moderately sloping to strongly sloping and are somewhat poorly drained and moderately

***Figure 4.*—A typical landscape in the Clarinda-Shelby-Adair association. Scattered trees are grown along fence rows and in waterways.**

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well drained. The surface layer is about 10 inches thick and consists of friable loam that is black in the upper part and dark brown in the lower part. The subsoil extends to a depth of about 44 inches. It is dark-brown, friable and firm, distinctly mottled clay loam in the upper part and dark-brown, faintly mottled clay in the lower part.

The minor soils in this association are the Lamoni, Pershing, Kniffin, Rathbun, Seymour, and Grundy. All of these soils except the Lamoni formed in leached loess. The Lamoni soils formed in a thin layer of weathered glacial till. The Lamoni and Seymour soils are somewhat poorly drained, the Kniffin and Grundy soils are somewhat poorly drained and moderately well drained, and the Pershing and Rathbun soils are moderately well drained. These minor soils are on the higher parts of ridgetops and are on benches along major streams.

The soils in this association are used mostly for hay and pasture, but the less sloping soils are suited to row crops. If these soils are used for row crops, crop rotations that provide protective cover are needed. Also needed is contour tillage or terracing (fig. 5). Most of the hay grown is fed to beef and dairy cows and some sheep. The grain produced is fed to hogs, cattle, and some dairy herds. Many ponds used to water livestock are within this association. Most of them are less than 2 acres in size. Most farmsteads are occupied and in fair repair, but several houses have been abandoned. The general trend is to enlarge the farm units. Farms vary in size, but many range from 200 to 300 acres.

Most of the soils have low to moderate fertility. Applications of nitrogen, phosphorus, potassium, and lime are needed. Crop response to applications of fertilizer and lime is fair.

4. Gara-Lindley Association

Moderately dark colored and light-colored, moderately well drained, strongly sloping and steep soils derived from till

This association consists of moderately steep and steep soils on valley sides that are dissected by V-shaped waterways. This association is widely distributed throughout the county. It borders the valleys of major streams. Gul-

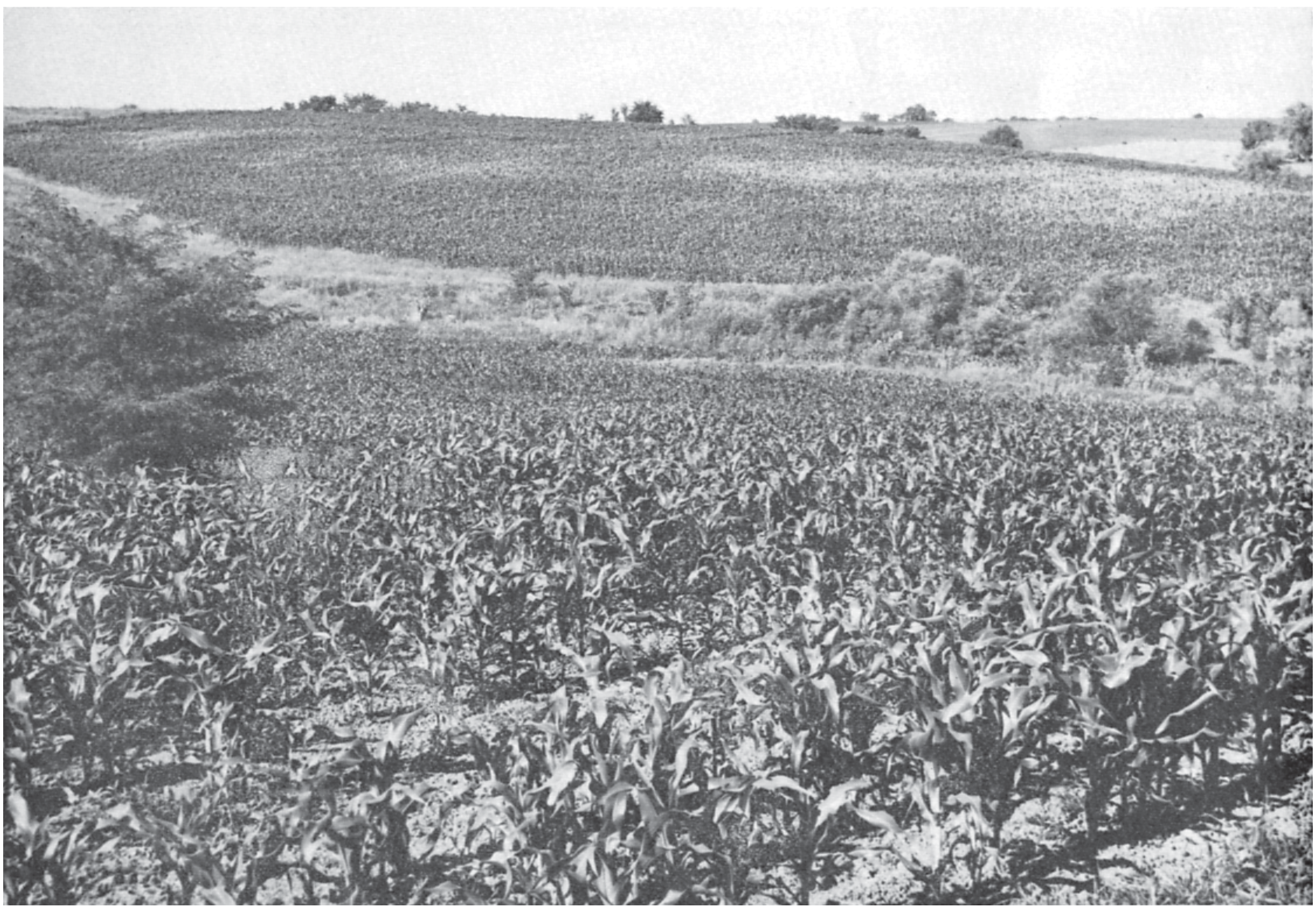

Figure 5.—**A cornfield in the Clarinda-Shelby-Adair association. The lighter colored areas in the background are of corn growing on less productive Clarinda soils.**

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lies and noncrossable drains are common, and they limit fields in size and make them irregular in shape. Roads follow the ridgetops in many places. Scattered trees and shrubs grow along most of the waterways and along the fences that enclose permanent pastures (fig. 6). Standing timber or brush covers about 30 to 40 percent of this association and generally is on the north-and east-facing slopes. This association occupies 8.5 percent of the county.

The Gara soils make up 70 percent of the association; the Lindley soils, 12 percent; and the minor soils, the remaining 18 percent.

The Gara soils are strongly sloping to moderately steep and are moderately well drained. The surface layer is 12 inches thick and consists of very dark gray, friable loam in the upper part and grayish brown, friable loam in the lower part. The subsoil extends to a depth of about 45 inches and is brown or dark yellowish-brown, friable loam.

Lindley soils are steep and are moderately well drained. Their surface layer is 8 inches thick and consists of very dark gray, friable loam in the top 2 inches and grayish-brown and pale-brown, friable loam below. The subsoil extends to a depth of 42 inches and is mostly a brownish clay loam.

The minor soils in this association are the Caleb, Adair, Mystic, Shelby, Rathbun, and Kniffin. The Caleb and Mystic soils developed from old alluvium. They are generally on the more gentle south- and east-facing slopes in benchlike areas 30 to 40 feet above bottom lands of the major streams in the county. The more nearly level parts of these areas are covered with 5 to 8 feet of loess (fig. 7). The Shelby and Adair soils developed from glacial till, and the Rathbun and Kniffin soils developed from loess. These minor soils are somewhat poorly drained or moderately well drained.

The soils in this association are used primarily for hay and pasture, but occasionally row crops are grown on the lesser slopes. If row crops are used, they should be planted on the contour in terraced fields and the crop rotations used should have a high proportion of close-growing crops. Reshaping and seeding the gullies and waterways in this association is advisable (fig. 8).

On most farms in this association hay is grown and livestock raised. Most of the hay is fed to beef cattle, sheep, and dairy herds. Grain is also grown and is fed to hogs and dairy herds. Farm ponds are numerous and provide water for livestock. Many farm buildings are unoccupied, and most of the farmsteads in use are in only

***Figure 6.*—A typical landscape in the Gara-Lindley association. Many scattered trees and shrubs grow along fence rows and waterways.**

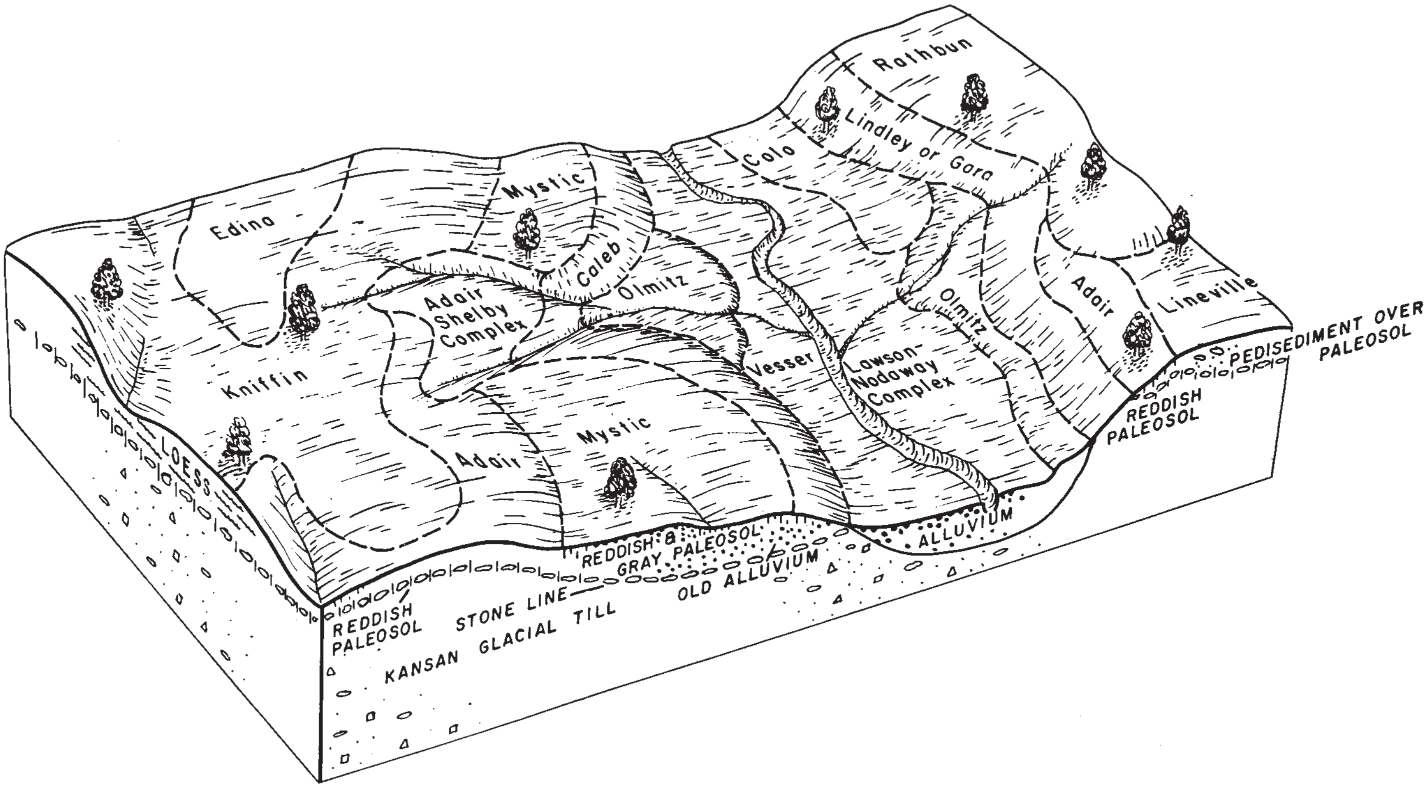

***Figure 7*.—Relationship of slope, vegetation, and parent materials in the Gara-Lindley association.**

fair repair. Sizes of farms vary; many farms are between 240 and 320 acres, and others are much larger. The general trend is to enlarge farm units. Many of the farms are partly in this association and partly in associations 3 and 5.

Most soils in this association have low to moderate fertility and require large additions of nitrogen, phosphorus, potassium, and lime. Crop response to applications of lime and fertilizer is fair.

***Figure 8*.—Gully in the Gara-Lindley association that would be improved by reshaping and seeding. The soil is Gara loam.**

5. Vesser-Lawson-Nodaway Association

Poorly drained to moderately well drained, nearly level soils on flood plains

This association consists of nearly level soils on flood plains that have some abandoned stream channels, especially where the stream channels have been straightened. Many fields and farms have been dissected by the stream channels and made irregular in shape. In many places fields are dissected by gullies and noncrossable drainageways that extend from the uplands. Trees and bushes grow along most stream channels and fence rows. About 10 percent of this association is in standing timber that generally can be cut for logs. This association occupies 8 percent of the county, and parts of it occur in all townships.

The Vesser soils make up 30 percent of the association; the Lawson soils, 15 percent; the Nodaway soils, 15 percent; and the minor soils the remaining 40 percent. The Lawson and Nodaway soils are closely intermingled.

The Vesser soils occur in alluvium on bottom lands and foot slopes. These soils are somewhat poorly drained and poorly drained. Their surface layer is 31 inches thick and consists of gray and dark-gray silt loam. The subsoil extends to a depth of 60 inches or more. It is dark-gray silty clay loam that is distinctly mottled to a depth of 46 inches.

The Lawson soils developed from silty alluvium on first bottoms and are likely to be flooded. They are somewhat poorly drained. The surface layer is very dark gray and very dark grayish-brown silt loam about 28 inches thick. It is mottled at a depth of about 21 inches. The subsoil is dark-grayish brown to very dark grayish brown silt loam that is faintly mottled below a depth of 34 inches. The subsoil extends to a depth of 48 inches or more.

The Nodaway soils developed from silty stratified alluvium on first bottoms and are likely to be flooded. They are moderately well drained. The surface layer is dark-gray, gritty silt loam about 4 inches thick. It is underlain by a stratified material in which the layers are dark gray, grayish brown, dark grayish brown, and very dark brown. Texture of these layers is very fine sandy loam, silt loam, fine sand, and loam.

The minor soils in this association are the Colo, Olmitz, Zook, Humeston, and Wabash. The Wabash and Zook soils are in slack-water areas of the flood plains and are poorly drained. The Humeston soils are also on the flood plains, but they are poorly drained and very poorly drained. Colo soils are poorly drained and occur on the larger flood plains.

The soils in much of this association are flooded occasionally, but they are used intensively for cultivated crops. Soils that are flooded more frequently, or that are not accessible to farm machines, are in pasture or trees (fig. 9, top). This association is important for its grain, much of which is fed to hogs, cattle, and dairy cows. Because many of the soils are poorly drained, cultivation is often delayed unless the soils are artificially drained. Tile lines work well in the soils that have moderate to moderately slow permeability in the subsoil. If permeability is slow to very slow, shallow surface ditches are needed (fig. 9, bottom).

Most farms in this association extend into the sloping uplands of soil associations 3 and 4, and nearly all of the farmsteads are in those associations because of flooding. Farmsteads on the large farms are generally in good repair. Farms vary in size, but many are 160 to 240 acres. The general trend is to enlarge farm units. Many of the roads in adjacent associations do not cross this association, because the cost of building and maintaining bridges is high.

Most of the soils in this association have moderate to high fertility, but they generally need additions of nitrogen, phosphorus, potassium, and lime. Crop response to applications of lime and fertilizer is good.

***Figure 9.*—Two parts of the Vesser-Lawson-Nodaway association. *Top:* Before the flash flood in September 1965 this area was in beans and pasture. *Bottom:* Recently constructed drainage ditch.**

Descriptions of the Soils

This section describes the soil series and mapping units of Wayne County. The acreage and proportionate extent of each mapping unit are given in table 2. Their location in the county is shown in the detailed soil map at the back of the survey.

The procedure in this section is first to describe the soil series, and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that mapping unit and also the description of the soil series to which it belongs. Unless otherwise stated, the soil colors given in this section are for a moist soil.

Following the name of each mapping unit is a symbol in parenthesis. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit and woodland suitability group in which the mapping unit has been placed. The pages on which each capability unit and woodland suitability group are described can be found by referring to the "Guide to Mapping Units" at the back of this survey.

For general information about the soils, the reader can refer to the section "General Soil Map," which describes broad patterns of soils in the county. Technical information is given in the section "Formation and Classification of Soils." Many terms used in the soil descriptions and other sections are defined in the Glossary and the "Soil Survey Manual" (*17*)[2].

[2] Italic numbers in parentheses refer to Literature Cited, p. 85.

TABLE 2.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent
	Acres	*Percent*
Adair loam, 5 to 9 percent slopes	2, 782	0. 8
Adair loam, 5 to 9 percent slopes, moderately eroded	19, 605	5. 8
Adair loam, 9 to 14 percent slopes	445	. 1
Adair loam, 9 to 14 percent slopes, moderately eroded	2, 498	. 7
Adair soils, 5 to 9 percent slopes, severely eroded	460	. 1
Adair soils, 9 to 14 percent slopes, severely eroded	791	. 2
Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded	3, 435	1. 0
Adair-Shelby complex, 9 to 14 percent slopes, severely eroded	3, 331	1. 0
Caleb loam, 9 to 14 percent slopes, moderately eroded	3, 072	. 9
Caleb loam, 14 to 18 percent slopes, moderately eroded	330	. 1
Caleb soils, 9 to 14 percent slopes, severely eroded	3, 049	. 9
Caleb soils, 14 to 18 percent slopes, severely eroded	364	. 1
Chequest silty clay loam	477	. 1
Clarinda silty clay loam, 5 to 9 percent slopes	2, 723	. 8
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	40, 441	11. 9
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	1, 524	. 4
Clarinda soils, 5 to 11 percent slopes, severely eroded	2, 577	. 8
Colo silty clay loam	3, 139	. 9
Colo silty clay loam, 2 to 5 percent slopes	2, 743	. 8
Colo-Zook silt loams, overwashed	386	. 1
Edina silt loam	27, 483	8. 1
Gara loam, 9 to 14 percent slopes, moderately eroded	512	. 2
Gara loam, 14 to 18 percent slopes	2, 353	. 7
Gara loam, 14 to 18 percent slopes, moderately eroded	7, 689	2. 3
Gara loam, 18 to 24 percent slopes	941	. 3
Gara loam, 18 to 24 percent slopes, moderately eroded	2, 743	. 8
Gara soils, 14 to 18 percent slopes, severely eroded	1, 576	. 5
Grundy silty clay loam, 2 to 5 percent slopes	6, 065	1. 8
Grundy silty clay loam, 5 to 9 percent slopes	3, 323	1. 0
Grundy silty clay loam, 5 to 9 percent slopes, moderately eroded	4, 250	1. 2
Haig silt loam	2, 539	. 7
Humeston silty clay loam	730	. 2
Humeston silty clay loam, 2 to 5 percent slopes	744	. 2
Kniffin silt loam, 2 to 5 percent slopes	1, 058	. 3
Kniffin silt loam, 5 to 9 percent slopes	3, 129	0. 9
Kniffin silt loam, 5 to 9 percent slopes, moderately eroded	1, 797	. 5
Lamoni silty clay loam, 5 to 9 percent slopes, moderately eroded	2, 806	. 8
Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	11, 913	3. 5
Lamoni soils, 9 to 14 percent slopes, severely eroded	2, 848	. 8
Lawson-Nodaway complex	5, 880	1. 7
Lindley loam, 18 to 30 percent slopes, moderately eroded	805	. 2
Lineville silt loam, 5 to 9 percent slopes	707	. 2
Lineville silt loam, 5 to 9 percent slopes, moderately eroded	330	. 1
Mystic silt loam, 5 to 9 percent slopes, moderately eroded	344	. 1
Olmitz loam, 2 to 5 percent slopes	2, 478	. 7
Olmitz-Vesser-Colo complex, 2 to 5 percent slopes	31, 231	9. 2
Pershing silt loam, 5 to 9 percent slopes	140	. 1
Pershing silt loam, 5 to 9 percent slopes, moderately eroded	300	. 1
Pershing silt loam, benches, 2 to 5 percent slopes	249	. 1
Pershing silt loam, benches, 5 to 9 percent slopes, moderately eroded	698	. 2
Rathbun silt loam, 5 to 9 percent slopes	251	. 1
Rathbun silt loam, 5 to 9 percent slopes, moderately eroded	1, 010	. 3
Seymour silt loam, 2 to 5 percent slopes	27, 355	8. 0
Seymour silty clay loam, 5 to 9 percent slopes	22, 989	6. 8
Seymour silty clay loam, 5 to 9 percent slopes, moderately eroded	11, 520	3. 4
Shelby loam, 9 to 14 percent slopes	790	. 2
Shelby loam, 9 to 14 percent slopes, moderately eroded	19, 716	5. 8
Shelby loam, 14 to 18 percent slopes	1, 350	. 4
Shelby loam, 14 to 18 percent slopes, moderately eroded	15, 703	4. 6
Shelby loam, 18 to 24 percent slopes, moderately eroded	925	. 3
Shelby soils, 9 to 14 percent slopes, severely eroded	6, 354	1. 9
Shelby soils, 14 to 18 percent slopes, severely eroded	4, 041	1. 2
Vesser silt loam	4, 709	1. 4
Vesser silt loam, 2 to 5 percent slopes	873	. 3
Wabash silty clay	235	. 1
Zook silty clay loam	698	. 2
Water	128	(1)
Total	340, 480	100. 0

[1] Less than 0.05.

Adair Series

The Adair series consists of dark colored to moderately dark colored, somewhat poorly drained to moderately well drained soils that formed from weathered glacial till on uplands. These soils are generally downslope from the Kniffin and Rathbun soils, which were derived from loess, and upslope from the Shelby and Gara soils, which were derived from till. Slopes range from 5 to 14 percent. These soils occur throughout the county. Areas of Adair soils less than 1 acre in size are shown on the soil map by the symbol for clay spots.

Adair soils developed from the reddish, fine-textured horizons of a soil that formed in an older geologic period, was later buried by loess, and still later was exposed by geologic erosion. The Adair soils formed after exposure of the buried soil. Buried, or formerly buried soils, are called paleosols.

In a typical profile, the surface layer is friable loam that has granular structure and ranges from black to yellowish brown. It is 14 inches thick. The subsoil extends to a depth of nearly 4 feet and is dark-brown and reddish-brown friable to firm clay loam that grades to very firm clay underlain by clay loam. Mottling begins at a depth of about 10 inches and is more prominent as depth increases. The substratum is mixed strong-brown and grayish-brown, firm clay loam that contains some pebbles.

The Adair soils are seasonally wet and seepy and are subject to erosion. They have a high available moisture holding capacity and are very slowly permeable.

Typical profile of an Adair loam, approximately 225 feet north and 530 feet west of the southeast corner of the NE¼NE¼ section 33, T. 69 N., R. 21 W., on a slope of 5 percent that faces northwest:

Ap—0 to 6 inches, black (10YR 2/1) to very dark brown (10YR 2/2) loam; few, fine, faint mottles of very dark grayish brown (10YR 3/2); gray (10YR 5/1) when dry; weak, fine, subangular blocky to granular structure; friable; strongly acid; abrupt boundary.

A31—6 to 10 inches, dark-brown (10YR 3/3) loam that has few, very dark brown (10YR 2/2) peds from horizon above; material is very dark grayish brown (10YR 3/2) when kneaded; brown (10YR 5/3) when dry; weak, fine to medium, granular structure; friable; strongly acid; clear boundary.

A32—10 to 14 inches, mixed dark-brown (10YR 3/3) and dark yellowish-brown (10YR 4/4) heavy loam that has few, medium, faint mottles of yellowish brown (10YR 5/6) and some very dark brown (10YR 2/2) streaks; material is dark brown (10YR 4/3) when kneaded; pale brown (10YR 6/3) when dry; moderate, fine to medium, granular structure; friable; strongly acid; clear boundary.

B1—14 to 19 inches, dark-brown (7.5YR 4/4) light clay loam that has few, fine, distinct mottles of dark red (2.5YR 3/6) and few streaks of very dark grayish brown (10YR 3/2); moderate, fine, subangular blocky structure; friable to firm; strongly acid; clear boundary.

IIB21—19 to 24 inches, medium clay loam that has peds with reddish-brown (5YR 4/4) interiors and brown (10YR 5/3) exteriors and some stones and pebbles; few, fine, prominent mottles of dark red (2.5YR 3/6); material is brown (7.5YR 4/4) when kneaded; very pale brown (10YR 7/3) when dry; grainy coatings on peds; moderate to strong, fine, subangular blocky structure; firm; stone line begins at upper part of this horizon; strongly acid; clear boundary.

IIB22t—24 to 29 inches, dark-brown (7.5YR 4/4) light clay that has common to many, fine, prominent mottles of dark red (2.5YR 3/6); material is yellowish red (5YR 4/6) when kneaded; moderate, fine to medium, subangular blocky structure; very firm; thin discontinuous clay films; coarse sand grains; medium acid; clear boundary.

IIB23t—29 to 35 inches, dark-brown (7.5YR 4/4) clay that has common, fine, prominent mottles of dark red (2.5YR 3/6), common, fine, faint mottles of grayish brown (10YR 5/2), and common, fine, distinct mottles of yellowish red (5YR 4/8); material is yellowish red (5YR 4/6) when kneaded; weak, medium, subangular blocky structure; very firm; thin discontinuous clay films; coarse sand grains; medium acid; gradual boundary.

IIB3—35 to 44 inches, dark-brown (7.5YR 4/4) heavy clay loam and some pebbles; common, fine, faint mottles of grayish brown (10YR 5/2) and common, fine, faint mottles of strong brown (7.5YR 5/8); weak, medium, subangular blocky structure to massive; medium acid; gradual boundary.

IIC—44 to 56 inches, mixed strong-brown (7.5YR 5/6) and grayish-brown (10YR 5/2) clay loam and some pebbles; massive; firm.

The A1 horizon generally ranges from black (10YR 2/1) to very dark brown (10YR 2/2) but in places is very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). The A horizon, unless eroded, is 10 to 16 inches thick in most places. Texture of the A horizon is loam or light clay loam. Except in extremely eroded areas, a stone line commonly occurs in the upper part of the B horizon. The depth to the stone line ranges from 18 to 28 inches. The B horizon is dark brown (7.5YR 4/4) and reddish brown (5YR 4/4) mottled with dark reddish brown (2.5YR 3/3) and (5YR 3/3) to yellowish red (5YR 4/6). Texture ranges from clay loam to silty clay or clay. At the most developed part of the B horizon, the clay content is 40 to 45 percent. The B horizon is 24 to 36 inches thick. The B3 and C horizons range from dark yellowish brown (10YR 4/4) to strong brown (7.5YR 5/6). In many places these horizons are highly mottled with grayish brown, strong brown, yellowish brown, and olive gray. The mottles in the B3 and C horizons range from fine to coarse, but coarse mottles are dominant and generally are olive gray.

The Adair soils have a more reddish clayey subsoil than the Shelby and Gara soils. Adair soils contain stones and pebbles in the profile, but the Kniffin and Rathbun soils do not.

Adair loam, 5 to 9 percent slopes (AaC).—This soil is on ridgetops that generally are slightly lower than surrounding ridgetops. It receives varying amounts of seepage water.

The surface layer is loam that is 10 to 14 inches thick in most places. Included areas have a gritty silty clay loam surface layer. The subsoil is reddish brown in most places, but in some places it is dark brown mottled with reddish colors. Because the subsoil is very firm, is clayey, and takes in water very slowly, runoff is rapid and erosion is a hazard.

The organic-matter content of this soil is medium. In most areas available nitrogen is low, available phosphorus is very low, and available potassium is medium. Reaction is strongly acid in most places.

This soil is better suited to hay or pasture than it is to row crops. Much of it is in permanent pasture because it commonly occurs with steeper areas of Shelby and Gara soils. Areas of this Adair soil are generally cultivated with adjacent areas of better soils. Growth of row crops is poor to medium. If row crops are planted 1 year in 4, tillage on the contour is needed. Also needed are rotations that maintain tilth and reduce the loss of soil.

Although amounts of seepage water vary, in most places artificial drainage is not needed or is not practical. Surface wetness can be reduced by tile interceptor drains that are installed upslope in the Pershing or Kniffin soils. Because this soil warms up slowly in spring, it must be worked later than many adjoining soils. (Capability unit IIIe-4; woodland suitability group 5)

Adair loam, 5 to 9 percent slopes, moderately eroded (AaC2).—This soil is on ridgetops and upper side slopes that are generally slightly lower than surrounding ridgetops. Areas of this soil range from 5 to 20 acres in size, and the total acreage in the county is large.

The surface layer is very dark gray to very dark grayish-brown loam 6 to 9 inches thick. It is underlain by a reddish-brown subsoil in most places, but in some places the subsoil is dark brown mottled with reddish colors. Because the subsoil is very firm, is clayey, and takes in water very slowly, runoff and the hazard of erosion are great.

Included with this soil in mapping were areas that have a light-colored subsurface layer and a browner surface layer than those described. Also included were areas that have a silt loam to gritty silty clay loam surface layer. In some included areas the soil near the top of ridges is gritty silty clay from the surface to a depth of 30 inches.

This Adair loam has a medium content of organic matter. In most areas available nitrogen is low, available phosphorus is very low, and available potassium is medium.

In many places this soil is better suited to hay or pasture than to row crops. Where it occurs with steeper soils, much of it is in permanent pasture or hay and some is wooded. Areas adjacent to soils in row crops are generally cultivated, but row crops grow poorly on this soil. Row crops are suitable only 1 year in 4, and then tillage should be on the contour. Crop rotations that maintain tilth and reduce the loss of soil are needed. Interceptor tile drains are needed in wet, seepy areas above this soil. (Capability unit IIIe–4; woodland suitability group 5)

Adair loam, 9 to 14 percent slopes (AaD).—This soil occurs on ridgetops and side slopes, generally below Adair loam, 5 to 9 percent slopes, and generally has a thinner surface layer. The surface layer is very dark gray loam 6 to 12 inches thick. The subsoil is dark brown mottled with reddish colors. In included areas the surface layer ranges to gritty silty clay loam.

This soil contains a medium amount of organic matter. It is low in available nitrogen, very low in available phosphorus, and medium in available potassium. It is strongly acid and generally needs additions of lime.

Use of this soil is limited by the very slowly permeable, clayey subsoil, moderate slopes, and excess water. Most of the acreage is in pasture along with adjacent areas of the steeper Shelby and Gara soils. A row crop is occasionally planted before pasture is renovated or hay is established. If row crops are planted, contour tillage is needed, but these crops grow poorly. (Capability unit IVe–2; woodland suitability group 5)

Adair loam, 9 to 14 percent slopes, moderately eroded (AaD2).—This soil is generally on ridgetops and side slopes below Adair loam, 5 to 9 percent slopes. On the crest of rounded side slopes, the dark-brown subsoil is exposed in places. Part of the subsoil, especially on the side slopes, generally has been mixed with the surface layer.

This soil has a browner, generally thinner surface layer than that of Adair loam, 9 to 14 percent slopes. The surface layer is 3 to 6 inches thick in most places but may be as much as 10 inches thick. It is often cloddy and hard when dry.

The content of organic matter is low. Available nitrogen and phosphorus are generally very low, and available potassium is medium. Acidity is strong.

This soil is well suited to pasture, and much of the acreage occurring with the steeper areas of Shelby and Gara soils is in pasture. Areas generally in pasture occasionally may be used for row crops before the pasture is renovated. Contour tillage is needed in cultivated areas. Where this soil occurs with better soils, it is used for cultivated crops. Cultivated areas are susceptible to erosion because the subsoil is clayey and slopes are strong. If erosion continues, this soil soon becomes unsuitable for cultivation. (Capability unit IVe–2; woodland suitability group 5)

Adair soils, 5 to 9 percent slopes, severely eroded (AdC3).—These soils are generally in coves and on the shoulders of ridgetops below more permeable soils derived from loess. In some places a narrow, wet, seepy area is near the boundary between these soils and the more permeable soils.

In most places these soils have a surface layer of dark grayish-brown to reddish-brown gritty silty clay loam or clay, but in some places there is as much as 3 inches of very dark grayish-brown loam on the surface.

The surface of these soils is cracked and cloddy when the soils are dry. When wet these soils puddle, the cracks seal, normal rainfall is not absorbed, and sheet erosion is increased. Gullies soon form where the plant cover is poor or has been destroyed.

These soils contain little organic matter. They are very low in available nitrogen and phosphorus and are medium in available potassium.

Pasture is better suited to these soils than cultivated crops, but pasture plants grow poorly. Heavy applications of manure are needed to improve tilth. Cultivated crops, particularly row crops, should not be grown frequently. (Capability unit IVe–2; woodland suitability group 5)

Adair soils, 9 to 14 percent slopes, severely eroded (AdD3).—These soils are in coves and on side slopes, especially at shoulders where slopes are strong. Individual areas generally are less than 10 acres in size.

In most places these soils have a surface layer of dark-brown to reddish-brown clay loam or clay, but in some places there is as much as 3 inches of very dark grayish-brown to dark-brown loam on the surface.

The content of organic matter is low, and generally these soils are in very poor tilth. In many places, the surface seals after rains. This sealing reduces the penetration of water and increases susceptibility to erosion. Deep gullies are fairly common on side slopes. In summer the surface layer hardens and cracks when it dries.

These soils are medium in available potassium and very low in available nitrogen and phosphorus. Applications of a complete fertilizer help in establishing pasture seedings and in improving growth.

These soils are not suitable for cultivation. They can be used for hay or pasture, but plants are difficult to establish in bare areas unless large amounts of manure are added. Where these soils occur with less sloping or less eroded soils, they may be used for hay grown in rotation with other crops. (Capability unit VIe–2; woodland suitability group 5)

Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded (AsD2).—This complex occurs throughout the county, normally on irregular side slopes and in coves. The complex is made up of Adair, Shelby, and included soils, all of which are in areas too small to be mapped separately. These soils are generally downslope from Clarinda and Lamoni soils and from Adair soils mapped separately. The soils in this complex formed on weathered glacial till and clay loam glacial till. The native vegetation was native grasses.

The surface layer of the soils in this complex consists of material of various texture that is generally very dark grayish brown. The surface layer is 3 to 10 inches thick in most places and is thinnest on the shoulders of the side slopes and on the crest of the rounded slopes between waterways in coves. Plowing has exposed the silty clay subsoil in some places.

Included with these soils are small areas of Gara, Clarinda, and Lamoni soils. The Gara soils are on the lower parts of slopes, and the Clarinda and Lamoni soils are on the upper parts.

The soils in this complex are generally low in organic-matter content and are only fair in tilth. They are strongly acid to medium acid. Available nitrogen and phosphorus are very low, and available potassium is low.

This complex is generally in areas 5 to 10 acres in size and is farmed the same way as adjacent Gara or Lamoni soils or as Adair or Shelby soils mapped separately. Cultivated crops can be grown once every 5 years if stripcropping or terraces are used. The growth of row crops is poor to medium. Pasture is a better use than cultivated crops, and these soils may be used for pasture where they occur next to the steeper areas of Shelby and Gara soils. (Capability unit IVe-2; woodland suitability group 5)

Adair-Shelby complex, 9 to 14 percent slopes, severely eroded (AsD3).—The soils in this complex are at the head of drainageways and are on rounded slopes between drains on side slopes. These soils generally occur with Lamoni and other Adair soils upslope and with Gara soils and other Shelby soils downslope.

The soils in this complex have a thinner, browner surface layer than the soils in Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded. In most places the surface layer is dark-brown clay loam to clay, but in some places as much as 3 inches of very dark grayish-brown loam is on the surface. This loam is thicker on the lower parts of the slopes where material eroded from hillsides accumulates. Crossable drains and many gullies dissect this complex. Wet spots of less than 1 acre occur in some places.

These soils are generally in poor tilth. Because they are strongly sloping, runoff is rapid and erosion is likely in cultivated areas. The subsoil is exposed in some areas, and it hardens and cracks when it dries.

These soils are strongly acid to medium acid in most places. They are very low in available nitrogen and phosphorus and are low in available potassium. Seedings respond well to additions of manure and of commercial fertilizer, especially phosphate.

These soils are not suited to row crops but are suited to pasture. Because the content of organic matter is low and tilth is generally poor, seedbed preparation and other cultivation are difficult. Oats are used as a nurse crop when pasture is reseeded. (Capability unit VIe-2; woodland suitability group 5)

Caleb Series

The Caleb series consists of moderately dark colored, moderately well drained soils that developed from water-sorted glacial sediments under a mixed grass and forest vegetation. Slopes range from 9 to 18 percent. These soils occur closely with the Mystic and Gara soils. They are in valleys along major streams throughout the county and are only fair for farming.

In a typical profile, the plow layer, about 6 inches thick, is very dark grayish-brown, friable loam that has granular structure. It is underlain by about 2 inches of dark-brown to brown, friable loam to silt loam that has platy structure. The subsoil extends to a depth of 4 feet or more. It is friable to firm clay loam to sandy loam that, in color, ranges from dark brown or brown to dark yellowish brown and yellowish brown. The substratum is yellowish-brown sandy loam, loam, and sandy clay loam.

The Caleb soils are subject to erosion and have very low natural fertility. They are moderately slowly permeable and have a moderately high available moisture holding capacity.

Typical profile of Caleb loam located 1,065 feet south and 225 feet west of the northeast corner of the NW¼ section 4, T. 69 N., R. 22 W., on a slope of 9 percent that faces southeast:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) loam, grayish brown (10YR 5/2) when dry; material same color as matrix when kneaded; weak, fine, granular structure; friable; medium acid; abrupt, smooth boundary.

A2—6 to 8 inches, dark-brown or brown (10YR 4/3) gritty heavy silt loam; material same color as matrix when kneaded; weak, thick, platy breaking to moderate, fine, subangular blocky structure; friable; discontinuous, grainy coats that are light gray (10YR 7/2) when dry; very strongly acid; clear, smooth boundary.

B1—8 to 12 inches, dark-brown or brown (10YR 4/3) light clay loam; material dark brown to dark yellowish brown (10YR 4/3 to 4/4) when kneaded; strong, fine and medium, subangular blocky structure; firm; nearly continuous, grainy coats on peds that are light gray (10YR 7/2) when dry; few, fine, dark reddish-brown (5YR 2/2) oxides; strongly acid; clear, smooth boundary.

B21t—12 to 17 inches, dark-brown or brown (10YR 4/3) medium clay loam; few, fine, faint mottles of yellowish brown (10YR 5/6); material dark yellowish brown to yellowish brown (10YR 4/4 to 5/4) when kneaded; strong, medium, subangular blocky structure; friable to firm; continuous, grainy coats that are light gray (10YR 7/2) when dry; few, fine, dark reddish-brown (5YR 2/2) oxide concretions; very strongly acid; clear, smooth boundary.

B22t—17 to 24 inches, dark yellowish-brown (10YR 4/4) medium clay loam; material yellowish brown (10YR 5/6) when kneaded; strong, fine, prismatic breaking to strong, fine, angular blocky and subangular blocky structure; firm; thick, discontinuous, dark-brown (7.5YR 3/2) clay films, mainly on vertical faces; few fine, dark reddish-brown (5YR 2/2) concretions of an oxide; roots mainly along prism faces and ped exteriors; medium acid; gradual, smooth boundary.

B23t—24 to 35 inches, mottled dark yellowish-brown (10YR 4/4) and grayish-brown (10YR 5/2) light clay loam; material yellowish brown (10YR 5/4) when kneaded; strong, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable to firm; thick, patchy, dark-brown (7.5YR 3/2) clay films on prism faces and in old channels; few, fine, dark reddish-brown (5YR 2/2) concretions of an oxide; medium acid; gradual, smooth boundary.

B31t—35 to 46 inches, dark yellowish-brown to yellowish-brown (10YR 4/4 to 5/4) light sandy clay loam; common, fine, faint mottles of grayish brown (10YR 5/2) and few, fine, faint mottles of strong brown (7.5YR 5/6); material yellowish brown (10YR 5/4) when kneaded; weak, coarse, prismatic structure; friable to firm; few, thin, discontinuous, dark-brown (10YR 3/3) clay films on prism faces and in old channels; few, fine, dark reddish-brown (5YR 2/2) concretions of an oxide; slightly acid; gradual, smooth boundary.

B32—46 to 66 inches, dark yellowish-brown to yellowish-brown (10YR 4/4 to 5/4) heavy sandy loam; few, fine, distinct mottles of yellowish red (5YR 4/6) and few, fine, faint mottles of strong brown (7.5YR 5/6); material yellowish brown (10YR 5/4) when kneaded; weak, coarse, prismatic structure; friable to firm; few, thin, discontinuous, dark-brown (10YR 3/3) clay films on prism faces and in old channels; also on prism faces are a few, patchy, grainy coats that are light gray (10YR 7/2) when dry; slightly acid.

The Ap or A1 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) and ranges from 6 inches to 9 inches thick. The texture of the Ap or A1 ranges from loam to silt loam but is loam in most places. The A2 horizon generally ranges from dark grayish brown (10YR 4/2) to dark brown or brown (10YR 4/3), but some very dark grayish brown (10YR 3/2) is present in places. This horizon is 2 to 4 inches thick.

The upper part of the B horizon ranges from dark brown or brown (10YR 4/3) to dark yellowish brown (10YR 4/4) and has a few yellowish-brown (10YR 5/4 or 5/6) mottles. The lower B2 horizons range from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/4) and in places contain a few grayish-brown mottles that may increase in number with depth. Very dark grayish-brown (10YR 3/2) exterior coats or clay films are common in the lower B horizons in some places. The clay content is about 35 to 42 percent in the finest part of the B horizon. The B3 and the C horizons, where observed, range from sandy loam to sandy clay loam and contain strata of coarse material in places. The matrix of the substratum is not calcareous.

Laboratory data on samples taken at this site show a clay maximum of 35 percent in the B22t horizon and a range of 17 to 35 percent throughout the solum. The B32 horizon shows the lowest amount of clay. The content of clay in the B2 horizons ranges from 30 to 35 percent. The content of silt varies throughout the solum, having a high of 53 percent in the Ap horizon and a low of 14 percent in the B31t horizon. The content of sand ranges from 23 percent in the Ap horizon to 42 percent in the B2 horizons to a maximum of 65 percent in the B31t horizon.

The Caleb soils have less clay in their subsoil than the Mystic soils and lack the reddish colors that are characteristic of those soils. Caleb soils contain less clay and fewer glacial stones and pebbles in the solum than do the Gara, Shelby, and Lindley soils.

Caleb loam, 9 to 14 percent slopes, moderately eroded (CaD2).—This is one of the most extensive Caleb soils in the county. It occurs on short, rounded side slopes of the high benches and at the lower part of the steeper upland slopes. The plow layer is very dark grayish-brown loam. Small severely eroded areas are included.

Because slopes are strong and tilth is poor, this soil is susceptible to erosion in cultivated areas. In many places the surface layer and the finer textured subsoil have been mixed by plowing, and in these the soil clods and hardens when it dries.

This soil is generally very low in available nitrogen, phosphorus, and potassium. It is medium acid to very strongly acid and very low in organic-matter content.

This soil is better suited to hay and pasture than to cultivated crops. A row crop can be grown 1 year in 5 when meadows are renovated. Contour tillage is needed for the row crop. (Capability unit IVe–2; woodland suitability group 1)

Caleb loam, 14 to 18 percent slopes, moderately eroded (CaE2).—This soil is on convex side slopes of benches that are generally less than 150 feet long. It is downslope from the Mystic and Adair soils and upslope from the Colo, Vesser, and other soils on the bottom land along the main drainageways in the county. In this county, individual areas are 5 to 15 acres in size and total acreage is small.

This soil has a dark grayish-brown surface layer, 3 to 6 inches thick, though in some areas this layer is slightly thicker. In some of the more eroded included areas the surface layer is clay loam.

Runoff is rapid, because slopes are strong. The subsoil is exposed in some places at the upper part of the rounded side slopes or near the drainageways in the hillsides. In many cultivated areas, the subsoil has been mixed with the surface layer. The surface layer is likely to clod and harden when it dries.

This soil is generally very low in available nitrogen, phosphorus, and potassium. It is medium acid to very strongly acid, and very low in organic-matter content. Tilth is generally poor. Grass seedings respond moderately well to nitrogen and phosphate fertilizers.

In many places this soil has been cultivated but is now in pasture. The soil is not suited to row crops and is only moderately well suited to pasture. If pasture is renovated, oats may be used as a nurse crop. (Capability unit VIe–1; woodland suitability group 1)

Caleb soils, 9 to 14 percent slopes, severely eroded (CbD3).—These soils are on the side slopes and shoulders of benches along most of the major streams in the county. Individual areas range from 5 to 50 acres, and the total acreage in this county is large. The surface layer is dark grayish-brown loam to clay loam, less than 3 inches thick.

Some areas of these soils are seepy and are generally good sources of well water. Because the surface often seals after rains, the penetration of moisture is lessened. Tilth is very poor. Deep gullies are common on sidehills.

These soils are very low in available nitrogen, phosphorus, and potassium. They are low in organic-matter content. Applications of a complete fertilizer help to establish pasture seedings and to improve production.

These soils are not suited to cultivated crops. They are better suited to hay or pasture, but pasture plants are extremely difficult to establish in bare areas unless heavy applications of manure are used. Where they occur with better soils, these soils are likely to be seeded to pasture. (Capability unit VIe–2; woodland suitability group 1)

Caleb soils, 14 to 18 percent slopes, severely eroded (CbE3).—These soils are on rounded side slopes of the benches that are dissected by uncrossable gullies in many places. In some places these soils are downslope from the Mystic or Adair soils and upslope from the Colo, Vesser, and other soils on bottom land along the major streams. Individual areas range from 3 to 15 acres in size.

In many places all of the original plow layer of these soils has been removed by erosion. The plow layer is dark grayish-brown to brown loam and clay loam.

Available nitrogen, phosphorus, and potassium are very low in these soils. Additions of lime, a phosphate fertilizer, and manure are needed to insure a good seeding. Seedings respond fairly well to a phosphate fertilizer.

These soils are only moderately well suited to pasture, and they are not suited to row crops. In areas left bare, the hazard of erosion is high and gullying is likely. Seedbeds, especially where the subsoil is exposed, are difficult to prepare. (Capability unit VIIe–1; woodland suitability group 1)

Chequest Series

The Chequest series consists of moderately dark colored, poorly drained soils on bottom lands in and along old abandoned stream channels and bayous. These soils developed from silty, moderately fine textured alluvium. They are not extensive in the county, but individual areas are rather large and are fairly good for farming.

The surface layer is about 11 inches thick and is very dark gray, friable to firm silty clay loam. The subsoil extends to a depth of 50 inches or more and is dark-gray, friable to firm, silty clay loam with brownish-colored mottles. The substratum has about the same texture as the subsoil but commonly is mottled with a lighter gray.

The Chequest soils are subject to flooding and have a seasonal high water table. They have high available moisture holding capacity and moderately slow permeability.

Typical profile of Chequest silty clay loam, approximately 400 feet south and 430 feet west of the northeast corner of section 15, T. 69 N., R. 20 W., on level to depressional alluvium:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silty clay loam, gray (10YR 6/1) when dry; dark-gray (10YR 4/1) patches on peds; weak, fine, subangular blocky structure; friable to firm; very slightly acid; abrupt boundary.

A3—7 to 11 inches, very dark gray (10YR 3/1) medium silty clay loam, gray (10YR 5/1) when dry; few, fine, faint mottles of dark brown (7.5YR 3/2); moderate, fine, subangular blocky structure; friable to firm; slightly acid; clear boundary.

B11tg—11 to 17 inches, dark-gray (10YR 4/1) light silty clay loam, gray (10YR 6/1) when dry; few, fine, distinct mottles of yellowish brown (10YR 5/8), few, fine, faint mottles of dark yellowish brown (10YR 4/4), and few, fine, faint mottles of very dark gray (10YR 3/1); weak, fine, subangular blocky structure; friable to firm; few, thin, discontinuous clay films; medium acid; gradual boundary.

B12tg—17 to 21 inches, dark-gray (10YR 4/1) light silty clay loam, gray (10YR 6/1) when dry; few, fine, faint mottles of dark yellowish brown (10YR 4/4); weak, fine, subangular blocky structure; friable to firm; few, thin, discontinuous clay films; strongly acid; gradual boundary.

B21tg—21 to 31 inches, very dark gray to dark gray (10YR 3/1 to 4/1) medium silty clay loam, gray (10YR 6/1) when dry; many, fine, faint mottles of dark brown (7.5YR 3/2); strong, fine, subangular blocky structure; firm; few clay flows and thin discontinuous clay films; strongly acid; gradual boundary.

B22tg—31 to 38 inches, dark-gray (10YR 4/1) light silty clay loam, gray (10YR 6/1) when dry; many, fine, distinct mottles of dark brown (7.5YR 3/2); weak, fine, subangular blocky structure; friable to firm; few clay flows; medium acid; gradual boundary.

B31tg—38 to 44 inches, dark-gray (10YR 4/1) light silty clay loam; many, coarse, distinct mottles of dark brown (7.5YR 3/2); weak, medium, prismatic breaking to weak, medium, subangular blocky structure; firm; few clay flows; medium acid to slightly acid; gradual boundary.

B32g—44 to 55 inches, dark-gray (10YR 4/1) silty clay loam; many, coarse, dark-brown (7.5YR 3/2) oxide concretions; weak, medium, prismatic structure; firm; thin, discontinuous, gray silt coats on most prism faces.

In most places the Ap or A1 horizon is very dark gray (10YR 3/1) in color and silty clay loam to heavy silt loam in texture. In Wayne County the A horizon is 8 to 12 inches thick, but in other places it is only 6 to 10 inches. Dark-colored material has been deposited on the surface in Wayne County. The clay content in the B horizon generally ranges from 28 to 36 percent, but in some places the B2 horizon has a thin heavy silty clay loam layer in which clay content is 36 to 40 percent.

The Chequest soils have more clay in the surface layer than the Vesser soils and more mottles in the subsoil. They have a thinner surface layer and a grayer subsoil than the Colo soils. Chequest soils have more clay throughout than the Nodaway and Lawson soils.

Chequest silty clay loam (Ch).—This soil is on the wider bottom lands in the county. It formed in low areas where floodwater often stands or where the water table is generally high. These areas still receive deposits during floods. This soil has a grayish-colored subsoil that is highly mottled with dark brown.

Silty clay loam extends from the surface throughout the profile. Tilth is generally poor, and the soil puddles if worked when wet. Use is limited by poor drainage and occasional flooding. Cultivated areas should be drained by open ditches or tile if outlets can be established.

This soil is low in available nitrogen and medium in available phosphorus and potassium. Response of corn to fertilizer is good. Reaction is generally medium acid to strongly acid. This soil is generally farmed with soils that are better suited to cultivated crops. Fields that are artifically drained can be planted to row crops, but row crops are only moderately well suited. In undrained areas this soil is better suited to pasture than to row crops. (Capability unit IIw-1; woodland suitability group 7)

Clarinda Series

The Clarinda series consists of moderately dark colored, poorly drained soils that formed from weathered glacial till on uplands. This till is gray clay that is commonly called gumbotil. The gumbotil was the subsoil of a soil on the nearly level drift plain that remained after the Kansan glacier receded. Later a deposit of loess covered the gumbotil, but geologic erosion has removed the loess in many places and has exposed the old buried soil. Clarinda soils are downslope from the Seymour and Grundy soils. They are on side slopes and short ridgetops where the once buried soil is exposed. Buried or once buried soils are called paleosols. Since these soils have been exposed, the native vegetation has been prairie grasses.

Clarinda soils have slopes ranging from 5 to 14 percent, but slopes are 5 to 9 percent in most places. These soils are in all parts of the county. Individual areas are as large as 80 acres. Areas that are too small to be mapped separately are shown on the soil map by the symbol for clay spots.

Typically the surface layer is about 11 inches thick and is very dark gray, friable silty clay loam. The subsoil extends to a depth of 60 inches or more and is a mottled dark-gray and gray, firm and very firm silty clay and clay. The substratum, where observed, is gray, very firm silty clay that has yellowish mottles and a few small pebbles.

The Clarinda soils are seasonally wet and seepy and are subject to erosion. They have a moderately high available moisture holding capacity and are very slowly permeable.

Typical profile of Clarinda silty clay loam, 700 feet west and 240 feet south of the northeast corner of the NW¼ section 24, T. 69 N., R. 22 W., on a slope of 6 percent facing southwest, near end of an interfluve:

Ap—0 to 5 inches, very dark gray (10YR 3/1) light silty clay loam; very fine granular structure; friable; strongly acid; clear boundary.

A3—5 to 11 inches, very dark gray (10YR 3/1) light to medium silty clay loam; same color when kneaded; moderate, very fine, subangular blocky to moderate, fine, granular structure; friable; numerous sand grains visible; strongly acid; gradual boundary.

IIB1t—11 to 19 inches, dark-gray (10YR 4/1) silty clay; few, fine, prominent mottles of yellowish red (5YR 4/8); very dark gray (10YR 3/1) to dark gray (10YR 4/1) when kneaded; dark gray (10YR 4/1) when dry; moderate, fine, subangular blocky that breaks to moderate, very fine, angular blocky structure; firm; thick discontinuous clay films on ped surfaces; numerous, gritty, fine, white particles visible; strongly acid; gradual boundary.

IIB21tg—19 to 34 inches, gray (5Y 5/1) clay; common, fine, yellowish-brown (10YR 5/6 and 5/8) mottles and few, fine, yellowish-red (5YR 5/8) mottles; weak and moderate, fine, subangular blocky structure; very firm; thick continuous clay films on peds; few fine (5 to 15 millimeters) pebbles; medium acid; gradual boundary.

IIB22tg—34 to 47 inches, gray (5Y 5/1) clay; common, coarse, yellowish-brown (10YR 5/6 and 5/8) mottles; weak, medium, prismatic that breaks to moderate, medium, subangular blocky structure; very firm; thick continuous clay films on peds; few fine (5 to 15 millimeters) pebbles; slightly acid; gradual boundary.

IIB3tg—47 to 67 inches, gray (10YR 5/1) clay with common, coarse, distinct mottles of yellowish brown (10YR 5/6 and 5/8); weak, medium, prismatic that breaks to moderate, medium, subangular blocky structure; very firm; very dark gray (10YR 3/1) coatings on peds and in channels and crevices; thick clay films; few small pebbles; slightly acid.

In uneroded areas the A horizon, when moist, ranges from very dark gray (10YR 3/1) to black (10YR 2/1) and is 10 to 14 inches thick. It generally is light silty clay loam but ranges to silt loam in places. The A horizon is a mixture of loess and silty material in the surface layer of the paleosol. In many places the loess in the upper part of the Clarinda soils ranges from 6 to 18 inches in thickness, but in some places the loess is 24 inches thick.

The B horizon is generally dark gray (10YR 4/1) in the upper part and gray (5Y 5/1) in the lower part. The maximum content of clay is at a depth of about 24 to 30 inches. The content of clay ranges from 50 to 60 percent in the B horizon. This horizon ranges from 3 to 12 feet in thickness but is generally about 4 to 5 feet thick.

These soils are medium acid to strongly acid in the most acid part of the solum.

In the Clarinda soils the clay part of the subsoil is thicker than that of the Lamoni soils. Clarinda soils have a more grayish subsoil than the Adair soils and lack the pebbles and stones that are common in the Adair. The Clarinda soils contain slightly more sand than the Seymour soils and have a thicker clay layer in the subsoil.

Clarinda silty clay loam, 5 to 9 percent slopes (ClC).—In many places this soil is at the shoulders of side slopes in bands that continue around the heads of drainageways that extend into broad, flat uplands. It is generally below the Seymour and Grundy soils and above the Adair and Lamoni soils. In some places this soil is only at the heads of drainageways, generally in areas below the Kniffin and Pershing soils and above or adjacent to the Adair soils. Seepy spots occur at the uphill side of many of these areas where they border soils derived from loess.

This soil has a silty clay loam surface layer 10 to 14 inches thick. In some included areas the surface layer is silt loam. The surface layer grades to a firm to very firm, gray clay subsoil 4 to 10 feet thick. Because of this fine-textured subsoil and the moderate slopes, susceptibility to erosion is high in cultivated areas. When this soil dries after wetting, cracks may appear on the surface and extend deep into the subsoil.

This soil is normally strongly acid, medium in organic-matter content, low in available nitrogen, and very low in available phosphorus. The available potassium is medium. Pasture plants respond fairly well to additions of fertilizer, but row crops generally do not respond so well.

Most of the soil is used for crops or pasture. If the soil is cultivated, it should be tilled on the contour and kept in meadow half of the time. Terraces generally are not suitable, because building them may expose the unfavorable subsoil.

Because this soil is very slowly permeable, in many places it stays wet for long periods in the spring and after heavy rainfall in any season.

Sometimes crops are yellow and stunted in growth during a wet year. By midsummer the yellow usually disappears, but crop growth still may be poor. Tile drains should not be placed in these soils, but it may be practical to place interceptor tile drains in the adjacent, loess-derived soils upslope. This tile helps to prevent seepage and reduce surface wetness. (Capability unit IVw-1; woodland suitability group 4)

Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded (ClC2).—The surface layer of this eroded soil is very dark gray silty clay loam 3 to 6 inches thick. The soil is normally in bands, about 200 feet wide, below the Seymour and Grundy soils. It is one of the most extensive soils in Wayne County, and individual areas are generally large.

In some places small spots of the grayish clay subsoil are exposed at the upper part of the slope or at the middle of rounded slopes between drains on the sides of hills. In many cultivated fields, part of the subsoil is mixed with the surface soil and the soil is difficult to work. This soil is low in organic-matter content, and when dry, the surface soil is cloddy and hard. As the soil continues to dry, cracks appear on the surface and extend deep into the subsoil. Much of this soil is used for cultivated crops, but row crops do not grow well if erosion continues. If wetness is controlled and tillage is on the contour, this soil is suited to row crops in rotations that include meadow 2 years in 4.

Tile drains should not be placed in this soil, but placing interceptor tile drains in adjacent loess-derived soils upslope reduces seepage and surface wetness. This soil dries slowly because it is very slowly permeable. Growth of row crops is generally poor because of wetness.

This soil is strongly acid. It is generally very low in available nitrogen and phosphorus and is low in available potassium. (Capability unit IVw-1; woodland suitability group 4)

Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded (ClD2).—The surface layer of this soil is very dark gray to very dark grayish brown silty clay loam 3 to 6 inches thick. The subsoil consists of very slowly permeable clay and is 3 to 6 feet thick in most places.

This strongly sloping soil is in bands in coves at the heads of drainageways, and it extends to the shoulders of the side slopes. In places it occupies entire short side slopes and is adjacent to drainageways that dissect broad uplands. The bands of this soil are not continuous in some places. Extent is moderate in this county, and generally areas are larger than 10 acres.

This soil is low in available nitrogen, very low in available phosphorus, and low in available potassium. It needs additions of organic matter and fairly heavy applications of lime, for it is strongly acid.

In some places this soil is in cultivated crops, but they do not grow well. Although forage crops also do not grow well, this soil is better suited to hay or pasture than to other uses. A row crop can be grown when meadows are renovated and tillage is on the contour.

Because this soil is strongly sloping and has a clay subsoil, it is extremely erosive and hard to manage. In some places the subsoil is exposed in small spots near drains in sidehills and at the upper part of slopes. When the surrounding soils on the slopes are ready for cultivation, this soil may still be too wet to work. It puddles if it is cultivated at the same time as the surrounding soils. By midsummer cracks appear on the surface, and as the soil continues to dry, the cracks extend deep into the clay subsoil. The surface of this soil is very hard and cloddy when dry. It may be practical to place tile drains in the loess-derived soils upslope to intercept seepage water, reduce surface wetness, and allow earlier cultivation. (Capability unit IVe-2; woodland suitability group 4)

Clarinda soils, 5 to 11 percent slopes, severely eroded (CmC3).—The surface layer of this soil is very dark grayish brown and is less than 3 inches thick. Most of the original surface layer has been removed by erosion, and in some places the dark-gray clay subsoil is exposed.

These soils generally are at the heads of drainageways below loess-derived soils of the uplands, but in some places they are on short, convex side slopes. The total acreage in this county is moderate, but individual areas are generally less than 5 acres in size.

These soils are very low in available nitrogen and phosphorus and are low in available potassium. Legume and grass seedings respond moderately well to heavy applications of manure and phosphate. Lime also should be applied because these soils are strongly acid.

These soils are generally used for hay and pasture or are left idle. They are not suited to cultivated crops. Oats are used as a nurse crop in reseeding pasture.

Wetness and erosion are the main concerns of management. The surface soil hardens and cracks severely when it dries. It puddles readily and absorbs moisture very slowly. In some places a practical way to reduce surface wetness is placing interceptor tile in the loess-derived soils upslope. The deep, active gullies that have formed in places should be shaped and planted to grass so as to prevent further erosion. A short, temporary diversion terrace placed upslope from these gullied areas helps to prevent erosion until a seeding is established. (Capability unit VIe-2; woodland suitability group 4)

Colo Series

The Colo series consists of poorly drained soils on bottom lands and foot slopes. These soils formed in moderately fine textured, silty alluvium. Colo soils occur with the Vesser, Zook, Wabash, Lawson, and Nodaway soils on the larger flood plains and with the Olmitz and Vesser soils on gentle slopes near drainageways and large streams. The native vegetation was water-tolerant prairie grasses. Colo soils are not extensive in this county, but individual areas are as much as 80 acres and are good for farming.

In a typical profile, the surface layer extends to about 34 inches and is very dark gray to black, friable to firm silty clay loam. The subsoil is black to very dark gray, firm silty clay loam that commonly has a few mottles in the lower part. The substratum is generally at a depth of 60 inches or more and is firm, mottled gray silty clay loam.

The Colo soils are seasonally wet because they are flooded, and the water table is high. Available moisture holding capacity is high, and permeability is moderately slow.

Colo soils that are drained and protected from flooding are well suited to corn and pasture.

Typical profile of Colo silty clay loam, 370 feet north and 235 feet west of the southeast corner of the NE¼ section 1, T. 70 N., R. 20 W., on a slope of 1 percent:

Ap—0 to 7 inches, very dark gray (10YR 3/1) light silty clay loam; cloddy, but structure breaks to weak granular; friable; slightly acid; gradual boundary.

A12—7 to 13 inches, black (10YR 2/1) medium silty clay loam; few, fine, distinct mottles of dark brown to brown (7.5YR 4/4); material same color as matrix when kneaded; moderate, fine, subangular and angular blocky structure; friable to firm; medium to slightly acid; gradual boundary.

A13—13 to 24 inches, black (10YR 2/1) medium silty clay loam; few, fine, distinct mottles of dark brown or brown (7.5YR 4/4); material same color as matrix when kneaded; moderate, very fine, subangular blocky and moderate, fine, granular structure; friable to firm; medium acid; gradual boundary.

A14—24 to 34 inches, black (10YR 2/1 to N 2/0) medium silty clay loam; few, fine, distinct mottles of dark brown or brown (7.5YR 4/4); material black (10YR 2/1) when kneaded; weak, fine, subangular blocky structure; firm; slightly acid; gradual boundary.

B21g—34 to 44 inches, black to very dark gray (N 2/0 and N 3/0) medium to heavy silty clay loam; few, fine, distinct mottles of dark brown or brown (7.5YR 4/4); material black (10YR 2/1) when kneaded; weak, fine, prismatic breaking to weak, fine, subangular blocky structure; firm; few, thin, discontinuous clay films or pressure faces; slightly acid; gradual boundary.

B22g—44 to 55 inches, very dark gray (N 3/0) medium to heavy silty clay loam; few, fine, distinct mottles of dark brown or brown (7.5YR 4/4); material very dark gray (10YR 3/1) when kneaded; weak, fine, prismatic breaking to weak, fine, subangular blocky structure; firm, thin, discontinuous clay films on pressure faces; few, fine, hard, dark reddish-brown (5YR 3/2) concretions; very slightly acid.

Typical profile of overwashed Colo silty clay loam in area of Colo-Zook silt loams, overwashed, on slope of 2 percent facing south, 730 feet east and 520 feet north of southwest corner of NW¼ section 1, T. 69 N., R. 21 W.:

Overwash—12 inches to 0, stratified very dark gray to very dark grayish-brown (10YR 3/1 to 3/2) silt loam, dark gray to grayish brown (10YR 4/1 to 5/2) when dry; few, fine, faint mottles of dark brown or brown (7.5YR 4/4); material very dark grayish brown (10YR 3/2) when kneaded; weak, fine, granular and platy structure; friable; slightly acid; clear boundary.

A11—0 to 6 inches, black (10YR 2/1) light silty clay loam, very dark gray to dark gray (10YR 3/1 to 4/1) when dry; material very dark gray (10YR 3/1) when kneaded; moderate, fine, subangular blocky structure; friable; slightly acid; gradual boundary.

A12—6 to 12 inches, black (10YR 2/1) medium silty clay loam; weak, fine, subangular blocky and angular blocky structure; friable to firm; slightly acid; gradular boundary.

A13—12 to 18 inches, black (10YR 2/1) medium silty clay loam; few, fine, faint mottles of dark brown or brown (7.5YR 4/4); weak to moderate, very fine, subangular blocky structure; firm; medium acid; gradual boundary.

A3—18 to 24 inches, black (10YR 2/1 to N 2/0) light to medium silty clay loam; few, fine, faint mottles of dark brown or brown (7.5YR 4/4); weak, fine, subangular blocky structure; firm; slightly acid; gradual boundary.

B2—24 to 30 inches, black to very dark gray (10YR 2/1 to 3/1) light silty clay loam; few, fine, faint mottles of dark brown or brown (7.5YR 4/4); weak, fine, prismatic breaking to weak, fine, subangular blocky structure; firm; very slightly acid; gradual boundary.

B3—30 to 43 inches, very dark gray (10YR 3/1) light silty clay loam; few, fine, faint mottles of dark brown to brown (7.5YR 4/4); weak, fine, prismatic breaking to weak, fine, subangular blocky structure; firm; neutral.

When moist, the A horizon ranges from very dark gray (10YR 3/1) to black (10YR 2/1, N 2/0), except when alluvium has been recently deposited. In most places the A horizon is 24 inches or more thick. On the surface of overwashed Colo soils is 6 to 16 inches of stratified very dark gray (10YR 3/1), dark grayish-brown (10YR 4/2), and very dark grayish-brown (10YR 3/2) silt loam. The clay content in the profile of Colo soils ranges from 28 to 36 percent.

The Colo soils are less clayey than the Zook and Wabash soils but are more clayey than the Nodaway soils, which are stratified. Colo soils are also more clayey than the Olmitz and Lawson soils and are more grayish in the subsoil. In the Colo soils the black colors extend deeper than in the Olmitz and Lawson soils.

Colo silty clay loam (0 to 2 percent slopes) (Co).—This soil is commonly on bottom lands in valleys of the smaller streams, and it occupies the entire width of the valleys. It also occurs on wider, more stable bottom lands. Here it lies between Lawson-Nodaway complex or the Vesser soils and the more clayey Zook soils, and small areas of the complex and of the Vesser and Zook soils are included with it. Individual areas of Colo silty clay loam are as much as 80 acres in size.

This soil has a high content of organic matter and generally good tilth. It is slightly acid to medium acid. Available nitrogen, phosphorus, and potassium are medium.

Most of this soil is used for cultivated crops, though the soil is flooded occasionally. It is well suited to cultivated crops if it is artificially drained and protected from flooding. Corn that does not follow a legume generally responds well to applications of fertilizer. If tilth becomes poor, a meadow crop should be grown for 1 year. Cultivation is often delayed unless this poorly drained soil is artificially drained. Although the subsoil is moderately slow in permeability, tile drains work fairly well. In many areas use of farm machinery is impeded by small uncrossable streams. (Capability unit IIw-1; woodland suitability group 7)

Colo silty clay loam, 2 to 5 percent slopes (CoB).—This soil formed from dark-colored sediments that washed from adjacent soils on uplands. It is on even to slightly concave foot slopes in areas downslope from the Shelby and Gara soils, and from these foot slopes it fans out to bottom lands.

The dark-colored surface layer is about 24 inches thick and is dominantly silty clay loam. In some places the surface layer is clay loam. Slopes are 3 percent or less in most places, and erosion is not a serious hazard. The subsoil has moderately slow permeability and normally absorbs most of the rainfall. This soil is often wet, for it receives excessive runoff and seepage from adjacent uplands. In many places diversion terraces have been built in the adjacent soil upslope so as to divert runoff (fig. 10).

This soil is farmed the same way as adjacent soils on first bottoms. Row crops can be grown intensively in drained well-managed areas. These crops grow moderately well. Corn responds well to additions of fertilizer. If tilth becomes poor after frequent row cropping, it can be improved by meadow grown for 1 year. (Capability unit IIw-1; woodland suitability group 7)

Colo-Zook silt loams, overwashed (0 to 2 percent slopes) (Cz).—These soils are in areas that had a silty clay loam surface layer until stratified very dark gray, dark grayish-brown, and very dark grayish-brown silt loam or loam was recently deposited in a layer 8 to 16 inches thick. The sediments in this layer were deposited from adjacent rivers or from small secondary drains in the uplands. Most of the acreage is on flood plains along the South Fork Chariton River and Caleb Creek. Most areas of these soils are small, and the total acreage in the county is small.

Although these soils are occasionally flooded, row crops are grown frequently. Tile drains can be installed where needed, for the subsoil is moderately slow to slow in permeability. (Capability unit IIw-1; woodland suitability group 7)

Edina Series

The Edina series consists of moderately dark colored, poorly drained soils on broad uplands and narrower flat ridgetops. These soils developed from leached loess that is 7 to 8 feet thick and underlain by very slowly permeable, gray, clayey material at that depth. Slopes range from 0 to 2 percent and are depressional in a few places. Edina soils are extensive throughout the county.

In a typical profile, the surface layer is about 18 inches thick and consists of friable silt loam that is very dark gray in the upper part and very dark gray and dark gray in the lower part. The next layer is dark-gray and gray silty clay loam about 3 inches thick. The subsoil extends to a depth of 61 inches and is mottled throughout. It is silty clay to a depth of 48 inches and is silty clay loam below. The color of the subsoil is black to gray in the upper part and olive gray in the lower part. The substratum is olive-gray, firm, massive silty clay loam that is mottled.

The Edina soils are seasonally wet and are ponded frequently after periods of heavy rainfall. They have high available moisture holding capacity and are very slowly permeable.

Typical profile of Edina silt loam, on a nearly level upland divide 680 feet east and 150 feet north of the southwest corner of NW¼ section 15, T. 68 N., R. 21 W., near northeast corner of schoolyard of abandoned country school at Harvard:

A1—0 to 7 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; moderate, medium, granular

***Figure 10.*—A diversion terrace built at the base of an upland slope so as to protect Colo silty clay loam, 2 to 5 percent slopes, from local runoff.**

and weak, thin, platy structure; friable; few ped coatings that are light gray (10YR 7/1) when dry; medium acid; clear, smooth boundary.

A21—7 to 12 inches, very dark gray (10YR 3/1) silt loam, light gray (10YR 7/1) when dry; moderate, thin, platy structure; friable; ped coatings that are light gray (10YR 7/1) when dry and more distinct than in above horizon; few, fine, dark-brown oxide concretions; slightly acid; clear, smooth boundary.

A22—12 to 18 inches, very dark gray (10YR 3/1) and dark-gray (10YR 4/1) silt loam, gray (10YR 5/1) and light gray (10YR 7/1) when dry; material is very dark gray (10YR 3/1) to dark gray (10YR 4/1) when kneaded; moderate to strong, medium, platy structure; friable; coats of dark gray (10YR 4/1) and gray (10YR 5/1) on peds in upper part of horizon and of very dark gray (10YR 3/1 on peds in lower part; few, dark-brown, soft oxide aggregations; medium acid; clear, smooth boundary.

ABt—18 to 21 inches, mixed dark-gray (10YR 4/1) and gray (5Y 5/1) light silty clay loam; material very dark grayish brown (10YR 3/2) to dark gray (10YR 4/1) when kneaded; moderate, fine, subangular blocky structure; friable to firm; thick, discontinuous, very dark gray (10YR 3/1) clay films on some peds; discontinuous grainy coats that are light gray (10YR 7/1) when dry on some peds; few dark-brown oxide concretions; medium acid; abrupt, smooth boundary.

B21tg—21 to 26 inches, black (10YR 2/1) and very dark gray (10YR 3/1) silty clay; common, medium, distinct mottles of yellowish brown (10YR 5/6 and 5/8), mostly on ped exteriors; weak, medium, subangular blocky structure; very firm; thick continuous clay films; peds cohere when moist; many, fine, hard iron and manganese concretions; medium acid; gradual, smooth boundary.

B22tg—26 to 30 inches, same as above horizon except clay content is greater and boundary is clear and smooth.

B23tg—30 to 32 inches, dark-gray (10YR 4/1) to gray (2.5Y 5/1) silty clay, common, medium, distinct mottles of yellowish brown (10YR 5/6); weak, medium, subangular blocky structure; firm to very firm; thin continuous clay firms; common, black (10YR 2/1), clay-filled tubular pores; few, fine, hard iron and manganese concretions; few fine pores; medium acid; gradual, smooth boundary.

B24tg—32 to 38 inches, dark-gray (2.5Y 4/1) to dark grayish-brown (2.5Y 4/2) to olive-gray (5Y 5/2) silty clay; few, fine, distinct mottles of brownish yellow (10 YR 6/6); moderate, medium, subangular blocky structure; firm; continuous clay films most prominent on slickensides of horizontal ped surfaces; few, fine iron and manganese concretions; few tubular pores filled with black (10YR 2/1) clay; medium acid; clear, smooth boundary.

B31tg—38 to 48 inches, olive-gray (5Y 5/2) silty clay; common, coarse, yellowish-brown (10YR 5/8) and yellowish-red (5YR 4/8) mottles; weak, medium, prismatic breaking to weak, medium, subangular blocky structure; firm; thin clay films on prism faces; few tubular pores filled with black (10YR 2/1) clay; slightly acid; clear, smooth boundary.

B32tg—48 to 53 inches, olive-gray (5Y 5/2) heavy silty clay loam; common, coarse, distinct mottles of strong brown (7.5YR 5/8) and mottles of dark brown to brown (10YR 4/3); weak, coarse, prismatic breaking to weak, coarse, subangular blocky structure; firm; clay films on prism faces; a few tubular channels that are one-quarter inch across and filled with black (10YR 2/1) clay; slightly acid; gradual, smooth boundary.

B33tg—53 to 61 inches, olive-gray (5Y 5/2) heavy silty clay loam; common, coarse, distinct mottles of yellowish red (5YR 4/8); very weak, coarse, subangular blocky structure; firm; few, thin, discontinuous clay films; few, fine tubular pores filled with black (10YR 2/1) clay; neutral.

The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1), and it is 7 to 9 inches thick. The A2 horizon ranges from very dark gray (10YR 3/1) to gray (10YR 5/1), and it is 10 to 12 inches thick. Depth to the B2 horizon ranges from 16 to 22 inches. The clay content of the B horizon is about 50 to 56 percent. The depth to glacial till ranges from 8 feet in the northwestern part of the county to about 7 feet in the southeastern part.

The gray silty A2 horizon in the Edina soils is missing in the Seymour, Grundy, and Haig soils. The B horizon of the Edina soils is more clayey than that of the Grundy and Haig soils and is grayer than that of the Grundy and Seymour soils. Edina soils have a thicker and more distinct A2 horizon than the Kniffin soils and a grayer B horizon.

Edina silt loam (0 to 2 percent slopes) (Ed).—This soil is on broad divides in the uplands. Its profile is the one described as typical for the series. In some plowed areas ashy spots appear on the surface because the grayish-colored lower part of the surface layer has been mixed with the upper part. The subsoil is plastic and sticky when wet. Because natural outlets are missing, runoff water collects and forms ponds in shallow depressions.

This soil is medium acid and needs additions of lime. It is generally low in available nitrogen and phosphorus and medium in available potassium. Corn responds well to additions of fertilizer.

In many places this soil is cultivated with Seymour soils. Where surface drains have been dug in this soil, row crops are well suited. The subsoil contains a large amount of clay, and tile drains do not work well. Crops planted in undrained spots are sometimes drowned. (Capability unit IIIw-3; woodland suitability group 7)

Gara Series

The Gara series consists of soils that formed from slightly weathered glacial till on uplands where the native vegetation is mixed trees and prairie grasses. These soils are moderately dark colored and moderately well drained. Their landforms range from rounded ends of narrow ridgetops to irregular, complex side slopes. Slopes range from 9 to 24 percent. In some places Gara soils occur with small areas of Caleb soils. Gara soils are along all rivers and large creeks in the county and have a rather large total acreage.

The surface layer consists of about 12 inches of friable loam that is very dark gray and granular in the upper part and very dark grayish brown in the lower part. The subsoil extends to a depth of about 45 inches and is dark-brown to dark yellowish-brown clay loam that is dominantly firm. The substratum is mottled yellowish-brown, firm clay loam that is calcareous.

The Gara soils are highly erosive where used for row crops. They have high available moisture holding capacity and are moderately slowly permeable.

Typical profile of Gara loam, on a convex northwest side slope of 11 percent in open woods about 270 feet south and 420 feet west of the center of the NW¼ section 23, T. 67 N., R. 23 W., 210 feet west of gravel road that runs northeast to southwest:

A1—0 to 7 inches, very dark gray (10YR 3/1) loam, gray to dark gray (10YR 5/1 to 4/1) when dry; weak, very fine, granular structure; friable; medium acid; clear boundary.

A2—7 to 12 inches, very dark grayish-brown (10YR 3/2) to dark grayish-brown (10YR 4/2) light loam, light brownish gray (10YR 6/2) when dry; common, fine, distinct worm casts of very dark gray (10YR 3/1); moderate, fine, subangular blocky structure with distinct horizontal cleavage; friable; a few pebbles ½ to 1 inch across in lower part of horizon; medium acid; clear boundary.

B1—12 to 17 inches, medium clay loam that is brown (10YR 4/3) on ped surfaces and dark yellowish brown (10YR 4/4) inside peds; a few, fine, distinct worm casts of very dark grayish brown (10YR 3/2); moderate to strong, fine, subangular blocky structure; friable to firm; peds in upper part have distinct coatings of sand and silt grains when dry; strongly acid; clear boundary.

B21t—17 to 24 inches, medium to heavy clay loam that is brown (10YR 4/3) on ped surfaces and dark yellowish brown (10YR 4/4) inside peds; moderate, fine, subangular blocky structure; firm; faint, almost continuous clay films on most peds; a few fine concretions of iron and manganese; very strongly acid; gradual boundary.

B22t—24 to 33 inches, dark yellowish-brown (10YR 4/4) medium to heavy clay loam; common, fine, distinct mottles of grayish brown (2.5Y 5/2); weak, medium, prismatic breaking to weak to moderate, medium, subangular blocky structure; firm, distinct clay films on most peds; a few concretions; a horizontal layer about 1 inch thick that is dominantly grayish brown occurs near lower boundary of horizon; very strongly acid; gradual boundary.

B3t—33 to 45 inches, medium clay loam that is dark yellowish brown (10YR 4/4) on ped surfaces and yellowish brown (10YR 5/6) inside peds; common, fine, distinct mottles of grayish brown (2.5Y 5/2) inside peds; weak, medium, prismatic breaking to weak, medium to coarse, subangular blocky structure; firm; a few, distinct, patchy, dark-gray films on ped faces and in root channels; slightly acid; clear boundary.

C—45 to 60 inches, yellowish-brown (10YR 5/6) medium clay loam; many, medium, prominent mottles of grayish brown (2.5Y 5/2); massive with distinct vertical cleavage faces; firm; a few soft carbonate concretions; calcareous.

The A1 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) and is 5 to 10 inches thick. Texture ranges from loam to silt loam, but loam is most common. The A2 horizon is commonly 2 to 6 inches thick. It ranges from very dark grayish brown (10YR 3/2) to dark grayish brown (10YR 4/2) but is dark grayish brown in most places.

The B horizon ranges from dark brown or brown (10YR 4/3) to dark yellowish brown (10YR 4/4) in color and from 18 to 36 inches in thickness. The content of clay ranges from 30 to 35 percent in the zone of maximum accumulation. Silt that is light colored when dry coats the peds in the B1 horizon.

Mottling generally begins at a depth of 24 to 30 inches and is mostly grayish brown (2.5Y 5/2).

The matrix of the substratum is calcareous at a depth ranging from 30 to 48 inches, but in most places the matrix is calcareous at a depth of about 40 inches. Depth to calcareous material depends on the position of Gara soils in the landscape.

The Gara soils have a thinner dark-colored A horizon than the Shelby soils and typically are more acid in the subsoil. They have a thicker surface layer than the Lindley soils. The Gara soils have more gravel-size material in the subsoil than the Caleb soils, which lack a calcareous substratum.

Gara loam, 9 to 14 percent slopes, moderately eroded (GaD2).—This soil formed from slightly weathered glacial till that has been exposed by geologic erosion. It normally is in bands on rounded side slopes. It is downslope from the Lamoni or Adair soils and upslope from soils on bottom land and from the soils along small drainageways. The total acreage in the county is small, and individual areas are as much as 80 acres in size. Much of this soil has been cleared of its native oak, hickory, and elm.

The topmost 7 inches of the surface layer is very dark gray, friable loam. It is underlain by a thin, leached layer. Included in mapped areas are soils that have a 10-inch surface layer. Also included are small severely eroded areas in which all of the surface layer has been removed. The surface layer and thin underlying layer are mixed where this soil has been plowed.

The surface layer contains only a small amount of organic matter and, in many places, is cloddy and hard when dry. Runoff is rapid because this soil is moderately steep and permeability is moderately slow. In small spots on rounded slopes, erosion has exposed subsoil material. Gullies that are uncrossable with farm machinery have formed in a few areas.

This soil is poorly suited to row crops, but these crops can be planted if terracing and contour tillage are used and meadow is grown for 4 in every 6 years. Row crops generally should be planted only when pasture is renovated. Large amounts of manure are needed for improving tilth. (Capability unit IVe–1; woodland suitability group 1)

Gara loam, 14 to 18 percent slopes (GaE).—The top layer of this soil is very dark gray, friable loam 5 to 8 inches thick. This soil is on rounded slopes in areas downslope from the Adair soils and upslope from soils on bottom lands or soils along narrow drainageways. Where it is adjacent to the valleys of major streams, this soil grades to the Olmitz or to the Colo soils in many places. The total acreage is moderate, but individual areas are large in some places.

This soil is low in content of organic matter. It is very low in available nitrogen and phosphorus and is low in potassium.

Most of this soil is in pasture or is wooded. Many areas are still in oak, hickory, and some elm, and these areas might be valuable as woodland if they were managed well. Cleared areas are better suited to pasture than as woodland. Because runoff is rapid and may cause erosion, areas cleared for pasture should be seeded as soon after clearing as possible. Lime and a complete fertilizer may be added at the time of seeding. (Capability unit VIe–1; woodland suitability group 1)

Gara loam, 14 to 18 percent slopes, moderately eroded (GaE2).—This is the most extensive Gara soil in the county. Its surface layer, about 6 inches thick, is very dark grayish-brown loam. Runoff is very rapid because this soil is moderately steep and is on slopes that are dissected by many small drains. Small areas of loam to clay loam were included in the mapping.

This soil is low in content of organic matter and generally is in poor tilth. It is very low in available nitrogen and phosphorus and is low in available potassium.

This soil is not suited to row crops, but it produces good pasture if it is managed well. Additions of manure and fertilizer help in establishing seedings. Applications of lime are also needed, for this soil is medium acid. Some areas of this soil are used for cultivated crops. (Capability unit VIe–1; woodland suitability group 1)

Gara loam, 18 to 24 percent slopes (GaF).—The surface layer of this soil consists of 5 to 8 inches of very dark gray, friable loam and a leached grayish-colored layer. This soil is on long slopes that are irregular and complex in some places. Runoff is rapid, and the hazard of erosion is high. This soil is downslope from the Adair soils and is upslope from soils on bottom land. The total acreage in the county is not large, but most individual areas are more than 20 acres in size.

Many areas of this soil have been partly cleared of timber and are in pasture. Renovation of pasture is difficult, but it should be carried out without destroying the existing grass. The use of equipment may be dangerous because the soils are steep and gullied. Oak and hickory trees grow in many places, and woodland is a good use where it is properly managed. (Capability unit VIIe–1; woodland suitability group 2)

Gara loam, 18 to 24 percent slopes, moderately eroded (GaF2).—The surface layer of this soil consists of about 5 inches of very dark grayish-brown loam and, in most places, a thin, leached, grayish-colored layer. The subsoil is thinner than that of less sloping Gara soils, and in some areas the calcareous substratum is within 24 inches of the surface. These areas are generally on the nose of short ridges.

This soil is on side slopes. It is downslope from the Adair soils and upslope from soils on bottom lands and in narrow drainageways. Individual areas are generally 10 to 30 acres in size.

Some areas of this soil have been partly cleared of timber and are in pasture that provides only limited grazing. Depleted pasture should be renovated without destroying the existing grass, but renovation is difficult. The use of equipment is dangerous in some places because this soil is steep and gullied. In places where oak and hickory trees grow this soil could be used as woodland if it were properly managed. (Capability unit VIIe–1; woodland suitability group 2)

Gara soils, 14 to 18 percent slopes, severely eroded (GrE3).—These soils have had most of their original surface soil removed by erosion. The remaining surface layer is dark-brown or brown to dark grayish-brown loam to clay loam.

These soils are on the shoulders of rounded side slopes and in many places occupy the entire side slope. They are susceptible to further erosion and gullying because slopes

***Figure 11.*—Gully in an area of Gara soils, 14 to 18 percent slopes, severely eroded.**

are strong, the surface layer is very thin, permeability is moderately slow, and the plant cover is sparse.

These soils are suited to pasture, but grazing is limited unless the level of management is high. Reseeding is needed in eroded, gullied areas, but these areas should be reshaped and the gullies filled before seeding (fig. 11). In reshaping, care is needed to avoid removing more of the existing vegetation than is necessary. New seedings respond well to heavy applications of manure, lime, and phosphate. Protection of the seeded pasture is needed until the plants are established. Areas of these soils not used for pasture can be used for wildlife. (Capability unit VIIe-1; woodland suitability group 1)

Grundy Series

The Grundy series consists of dark-colored, moderately well drained to somewhat poorly drained soils on uplands. These soils developed from leached loess that is normally 80 to 100 inches thick and is underlain by a very slowly permeable, clayey buried soil. Grundy soils are on slopes and ridgetops that surround nearly level upland flats. They are downslope from the Haig soils and upslope from the Clarinda soils. Slopes range from 2 to 9 percent and are mostly short and convex. They are extensive in the northwestern and north-central parts of the county.

In a typical profile, the surface layer, about 15 inches thick, is black and very dark gray silty clay loam that is mainly friable. Brownish mottling begins in the lower part of the surface layer and extends throughout the subsoil. The upper part of the subsoil is firm silty clay that is dark grayish brown, yellowish brown, and light olive brown. The lower part is firm, olive-gray and gray silty clay to silty clay loam. Underlying this layer is a massive, mottled silty clay loam substratum at a depth of 5 to 6 feet.

The Grundy soils have high available moisture holding capacity and are slowly permeable. Row-cropped areas are subject to erosion.

Typical profile of Grundy silty clay loam, on a convex slope of 3 percent, SE¼ section 4, T. 70 N., R. 22 W. in a meadow:

Ap—0 to 7 inches, black (10YR 2/1) silty clay loam; color value slightly higher when material is kneaded; weak, fine, granular structure; friable; many fine roots; slightly acid; abrupt, smooth boundary.

A12—7 to 11 inches, black (10YR 2/1) light silty clay loam; material very dark gray (10YR 3/1) when kneaded; moderate, fine, granular and very fine subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

A3—11 to 15 inches, very dark gray (10YR 3/1) medium silty clay loam, gray (10YR 5/1) when dry; few, fine, faint mottles of dark grayish brown (10YR 4/2); material very dark grayish brown (10YR 3/2 to 2.5Y 3/2) when kneaded; moderate, very fine, subangular blocky structure; friable to firm; few, discontinuous, grainy ped coats that are gray (10YR 6/1) when dry; medium acid; gradual, smooth boundary.

B1—15 to 19 inches, light silty clay that is dark grayish brown (10YR 4/2) on exterior of peds and mixed grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/4) on interior of peds; material is dark grayish brown (2.5Y 4/2) when kneaded; strong, fine, subangular blocky structure; firm; very few patchy coats of silt; few dark reddish-brown oxides; medium acid; gradual, smooth boundary.

B21t—19 to 23 inches, medium silty clay that is dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/4) on ped exteriors and yellowish brown (10YR 5/6) and gray (10YR 5/1) on ped interiors; few, fine, faint mottles of strong brown (7.5YR 5/8); material is light olive brown (2.5Y 5/4) when kneaded; moderate, medium, subangular blocky breaking to very fine subangular blocky structure; firm; common dark reddish-brown oxide concretions with a few oxides having an outer ring of strong brown (7.5YR 5/8); thick continuous clay films; slightly acid; gradual, smooth boundary.

B22t—23 to 30 inches, medium silty clay that is mixed grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4); few, fine, distinct mottles of strong brown (7.5YR 5/8); few, discontinuous, dark-gray (10YR 4/1) coatings near top of horizon; moderate, medium, subangular blocky breaking to strong, fine, subangular blocky structure; firm; nearly continuous clay films; few dark-gray (10YR 4/1) clay-lined root channels; many dark reddish-brown oxide concretions; slightly acid; gradual, smooth boundary.

B23t—30 to 36 inches, olive-gray (5Y 5/2) light silty clay; few, discontinuous, gray (5Y 5/1) coats on peds; common, fine, distinct mottles of light olive brown (2.5Y 5/4) and common, medium, prominent mottles of strong brown (7.5YR 5/6); moderate, medium, subangular blocky structure; firm; relict, deoxidized, and leached weathering zone; few dark-gray (10YR 4/1) and many, fine, black (10YR 2/1) oxide concretions; concentration of strong-brown mottles at a depth of 31 inches; some clay in root channels; slightly acid; gradual, smooth boundary.

B3t—36 to 48 inches, gray (5Y 5/1) medium silty clay loam; few, fine, distinct mottles of light olive brown (2.5Y 5/4); material is olive (5Y 5/3) when kneaded; weak, coarse, subangular blocky breaking to moderate, medium, subangular blocky structure; firm; few dark-gray (10YR 4/1) clay flows in old root channels; relict deoxidized and leached weathering zone; common dark reddish-brown oxide concretions; neutral.

The A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) in color and from 10 to 18 inches in thickness. Texture of the A horizon is mainly silty clay loam, but the A1 horizon ranges from silty clay loam to silt loam.

In the B horizon when moist, the exterior of the peds ranges from 10YR to 5Y in hue. As depth increases, values range from 3 to 5; chroma is 1 or 2. In the interior of the peds, chroma is dominantly 4 to 6. In most places the B horizon is mottled with gray and strong brown. Maximum clay content of the B horizon ranges from 40 to 48 percent. The most acid part of the B horizon ranges from medium acid to strongly acid. The matrix color of the B3 horizon ranges from 2.5Y to

5Y in hue and has value of 5 or 6 and chroma of 1 or 2. Thickness of the solum ranges from 4 to 5 feet and depends on topographic position.

The C horizon is similar to the B3 horizon in hue, value, and chroma. The depth to glacial till ranges from 7 to 8 feet.

The Grundy soils are more brownish in their subsoil than are the Haig soils. Grundy soils are not so gray as the Clarinda and Edina soils, and they do not have so much clay in their subsoil. They have a thicker, darker surface layer than the Pershing soils, but they lack the grayish A2 horizon characteristics of those soils. Grundy soils have less clay in their subsoil than the Seymour soils.

Grundy silty clay loam, 2 to 5 percent slopes (GuB).—This soil is on short, slightly convex side slopes and ridgetops near the broad upland flats. It is upslope from the moderately sloping Grundy soils.

This soil has a black silty clay loam surface layer 10 to 18 inches thick. The mottled silty clay subsoil generally occurs at a depth of 20 to 24 inches. Included in mapping were small areas that have a silt loam surface layer.

This soil is high in organic matter and is generally in good tilth. It is generally low in available nitrogen and phosphorus and medium in available potassium. If row crops are planted frequently, nitrogen and phosphate fertilizers are needed. This soil is slightly acid to medium acid and requires additions of lime.

This soil is well suited for frequent row cropping, but erosion is a slight hazard unless terracing and contour tillage are practiced. Most of the acreage is used for cultivated crops. Under good management, row crops can be grown continuously. Tilth and fertility are maintained by plowing under all crop residues, using fertilizer, and if necessary, replacing meadow in the rotation with a green-manure crop. (Capability unit IIe–1; woodland suitability group 3)

Grundy silty clay loam, 5 to 9 percent slopes (GuC).—This soil is generally downslope from the gently sloping Grundy soils and upslope from the moderately sloping Clarinda soils. Included in mapping were small areas of these adjacent soils.

This soil has a black to very dark gray surface layer 10 to 16 inches thick. A mottled silty clay subsoil generally occurs at a depth of 18 to 24 inches.

This soil is high in organic matter and generally has good tilth. It is slightly acid to medium acid, low in available nitrogen and phosphorus, and medium in available potassium. Additions of lime and nitrogen are needed if this soil is cultivated. In some places phosphate is needed for good growth of crops.

Most of this soil is farmed the same way as surrounding soils. This soil is suited to row crops, but cultivated areas erode readily. Terracing and contour tillage help to control erosion. In terraced fields, rotations that include meadow for 2 years in 5 are suitable. Under good management, row crops generally grow well. (Capability unit IIIe–3; woodland suitability group 3)

Grundy silty clay loam, 5 to 9 percent slopes, moderately eroded (GuC2).—This soil occupies slightly convex side slopes and short ridgetops. In areas adjacent to the valleys of major streams it occurs closely with the Pershing soils.

This soil has a very dark gray silty clay loam plow layer. A mottled silty clay subsoil generally occurs at a depth of 18 to 22 inches. Less than 3 inches of the original plow layer remains in a few small areas. These small areas are shown on the soil map by the symbol for severely eroded spots. Small spots of subsoil are exposed at the shoulder of slopes or near drains on side slopes.

This soil is generally in fair tilth, but the surface soil is somewhat cloddy when it dries. Water runs off excessively because this soil is moderately sloping and moisture is absorbed slowly.

This soil contains a medium amount of organic matter. It is slightly acid to medium acid and needs additions of lime. This soil is low in available nitrogen and phosphorus and medium in available potassium. Crops respond well to nitrogen and phosphate fertilizers.

Nearly all of this soil is farmed in crop rotations. Row crops are moderately well suited and normally grow well. If row crops are planted 2 years in 5, terracing and contour tillage are needed. This soil is worked more easily if manure and other organic material are added. (Capability unit IIIe–3; woodland suitability group 3)

Haig Series

The Haig series consists of dark-colored, poorly drained soils on uplands. These soils formed from leached loess that is 7½ to 9 feet thick. The natural vegetation was prairie grasses. The Haig soils are nearly level and occur on broad uplands in the northwestern and north-central parts of Wayne County. They are of minor extent in the county, but are good for farming.

In a typical profile, the surface layer is about 17 inches thick and consists of black, friable to firm silt loam and silty clay loam. Mottling begins in the lower part of the surface layer. The subsoil extends to 4 feet or more and, in the upper part, is black, very dark gray, dark-gray, and grayish-brown, firm to very firm silty clay. In the lower part, the subsoil is friable to firm silty clay loam that is dark gray to grayish brown and light brownish gray. The subsoil is mottled with brownish and grayish colors. The substratum is mottled light brownish-gray, massive, friable silty clay loam.

The Haig soils are seasonally wet because the water table is high. A drainage system is needed for increasing the growth of crops. Available moisture holding capacity is high, and permeability is slow.

A typical profile of Haig silt loam, on an upland divide, 520 feet east and 30 feet south of the northwest corner of section 3, T. 70 N., R. 23 W.:

Ap—0 to 6 inches, black (10YR 2/1) silt loam, dark gray (10YR 4/1 to N 4/0) when dry; material the same color when kneaded; moderate, fine, granular to weak, fine, subangular blocky structure; friable; slightly acid; abrupt boundary.

A12—6 to 10 inches, black (10YR 2/1) light silty clay loam, dark gray (10YR 4/1 to N 4/0) when dry; material the same color when kneaded; moderate, very fine, granular structure; friable; medium acid; clear boundary.

A3—10 to 17 inches, black (10YR 2/1) medium to heavy silty clay loam; common, fine, faint mottles of very dark gray (10YR 3/1) and few, fine, faint mottles of dark gray (10YR 4/1); material very dark gray (10YR 3/1) when kneaded; weak, very fine, subangular blocky structure; friable to firm; some, grainy, gray coats on peds; medium acid; clear boundary.

B21—17 to 22 inches, black (10YR 2/1) medium silty clay; common, fine, faint mottles of dark gray and dark grayish brown (10YR 4/1 and 10YR 4/2) and few, fine, faint mottles of dark yellowish brown (10YR 4/4); very dark gray (10YR 3/1) when kneaded; moderate, fine to very fine, subangular blocky structure; firm; common fine concretions of iron and manganese; medium acid; clear boundary.

B22tg—22 to 28 inches, very dark gray (10YR 3/1) and dark-gray (5Y 4/1) medium silty clay; many, fine, faint mottles of yellowish brown (10YR 5/4 to 10YR 5/6) and few, fine, faint mottles of dark gray (10YR 4/1); material dark grayish brown (2.5Y 4/2) when kneaded; moderate, fine, blocky and subangular blocky structure; firm to very firm; common, thick, discontinuous clay films; common, fine concretions of iron and manganese; medium acid; gradual boundary.

B23tg—28 to 34 inches, dark-gray (5Y 4/1) and grayish-brown (2.5Y 5/2) light to medium silty clay; many fine mottles of yellowish brown (10YR 5/4) and few, fine, distinct mottles of strong brown (7.5YR 5/6); material grayish brown (10YR 5/2) when kneaded; weak to moderate, fine to medium, subangular blocky structure; firm to very firm; almost continuous, thick, dark-gray to gray (10YR 4/1 to 10YR 5/1) clay films; slightly acid; gradual boundary.

B31t—34 to 42 inches, grayish-brown (2.5Y 5/2) and some dark-gray (5Y 4/1) medium to heavy silty clay loam; common, fine, distinct mottles of yellowish brown (10YR 5/6 to 10YR 5/8) and few, fine, faint mottles of grayish brown (2.5Y 5/3); material brown to dark brown (10YR 4/3) when kneaded; weak, medium, subangular block structure; firm; thin discontinuous clay films; relict deoxidized and leached weathering zone; few, fine, soft, black (10YR 2/1) concretions and stains; neutral; gradual boundary.

B32t—42 to 55 inches, light brownish-gray (2.5Y 6/2) light to medium silty clay loam; common, fine, faint mottles of light olive brown (2.5Y 5/4); very weak, medium, prismatic breaking to weak, medium, subangular blocky structure; friable to firm; thin discontinuous clay films on some prism faces; relict deoxidized and leached weathering zone; neutral; gradual boundary.

C—55 to 70 inches, light brownish-gray (2.5Y 6/2) light to medium silty clay loam; many, fine, distinct mottles of strong brown (7.5YR 5/8) and few fine mottles of yellowish red (5YR 4/6); massive with some vertical cleavage; several cleavage planes at about 30° from vertical and coated with black (10YR 2/1 to 3/1) clay; friable; pores have distinct black (10YR 2/1) clay films; relict deoxidized and leached weathering zone; neutral.

The A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) in color and from 10 to 18 inches in thickness. Texture ranges from silt loam to silty clay loam. In some areas adjacent to Edina soils, the lower part of the A horizon is slightly grayer than the upper part.

The matrix color of the B horizon ranges from 10YR to 5Y in hue and has values of 2 to 4 and a chroma of 1 in the upper part. In the lower part this horizon has colors with values of 4 to 6 and a chroma of 1 or 2. Thickness of the solum ranges from 3 to 4 feet. Content of clay ranges from 42 to 48 percent in the zone of maximum accumulation.

The C horizon is silty clay loam. It has colors similar to those in the lower part of the B horizon, but commonly the hue is 2.5Y. Depth to the glacial till is about 8 to 9 feet.

The Haig soils have a thicker, dark-colored surface layer than the Edina soils, but Haig soils lack the grayish A2 horizon characteristic of the Edina soils. Haig soils have poorer drainage than the adjacent sloping Grundy soils, and their subsoil is more mottled and less brown than that of the Grundy soils.

Haig silt loam (0 to 2 percent slopes) (Ha).—This soil has a black surface layer that is 10 to 18 inches thick and contains much organic matter. Tilth is generally good, but this soil tends to puddle if cultivated too soon after rains.

This soil is slightly acid. Most crops respond well to applications of lime. Available nitrogen and potassium are medium, and available phosphorus is low.

Haig silt loam is farmed with surrounding Grundy soils that are well suited to and are used for row crops. It dries more slowly after rains and warms more slowly in spring than the Grundy soils, but it is suitable for intensive row cropping if it is drained. Corn responds well to applications of fertilizer. Because surface drainage is poor and permeability is very slow in the subsoil, shallow ditches may be needed to remove surface water during wet periods. Tile drains are not suitable. (Capability unit IIw-2; woodland suitability group 7)

Humeston Series

The Humeston series consists of moderately dark colored, poorly drained to very poorly drained soils that formed from alluvium. These soils are level to gently sloping. Where they are level, they occur on bottom lands with Zook, Wabash, Colo, and Vesser soils. Where Humeston soils are gently sloping, they occur near drainageways and larger streams and are associated with Vesser soils. Wet prairie grasses made up the native vegetation. These soils are of minor extent in Wayne County and are in areas ranging from 5 to 20 acres in size. They are only fair for farming.

In a typical profile, the surface layer extends to a depth of about 24 inches. It is very dark gray silty clay loam to a depth of 7 inches and, below that depth, is very dark gray to gray silt loam mottled with dark brown. The next layer is distinctly mottled very dark gray silty clay loam about 7 inches thick. It is underlain by a subsoil of silty clay and silty clay loam that is black to dark gray mottled with gray and olive brown. The subsoil extends to a depth of 5 feet or more and is underlain by gray silty clay loam that is mottled.

The Humeston soils are seasonally wet because the water table is high or the soils are flooded. Drainage and flood protection are needed. Permeability is very slow, and available moisture holding capacity is high.

Typical profile of Humeston silty clay loam, on a slope of 1 percent, about 250 feet north and 100 feet west of the southeast corner of NE¼ section 31, T. 70 N., R. 22 W.:

A1—0 to 7 inches, very dark gray (10YR 3/1) silty clay loam; granular to weak, fine, subangular blocky structure; friable; medium acid; clear boundary.

A12—7 to 13 inches, very dark gray (10YR 3/1) silt loam; common, fine, distinct mottles of dark brown (7.5YR 3/2); material dark gray (10YR 4/1) when kneaded; moderate, thin, platy breaking to moderate, fine, granular structure; friable; discontinuous grainy ped coats that are light gray and gray (10YR 6/1 and 7/1) when dry; medium acid; clear boundary.

A21—13 to 18 inches, dark-gray (10YR 4/1) silt loam; common, fine, distinct mottles of dark brown (7.5YR 3/2); color same as matrix when kneaded; moderate, thin, platy structure; friable; discontinuous grainy ped coats that are light gray (10YR 7/1) when dry, few fine pores; strongly acid; clear boundary.

A22—18 to 24 inches, dark-gray to gray (10YR 4/1 to 5/1) silt loam; few, fine, distinct mottles of dark brown (7.5YR 3/2); dark gray to grayish brown (10YR 4/1 to 5/2) when kneaded; weak, medium, subangular blocky structure with some horizontal cleavage; friable; nearly continuous grainy ped coats that are light gray (10YR 7/1) when dry; numerous fine pores; few fine concretions; very strongly acid; clear boundary.

AB—24 to 31 inches, very dark gray (10YR 3/1) light silty clay loam; many, coarse, distinct mottles of gray (N 5/0); material dark gray (10YR 4/1) when kneaded; weak, medium, subangular blocky structure; friable to firm; very dark gray (10YR 3/1), thin, discontinuous clay films; few, patchy, grainy ped coats that are light gray (10YR 7/1) when dry; numerous fine pores; few hard concretions; very strongly acid; gradual boundary.

B21t—31 to 45 inches, black (10YR 2/1) light silty clay; few, fine, distinct mottles of gray (N 5/0); material black to very dark gray (10YR 2/1 to 3/1) when kneaded; weak, medium, prismatic breaking to moderate, medium, subangular blocky structure; firm; thin discontinuous clay films; few, discontinuous, grainy ped coats that are light gray (10YR 7/1) when dry; very strongly acid; gradual boundary.

B22tg—45 to 60 inches, black (N 2/0 to 10YR 2/1) light silty clay; material black (10YR 2/1) when kneaded; moderate, medium, prismatic structure; firm; few, fine, discontinuous clay films; strongly acid; gradual boundary.

B3tg—60 to 80 inches, dark-gray (10YR 4/1) medium to heavy silty clay loam; few, fine, distinct mottles of light olive brown (2.5Y 5/4); material dark grayish brown (10YR 4/2) when kneaded; weak, coarse, subangular blocky structure; firm; few, thin, discontinuous clay films; medium acid.

The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) in color and from 10 to 14 inches in thickness. The A2 horizon is 8 to 16 inches thick. The B horizon is black (10YR 2/1) to very dark gray (10YR 3/1) in the upper part, but its color grades to dark gray (10YR 4/1) or gray (10YR 5/1) as depth increases. In the most developed part of the B horizon, the content of clay ranges from 38 to 50 percent.

Laboratory data on samples taken at this site show a clay maximum of 40 percent in the B21 horizon and a range of 19 to 40 percent throughout the solum. The lowest content of clay is in the A22 horizon. The content of clay is uniform between depths of 31 and 60 inches and has a narrow range of 38 to 40 percent. The content of silt is lowest in the B21 horizon (53 percent) and highest in the A22 horizon (73 percent). The content of sand is low in all horizons and ranges from 2 to 9 percent in an irregular pattern.

The Humeston soils have a gray silt loam A2 horizon that is lacking in the Colo, Zook, and Wabash soils. The B horizon of Humeston soils is thinner than that of the Colo soils. Humeston soils have a thinner A2 horizon and a more clayey B horizon than the Vesser soils.

Humeston silty clay loam (0 to 2 percent slopes) (Hu).—This soil is generally wet, and many areas are flooded occasionally. The surface layer is very dark gray silty clay loam 10 to 14 inches thick. It is underlain by a gray leached layer that, in turn, is underlain by a very slowly permeable subsoil consisting of dark-colored silty clay.

This soil is strongly acid to very strongly acid. It is low in available nitrogen and medium in potassium. The content of organic matter is medium.

Except for corn, row crops are fairly well suited to this soil. Soybeans can be planted in rotations instead of corn, but corn responds fairly well to fertilizer. Poor tilth can be improved by growing a meadow crop for 1 year. Because this soil dries slowly in spring and after rains, planting and cultivation may be delayed. Some pasture plants grow well on this soil, particularly in undrained areas.

Drainage is needed on this wet soil. Excess surface water can be drained by open ditches, but even in drained areas these soils are difficult to work, and they puddle easily. Tile drains do not work well, because the subsoil is very slowly permeable. (Capability unit IIIw-1; woodland suitability group 7)

Humeston silty clay loam, 2 to 5 percent slopes (HuB).—This soil occurs on foot slopes along the valleys of the major streams. This soil has a profile similar to the one described for the series, but included areas have a silt loam surface layer.

Most of this soil has slopes of 3 percent or less, and erosion is not a serious hazard. This soil is often wet, however, for it receives excessive runoff and some seepage from soils on adjacent uplands. In many places diversion terraces are built in the adjacent soils upslope so as to divert water that runs from the uplands.

This soil is strongly acid to very strongly acid. It is low in available nitrogen and phosphorus and is medium in available potassium.

Row crops are fairly well suited to this soil if contour cultivation is used. Soybeans generally grow better than corn, but corn responds fairly well to fertilizer. A meadow crop is needed if tilth becomes poor. (Capability unit IIIw-1; woodland suitability group 7)

Kniffin Series

The Kniffin series consists of moderately dark colored, somewhat poorly drained to moderately well drained soils on uplands. These soils developed from leached loess that is about 48 to 80 inches thick and is underlain by a buried, very slowly permeable, clayey soil. A mixture of grass and trees was the native vegetation. Kniffin soils are on narrow ridgetops upslope from the Adair, Clarinda, Lamoni, and Gara soils. Slopes generally range from 2 to 9 percent and are mostly short and convex. These soils occur in most of the county except the northwestern corner and the extreme northern part. They are only fair for farming. Individual areas of these soils range from 5 to 30 acres in size.

In a typical profile, the surface layer is friable silt loam to silty clay loam that is mainly very dark gray and very dark grayish brown in color and is subangular blocky to granular in structure. It is about 9 inches thick. The subsoil extends to a depth of about 57 inches. To a depth of about 28 inches, it is very dark grayish-brown, dark grayish-brown, and grayish-brown, friable to very firm silty clay that is mottled with dark yellowish brown, yellowish brown, and strong brown. Below this is friable to firm, mottled olive-gray, yellowish-brown, and strong-brown silty clay loam. Mottling begins at a depth of about 9 inches and extends throughout the subsoil. The substratum is typically about the same color as the lower part of the subsoil but has a slightly lower content of clay.

The Kniffin soils are subject to erosion, particularly if planted to a row crop. These soils have a high available moisture holding capacity and are very slowly permeable.

A typical profile of Kniffin silt loam, near the center of a convex ridgetop that has a slope of 3 percent, about 60 feet north and 750 feet east of the southwest corner of SE¼SW¼ section 16, T. 67 N., R. 22 W.:

A1—0 to 6 inches, very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) when dry; moderate, fine, subangular blocky breaking to moderate, fine, granular structure; friable; strongly acid; clear, smooth boundary.

A2—6 to 9 inches, silt loam to silty clay loam that is very dark grayish brown (10YR 3/2) on ped exteriors and dark grayish brown (10YR 4/2) in ped interiors; few very dark gray (10YR 3/1) worm casts; material is very dark grayish brown (10YR 3/2) when kneaded; weak, medium, platy breaking to moderate, very fine, subangular blocky and granular structure; friable; on plates are patches of thin grainy coats that are gray or light gray (10YR 6/1) when dry; few, fine, dark-brown (7.5YR 3/2) oxide concretions; very strongly acid; clear, smooth boundary.

B1—9 to 14 inches, light silty clay that is dark grayish brown (10YR 4/2) and has discontinuous patches of very dark grayish brown (10YR 3/2) on ped exteriors; few, fine, faint mottles of dark yellowish brown (10YR 4/4); few very dark gray (10YR 3/1) worm casts; material dark grayish brown (2.5Y 4/2) when kneaded; moderate, very fine, subangular blocky structure; friable to firm; on peds are grainy coats that are gray or light gray (10YR 6/1) when dry; few, fine, dark-brown (7.5YR 3/2) oxide concretions; very strongly acid; clear, smooth boundary.

B21t—14 to 18 inches, dark grayish-brown (10YR 4/2) heavy silty clay; many, fine, distinct mottles of yellowish brown (10YR 5/6) and few, fine, distinct mottles of strong brown (7.5YR 5/6); few very dark gray (10YR 3/1) worm casts; material brown to yellowish brown (10YR 4/3 to 5/4) when kneaded; moderate, fine, angular blocky and subangular blocky structure; very firm; thick, discontinuous, very dark gray (10YR 3/1) clay films; few, fine, dark-brown (7.5YR 3/2) oxide concretions; strongly acid; gradual, smooth boundary.

B22t—18 to 23 inches, dark grayish-brown (10YR 4/2) medium silty clay; many, fine, distinct mottles of yellowish brown (10YR 5/6) and common, fine, distinct mottles of strong brown (7.5YR 5/6); material brown to yellowish brown (10YR 4/3 to 5/4) when kneaded; moderate, fine, angular blocky and subangular blocky structure; very firm; thick, discontinuous, dark-gray (10YR 4/1) clay films; few, fine, dark reddish-brown (5YR 3/2) oxide concretions; strongly acid; gradual, smooth boundary.

B23t—23 to 28 inches, grayish-brown (2.5Y 5/2) light silty clay; many, fine, distinct mottles of yellowish brown (10YR 5/4 and 5/8); material yellowish brown (10YR 5/4) when kneaded; weak, coarse, prismatic breaking to moderate, medium, subangular blocky structure; very firm; thin discontinuous clay films, mostly on prism faces; relict deoxidized and leached weathering zone; few, fine, dark reddish-brown (5YR 3/2) oxide concretions; medium acid; gradual, smooth boundary.

B31t—28 to 35 inches, mottled olive-gray (5Y 5/2) and yellowish-brown (10YR 5/6) heavy silty clay loam; material yellowish brown (10YR 5/4) when kneaded; weak, coarse, prismatic breaking to weak, medium and coarse, subangular blocky structure; firm; few patchy clay films, some of which are dark grayish brown (10YR 4/2) on prism faces; relict deoxidized and leached weathering zone; many, fine, dark reddish-brown (5YR 3/2), soft oxide concretions; few dark reddish-brown (5YR 2/2) stains on ped surfaces; slightly acid; gradual, smooth boundary.

B32t—35 to 45 inches, mottled olive-gray (5Y 5/2), yellowish-brown (10YR 5/6), and strong-brown (7.5YR 5/6) medium silty clay loam; material yellowish brown (10YR 5/4) when kneaded; weak, coarse, prismatic structure; firm to friable; few patchy clay films on prism faces; relict deoxidized and leached weathering zone; many, fine, soft, dark reddish-brown (5YR 3/2) oxide concretions; slightly acid; gradual, smooth boundary.

B33—45 to 57 inches, light olive-gray (5Y 6/2) light silty clay loam; many, fine, prominent mottles of strong brown (7.5YR 5/8) and few, fine, prominent mottles of reddish brown (5YR 4/4); material yellowish brown (10YR 5/4) when kneaded; weak, coarse, prismatic structure; friable to firm; relict deoxidized and leached weathering zone; many, fine, soft, dark reddish-brown (5YR 3/2) oxide concretions and stains; neutral.

The A1 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color and from 5 to 8 inches in thickness. The A2 horizon generally ranges from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2), but it has some very dark grayish brown (10YR 3/2) and very dark gray (10YR 3/1) on the exteriors of peds. The A2 horizon is 3 to 8 inches thick.

The B horizon ranges from dark grayish brown (10YR 4/2) in the upper part to grayish brown (2.5Y 5/2) and light olive gray (5Y 6/2) in the lower part. Mottles in the B horizon are commonly yellowish brown (10YR 5/6 and 5/8). The grayish colors are relict and are related to a deoxidized and leached weathering zone. By volume, clay makes up 48 to 56 percent of its zone of maximum accumulation, which occurs at a depth of about 12 to 18 inches.

Laboratory data on samples taken at this site show a clay maximum of 54 percent in the B21t horizon and a range from 22 to 54 percent throughout the solum. The lowest content of clay is in the A1 horizon. The content of clay of the B1 horizon is 44 percent and is twice that of the A1 horizon. The content of clay in the B33 horizon is 32 percent. The content of silt ranges from a high of 74 percent in the A1 horizon to a low of 44 percent in the B21t horizon. The content of sand is low in all horizons and is less than 4 percent through all parts of the profile.

The Kniffin soils have a thinner A1 horizon than have the Seymour and Grundy soils, in which an A2 horizon is missing. Kniffin soils have a thicker A1 horizon than have the Rathbun soils. Less of sand, pebbles, and stones is in the Kniffin soils than are in the Adair, Lamoni, and Gara soils, which were derived from till. The B horizon of the Kniffin soils is thinner and less gray than that of the Clarinda soils.

Kniffin silt loam, 2 to 5 percent slopes (KnB).—This soil is on somewhat rounded ridgetops and short, slightly convex side slopes. It is generally surrounded by moderately sloping Kniffin soils.

The surface layer of this soil consists of very dark gray silt loam, 5 to 8 inches thick, and a thin layer that becomes gray when it dries. The subsoil is very firm and clayey.

Lime is needed because this soil is strongly acid. In most of the acreage, available nitrogen and phosphorus are low and available potassium is medium. Erosion is likely because the surface layer contains only a medium amount of organic matter and is not strongly granular.

If terraces and contour tillage are used on this soil, row crops can be grown 3 years in 5. Additions of organic matter are needed to improve tilth. Crops grow moderately well if management is good. (Capability unit IIIe-2; woodland suitability group 3)

Kniffin silt loam, 5 to 9 percent slopes (KnC).—Most of this soil is on rounded ridgetops, but some is on slightly convex side slopes. The ridgetops extend toward broader divides, and near them this soil generally occurs with the Seymour soils. Downslope are moderately sloping Clarinda and Adair soils. Some areas of this Kniffin soil are very large.

The surface layer of this soil consists of very dark gray silt loam, 5 to 8 inches thick, and a very thin layer that becomes gray when it dries. The subsoil is very firm and clayey.

This soil contains a medium amount of organic matter. It is strongly acid and requires lime. Available nitrogen and phosphorus are low, and available potassium is medium. Response to nitrogen and phosphate fertilizers is good.

Much of this soil is in cropland, and many areas are farmed separately from areas of other soils. This soil is moderately well suited to row crops, though runoff is rapid and erosion is very likely in cultivated areas. Rotations that include meadow 3 years in 6 are suitable if terracing and contour tillage are used. (Capability unit IIIe-3; woodland suitability group 3)

Kniffin silt loam, 5 to 9 percent slopes, moderately eroded (KnC2).—This soil is in bands on short, slightly convex side slopes and is on rounded ridgetops upslope from soils derived from till. The total acreage of this soil in the county is moderate, and individual areas are generally large.

The surface layer of this soil consists of very dark gray to very dark grayish brown silt loam, 3 to 6 inches thick, and a very thin grayish layer. In many places the plow layer is noticeably lighter colored when dry because the thin grayish layer has been mixed into it by tillage. The subsoil is very firm and clayey.

Included with this soil in mapping were a few areas that have slopes of more than 9 percent.

Susceptibility to erosion is high. The surface layer is low in organic matter, and tilth is generally poor. After rains the soil surface tends to crust. Plowing may expose the subsoil at the edge of slope shoulders and at the head of waterways on sidehills.

This soil needs lime, for it is strongly acid. It is low in available nitrogen and phosphorus and medium in available potassium. The response to nitrogen and phosphate fertilizers is good.

This soil is mostly used in crop rotations. If it is terraced and tilled on the contour, it can be planted to row crops, but meadow is needed 3 years in 6. The meadow generally improves soil tilth, as do applications of manure. Under good management, crops grow moderately well. (Capability unit IIIe-3; woodland suitability group 3)

Lamoni Series

The Lamoni series consists of moderately dark colored, somewhat poorly drained soils on uplands. These soils formed from a thin layer of weathered glacial till that is gray clay commonly called gumbotil. Gumbotil was the subsoil of a soil on the nearly level drift plain that remained after the Kansan glacier. Later a deposit of loess covered the gumbotil, but geologic erosion removed the loess and much of the gumbotil in many places. The Lamoni soils are mostly on side slopes where the soil that was buried had been modified by geologic erosion and is exposed. Soils that are buried or were once buried are called paleosols. Since they have been exposed, the native vegetation has been prairie grasses.

These soils are downslope from the Clarinda soils. Lamoni soils have slopes of 5 to 14 percent but are most common on slopes of 9 to 14 percent. Individual areas range from 5 to 20 acres in size and occur in all parts of the county.

In a typical profile, the surface layer is about 11 inches thick and consists of black to very dark gray and very dark grayish-brown, friable silty clay loam to clay loam. The subsoil extends to a depth of about 55 inches. It consists of many layers that range from clay to clay loam in texture and from dark grayish brown and grayish brown to yellowish brown in color. Mottling begins at a depth of about 11 inches and extends throughout the subsoil. Mottles are mainly brownish colored in the upper part and grayish colored in the lower part. The substratum is mottled yellowish-brown, firm clay loam.

The Lamoni soils are seasonally wet by seepage on hillsides. They are subject to erosion, particularly where they are in row crops. Available moisture holding capacity is high, and permeability is very slow.

A typical profile of Lamoni silty clay loam, on a west-facing slope of 9 percent, 200 feet east and 30 feet south of the northwest corner of NE¼ section 22, T. 70 N., R. 22 W.:

A1—0 to 6 inches, black (10YR 2/1) to very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) when dry; very dark gray (10YR 3/1) when kneaded; moderate, fine, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

A3—6 to 11 inches, very dark grayish-brown (10YR 3/2) heavy clay loam that has discontinuous very dark gray (10YR 3/1) colors on ped exteriors; color same as matrix when material is kneaded; moderate, very fine, subangular blocky and granular structure; friable; few black (10YR 2/1) worm casts; strongly acid; clear, smooth boundary.

IIB1—11 to 14 inches, light clay that is dark grayish brown (10YR 4/2) on ped exteriors and dark brown or brown (10YR 4/3) on ped interiors; few, fine, faint mottles of dark yellowish brown (10YR 4/4); moderate, fine, subangular blocky structure; firm to friable; few very dark gray (10YR 3/1) worm casts; paleo B3 strongly acid; gradual, smooth boundary.

IIB21t—14 to 19 inches, dark grayish-brown to grayish-brown (10YR 4/2 to 5/2) clay; many, fine, distinct mottles of yellowish brown (10YR 5/6) and few, fine, distinct mottles of strong brown (7.5YR 5/6); dark brown to brown (10YR 4/3) when kneaded; moderate, fine, subangular blocky structure; firm to very firm; thin continuous clay films; weatherable minerals; medium acid; gradual, smooth boundary.

IIB22t—19 to 25 inches, grayish-brown (2.5Y 5/2) clay; common, fine, distinct mottles of yellowish brown (10YR 5/6) and few, fine, prominent mottles of strong brown (7.5YR 5/6); material yellowish brown (10YR 5/4) when kneaded; moderate, fine, subangular blocky structure; firm to very firm; thick continuous clay films; dark-brown (7.5YR 3/2) soft oxides; few pebbles one-fourth inch in diameter; weatherable minerals; color partly inherited from B horizon of Yarmouth–Sangamon paleosol; medium acid; gradual, smooth boundary.

IIB31t—25 to 33 inches, mottled light brownish-gray (2.5Y 6/2), gray or light-gray (5Y 6/1), and yellowish-brown (10YR 5/6) light clay; material dark yellowish brown to yellowish brown (10YR 4/4 to 5/4) when kneaded; moderate, medium, prismatic breaking to weak, medium, subangular blocky structure; firm; thin discontinuous clay films on prism faces; common, black (10YR 2/1) and dark-brown (7.5YR 3/2) soft oxide concretions; some pebbles one-fourth inch in diameter; color partly inherited from B horizon of Yarmouth-Sangamon paleosol; medium acid; gradual boundary.

IIB32t—33 to 42 inches, yellowish-brown (10YR 5/6) medium clay loam; common, medium, distinct mottles of gray to light gray (5Y 6/1) and few medium mottles of strong brown (7.5YR 5/8); material yellowish brown (10YR 5/8) when kneaded; moderate, medium, prismatic breaking to weak, medium, subangular blocky structure; firm; thin discontinuous clay films; some very dark gray (10YR 3/1) around root channels; many, black (10YR 2/1) and dark-brown (7.5YR 3/2) soft oxide concretions; some pebbles one-fourth inch in diameter; slightly acid; gradual boundary.

IIB33—42 to 55 inches, same as horizon above except that texture is light clay loam.

IIC—55 to 80 inches, yellowish-brown (10YR 5/6) light clay loam; common, medium, distinct mottles of gray or light gray (5Y 6/1) and a few, medium, faint mottles of strong brown (7.5YR 5/8); material yellowish brown (10YR 5/6) when kneaded; massive; firm; many, black (10YR 2/1) and dark-brown (7.5YR 3/2) soft oxide concretions; some pebbles one-fourth inch in diameter; neutral.

The A horizon ranges from 8 to 16 inches in thickness. The B2 horizon ranges from dark grayish brown (10YR 4/2) to light brownish gray (2.5Y 6/2) with common yellowish-brown (10YR 5/4 to 5/8) mottles. Clay makes up about 45 to 50 percent of the soil mass in its zone of maximum accumulation, which occurs at a depth of about 14 to 20 inches. The gleyed colors of the B2 horizon are inherited from the Yarmouth-Sangamon paleo B horizon. Thickness of the IIB2 horizon ranges from 11 to 24 inches. The B3 and C horizons generally are mottled dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/4 to 5/6) clay loam. Carbonates are commonly leached to depths below 48 inches.

Laboratory data on samples taken at this site show that the content of clay throughout the solum ranges from 30 percent to 51 percent. The lowest content of clay is in the B33 horizon. The A1 horizon has a content of clay of 31 percent, and there is a gradual increase to the maximum of 51 percent in the IIB21t horizon. The content of silt ranges from a high of 47 percent in the A1 horizon to a low of 28 percent in the IIB31t horizon. The content of sand ranges from a low of 18 percent in the IIB21t horizon to a high of 40 percent in the IIB33 horizon. The content increases rather consistently to 55 inches.

The Lamoni soils have a higher clay content than the Shelby and Gara soils and a more grayish subsoil. They have a thinner and more mottled B horizon than the Clarinda soils. Lamoni soils have a grayish-colored subsoil, whereas the subsoil of the Adair soils is reddish colored.

Lamoni silty clay loam, 5 to 9 percent slopes, moderately eroded (LaC2).—This soil is normally on slopes of ridgetops and some coves. It is generally downslope from the Clarinda soils. In some places it is in bands at the shoulders of side slopes that are upslope from the Shelby soils.

This soil has a silty clay loam plow layer. It grades to a firm, grayish-brown clay subsoil. Included in mapping were a few areas where the subsoil is exposed. Because of the firm clayey subsoil and the moderate slopes, this soil is highly susceptible to erosion if cultivated. When the soil dries, cracks appear on the surface and extend deep into the subsoil. The grayish clay subsoil is exposed in some places on the upper part of the slope or in the center of rounded slopes between drains. In many cultivated fields this soil is difficult to work because the clayey subsoil is mixed with the surface layer.

This soil is low in organic-matter content and is slightly acid to strongly acid. It is generally low in available nitrogen, very low in available phosphorus, and medium in available potassium. Pasture plants respond fairly well to fertilizer, but row crops do not.

Most of this soil is in pasture or is cropland. Cultivated areas should be tilled on the contour and kept in meadow 3 years in 5. Pasture is a better use than row crops, which are poorly suited. (Capability unit IIIe–4; woodland suitability group 4)

Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded (LaD2).—This soil is on side slopes that extend toward the heads of drainageways. It is below the Clarinda soils in most places. It is of moderate extent and is generally in areas 5 to 20 acres in size.

The plow layer of this soil is very dark gray silty clay loam. It grades to a grayish clay subsoil.

Included with this soil in mapping were areas that have a clay loam plow layer.

Because of the clay subsoil and strong slopes, this soil is erodible in cultivated areas and is hard to manage. Small spots of the clayey subsoil may be exposed near drains in sidehills and at the upper parts of slopes. When other soils in the field are ready for cultivation, this soil may be still too wet to work. If cultivated at the same time as the other soils, this soil puddles. The surface of this soil becomes hard and cloddy when dry.

This soil is very low in available nitrogen and phosphorus and medium in available potassium. It needs fairly heavy applications of lime because it is slightly acid to strongly acid. It also needs additions of organic matter.

In many places this soil is cultivated, but it is not well suited to row crops. It is better suited to meadow, but a row crop can be grown when pastures are renovated. Hay or pasture is probably the best use for this soil, though these crops do not grow well. (Capability unit IVe–2; wood and suitability group 4)

Lamoni soils, 9 to 14 percent slopes, severely eroded (LmD3).—These soils are on strong side slopes or in the heads of drainageways. They are downslope from the Clarinda soils. Areas are generally 5 to 15 acres in size, and the total acreage in the county is moderate.

Most of the original surface soil has been removed by erosion, and the remaining surface soil has been mixed with the former subsoil by plowing. The plow layer is usually dark grayish brown in color and clay or clay loam in texture. Gullies are common.

The surface layer of these soils is variable in texture but is fine textured in most places. When the soil dries, wide cracks open and the surface becomes hard. Runoff is rapid, and erosion is likely in cultivated areas.

These soils are very low in available nitrogen and phosphorus and medium in available potassium. In some areas lime and a phosphate fertilizer are needed for establishing grass.

Grains grow poorly on these soils. These soils are better suited to pasture than to grain, but pasture and other forage crops do not grow well. Most of the acreage is in pasture. Some areas of these soils could be managed to provide cover and food for wildlife (fig. 12).

On these soils erosion can be controlled by working and shaping the gullies and seeding them to grass. Good seedbeds, however, are difficult to prepare. By building short temporary diversion terraces above these soils, runoff is diverted until the seedings are well established. If possible, old pastures should be renovated without destroying existing vegetation. (Capability unit VIe–2; woodland suitability group 4)

Lawson Series

The Lawson series consists of dark-colored, somewhat poorly drained, nearly level to undulating soils on first bottoms that are dissected by old meandering channels in some places. These soils developed from silty alluvium. They are fairly extensive throughout the county and occur on both wide and narrow stream bottoms.

Figure 12.—**A farm pond built in an area of Lamoni soils. It provides livestock with water and is excellent for wildlife.**

They are closely intermingled with the Nodaway soils and, in this county, are mapped only in complex with them.

In a typical profile, the surface layer of Lawson soils consists of about 28 inches of very dark gray to very dark grayish-brown, friable silt loam. The subsoil is dark grayish-brown, friable silt loam that extends to 4 feet or more and is mottled mainly with brown and dark brown. The substratum is similar to the subsoil in color and texture.

Some areas of these soils are subject to occasional flooding, but others are protected by levees. These soils have high available moisture holding capacity and are moderately permeable.

Typical profile of Lawson silt loam, on a slope of 1 percent, about 175 feet east and 550 feet south of northwest corner of NE¼SW¼ section 11, T. 69 N., R. 20 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam; few dark-gray (10YR 4/1) streaks; material very dark gray to very dark grayish brown (10YR 3/1 to 3/2) when kneaded; gray (10YR 5/1) when dry; weak, fine, granular structure; friable; slightly acid; clear boundary.

A12—7 to 11 inches, very dark gray (10YR 3/1) silt loam; few very dark grayish-brown (10YR 3/2) patches in interior of peds; material very dark gray to very dark grayish brown (10YR 3/1 to 3/2) when kneaded; weak, fine and very fine, subangular blocky structure; friable; common fine pores; slightly acid; clear boundary.

A13—11 to 16 inches, silt loam that is very dark gray (10YR 3/1) on ped exteriors and very dark grayish brown (10YR 3/2) in most ped interiors; material very dark grayish brown (10YR 3/2) when kneaded; moderate, fine and very fine, subangular blocky and angular blocky structure; friable; few black concretions of manganese oxide; common fine pores; slightly acid; gradual boundary.

A14—16 to 21 inches, very dark gray to very dark grayish-brown (10YR 3/1 to 3/2) silt loam; few light grayish-brown (10YR 6/2) streaks; material very dark grayish brown (10YR 3/2) when kneaded; moderate, fine, subangular blocky and angular blocky structure; friable; few black concretions of manganese oxide; many common pores; slightly acid; gradual boundary.

A3—21 to 28 inches, very dark grayish-brown (10YR 3/2) silt loam; few, fine, faint mottles of dark grayish brown (10YR 4/2); few very dark gray (10YR 3/1) root channels and patches on peds; material very dark grayish brown to dark grayish brown (10YR 3/2 to 4/2) when kneaded; weak, fine and medium, subangular blocky structure; friable; few soft concretions of manganese oxide; many fine pores; slightly acid; gradual boundary.

B1—28 to 34 inches, dark grayish-brown to very dark grayish-brown (10YR 4/2 to 3/2) silt loam; common, very dark grayish-brown (10YR 3/2) patches in root channels and on peds; material dark grayish brown (10YR 4/2) when kneaded; weak, fine, prismatic breaking to weak, medium, subangular blocky structure; friable; few grainy ped coats that are light brownish gray (10YR 6/2) when dry; few soft oxide concretions; common fine pores; slightly acid; gradual boundary.

B2—34 to 40 inches, dark grayish-brown to very dark grayish-brown (10YR 4/2 to 3/2) silt loam; few, fine, faint mottles of dark brown to brown (10YR 4/3); common, very dark grayish-brown (10YR 3/2) patches in root channels and on peds; material very dark grayish brown to dark brown (10YR 3/2 to 3/3) when kneaded; weak, medium and fine, prismatic structure; friable; common grainy ped coats that are light brownish gray (10YR 6/2) when dry; few soft concretions of manganese oxide; common fine pores; medium acid; gradual boundary.

B3—40 to 48 inches, dark grayish-brown to very dark grayish-brown (10YR 4/2 to 3/2) silt loam; common, fine, faint mottles of very dark grayish brown (10YR 3/2); material dark brown to brown (10YR 3/3 to 4/3) when kneaded; weak, medium and fine, prismatic structure; friable; almost continuous grainy ped coats that are light gray (10YR 7/2) when dry; common soft oxide concretions; common fine pores; medium acid.

The A horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color and from 24 to 36 inches in thickness. In places the Ap horizon is somewhat lighter colored than normal because it is mixed with recent deposits. The B horizon ranges from very dark grayish brown (10YR 3/2) in the upper part to dark grayish brown (10YR 4/2). The silt loam texture extends from the surface to a depth of 42 to 60 inches.

The Lawson soils are not so fine textured as the Colo, Wabash, or Chequest soils but are better drained. They lack the grayish-colored silty A2 horizon of the Vesser soils. Lawson soils are darker colored than the Nodaway soils and are not stratified with material of variable textures.

Lawson-Nodaway complex (0 to 2 percent slopes) (Ln).—The soils in this complex are nearly level and occur on first bottoms. Some areas are slightly undulating where large stream channels have been straightened. Areas that were once old bayous are now farmed. Individual areas are generally large, and total acreage in the county is moderate.

These soils are friable, and they show little development in the profile. In a few areas a dark, buried soil occurs below a depth of 30 inches. The Lawson soils receive only small amounts of deposits, and their surface layer is darker than that of Nodaway soils. In both kinds of soil the subsoil is not mottled in most places, but the amount and color of mottles vary with the frequency of overflow. Permeability is moderate in the subsoil.

Tilth is generally good. These soils warm up quickly and can be worked earlier in the spring than the soils with a more developed profile. Except after damaging floods, crops generally grow very well.

These soils are medium acid to neutral. They are low in available nitrogen and medium in available phosphorus and potassium. A nitrogen fertilizer improves the growth of corn. The content of organic matter is medium to low.

These soils are suited to row crops grown intensively. Most of the acreage is cultivated, but occasional flooding is a hazard. Pasture and woodland are generally next to the main river channel and are flooded more frequently than cultivated fields. Instead of artificial drainage, protection from flooding is needed. (Capability unit I-1; woodland suitability group 6)

Lindley Series

The Lindley series consists of light-colored, moderately well drained soils of the uplands. These soils developed from slightly weathered glacial till under forest vegetation. They lack the reddish or grayish clayey subsoil that occurs in soils developed from highly weathered glacial till.

Lindley soils are in topography that ranges from the rounded ends of narrow ridgetops to irregular, complex side slopes. Slopes range from 14 to 30 percent. These soils generally are downslope from the Adair soils and are adjacent to the Mystic or Gara soils. Lindley soils have a small acreage in this county and occur mostly along the south side of the South Fork Chariton River.

In a typical profile the surface layer extends to a depth of about 8 inches. It is very dark gray, friable loam to silt loam in the upper part and grayish-brown loam in the lower part. The subsoil, which extends to a depth of about 42 inches, is predominantly dark yellowish-brown, firm clay loam that is mainly strongly acid. Mottling begins at a depth below 20 inches, and the mottles are mostly grayish brown. The substratum is calcareous and is about the same color and texture as the subsoil.

The Lindley soils are subject to erosion when cropped. They have high available moisture holding capacity and moderately slow permeability.

A typical profile of Lindley loam, on a convex side slope of 14 percent, 225 feet west and 1,175 feet north of the southeast corner of SW¼NW¼, section 14, T. 69 N., R. 20 W., 175 feet north of old abandoned fence line at edge of timber:

A1—0 to 2 inches, very dark gray (10YR 3/1) loam; weak, fine, granular structure; friable; medium acid to slightly acid; clear boundary.

A2—2 to 8 inches, grayish-brown and pale-brown (10YR 5/2 and 6/3) loam, light gray and white (10YR 7/2 and 8/2) when dry; weak, thin, platy breaking to weak, fine, subangular blocky structure; friable; very strongly acid; gradual boundary.

B1—8 to 10 inches, dark-brown or brown (10YR 4/3) light clay loam with some pebbles; weak, fine to very fine, subangular blocky structure; friable to firm; common grainy ped coatings; very strongly acid; gradual boundary.

B21t—10 to 20 inches, dark yellowish-brown (10YR 4/4) medium to heavy clay loam with some pebbles; moderate, fine to very fine, angular blocky structure; firm; thin discontinuous clay films; strongly acid; gradual boundary.

B22t—20 to 28 inches, medium clay loam that is dark yellowish brown (10YR 4/4) with some slightly darker ped exteriors; fine distinct mottles of grayish brown (2.5Y 5/2); some pebbles; moderate, fine to medium, angular blocky structure; firm; almost continuous thick clay films; strongly acid; gradual boundary.

B31t—28 to 33 inches, sandy clay loam that is dark brown or brown (7.5YR 4/4) with common strong-brown (7.5YR 5/6) ped interiors; weak, medium, angular and subangular blocky structure; firm; few, thin, discontinuous clay films; many coarse sand grains; medium acid; gradual boundary.

B32t—33 to 38 inches, light clay loam with dark yellowish-brown (10YR 4/4) ped exteriors and yellowish-brown (10YR 5/6) ped interiors; few, fine, faint mottles of grayish brown (2.5Y 5/2); weak, medium, subangular blocky structure to massive; firm; few, thin, discontinuous clay films; slightly acid; gradual boundary.

B33t—38 to 42 inches, dark yellowish-brown (10YR 4/4) light clay loam with common, medium, faint mottles of grayish brown (2.5Y 5/2); some pebbles; massive with some cleavage planes; firm; few, thin, discontinuous clay films; calcareous at depth of 38 inches; calcium carbonate concretions; neutral.

The A1 horizon ranges from very dark grayish brown (10YR 3/2) to very dark gray (10YR 3/1) in color and from 1 to 4 inches in thickness. In places the A1 horizon is silt loam that is gritty. In cultivated or eroded areas, the surface layer commonly is dark gray (10YR 4/1) to dark grayish brown (10YR 4/2). The A2 horizon ranges from grayish brown (10YR 5/2) to pale brown (10YR 6/3) in color and from 4 to 8 inches in thickness. The B horizon is dark brown or brown (10YR 4/3) to dark yellowish-brown (10YR 4/4) clay loam and has grayish mottles in the lower part of the B2 horizon and in the B3 horizon. Clay in the B horizon is estimated to be 30 to 36 percent. The depth to carbonates is about 30 to 48 inches. These soils range from very strongly acid to strongly acid in the most acid part of the solum.

The Lindley soils have less clay in their subsoil than the Adair soils, and they lack the reddish colors of the Adair.

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Lindley soils have a thinner dark-colored surface layer than have Gara soils, and they are finer textured in the lower part of the subsoil than the Caleb soils.

Lindley loam, 18 to 30 percent slopes, moderately eroded (LoF2).—This soil is on abrupt, steep side slopes. It is downslope from the Rathbun and Adair soils and is upslope from soils on bottom lands. Individual areas are as large as 30 acres in some places, but in most places they are smaller.

In most places the upper part of the surface layer is very dark gray loam and the lower part is leached, grayish-brown loam. In a few places the dark-brown clay loam subsoil is exposed. The subsoil contains lime at 30 inches in many places.

This soil is in trees, mostly oak and hickory, but there is some elm. Some areas are used for limited grazing, but clearing the soil and seeding pasture generally is not practical. This soil is best suited as woodland. (Capability Unit VIIe-1; woodland suitability group 2)

Lineville Series

The Lineville series consists of moderately dark colored, moderately well drained to somewhat poorly drained soils on uplands. These soils developed from leached loess that is 10 to 20 inches thick over pedisediment and weathered glacial till. The native vegetation was forest and grass. Lineville soils are underlain by very slowly permeable clayey materials that are similar to the materials underlying Adair and Clarinda soils. Slopes range from 5 to 9 percent and are mostly convex ridgetops. The Lineville soils are on the narrow ridgetops upslope from the Adair soils and downslope from the Kniffin and Pershing soils.

These soils are adjacent to the larger valleys in most parts of the county. Individual areas are generally small, and they are only fair for farming.

In a typical profile, the surface layer extends to a depth of about 10 inches. The upper part of the surface layer is very dark brown, friable silt loam that has granular structure. The lower part is dark grayish-brown, friable silt loam that has subangular blocky structure. Mottling begins in the lower part of the surface layer and continues down through the subsoil. Mottles are predominantly yellowish brown, grayish brown, and yellowish red. The subsoil extends to a depth of 5 feet or more and is dark-brown to brown firm clay in the lower part. The substratum is commonly below a depth of 6 feet and is yellowish-brown, firm clay loam.

The Lineville soils erode readily where they are cultivated. They have high available moisture capacity. Permeability is moderately slow in the upper part of the subsoil and is very slow in the lower part.

Typical profile of Lineville silt loam on a 5 percent convex ridgetop in a meadow about 50 feet south and 110 feet west of the northeast corner of the SW¼SE¼ section 24, T. 69 N., R. 21 W.:

Ap—0 to 6 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; material very dark grayish brown (10YR 3/2) when kneaded; weak, fine, subangular blocky breaking to moderate, fine, granular structure; friable; sand grains evident; slightly acid; abrupt, smooth boundary.

A2—6 to 10 inches, dark grayish-brown (10YR 4/2) silt loam, pale brown (10YR 6/3) when dry; common, medium, faint mottles of brown to dark brown (10YR 4/3); material brown or dark brown (10YR 4/3) when kneaded; discontinuous very dark grayish-brown (10YR 3/2) color on ped exteriors; weak, thin, platy breaking to moderate, very fine, subangular blocky structure; friable; sand grains evident; numerous fine pores; strongly acid; clear, smooth boundary.

B1—10 to 15 inches, mixed dark-brown or brown (10YR 4/3) and dark grayish-brown (10YR 4/2) light silty clay loam; few, fine, faint mottles of dark yellowish brown (10YR 3/4) and yellowish brown (10YR 5/4); material brown (10YR 4/3) when kneaded; moderate, fine, subangular blocky structure; friable; numerous sand grains; light-gray (10YR 7/2) grainy coatings on some ped surfaces; strongly acid; clear, smooth boundary.

I & IIB21—15 to 23 inches, dark-brown to brown (10YR 4/3) light clay loam; common, fine, faint mottles of yellowish brown (10YR 5/4 and 5/6) and few, fine, faint mottles of dark brown (10YR 3/3); material yellowish brown (10YR 5/4) when kneaded; moderate, fine, subangular blocky structure; firm; ped surfaces are commonly dark grayish brown (10YR 4/2); on most ped surfaces are grainy coatings that are light gray (10YR 7/2) when dry; many sand grains and pores; strongly acid; clear, smooth boundary.

IIB22t—23 to 29 inches, dark grayish-brown (10YR 4/2) and dark-brown or brown (10YR 4/3) heavy loam; common, fine, faint mottles of yellowish brown (10YR 5/6) and few, fine, distinct mottles of brown (7.5YR 4/4); material brown (10YR 4/3) when kneaded; moderate, medium, subangular blocky structure; firm; few dark-brown (10YR 3/3) clay films; few grainy coatings that are light gray (10YR 7/2) when dry; many iron and manganese concretions; many pores; medium acid; gradual, smooth boundary.

IIB23t—29 to 36 inches, mottled dark-brown or brown (7.5YR 4/4), grayish-brown (2.5Y 5/2), and yellowish-brown (10YR 5/4) light clay loam; common, medium, distinct mottles of strong brown (7.5YR 5/8) and few, fine, prominent mottles of yellowish red (5YR 4/6); material yellowish brown (10YR 5/4) when kneaded; weak, medium, subangular blocky structure; firm; few, discontinuous, very dark brown (10YR 2/2) clay films on vertical faces of peds; few grainy ped coatings that are light gray (10YR 7/2) when dry; many iron and manganese concretions; many pores; medium acid; gradual, smooth boundary.

IIB24t—36 to 42 inches, reddish-brown (5YR 4/4) clay loam; common, medium, prominent mottles of grayish brown (2.5Y 5/2) and few, fine, faint mottles of yellowish red (5YR 4/8); material yellowish brown (10YR 5/6) when kneaded; weak, medium, subangular blocky structure; firm; thin, discontinuous, dark-brown (10YR 3/3) clay films; stone line near base of horizon; medium acid; clear boundary.

IIB25t—42 to 50 inches, strong-brown (7.5YR 5/6) medium clay loam; common, fine, distinct mottles of red (2.5YR 4/6) and few, fine, distinct mottles of grayish brown (2.5Y 5/2); moderate, fine, subangular blocky structure; firm; few dark grayish-brown (10YR 4/2) clay films; many pebbles; few black concretions; neutral; clear, smooth boundary.

IIIB26t—50 to 58 inches, strong-brown (7.5YR 5/6) heavy clay loam; many, fine, distinct mottles of red (2.5YR 4/6) and few, fine, distinct mottles of grayish brown (2.5Y 5/2); moderate, fine, subangular blocky structure; firm; thick, discontinuous, dark-brown or brown (7.5YR 4/2) clay films on vertical faces; very few pebbles; very few pores; common, fine, black concretions; neutral; gradual, smooth boundary.

IIIB3t—58 to 72 inches, mottled strong-brown (7.5YR 5/6), yellowish-brown (10YR 5/4) and grayish-brown (2.5Y 5/2) heavy clay loam; material strong brown (7.5YR 5/6) when kneaded; moderate, fine, subangular blocky structure; firm; thin, discontinuous, dark-brown or brown (7.5YR 4/2) clay films; common, fine, soft, black concretions; neutral.

The A1 or Ap horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) in color and from 5 to 8 inches in thickness. The A2 horizon ranges from 3 to 6 inches in thickness.

The B1 horizon ranges from dark brown or brown (10YR 4/3) to dark grayish brown (10YR 4/2). It is 5 to 14 inches thick. The upper part of the profile (A and B horizons) has a maximum accumulation of clay of 28 to 35 percent and is 15 to 25 percent sand. The IIB horizon has a maximum accumulation of clay of 26 to 35 percent and is 30 to 40 percent sand. The upper part of the IIB horizon ranges from grayish brown (2.5Y 5/2) to brown (7.5YR 4/4). The pedisediment ranges from 18 to 30 inches in thickness. The reddish paleosol occurs at a depth of 24 to 50 inches. Its content of clay ranges from 35 to 50 percent.

Laboratory data on samples taken at this site show a content of clay that ranges from 22 to 37 percent. The clay maximum is in the IIIB26t horizon. Horizons below 58 inches were not sampled for laboratory analysis. The Ap horizon is 22 percent clay. The content of silt ranges from a high of 57 percent in the Ap horizon to a low of 25 percent in the IIIB26t horizon. This decrease in silt is gradual. The content of sand ranges from a low of 16 percent in the B1 horizon to a high of 39 percent in the IIB25t horizon. The content of sand shows a consistent increase from material I to material II to material III.

The Lineville soils are less clayey than the Adair soils and are more permeable in the upper part of the subsoil. Unlike the Seymour, Grundy, Pershing, and Kniffin soils, Lineville soils developed from two kinds of parent material. Lineville soils have an A2 horizon, but Seymour and Grundy soils do not.

Lineville silt loam, 5 to 9 percent slopes (LvC).—This soil is mostly on rounded ridgetops. Upslope toward the broader ridgetops are areas of Kniffin and Seymour soils. Downslope are moderately sloping areas of Adair soils.

The topmost layer of this soil is a very dark brown silt loam 5 to 8 inches thick. It is underlain by a very thin layer that is nearly gray when it dries. The subsoil, commonly at a depth of 15 to 20 inches, is medium to heavy silty clay loam. A reddish clayey material similar to the Adair subsoil is at a depth of 24 to 42 inches.

This soil erodes readily in cultivated areas. The silty surface layer contains only a medium amount of organic matter and is not strongly granular. Generally a perched water table is near the surface in wet seasons.

This soil is medium acid to strongly acid and requires lime. It is low in available nitrogen and phosphorus and medium in available potassium.

Much of this soil is in pasture, though row crops are moderately well suited. Rotations that include meadow 3 years in 6 are suitable if the soil is terraced and tilled on the contour. (Capability unit IIIe-3; woodland suitability group 5)

Lineville silt loam, 5 to 9 percent slopes, moderately eroded (LvC2).—This soil is mostly on rounded ridgetops. The total acreage of this soil in the county is small, and individual areas are generally small.

The topmost layer of this soil is very dark gray to very dark grayish-brown silt loam. Other profile characteristics are similar to those of Lineville silt loam, 5 to 9 percent slopes. In many places the thin layer of grayish material has been mixed with the plow layer by tillage, and the plow layer is noticeably lighter colored when dry.

This soil erodes readily if the plant cover is sparse. The surface layer is low in organic matter, and tilth is generally poor. A perched water table is generally near the surface in wet seasons. After heavy rains the surface tends to crust.

This soil is medium acid to strongly acid. It is low in available nitrogen and phosphorus and medium in available potassium. Additions of lime and nitrogen are needed if this soil is used for cultivated crops.

This soil is mostly cropland, but there is some woodland and pasture. Row crops are moderately well suited. These crops grow fairly well. If this soil is terraced and tilled on the contour, it is suited to a rotation that includes meadow 3 years in 6. (Capability unit IIIe-3; woodland suitability group 5)

Mystic Series

The Mystic series consists of moderately dark colored, somewhat poorly drained soils that developed from water-sorted glacial sediments under a mixed grass and forest vegetation. Slopes range from 5 to 9 percent. These soils are along the major stream valleys throughout the county. They are closely associated with the Caleb soils.

Mystic soils developed in moderately fine textured to fine textured materials that were deposited as alluvium during an earlier geologic period. They generally do not have a stone line in the surface layer or subsoil. They probably were partly buried by loess at one time and later were exposed by geologic erosion.

In a typical profile, the surface layer extends to a depth of about 10 inches. It is very dark grayish-brown, friable silt loam in the upper part and dark-brown to brown, friable silt loam in the lower part. The lower part of the surface layer is mottled with brownish colors. The subsoil extends to a depth of 4 feet or more. In the subsoil, clay loam extends to a depth of 43 inches and is mainly brown or grayish brown. This is underlain by pale-brown sandy clay loam. Most of the subsoil is mottled with brownish colors. The substratum ranges from pale brown to yellowish brown in color and from sandy loam to clay loam in texture.

The Mystic soils are seasonally wet and seepy and are susceptible to erosion if cultivated. They have high available moisture holding capacity and are slowly permeable.

A typical profile of Mystic silt loam located near the center of a convex ridgetop where slopes are 5 percent, about 715 feet south and 575 feet east of the northwest corner of SW¼NW¼ section 4, T. 69 N., R. 22 W.:

Ap—0 to 6 inches, silt loam that is mainly very dark grayish brown (10YR 3/2) but is dark brown or brown (10YR 4/3) in less than 5 percent of the soil; grayish brown (10YR 5/2) when dry; kneaded color same as matrix; weak, fine, granular structure; friable; few patches of grainy coats that are light brownish gray (10YR 6/2) when dry; medium acid; abrupt, smooth boundary.

A2—6 to 10 inches, heavy silt loam that is mainly dark brown to brown (7.5YR 4/2 to 4/4), but is very dark grayish brown (10YR 3/2) in less than 5 percent of the soil; few, fine, faint mottles of reddish brown (5YR 4/4); material dark grayish brown to dark brown (10YR 4/2 to 4/3) when kneaded; weak, thick, platy breaking to moderate, fine, subangular blocky structure; friable; common patches of grainy ped coats that are light brownish gray (10YR 6/2) when dry; very strongly acid; clear, smooth boundary.

B1—10 to 13 inches, brown (7.5YR 5/4) light clay loam; dark brown to brown (7.5YR 4/2 to 5/2) ped exteriors; few, fine, prominent, red (2.5YR 4/6) mottles; material dark brown to brown (7.5YR 4/4) when kneaded; moderate, fine, subangular blocky structure; friable; common patches of grainy ped coats that are light brownish gray (10YR 6/2) when dry; strongly acid; clear, smooth boundary.

B21t—13 to 17 inches, dark reddish-brown (2.5YR 3/4) heavy clay loam that has grayish-brown (10YR 5/2) ped exteriors; material reddish brown (5YR 4/4) when kneaded; strong, fine, subangular blocky structure; friable to firm; continuous, grainy, thick ped coatings that are white (10YR 8/1) when dry; thin discontinuous clay films; few, fine, dark reddish-brown (5YR 3/2) concretions; strongly acid; clear, smooth boundary.

B22t—17 to 23 inches, grayish-brown (2.5Y 5/2) heavy clay loam; many, fine, prominent mottles of dark reddish brown (2.5YR 3/4); dark brown to brown (7.5YR 4/4) when kneaded; moderate, fine, prismatic breaking to moderate, fine, subangular blocky structure; firm; nearly continuous thin clay films; common, fine, dark reddish-brown (5YR 3/2) concretions; strongly acid; gradual, smooth boundary.

B23t—23 to 32 inches, brown (10YR 5/3) medium clay loam that is grayish brown (10YR 5/2) on ped exteriors; few, fine, faint mottles of yellowish brown (10YR 5/6); material yellowish brown (10YR 5/4) when kneaded; weak, medium, prismatic breaking to weak, medium and coarse, subangular blocky structure; firm; thin discontinuous clay films on prism faces and in root channels; many, fine, dark reddish-brown (5YR 2/2) concretions; medium acid; gradual, smooth boundary.

B31t—32 to 43 inches, brown (10YR 5/3) medium clay loam; few, fine, faint mottles of gray (10YR 5/1) and yellowish brown (10YR 5/6); material brown (10YR 5/3) when kneaded; weak, medium, prismatic structure; friable to firm; few discontinuous clay films on prism faces and in root channels; common, fine, dark reddish-brown (5YR 2/2) concretions; slightly acid; gradual, smooth boundary.

B32—43 to 54 inches, pale-brown (10YR 6/3) sandy clay loam; common, fine and medium, faint mottles of light brownish gray (10YR 6/2) and few, fine, distinct mottles of yellowish brown (10YR 5/6); material brown (10YR 5/3) when kneaded; weak, coarse, prismatic structure; friable; few discontinuous clay films on prisms; few, fine, dark reddish-brown (5YR 2/2) concretions; slightly acid; gradual, smooth boundary.

C—54 to 64 inches, pale-brown (10YR 6/3) heavy sandy loam; common, fine and medium, faint mottles of light gray (10YR 7/2) and few, fine, distinct mottles of yellowish brown (10YR 5/6); massive; friable; few, fine, dark reddish-brown (5YR 2/2) concretions; slightly acid.

The A1 or Ap horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) and is 5 to 9 inches thick. The texture of the A1 horizon ranges from loam to light clay loam. The A2 horizon ranges from dark grayish brown (10YR 4/2) to dark brown or brown (7.5YR 4/3). It is 3 to 6 inches thick. The A2 horizon is a silt loam or loam in texture.

The upper part of the B horizon has dark-brown to brown (7.5YR 4/2 to 4/4) and grayish-brown (2.5Y 5/2) ped exteriors and brown (7.5YR 5/4) to dark reddish-brown (2.5YR 3/4) ped interiors. The upper part of the B horizon is generally mottled with reddish brown (5YR 4/4) to dark reddish brown (2.5YR 3/4). The lower part of the B horizon is normally brown (10YR 5/3) to pale brown (10YR 6/3) mottled with gray and yellowish brown. The content of clay is about 36 to 40 percent in the heaviest part of the B horizon. The clay content is extremely variable in the B3 and C horizons. The reaction ranges from medium acid to very strongly acid in the most acid part of the solum. Carbonates are leached to a depth of 6 to 8 feet or more.

Laboratory data on samples taken at this site show that the content of clay ranges from 17 percent in the IIC horizon to 38 percent in the B22t horizon. The Ap horizon is 23 percent clay, and there is a gradual increase in clay to the maximum content of 38 percent in the B22t horizon; then there is a gradual decrease to the low of 17 percent in the IIC horizon. The content of silt ranges from a high of 53 percent in the Ap horizon to a low of 15 percent in the IIC horizon. The decrease in silt from the high to the low is gradual. The content of sand is fairly variable throughout the profile. It ranges from a low of 19 percent in the B21t horizon to a high of 67 percent in the IIC horizon. Material I has a content of sand ranging from 19 to 27 percent, but the content of sand in material II ranges from 57 to 67 percent.

The Mystic soils have more variable texture in the lower part of the subsoil than have the Adair soils, and they lack the prominent stone line characteristic of the Adair. Mystic soils are finer textured and more reddish than the Caleb soils.

Mystic silt loam, 5 to 9 percent slopes, moderately eroded (MyC2).—This soil is on slopes near the ends of ridgetops that extend down onto the high benches along streams. These ridgetops generally are lower than surrounding ones. Because of its position, this soil has a small total acreage. Each area generally is less than 5 acres.

The surface layer, about 10 inches thick, is mostly silt loam, but areas of light clay loam were included in mapping. The thin lower part of the surface layer is distinctly light colored when dry. It overlies a dark-brown to brown and grayish-brown subsoil that is mottled with reddish colors. Because the subsoil is firm, contains a large amount of clay, and takes in water slowly, runoff and the hazard of erosion are great.

The organic matter content of this soil is low. Most areas are very low in available nitrogen, phosphorus, and potassium. This soil is slightly acid to very strongly acid.

Because this soil commonly occurs with the steeper Caleb soils in pasture or hay, much of it is in permanent pasture or hay. It is better suited to hay and pasture than to row crops. Row crops are not well suited and generally are not planted. If row crops are planted, contour tillage and rotations providing 2 years of meadow in 5 are needed. Although varying amounts of seepage water are received, artificial drainage is not practical in most places. (Capability unit IIIe-4; woodland suitability group 5)

Nodaway Series

The Nodaway series consists of moderately well drained soils that developed from stratified light colored and moderately dark colored silty alluvium. These soils occur on first bottoms near the main channel of streams. Each flood deposits fresh sediments on the surface. Some areas are dissected by meandering old channels. The Nodaway soils are so closely associated with the Lawson soils that they have been mapped as a complex with the Lawson soils. The Nodaway soils occur fairly extensively throughout the bottom lands in the county. They are on both narrow and wide stream bottoms.

In a typical profile, the surface layer is dark-gray, friable silt loam that extends to a depth of 4 inches. It is underlain by a substratum consisting of many layers. The substratum is very fine sandy loam, silt loam, and loose fine sand to a depth of 10 inches and is mainly silt loam below. It extends to a depth of 4 feet or more. Color of the substratum is dark gray, grayish brown, and dark grayish brown.

The Nodaway soils have high available moisture holding capacity and are moderately permeable. Frequent overflow is the greatest hazard to these soils.

A typical profile of Nodaway silt loam that has a slope of 1 percent and is on an old stream levee, 854 feet north and 1,530 feet east of the southwest corner of section 6, T. 67 N., R. 23 W., in a bluegrass pasture:

A1—0 to 4 inches, dark-gray (10YR 4/1) gritty silt loam, light brownish gray (10YR 6/2) when dry; horizontal streaks of dark grayish brown and grayish brown (10YR 4/2 and 5/2); material dark grayish brown (10YR 4/2) when kneaded; weak, fine, granular and some weak, medium, platy (stratified) structure; friable; neutral; abrupt boundary.

C1—4 to 6 inches, stratified dark-gray and grayish-brown (10YR 4/1 and 5/2) very fine sandy loam, light brownish gray to very pale brown (10YR 6/2 to 7/3) when dry; material dark grayish brown when kneaded (10YR 4/2); weak, medium, platy structure; friable; neutral; abrupt boundary.

C2—6 to 8 inches, dark-gray (10YR 4/1) gritty silt loam, light brownish gray (10YR 6/2) when dry; common, gray (10YR 5/1) strata; weak, medium, platy structure; friable; neutral; abrupt boundary.

C3—8 to 10 inches, grayish-brown (10YR 5/2) loose fine sand, very pale brown (10YR 7/3) when dry; single grain (structureless); neutral; abrupt boundary.

C4—10 to 26 inches, dark grayish-brown (10YR 4/2) silt loam to loam (sand is very fine); horizontal streaks of grayish brown (10YR 5/2) and some discontinuous patches of dark gray on platy exteriors; few strong-brown (7.5YR 5/6) stains and oxides of iron; band of pale-brown (10YR 6/3) shale at 23 inches to 24 inches; weak, thick, platy structure; friable; neutral; abrupt boundary.

C5—26 to 40 inches, very dark gray (10YR 3/1) silt loam with few grayish-brown lenses of sand ¼ to ½ inch thick; few, fine, distinct mottles of strong brown (7.5YR 5/6); material has chroma slightly higher than 6 when kneaded; silt loam material has weak, fine, granular structure; sand lenses are single grain and have some platiness; friable; neutral; gradual boundary.

C6—40 to 57 inches, dark-gray (10YR 4/1) and about 10 percent dark grayish-brown (10YR 4/2) gritty silt loam; horizontal streaks of grayish brown and dark grayish brown (10YR 5/2 and 4/2); few, fine, distinct mottles of strong brown (7.5YR 5/6); 1-inch band of grayish-brown (10YR 5/2) very fine sand at 48 and 53 inches; material very dark grayish brown (10YR 3/2) when kneaded; massive; friable; neutral.

The A horizon ranges from dark gray (10YR 4/1) to dark grayish brown (10YR 4/2). In some cultivated areas the A horizon is very dark grayish brown (10YR 3/2). The material from the surface to a depth of 42 to 60 inches is less than 15 percent fine or medium sand. Most profiles have some platy structure and lenses of lighter colored silt or fine sand that generally are the result of stratification of the relatively recent deposit of the material. If mottles occur, they are at a depth greater than 24 inches and are few, fine, and faint or distinct. The occurrence of mottles depends on the frequency and duration of overflow.

The Nodaway soils are not so fine textured as the Colo, Wabash, or Chequest soils and are better drained.

Olmitz Series

The Olmitz series consists of dark-colored, moderately well drained loamy soils on foot slopes. These soils formed from loamy materials that washed from adjoining slopes. The native vegetation was of the prairie type.

These soils occupy many slightly concave foot slopes of 2 to 5 percent that are between the soils on bottom lands and steeper soils that were derived from till on hillsides. Olmitz soils occur closely with gently sloping Colo soils and are even more closely intermingled with Vesser and Colo soils. They are not, however, in a continuous band. Olmitz soils are also on alluvial fans. These soils are in all parts of the county, and individual areas range from 3 to 20 acres in size. They are good agricultural soils.

In a typical profile the surface layer, about 24 inches thick, is black and very dark gray, friable loam. The subsoil is friable clay loam that extends to a depth of 4 feet or more. It is very dark grayish brown in the upper part, dark yellowish brown in the middle, and dark grayish brown in the lower part. Mottling begins at a depth of 24 inches. The substratum, where observed, is yellowish-brown, friable clay loam that is mottled.

The Olmitz soils receive runoff and some overwash from the uplands. They have high available moisture holding capacity and are moderately permeable.

Typical profile of Olmitz loam, on a foot slope of 4 percent, 435 feet east and 100 feet north of the southwest corner of section 33, T. 69 N., R. 21 W., 135 feet east of south corner post:

Ap—0 to 7 inches, black (10YR 2/1) loam that is the same color when kneaded; moderate, fine, granular structure; friable; strongly acid; gradual boundary.

A1—7 to 18 inches, black (10YR 2/1) loam that is the same color when kneaded; moderate, fine, granular structure; friable; medium acid; gradual boundary.

A3—18 to 24 inches, very dark gray (10YR 3/1) heavy loam with few black (10YR 2/1) coatings on peds; very dark gray (10YR 3/1) when kneaded; weak, very fine, subangular blocky structure; friable; slightly acid; gradual boundary.

B1—24 to 31 inches, clay loam that is very dark grayish brown (10YR 3/2) on exteriors of peds and dark brown (10YR 3/3) on their interiors; few, fine, faint mottles of very dark gray (10YR 3/1); material very dark grayish brown (10YR 3/2) when kneaded; weak, very fine, subangular blocky structure; friable; neutral; gradual boundary.

B2t—31 to 39 inches, dark yellowish-brown (10YR 4/4) clay loam that has some dark grayish brown (10YR 4/2) on exteriors of peds; few, fine, faint mottles of yellowish brown (10YR 5/4) and few, fine, distinct mottles of strong brown (7.5YR 5/8); material brown (10YR 4/3) when kneaded; weak, fine, subangular blocky structure; friable; few, thin, discontinuous clay films that are very dark grayish brown; few, fine, dark reddish-brown oxide concretions; neutral; gradual boundary.

B3t—39 to 55 inches, dark grayish-brown (10YR 4/2), brown or dark-brown (10YR 4/3), and yellowish-brown (10YR 5/4) clay loam; few, fine, distinct mottles of strong brown (7.5YR 5/6); material dark grayish brown (10YR 4/2) to brown or dark brown (10YR 4/3) when kneaded; weak, fine, subangular blocky structure; friable; few, thin, discontinuous clay films that are dark gray (10YR 4/1); few, fine, dark reddish-brown (5YR 3/2) oxide concretions; neutral.

The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). In some places color has a value of 3 from the surface to a depth of 24 to 36 inches. The B horizon ranges from dark brown (10YR 4/3) to dark yellowish brown (10YR 4/4). A few discontinuous dark grayish-brown (10YR 4/2) to dark-gray (10YR 4/1) coats or clay films are present in the B horizon, but the content of clay of the B horizon, compared to that of the A horizon, is not high. Clay loam glacial till is at a depth below 40 inches. Mottles, where present, occur in the B horizon and are few, fine, faint, and yellowish brown (10YR 5/6), dark yellowish brown (10YR 4/4), or strong brown (7YR 5/6). The reaction ranges from neutral to strongly acid in the solum.

The Olmitz soils contain less clay and more sand than the Colo and Vesser soils and are better drained. Unlike the Vesser soils, the Olmitz soils lack an A2 horizon.

Olmitz loam, 2 to 5 percent slopes (OmB).—This soil is generally on foot slopes below the Gara and Shelby soils or near the mouth of upland drainageways. Some variations in texture of the profile may result from deposition of different kinds of sediment rather than from profile development.

The surface layer of this soil is thick and consists of black to very dark gray loam. Its color depends on the amount and source of the recently deposited sediments. In some included areas the surface layer is light clay loam.

This soil has a high organic-matter content, but additions of lime are needed. Corn grown frequently responds well to fertilizer. This soil is generally low in available nitrogen and medium in available phosphorus and potassium.

Many areas of this soil are cultivated with the soils on adjoining bottom lands. Because it is somewhat erodible, this soil should be tilled on the contour. Also needed, in some places, is a diversion terrace constructed above this soil so that the hazard of sheet erosion is reduced by diverting water that runs in from higher areas. If it is tilled on the contour, this soil is suitable for intensive row cropping. Tilth is usually good, and crops generally grow well. (Capability unit IIe-1; woodland suitability group 1)

Olmitz-Vesser-Colo complex, 2 to 5 percent slopes (OvB).—The soils in this complex are along narrow drainageways and are near gently sloping to steep soils of the upland that were derived from till. Olmitz loam, Vesser silt loam, and Colo silty clay loam are the dominant soils, and each of them has a profile similar to the one described as typical for its respective series.

Along the narrow drainageways, the Colo soils lie adjacent to the streams and the Olmitz soils are in fairly uniform bands at the base of upland slopes. These areas are sometimes cut by gullies and cannot be crossed with farm machinery. The Vesser soils are generally at the upper end of the drainageways in the more gently sloping areas. This complex occurs in all parts of the county and has a large total acreage.

These soils are slightly acid in most places. They are medium in available nitrogen, phosphorus, and potassium.

The soils in this complex are moderately well drained to poorly drained. Diversion terraces can be used to control runoff from the uplands (fig. 13), and most areas can be drained by tile. Grassed waterways are needed in gullied areas.

These soils have many uses. Where they are in small patches within cultivated fields consisting mainly of other soils, they are planted to the same crops as are the other soils. Where they are in larger areas, they may

Figure 13.—A diversion terrace constructed above Olmitz-Vesser-Colo complex, 2 to 5 percent slopes. Alfalfa is planted on the steeper Shelby soils above the diversion, and soybeans are planted below.

be cultivated separately. Much of the acreage, however, is in pasture along with other more sloping soils. The soils in this complex are well suited to pasture if they are protected from gullying. They can be used for intensive row cropping if gullying is prevented and drainage is provided. Corn generally grows well. It responds well to additions of fertilizer. (Capability unit IIw-1; woodland suitability group 7)

Pershing Series

The Pershing series consists of moderately dark colored, somewhat poorly drained to moderately well drained soils on uplands. These soils developed from leached loess that is 48 to 96 inches thick and is underlain by a buried, very slowly permeable, gray, clayey soil. In some places Pershing soils are on benches and are underlain by stratified alluvium. The native vegetation was a mixture of grass and trees. Slopes range from 2 to 9 percent and are mostly short and convex. Pershing soils are upslope from the Adair, Clarinda, and Gara soils. The landscape of Pershing soils is similar to that of the Grundy and Lineville soils.

Pershing soils on uplands are only in the northwestern and north-central part of the county, but those on benches are along most of the major streams. Individual areas range from 3 to 25 acres in size and are fair to good for farming.

In a typical profile, the surface layer is about 9 inches thick. It is very dark gray friable silt loam in the upper part and very dark grayish brown to dark grayish brown in the lower part. Underlying this layer is about 2 inches of dark grayish-brown, friable silty clay loam. The subsoil extends to a depth of about 4 feet or more. In the subsoil, silty clay loam extends to a depth of 34 inches and is mainly dark grayish brown and grayish brown. The next layer is silty clay loam with the same color as the layer above. Most of the subsoil is mottled with brownish colors. The substratum is light brownish-gray, friable to firm silty clay loam.

The Pershing soils erode easily if cultivated and are seepy early in spring. They have high available moisture holding capacity and are slowly permeable.

A typical profile of Pershing silt loam, near the center of a convex ridgetop on a slope of about 3 percent, 440 feet north and 640 feet west of the southeast corner of SW¼ of section 4, T. 70 N., R. 22 W.:

Ap—0 to 6 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; moderate, fine, granular structure; friable; few grainy coats that are gray to light gray (10YR 6/1) when dry; neutral; abrupt boundary.

A2—6 to 9 inches, very dark grayish-brown to dark grayish-brown (10YR 3/2 to 4/2) silt loam, gray to light gray (10YR 6/1) when dry; material very dark grayish brown (10YR 3/2) when kneaded; moderate, thin, platy breaking to moderate, fine, granular structure; friable; grainy coats on plates; few dark-brown to brown (7.5YR 4/4) concretions; slightly acid; clear boundary.

AB—9 to 11 inches, dark grayish-brown (10YR 4/2) light silty clay loam; kneaded color same as matrix; moderate, fine, subangular blocky structure; friable; thin, discontinuous, grainy ped coats that are gray to light gray (10YR 6/1) when dry; few dark-brown to brown (7.5YR 4/4) concretions; slightly acid; clear boundary.

B1—11 to 14 inches, medium silty clay loam that has dark grayish-brown (10YR 4/2) ped exteriors and dark-brown or brown (10YR 4/3) ped interiors; material dark brown or brown (10YR 4/3) when kneaded; strong, fine, subangular blocky and angular blocky structure; friable; thin, discontinuous, grainy coats that are gray to light gray (10YR 6/1) when dry; few dark-brown to brown (7.5YR 4/4) concretions; medium acid; gradual boundary.

B21t—14 to 20 inches, light to medium silty clay that has dark grayish-brown to grayish-brown (10YR 4/2 to 5/2) ped exteriors and mostly yellowish-brown (10YR 5/6) ped interiors; material brown to yellowish brown (10YR 4/3 to 5/4) when kneaded; strong, very fine and fine, subangular blocky and angular blocky structure; firm to very firm; continuous dark-gray (10YR 4/1) clay films; medium acid; gradual boundary.

B22t—20 to 25 inches, mixed dark grayish-brown (10YR 4/2) and yellowish-brown (10YR 5/6) light to medium silty clay; few, fine, faint mottles of strong brown (7.5YR 5/6); material yellowish brown (10YR 5/4) to light olive brown (2.5Y 5/4) when kneaded; moderate to strong, fine, subangular blocky to angular blocky structure; firm to very firm; continuous clay films; few black (10YR 2/1) concretions; strongly acid; gradual boundary.

B31t—25 to 34 inches, grayish-brown (2.5Y 5/2) light silty clay; many, fine, distinct mottles of yellowish brown (10YR 5/4 to 5/6); material yellowish brown (10YR 5/4) when kneaded; weak, medium, prismatic breaking to moderate, fine, subangular blocky structure; firm; discontinuous clay films; relict deoxidized and leached weathering zone; few dark reddish-brown (5YR 3/2) concretions; medium acid; gradual boundary.

B32t—34 to 45 inches, same as above horizon except that texture is medium silty clay loam, consistence is friable to firm, and reaction is slightly acid.

C—45 to 60 inches, light brownish-gray (2.5Y 6/2) light silty clay loam; common, fine, distinct mottles of yellowish brown (10YR 5/6) and few, fine, prominent mottles of strong brown (7.5YR 5/8); massive with some cleavages; friable to firm; relict deoxidized and leached weathering zone; many dark reddish-brown (5YR 2/2) concretions; slightly acid.

The A1 or Ap horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color and from 5 to 10 inches in thickness. The A2 horizon is 3 to 8 inches thick.

The upper part of the B horizon has dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) ped exteriors and dark-brown or brown (10YR 4/3) to yellowish-brown (10YR 5/4 to 5/6) ped interiors. The B3 and C horizons are grayish brown (2.5Y 5/2) to light brownish gray (2.5Y 6/2) and have mottles with a high chroma. The gray colors in the subsoil are relict and are related to deoxidized and leached weathering zones. The maximum content of clay occurs at a depth of about 14 to 20 inches and is 42 to 48 percent. Reaction ranges from medium acid to strongly acid in the most acid part of the solum.

The Pershing soils have a grayish-colored A2 horizon, which the Grundy and Seymour soils lack. The A1 horizon of Pershing soils is somewhat thinner than that of the Grundy and Seymour soils. Less clay is in the subsoil of the Pershing soils than is in that of the Kniffin and Rathbun soils. Pershing soils contain more clay and less sand than the Lineville soils.

Pershing silt loam, 5 to 9 percent slopes (PeC).—This soil is on ridgetops and short slightly convex side slopes. The topmost layer of this soil is 5 to 8 inches thick and very dark gray. It is underlain by a very thin layer that is grayish when dry. The mottled subsoil is silty clay and commonly begins at a depth of 14 to 18 inches.

Water runs off in large amounts, and erosion is likely in cultivated areas.

This soil is medium in organic-matter content. It is medium acid, low in available nitrogen and phosphorus, and medium in available potassium. Additions of lime and nitrogen are needed if this soil is used for cultivated crops.

Much of this soil is in cropland, and the rest in woodland or pasture. This soil is moderately well suited to row crops if it is terraced and tillage is on the contour. Rotations that include meadow for 3 years in 6 are suitable on terraces. Crops usually grow fairly well to very well under good management. (Capability unit IIIe-3; woodland suitability group 3)

Persing silt loam, 5 to 9 percent slopes, moderately eroded (PeC2).—This soil is on rounded ridgetops and on short, convex side slopes. In Wayne County, individual areas are as much as 20 acres in size, and the total acreage is small. The topmost layer of this soil is very dark grayish-brown to very dark gray silt loam 3 to 6 inches thick. In most places the next layer has been mixed with the surface layer by plowing. The mottled part of the subsoil is medium silty clay and commonly is at a depth of 14 to 16 inches from the surface.

Runoff is rapid on this soil. The surface soil, which is low in organic-matter content, erodes if vegetation is sparse. On the rounded shoulders of side slopes, the subsoil is exposed in some places. In a few small spots the subsoil has been mixed with the surface layer by plowing. After rains the surface soil tends to seal and crust.

This soil is medium acid and needs lime. It is generally low in available nitrogen and phosphorus and medium in available potassium. Most crops on this soil respond well to applications of nitrogen and phosphate.

This soil is commonly used for crop rotations. If terracing and contour tillage are used, a rotation that includes meadow for 3 years in 6 is suitable. Crops generally grow fairly well. (Capability unit IIIe-3; woodland suitability group 3)

Pershing silt loam, benches, 2 to 5 percent slopes (PhB).—This soil is on high benches that extend into the bottom lands. Strongly sloping soils derived from till are generally upslope from this soil, and the Caleb and Mystic soils are downslope.

This soil has a very dark gray surface layer 6 to 10 inches thick. The silty clay subsoil is somewhat less mottled than the subsoil in the Pershing soils of the uplands. Some of the loess parent material may have come from adjacent stream valleys.

This soil needs lime in most places, for it is generally medium acid. In many places it is low in available nitrogen and phosphorus and medium in available potassium. Its content of organic matter is medium. The response of crops to nitrogen and phosphate fertilizers is normally good.

Most of this soil is cultivated, though cultivated areas are susceptible to erosion. Rotations that include meadow 1 year in 5 are suitable for this soil. If tilth becomes poor, the soil should be kept in meadow for an additional year. Crops generally grow fairly well. (Capability unit IIIe-2; woodland suitability group 3)

Pershing silt loam, benches, 5 to 9 percent slopes, moderately eroded (PhC2).—This soil is on high benches along many of the major streams in the county. It is on side slopes and short ridgetops and is upslope from the Caleb soils. The total acreage of this soil is not extensive, and individual areas are small. The topmost layer of this soil is very dark grayish brown to very dark gray and 3 to 6 inches thick. In most places the next layer has been mixed with the surface layer by plowing. The mottled part of the subsoil is silty clay that is about 12 to 14 inches below the surface.

This soil is low in organic-matter content. It is medium acid and requires additions of lime. It is low in available nitrogen and phosphorus and medium in potassium. Crop response to nitrogen and phosphate fertilizers is good.

This soil is highly susceptible to erosion because runoff is rapid. It is moderately well suited to row crops. Rotations that include meadow for 3 years in 6 are suitable if this soil is terraced and tilled on the contour. (Capability unit IIIe-3; woodland suitability group 3)

Rathbun Series

The Rathbun series consists of moderately dark colored to light-colored, moderately well drained soils on uplands. These soils developed from leached loess that is 48 to 80 inches thick and is directly underlain by a reddish, clayey buried soil. These buried materials are similar to the Adair soils that developed from Kansan till. The native vegetation was forest. Slopes range from 5 to 9 percent and are generally short and convex. Rathbun soils are upslope from the Adair, Gara, and Lindley soils.

These soils occur in all the county except the northwestern corner and the north-central part. Individual areas range from 5 to 30 acres in size. They are fair for farming.

In a typical profile, the surface layer extends to a depth of 12 inches. It is very dark gray, friable silt loam in the upper part and grades to yellowish-brown, friable silt loam in the lower part. Below this is yellowish-brown, friable silt loam about 3 inches thick. The subsoil, which extends to a depth of about 54 inches, is silty clay and silty clay loam in texture and brown, dark grayish brown, and grayish brown in color. Mottles begin at a depth of 19 inches and continue through the subsoil and substratum. The substratum, to a depth of 75 inches, is mostly mottled light brownish-gray, friable to firm silt loam to silty clay loam.

The Rathbun soils erode easily if cultivated. They have high available moisture holding capacity and are very slowly permeable.

A typical profile of Rathbun silt loam near the center of a convex ridgetop that has a north aspect and a slope of about 3 percent, 685 feet south and 540 feet west of the northeast corner of SW¼ section 19, T. 67 N., R. at W.:

A1—0 to 4 inches, very dark gray (10YR 3/1) silt loam, gray to light gray (10YR 6/1) when dry; material very dark grayish brown (10YR 3/2) when kneaded; moderate, thin and very thin, platy structure; friable; thin, patchy, grainy coatings that are light gray (10YR 7/1) when dry; few, fine, dark-brown to brown

(7.5YR 4/4) concretions; medium acid; abrupt, smooth boundary.

A21—4 to 8 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) when dry; kneaded material same color as matrix; moderate, thin, platy structure; friable; few dark grayish-brown (10YR 4/2) patches; thin, patchy, grainy coatings that are light gray (10YR 7/2) when dry; few, fine, dark reddish-brown (5YR 3/2) concretions; very strongly acid; clear, smooth boundary.

A22—8 to 12 inches, yellowish-brown (10YR 5/4) silt loam, pale brown (10YR 6/3) when dry; kneaded material same color as matrix; weak, thick, platy breaking to weak, medium and fine, subangular blocky structure; friable; thin, patchy, grainy coatings that are light gray (10YR 7/2) when dry; few, fine, dark reddish-brown (5YR 3/2) concretions; very strongly acid; clear, smooth boundary.

AB—12 to 15 inches, yellowish-brown (10YR 5/4) heavy silt loam; kneaded material same color as matrix; moderate, fine, subangular blocky structure; friable; thin, nearly continuous, grainy coatings that are light gray (10YR 7/1) when dry; few, fine, dark reddish-brown (5YR 3/2) concretions; very strongly acid; clear, smooth boundary.

B1—15 to 19 inches, light silty clay loam that has brown (10YR 5/3) ped exteriors and yellowish-brown (10YR 5/4) ped interiors; kneaded material yellowish brown (10YR 5/4); strong, fine and very fine, angular blocky and subangular blocky structure; friable to firm; thin, nearly continuous, horizontal band of grainy coatings that are light gray (10YR 7/1) when dry; few, fine, dark reddish-brown (5YR 3/2) concretions; very strongly acid; abrupt, smooth boundary.

B21t—19 to 24 inches, dark grayish-brown (10YR 4/2) medium to heavy silty clay; few, fine, faint mottles of dark yellowish brown (10YR 4/4); material grayish brown to brown (10YR 5/2 to 5/3) when kneaded; moderate, very fine, subangular blocky structure; very firm; few, fine, dark-brown (7.5YR 3/2) concretions; thick, continuous clay films; very strongly acid; clear, smooth boundary.

B22t—24 to 30 inches, dark grayish-brown (10YR 4/2) medium silty clay; common, fine, faint mottles of dark yellowish brown (10YR 4/4); material grayish brown to brown (10YR 5/2 to 5/3) when kneaded; weak; medium, prismatic breaking to weak, fine, subangular blocky structure; very firm; thick, discontinuous clay films; few, fine, dark-brown (7.5YR 3/2) concretions; very strongly acid; clear, smooth boundary.

B23t—30 to 35 inches, mottled grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/4) medium silty clay; few, fine, faint mottles of dark brown or brown (7.5YR 4/4); yellowish brown (10YR 5/4) when kneaded; weak, medium, prismatic structure breaking to weak, fine and medium, subangular blocky structure; firm; thin, discontinuous clay films; relict, mottled, deoxidized and leached weathering zone; common, fine, dark-brown (7.5YR 3/2) concretions; strongly acid; gradual, smooth boundary.

B31t—35 to 46 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) medium to heavy silty clay loam; material yellowish brown (10YR 5/4) when kneaded; weak, medium, prismatic breaking to weak, medium, subangular blocky structure; firm; thin, patchy, dark grayish-brown (10YR 4/2) clay films; relict, mottled, deoxidized and leached weathering zone; common, fine, dark-brown (7.5YR 3/2) concretions; strongly acid; gradual, smooth boundary.

B32t—46 to 54 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) medium silty clay loam; material brown (10YR 5/3) when kneaded; weak, medium, prismatic structure; friable to firm; few, thin, patchy clay films on vertical prism faces; relict, mottled, deoxidized and leached weathering zone; common, fine, dark-brown (7.5YR 3/2) concretions; slightly acid; gradual, smooth boundary.

C1—54 to 63 inches, light brownish-gray (2.5Y 6/2) silt loam to light silty clay loam; many, fine and medium, prominent mottles of strong brown (7.5YR 5/6); material brown (10YR 5/3) when kneaded; massive with some vertical cleavages; friable to firm; relict deoxidized and leached weathering zone; common, fine, dark-brown (7.5YR 3/2) and few, fine, yellowish-red (5YR 5/6) concretions; slightly acid; gradual boundary.

C2—63 to 75 inches, light brownish-gray (2.5Y 6/2) silt loam to light silty clay loam; common, fine, prominent mottles of strong brown (7.5YR 5/6) and yellowish brown (10YR 5/4); material brown (10YR 5/3) when kneaded; massive with some vertical cleavages; friable to firm; relict deoxidized and leached weathering zone; common, fine, dark-brown (7.5YR 3/2) and few, fine, yellowish-red (5YR 4/6) concretions; slightly acid; abrupt boundary.

IIC3—75 inches +, pedisedimentlike material that is light olive brown (2.5Y 5/4) and gray (5Y 5/1), very firm light silty clay loam; common, grainy coatings and sand grains; slightly acid.

The A1 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color and from 2 to 5 inches in thickness. Cultivated or slightly eroded areas normally have a dark grayish-brown (10YR 4/2) plow layer. The A2 horizon ranges from grayish brown (10YR 5/2) to yellowish brown (10YR 5/4), and it is 4 to 8 inches thick. The B1 horizon ranges from brown (10YR 5/3) to yellowish brown (10YR 5/4) and commonly has mottles of higher and lower chroma than the matrix color. The grayish color of the B3 and C horizon is relict and related to a deoxidized and leached weathering zone. The clay maximum occurs at a depth of about 14 to 20 inches. The content of clay in the B2 horizon ranges from 48 to 58 percent. The reaction ranges from medium acid to very strongly acid in the most acid part of the solum.

Laboratory data on samples taken at this site show a high of 55 percent clay in the B21t horizon and a low of 21 percent clay in the A1 horizon. The content of clay in the A horizon ranges from 21 to 28 percent. The clay maximum is in the B21t horizon and is 55 percent. The content of silt ranges from a high of 76 percent in the A1 horizon to a low of 44 percent in the B21t horizon. Sand makes up less than 5 percent of the layer where it is most plentiful.

The Rathbun soils have a thinner dark surface layer and browner colors in the subsoil than have the Seymour and Kniffin soils. Rathbun soils are not so reddish as are the Adair soils, and they contain less sand. They did not form in glacial till as did the Gara and Lindley soils, and they contain less sand and gravel than those soils.

Rathbun silt loam, 5 to 9 percent slopes (RaC).—This soil is on ridgetops and short, slightly convex side slopes. It erodes readily in cultivated areas because water runs off in large amounts. The topmost layer of this soil is thin and very dark grayish brown. The next layer is grayish brown and moderately thick. The very firm part of the subsoil is silty clay and occurs at a depth of 14 to 18 inches.

This soil is low in organic-matter content. It is low in available nitrogen and potassium and medium in available phosphorus. Additions of lime are needed because this soil is strongly acid to very strongly acid.

Much of this soil is cropland, and the rest is in pasture. This soil is moderately well suited to row crops, but if they are grown, the soil should be terraced and tilled on the contour. Rotations that include meadow for 3 years in 6 are suitable on terraces. (Capability unit IIIe–1; woodland suitability group 3)

Rathbun silt loam, 5 to 9 percent slopes, moderately eroded (RaC2).—This soil is on rounded ridgetops and short, convex side slopes. In Wayne County individual areas of this soil are as much as 30 acres in size, but the total acreage is small. Included with this soil in mapping were a few areas that have slopes of more than 9 percent.

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This soil has a thin, very dark grayish-brown to grayish-brown topmost layer that is underlain by a moderately thick, grayish-brown layer. The subsoil is very firm silty clay. Depth to the clayey subsoil is about 14 to 16 inches.

Runoff is rapid on this soil, and further erosion is likely in bare areas. On the rounded shoulders of side slopes, the subsoil is exposed in some places. In a few small spots the subsoil has been mixed with the surface layer by plowing. After rains the surface of this soil tends to seal and crust.

This soil is strongly acid to very strongly acid and needs lime. The content of organic matter is low. This soil is generally low in available nitrogen and potassium and medium in available phosphorus.

This soil is commonly used for crop rotation. If this soil is terraced and tilled on the contour, a rotation that includes meadow for 3 years in 6 is suitable. Crops generally grow poorly. (Capability unit IIIe-1; woodland suitability group 3)

Seymour Series

The Seymour series consists of dark to moderately dark, somewhat poorly drained soils on uplands. These soils developed from leached loess that is 48 to 87 inches thick and is directly underlain by a very slowly permeable, gray, clayey buried soil. The native vegetation was prairie. Slopes range from 2 to 9 percent and are mostly short and convex.

These soils are in most parts of the county except the northwestern corner and extreme northern parts. Individual areas are normally large, and they are fair to good farming soils.

In a typical profile, the surface layer extends to a depth of about 15 inches. It is very dark gray, friable silt loam that is mixed with some very dark grayish-brown silty clay loam in the lower part. The subsoil extends to a depth of 64 inches. To a depth of 36 inches, the subsoil is dark grayish-brown, very dark gray, and gray silty clay. Below this depth the subsoil is olive-gray silty clay loam. Mottling begins at a depth of 15 inches and extends through the subsoil. Mottles are brownish colored.

The Seymour soils are seasonably wet and seepy, and the hazard of erosion is high in cultivated areas. Available moisture holding capacity is high, and permeability is very slow.

Typical profile of Seymour silt loam, on a convex north-facing slope of 2 percent, 342 feet west and 497 feet south of the center of road in the northeast corner of the SW¼ section 3, T. 68 N., R. 20 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) heavy silt loam, gray (10YR 5/1) when dry; very weak, thick, platy breaking to weak, fine, subangular blocky and fine, granular structure; friable; platy structure at lower boundary due to compaction; very few, very fine, dark-brown, soft concretions; abundant, fine roots; slightly acid; abrupt, smooth boundary.

A12—7 to 11 inches, heavy silt loam that is mainly very dark gray (10YR 3/1) and partly very dark grayish brown (10YR 3/2), gray (10YR 5/1 to 6/1) when dry; weak, very fine, subangular blocky and weak, fine, granular structure; friable; material very dark gray (10YR 3/1) when kneaded; few krotovinas; weak platiness due to compaction at 7 to 8 inches; abundant, fine roots; common, very fine, moderately hard, dark-brown and black concretions of an oxide; medium acid; clear, smooth boundary.

A3—11 to 15 inches, medium silty clay loam that is mainly very dark gray (10YR 3/1), but is very dark grayish brown (10YR 3/2) in 20 percent of soil; very dark grayish brown (10YR 3/2) increases with depth; moderate, very fine, subangular blocky structure; friable; material very dark grayish brown (10YR 3/2) when kneaded; few worm casts or mixings of dark grayish brown (10YR 4/2); few krotovinas; few thin silt coats on peds; abundant, fine roots; few, very fine, soft, dark-brown and black concretions; medium acid; clear, smooth boundary.

B1—15 to 19 inches, dark grayish-brown (2.5Y 4/2) light silty clay, gray (10YR 6/1) to light brownish gray (10YR 6/2) when dry; moderate, very fine, subangular blocky structure; firm; few to common, fine, olive-brown (2.5Y 4/4) mottles; few thin silt coats on peds; few, fine, dark-brown and black concretions; common, fine roots; medium acid; clear, smooth boundary.

B21t—19 to 23 inches, dark grayish-brown (10YR 4/2) and dark-gray (10YR 4/1) silty clay; strong, very fine, subangular blocky structure; very firm; exterior of peds is dark gray (10YR 4/1) and has common. fine mottles of dark yellowish brown and interior of peds is dark grayish brown (10YR 4/2) with many fine, yellowish-brown (10YR 5/4) mottles; thin, discontinuous clay films; few silt coats on some peds; krotovina (1 inch by 3 inches) filled with very dark gray silty clay loam at side of pit; few fine roots; common, very fine, soft, dark-brown and black concretions; medium acid; clear, smooth boundary.

B22t—23 to 28 inches, very dark gray (10YR 3/1) silty clay; strong, very fine, angular and subangular blocky structure; very firm; few, fine, dark-brown (10YR 4/3) mottles on the ped exteriors and many, fine, yellowish-brown (10YR 5/4 to 5/6) mottles in ped interiors; thin, continuous clay films; few, fine, tubular pores in peds; some large oblique pressure faces; few fine roots; common, fine, moderately hard black concretions; few very fine roots; slightly acid; clear, smooth boundary.

B23t—28 to 36 inches, dark-gray (10YR 4/1), dark grayish-brown (10YR 4/2), and grayish-brown (2.5Y 5/2) light silty clay; weak, medium, prismatic structure breaking to moderate, fine and medium, subangular blocky structure; firm; exteriors of peds are dark gray (10YR 4/1); vertical faces are dark grayish brown (10YR 4/2) with common, fine, yellowish-brown (10YR 5/4) mottles; interiors are grayish brown (2.5Y 5/2) with common to many, fine, yellowish-brown (10YR 5/6) to strong-brown (7.5YR 5/8) mottles; thin, discontinuous clay films and some very dark gray clay coats in a few pores; some oblique pressure faces; very few thin silt coats; few, fine, tubular pores in peds; fewer concretions than in horizon above; slightly acid; clear, irregular boundary.

B31t—36 to 45 inches, heavy silty clay loam that is mainly olive gray (5Y 5/2) and partly dark gray (2.5Y 4/1); moderate, medium, prismatic breaking to moderate, medium, subangular blocky structure; friable to firm; common, medium to fine, yellowish-brown (10YR 5/6) mottles; very thin, discontinuous clay films on prism faces and as coats in a few pores; concretions same as in B22 horizon; few thin silt coats on some peds; common, fine, tubular pores in peds; some oblique pressure faces; relict deoxidized and leached weathering zone; slightly acid; gradual, smooth boundary.

B32t—45 to 54 inches, same color, texture, and structure as the B31 horizon; common to many, fine and medium, strong-brown (7.5YR 5/6) mottles; few very dark gray clay coats in pores and dark-gray clay films on some vertical faces, several accumulations of clay balls, one-half inch in diameter; some oblique pressure faces; friable to firm; common, fine, tubular pores in peds; relict deoxidized and leached weathering zone; slightly acid; gradual, smooth boundary.

B33t—54 to 64 inches, medium silty clay loam that is the same color as the B31 horizon; very weak, coarse, prismatic breaking to very weak, coarse, angular blocky structure; friable to firm; few to common, fine mottles of yellowish brown (10YR 5/6) to strong brown (7.5YR 5/6); few dark-gray clay coats in a few pores; several accumulations of clay balls one-half inch in diameter; relict deoxidized and leached weathering zone; common, fine, tubular pores in peds.

The A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) in color and from 10 to 18 inches in thickness. Its texture ranges from silty clay loam to silt loam. The B2 horizon is typically 17 inches thick but ranges from 17 to 30 inches in thickness. The maximum content of clay ranges from 46 to 58 percent. When the B horizon is moist, matrix colors range from 10YR to 5Y in hue, and value increases from 3 to 5 as depth increases; the dominant chroma in the B horizon is 2. Colors that have a chroma of 1 are common on ped exteriors. The olive-gray and gray colors in the B3 and C horizons are relict and related to a deoxidized and leached weathering zone. Where the C horizon is observed, its texture is silty clay loam and its matrix colors range from 2.5Y to 5Y in hue, have a value of 5 or 6, and a chroma of 1 or 2. The depth to glacial till ranges from 6 to 7 feet, and the solum is 3 to 6 feet thick, depending on topographic position.

The Seymour soils normally have a thicker dark surface layer than the Pershing and Kniffin soils, but Seymour soils lack an A2 horizon. They are finer textured than the Grundy soils. The grayish clay and silty clay textures do not extend so deep in the Seymour soils as in the Clarinda soils. Seymour soils lack the prominent grayish A2 horizon that occurs in the Edina soils.

Seymour silt loam, 2 to 5 percent slopes (SeB).—This soil is on short, slightly convex side slopes and ridgetops near the broad upland flats. It is generally adjacent to the moderately sloping Seymour soils, which are downslope, and to the Edina soils, which are upslope. Included with this soil in mapping were a few areas that have a slightly grayish layer below the topmost layer.

This soil has a black to very dark gray surface layer 10 to 18 inches thick. The silty clay subsoil is commonly at a depth of 18 to 24 inches. The subsoil is distinctly mottled, firm, and clayey.

This soil is acid unless recently limed, and it responds well to the use of lime and fertilizer. It is typically low in available nitrogen and phosphorus and is medium in available potassium.

This soil needs good management for good crop growth. Tilth is generally good and can be maintained if crop residues are returned to the soil. This soil is suited to a rotation that includes meadow 1 year in 5. (Capability unit IIIe–2; woodland suitability group 3)

Seymour silty clay loam, 5 to 9 percent slopes (SfC).—This soil is on short, convex ridgetops and on short, slightly convex side slopes that are irregular in places. It is generally surrounded by soils that have a clayey subsoil, and small spots that have a clayey subsoil were included in mapping in some places.

This soil has a very dark gray surface layer 10 to 14 inches thick. In many places the subsoil is silty clay at a depth of 16 to 22 inches. The highly mottled subsoil is firm.

This soil is acid unless recently limed. Response to additions of lime and fertilizer is good. Typically, this soil is low in available nitrogen and phosphorus and medium in available potassium.

This soil needs careful management for good crop growth. Tilth is generally good and can be maintained if crop residues are returned to the soil. If terraced and tilled on the contour, this soil is suited to a rotation that includes meadow for 3 years in 6. (Capability unit IIIe–3; woodland suitability group 3)

Seymour silty clay loam, 5 to 9 percent slopes, moderately eroded (SfC2).—This soil is on short side slopes that are irregular in places. Runoff is generally high because of the slopes and the compacted surface layer that occurs in places. Included with this soil in mapping were small areas of other soils that have a clayey subsoil.

The topmost layer of this soil is very dark gray to very dark grayish brown and is 3 to 7 inches thick. The subsoil is commonly at a depth of about 15 to 20 inches and consists of mottled silty clay.

This soil is acid unless recently limed, and response to additions of lime and fertilizer is good. Typically, available nitrogen is very low, available phosphorus is low, and available potassium is medium.

Since this soil is cloddy when it dries, practices are needed to improve tilth. Applications of manure improve tilth and help to keep the loss of soil to a minimum. If terracing and contour tillage are used, a rotation that includes meadow for 3 years in 6 is suitable. If this soil is managed well, crops grow fairly well. (Capability unit IIIe–3; woodland suitability group 3)

Shelby Series

The Shelby series consists of dark to moderately dark colored, moderately well drained soils that formed from glacial till on uplands. These soils have a prominent yellow-brown subsoil. The native vegetation was prairie grasses, but there are a few trees.

Shelby soils have slopes that generally range from 9 to 24 percent. They are very extensive in all parts of the county and are fair for farming.

In a typical profile, the surface layer is black to very dark brown, friable loam and clay loam about 12 inches thick. The subsoil extends to a depth of about 44 inches and consists of dark-brown to yellowish-brown, firm clay loam that is mottled. The upper part of the substratum is yellowish-brown, firm, calcareous clay loam that is mottled with strong brown.

The Shelby soils are highly susceptible to erosion in cultivated areas. Available moisture holding capacity is high, and permeability is moderately slow.

Typical profile of Shelby loam, on a convex side slope of 11 percent, 100 feet south and 510 feet east of northwest corner of SW¼ of section 15, T. 69 N., R. 21 W.:

A1—0 to 7 inches, black to very dark brown (10YR 2/1 to 2/2) heavy loam, dark gray (10YR 4/1) when dry; material very dark gray (10YR 3/1) when kneaded; moderate, fine, granular structure; friable; neutral; clear boundary.

A3—7 to 12 inches, very dark grayish-brown (10YR 3/2) light clay loam and some pebbles; common, fine, faint coats and streaks of very dark gray (10YR 3/1); few dark-brown or brown (10YR 4/3) worm casts; material very dark grayish brown (10YR 3/2) when kneaded; moderate, fine, subangular blocky breaking to moderate, fine, granular structure; friable; neutral; clear boundary.

B21t—12 to 18 inches, medium clay loam that has dark-brown (10YR 3/3) ped exteriors and dark yellowish-brown (10YR 4/4) ped interiors; some pebbles; considerable mixing of very dark gray (10YR 3/1); material dark brown or brown (10YR 4/3) when kneaded; moderate, fine and medium, subangular blocky structure; firm; thin, discontinuous clay films; medium acid; gradual boundary.

B22t—18 to 28 inches, heavy to medium clay loam that has dark-brown or brown (10YR 4/3) ped exteriors and dark yellowish-brown (10YR 4/4) ped interiors; some pebbles; few, fine, faint mottles of grayish brown (10YR 5/2); material dark yellowish brown (10YR 4/4) when kneaded; moderate, medium, subangular blocky structure; firm; few dark-brown (10YR 3/3) clay films; few, fine, distinct, dark reddish-brown (5YR 2/2) concretions; medium acid; gradual boundary.

B31t—28 to 34 inches, dark-brown or brown to dark yellowish-brown (10YR 4/3 to 10YR 4/4) medium clay loam and some pebbles; few, fine, faint mottles of grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) and few, fine, distinct mottles of gray (5Y 6/1); common dark-brown (10YR 3/3) clay films; material yellowish brown (10YR 5/6) when kneaded; weak, fine, prismatic breaking to weak, medium, subangular blocky structure; firm; few, fine, distinct, dark reddish-brown (5YR 2/2) concretions; slightly acid; gradual boundary.

B32t—34 to 44 inches, yellowish-brown (10YR 5/6) light clay loam and some pebbles; on exterior of peds are common, medium, faint mottles of yellowish brown (10YR 5/8), few, medium, faint mottles of gray (10YR 5/1 to 6/1), and common, fine, faint mottles of dark brown or brown (10YR 4/3 and 4/4); material yellowish brown (10YR 5/6) when kneaded; few, discontinuous, dark-brown (10YR 3/3) clay films; weak, coarse, prismatic breaking to weak, medium, subangular blocky structure; firm; slightly acid; gradual boundary.

C1—44 to 56 inches, yellowish-brown (10YR 5/4 and 5/6) light clay loam and some pebbles; few, medium, faint mottles of strong brown (7.5YR 5/8) and common, fine to medium, faint mottles of gray (10YR 5/1 to 6/1); vertical cleavage faces are dark yellowish brown (10YR 4/4); weak, coarse, prismatic structure; firm; common, small, white (10YR 8/1) concretions of calcium carbonate; mildly alkaline; gradual boundary.

C2—56 to 62 inches, strong-brown (7.5YR 5/6) and gray to light-gray (5Y 6/1) clay loam and some pebbles; common, fine to medium, faint mottles of gray (5Y 6/1); massive but some cleavage faces occur; firm; few large concretions of calcium carbonate; mildly alkaline.

The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2), depending on the degree of erosion. Texture ranges from loam to light clay loam but is generally loam. The A horizon ranges in thickness from 10 to 16 inches, depending on the topography. The matrix color of the B horizon ranges from dark brown or brown (10YR 4/3) to yellowish brown (10YR 5/6). Clay, in its zone of maximum accumulation, has a content ranging from 30 to 35 percent. Mottling begins at a depth of 24 to 30 inches. The mottles are mostly common, fine to medium, gray (5Y 5/1) and few, fine, faint, yellowish brown (10YR 5/6). The reaction ranges from medium acid to strongly acid in the most acid part of the solum. Depending on the position of these soils, the C horizon is calcareous in its matrix at a depth ranging from 30 to 54 inches, but in most places the matrix is calcareous at a depth of about 40 inches.

The Shelby soils occur with the Lamoni, Adair, and Clarinda soils but have a less clayey subsoil. The subsoil of Shelby soils is darker brown than that of the Lamoni soils. The Shelby soils have a brownish subsoil, whereas the subsoil of the Clarinda soils is grayish, and part of the subsoil of the Adair soils is reddish. The glacial till underlying the Shelby soils is not so highly weathered as that underlying Adair and Clarinda soils. Unlike the Gara soils, the Shelby soils do not have an A2 horizon.

Shelby loam, 9 to 14 percent slopes (ShD).—This soil generally bands the lower slopes at the upper end of drainageways, and it extends to the strong side slopes. It is similar to the adjoining steep Shelby soils and is downslope from the Adair and Lamoni soils. Individual areas are about 10 to 40 acres in size and occur in all parts of the county.

This soil has a very dark gray surface layer 12 to 16 inches thick. In most places the surface layer is thicker and more friable than that of the profile described as typical for Shelby series. This soil formed from Kansan till.

Water runs off this soil excessively because slopes are strong and the subsoil is moderately slow in permeability. The hazard of erosion is very high in cultivated areas.

The tilth of this soil is generally very good. The content of organic matter is medium. Lime is required in most areas. Available nitrogen and phosphorus is low to very low, and available potassium is medium.

Much of this soil is in meadow and permanent pasture, and some of it probably will remain so because it is managed the same way as adjacent soils poorly suited to cultivation. On this soil pasture is excellent after it is renovated. If row crops are planted, terracing and contour tillage are needed. Rotations that include meadow for 2 years in 4 are suitable on terraced fields. Crops generally grow moderately well. (Capability unit IIIe–5; woodland suitability group 1)

Shelby loam, 9 to 14 percent slopes, moderately eroded (ShD2).—This soil is in bands that in many places cover entire side slopes. It is downslope from Adair and Lamoni soils, and in some small areas these soils were included in mapping. This Shelby soil occurs throughout the county in areas as much as 80 acres in size, and it is the most extensive Shelby soil in the county.

The topmost layer of this soil is very dark brown loam about 3 to 7 inches thick. The soil formed from Kansan till on moderate rounded slopes, generally in strongly dissected areas.

This soil erodes readily in cultivated areas. The yellowish-brown subsoil is exposed near drains in side slopes and near areas of Adair soils that are upslope.

Although lime occurs at a depth of 36 inches or more, this soil is normally medium acid. It is generally low in available nitrogen, very low in available phosphorus, and medium in potassium. Response to nitrogen and phosphate fertilizers is fairly good. Applications of manure improve tilth and fertility.

This soil is moderately well suited to row crops, and they are planted in crop rotations. Rotations that include meadow for 2 years in 4 are suitable if this soil is terraced and tilled on the contour. Row crops grow fairly well if management is good. (Capability unit IIIe–5; woodland suitability group 1)

Shelby loam, 14 to 18 percent slopes (ShE).—This soil is in all parts of the county, but most of it is near valleys of large streams. It covers entire side slopes between the Adair soils upslope and the Olmitz, Vesser, or Colo soils downslope.

The surface layer of this soil is very dark gray, friable loam 10 to 12 inches thick in most places. Near the base of some long slopes, however, the surface layer has been covered by 8 to 10 inches of local alluvium that washed from the upper part of the slope. Because of the excessive runoff, erosion is a hazard in cultivated areas.

Included with this soil in mapping were small areas that have slopes of more than 18 percent and small areas that have slopes of less than 14 percent.

This soil is generally medium acid. Depth to lime ranges from 30 to 48 inches. The available nitrogen is low, available phosphorus is very low, and the available potassium is medium.

Nearly all of this soil is in meadow or permanent pasture. If managed well, this soil is well suited to pasture and to renovated meadow. This soil is not suitable for terracing, but if row crops are planted, it should be tilled on the contour. A row crop can be grown for 1 year when pastures are renovated. Row crops grow fairly well to poorly. (Capability unit IVe–1; woodland suitability group 1)

Shelby loam, 14 to 18 percent slopes, moderately eroded (ShE2).—This soil is in all parts of the county, but most of it is near the valleys of large streams. It covers entire side slopes between the Adair soils upslope and the Olmitz, Vesser, or Colo soils downslope. The slopes are slightly irregular and complex in many places.

This soil has a very dark gray to very dark grayish-brown plow layer that is 3 to 6 inches thick. In some places at the base of slopes, the surface layer is more than 6 inches thick where local alluvium has accumulated.

Included with this soil in mapping were small areas that have slopes of more than 18 percent and small areas that have slopes of less than 14 percent. Also included were small inclusions of Nebraskan gumbotil.

Runoff is excessive, and the hazard of erosion is high in cultivated areas. Tilth is generally poor, particularly where the yellowish-brown subsoil is exposed.

This soil is slightly acid in most places, but lime generally is abundant below a depth of 30 inches. Available nitrogen is low, available phosphorus is very low, and available potassium is medium.

This soil is better suited to pasture than to row crops, but row crops are sometimes grown for 1 year when pastures are renovated. Row crops grow poorly. Terraces are generally not used, but contour tillage is needed if row crops are planted. (Capability unit IVe–1; woodland suitability group 1)

Shelby loam, 18 to 24 percent slopes, moderately eroded (ShF2).—This soil is on slopes that form an irregular and complex pattern. In a few places small areas of short, abrupt side slopes next to the valleys of large Nebraskan gumbotil are exposed. This soil is also on short, abrupt side slopes next to the valleys of large streams.

The surface layer of this soil ranges from very dark gray to very dark grayish brown. In most places the surface layer is about 6 inches thick, but near drainageways and at the lower parts of slopes it is as much as 10 inches thick. The depth to the underlying material is about 30 inches. Included in mapping were small areas of less eroded Shelby soils and areas that have slopes of slightly more than 24 percent.

This soil is generally low in available nitrogen, very low in available phosphorus, and medium in available potassium. Oats, pasture seedings, and permanent pasture respond well to additions of fertilizer. Lime may not be needed, for this soil generally has an adequate amount at a depth of about 30 inches.

Nearly all of this soil is in permanent pasture, and there are some scattered areas of woodland. This soil is moderately well suited to pasture, but it is not suited to cultivated crops. It is extremely erodible where vegetation is sparse. Although renovation of pasture is desirable, the use of farm equipment may be dangerous on the steep slopes. Where pasture can be renovated, oats should be seeded as a nurse crop. Grazing needs to be controlled so as to prevent the loss of plant cover and subsequent erosion. (Capability unit VIe–1; woodland suitability group 2)

Shelby soils, 9 to 14 percent slopes, severely eroded (SoD3).—These soils occur in some places as a series of eroded spots between the drainageways on strong side slopes. They also are in thin, narrow bands at the shoulders of side slopes immediately downslope from the Adair and Clarinda soils. Individual areas have a wide range in size, but areas of less than 1 acre are shown on the soil map by the symbol for severely eroded spots.

The profile of these soils is similar to the profile described as typical for the Shelby series, but most of the original surface soil has been removed by erosion. The surface layer is firm clay loam or loam that is very dark grayish brown or dark brown to dark yellowish brown.

Because they are strongly sloping and absorb moisture slowly, these soils are extremely erodible if cultivated. They puddle easily and seal quickly after rains.

These soils are low in organic-matter content. They are very low in available nitrogen and phosphorus and are medium in available potassium. Manure and a complete fertilizer are needed to improve tilth and fertility. Although lime is abundant at a depth of 36 inches and below, the upper part of these soils is slightly acid.

These soils are better suited to pasture than to row crops. Although they are poorly suited to row crops, they will probably continue to be used for them in small areas that adjoin better soils in row crops. In some places small areas of these Shelby soils could be used to provide food and cover for wildlife. (Capability unit IVe–1; woodland suitability group 1)

Shelby soils, 14 to 18 percent slopes, severely eroded (SoE3).—These soils are on the shoulders of side slopes below the Adair and Clarinda soils, and some mapped areas include spots of those soils. In some places these Shelby soils are on irregular side slopes in a series of sharply rounded slopes. The slopes are moderately long in many places.

The profile of these soils is similar to the one described as typical for the Shelby series, except that nearly all the original surface layer has been lost. In some small areas, however, enough of the original surface layer remains to give plowed fields a spotted light and dark appearance. The present surface layer is firm clay loam or loam that is very dark grayish brown, dark brown, or dark yellowish brown.

These soils are generally in poor tilth, and they puddle readily if they are worked when wet. When dry, the surface layer is hard and cracked. In some areas gullies are so deep that they cannot be crossed with ordinary farm implements. Areas less than 1 acre in size that occur within other soils are shown on the soil map by the symbol for severely eroded spots.

Needed on this soil are applications of manure and of fertilizer that contain enough nitrogen and phosphate for quick growth. The supply of available potassium is medium. Lime may not be needed.

These soils are not suited to row crops. They should remain in permanent pasture. Where renovating pasture is practical, the gullies should be filled before planting a grass-legume mixture along with a nurse crop. (Capability unit VIe-2; woodland suitability group 1)

Vesser Series

The Vesser series consists of dark to moderately dark, somewhat poorly drained to poorly drained soils on bottom lands and foot slopes. These soils developed from alluvium. The native vegetation was probably mixed forest and prairie grasses. These soils are closely associated with the Humeston, Nodaway, Lawson, and Colo soils on bottom lands and with the Olmitz soils on gentle foot slopes. Areas that are drained and protected from flooding are among the most productive in the county.

In a typical profile, the surface layer is about 31 inches thick and consists of very dark gray and dark-gray friable silt loam. Mottling begins at a depth of 12 inches and continues through the subsoil. Mottles are predominantly dark brown. The subsoil extends to a depth of about 60 inches. It consists of dark-gray to very dark gray silty clay loam that is dominantly firm. The substratum is of similar color but is massive.

The Vesser soils are subject to flooding and have a seasonal high water table. They have high available moisture holding capacity and moderately slow permeability.

Typical profile of Vesser silt loam, on a slope of 1 percent, 655 feet west and 935 feet south of the northeast corner of SE¼ section 5, T. 69 N., R. 21 W., cropland near old abandoned stream channel:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) when dry; material same color when kneaded; moderate, fine, subangular blocky breaking to weak, fine, granular structure; friable; slightly acid; abrupt boundary.

A12—8 to 12 inches, very dark gray (10YR 3/1) heavy silt loam, dark gray to gray (10YR 4/1 to 5/1) when dry; material same color when kneaded; weak, fine, subangular blocky breaking to moderate, fine, granular structure; friable; medium to slightly acid; clear boundary.

A21—12 to 20 inches, very dark gray and dark-gray (10YR 3/1 tnd 4/1) silt loam, gray and gray to light gray (10YR 5/1 and 6/1) when dry; few, fine, distinct mottles of dark brown (7.5YR 3/2); material very dark gray to dark gray (10YR 3/1 to 4/1) when kneaded; moderate, fine, granular structure; friable; common, dark, hard concretions; medium acid; clear boundary.

A22—20 to 31 inches, dark-gray (10YR 4/1) silt loam; common grayish-brown (10YR 5/2) ped coatings; few, fine, distinct, mottles of dark brown (7.5YR 3/2); material dark grayish brown (10YR 4/2) when kneaded; when dry, light-gray (10YR 7/1 to 7/2) coatings and gray to light-gray (10YR 5/1 to 6/1) ped interiors; weak, medium, platy and weak, medium, subangular blocky structure; friable; common soft black oxide concretions; strongly acid; clear boundary.

B21tg—31 to 37 inches, dark-gray (10YR 4/1) light to medium silty clay loam; common, fine, distinct mottles of dark brown (7.5YR 3/2); kneaded material same color as matrix; many gray (10YR 5/1) ped coatings that are light gray (10YR 7/1 to 7/2) when dry; moderate, fine to medium, prismatic breaking to moderate, medium, subangular blocky structure; firm to friable; common, thick, discontinuous, black (10YR 2/1) clay films; common soft black oxide concretions and hard concretions; strongly acid; gradual boundary.

B22tg—37 to 46 inches, dark-gray (10YR 4/1) medium silty clay loam; few, fine, distinct, brown or dark-brown (7.5YR 4//4) mottles; moderate, medium, prismatic breaking to weak to moderate, medium, subangular blocky structure; firm; common, thick, discontinuous, black (N 2/0) clay films and flows; few, black, hard concretions; medium acid; gradual boundary.

B3—46 to 60 inches, dark-gray (10YR 4/1) and very dark gray (10YR 3/1) medium to heavy silty clay loam; kneaded material has same color; light-gray (10YR 7/1) ped coatings; weak, medium, prismatic structure; firm; slightly acid.

The A1 horizon ranges from very dark gray (10YR 3/1) to black (10YR 2/1) in color and from 10 to 16 inches in thickness. The A2 horizon is commonly 18 to 20 inches thick but ranges from 16 to 22 inches in thickness. The A2 horizon ranges from very dark gray (10YR 3/1) to grayish brown (10YR 5/2) in color.

The matrix colors of the B horizon are generally very dark grayish brown (10YR 3/2) and dark gray (10YR 4/1), but they range to grayish brown (10YR 5/2) in places. The peds in the B horizon have a grayer exterior than interior. This grayer color is caused by thin silt coats. The B horizon generally occurs at a depth of about 30 inches, but depth to this horizon ranges from 26 to 36 inches. Above a depth of 40 inches the clay content of the B horizon generally ranges from 30 to 36 percent. Clay films are evident. Horizons that have a clay content of 36 to 40 percent occur below a depth of 40 inches in some places. The reaction ranges from medium acid to strongly acid in the most acid part of the profile.

Laboratory data on samples taken at this site show a maximum of 36 percent clay in the B21tg horizon and a minimum of 25 percent clay in the A21 horizon. The Ap horizon is 28 percent clay. The content of silt ranges from 67 percent in the Ap horizon to 51 percent in the B22tg horizon. The content of sand ranges from a low of 4 percent in the Ap horizon to a high of 15 percent in the B22tg horizon. Throughout the solum, the content of sand increases gradually as depth increases.

The Vesser soils have a thicker, grayer A2 horizon than the Nodaway, Lawson, Colo, and Olmitz soils. The subsoil of Vesser soils contains less clay than that of the Humeston soils.

Vesser silt loam (0 to 2 percent slopes) (Ve).—This soil occurs along streams. It has a black to very dark gray topmost layer that is 10 to 16 inches thick. Beneath this is a thick, gray, leached layer that is underlain by a silty clay loam subsoil at a depth of 26 to 36 inches. Included with this soil in mapping were areas that have a fine-textured subsoil and, above it, a gray leached layer that is thinner than normal.

This soil is slightly acid to strongly acid. It is low in available nitrogen and medium in available phosphorus and potassium. Corn that does not follow a legume normally responds well to a nitrogen fertilizer.

This soil, though flooded occasionally, is used mostly for cultivated crops. Areas that are flooded most frequently, and those that are inaccessible, are in pasture or trees. Where artificially drained and protected from flooding, this soil is well suited to row crops. The content of organic matter is medium, and tilth is generally good. If tilth becomes poor, a meadow crop can be grown for 1 year. Cultivation is often delayed in areas that are artificially drained. Tile lines work well in draining this soil, for its subsoil has moderately slow permeability. (Capability unit IIw-1; woodland suitability group 6)

Vesser silt loam, 2 to 5 percent slopes (VeB).—This soil has formed from alluvium, including sediments washed from adjacent soils on uplands. It is on even to slightly concave foot slopes and is downslope from the Caleb, Shelby, and Gara soils. Most of this soil has slopes of 3 percent or less. Erosion is not a serious hazard.

The subsoil has moderately slow permeability and normally absorbs most of the rainfall. This soil is often wet because it receives excessive runoff and some seepage from adjacent uplands. The seepage can be reduced by tile drainage. In many places diversion terraces are built in soils on adjacent uplands so as to divert the runoff that comes from higher areas.

This soil is slightly acid to strongly acid. It is low in available nitrogen and medium in available phosphorus and potassium. The content of organic matter is medium. Corn that does not follow a legume normally responds well to a nitrogen fertilizer.

This soil is well suited to row crops if it is adequately drained. The content of organic matter is medium, and tilth is generally good. If tilth becomes poor, a meadow crop can be grown for 1 year. (Capability unit IIw-1; woodland suitability group 6)

Wabash Series

The Wabash series consists of poorly drained soils that have formed from silty alluvium on bottom lands. These soils are in slack water areas of the flood plains. In many places they are away from the stream channel and adjacent to the foot slopes. These soils occur with the Colo, Zook, Vesser, and Humeston soils.

These soils are likely to be the first flooded, as they are generally slightly lower than surrounding soils on the bottom lands. Wabash soils have a small acreage in this county. They are fair for farming.

In a typical profile, the surface layer is about 12 inches thick and consists of black silty clay that is friable to firm. The subsoil extends to a depth of about 4 feet and is silty clay that is firm to very firm and mainly black. The subsoil is mixed black and very dark gray in the lower part. The substratum is mixed dark gray and black to very dark gray and gray firm silty clay that is mottled in the lower part.

The Wabash soils are subject to flooding, and their water table is seasonally at or near the surface. Adequate drainage is difficult to provide. Available water holding capacity is high, and permeability is very slow.

Typical profile of Wabash silty clay, on a slope of 1 percent on bottom land, 520 feet south and 200 feet east of the northwest corner of the SW¼ section 10, T. 69 N., R. 20 W.:

Ap—0 to 7 inches, black (10YR 2/1) light silty clay, dark gray (10YR 4/1) when dry; material is same color when kneaded; some granular structure in topmost 2 inches but weak to moderate, fine, subangular blocky and angular blocky structure below; friable to firm; slightly acid; clear boundary.

A3—7 to 12 inches, medium silty clay that is mainly black (N 2/0) but includes a small amount of black (10YR 2/1); very dark gray (N 3/0) when dry; chroma and hue are slightly higher when material is kneaded; moderate, very fine, subangular blocky structure; firm; slightly acid; clear boundary.

B21—12 to 18 inches, medium silty clay that is mainly black (N 2/0) but includes some black (10YR 2/1); color has slightly higher chroma and hue when kneaded; weak, fine, prismatic breaking to weak to moderate, very fine and fine, subangular blocky structure; firm to very firm; slightly acid; clear boundary.

B22—18 to 28 inches, black (N 2/0) medium to heavy silty clay; some coarse black (10YR 2/1) deposits; color has slightly higher chroma when material is kneaded; moderate, fine to medium, prismatic breaking to moderate, fine, subangular blocky structure; very firm; common, thick, discontinuous clay films on pressure faces; few, fine, soft concretions; neutral; gradual boundary.

B23—28 to 39 inches, black (N 2/0 to 10YR 2/1) medium silty clay; some black (10YR 2/1) deposits; color has slightly higher chroma when material is kneaded; weak to moderate, medium, prismatic breaking to moderate, fine to medium, subangular blocky structure; very firm; almost continuous clay films on pressure faces; neutral; gradual boundary.

B3g—39 to 50 inches, mixed black and very dark gray (10YR 2/1 and 3/1) medium silty clay; material very dark gray (10YR 3/1) when kneaded; moderate, medium, prismatic breaking to weak, medium, subangular blocky structure; firm; thick, discontinuous clay films on pressure faces; neutral; gradual boundary.

C1g—50 to 65 inches, mixed dark gray (10YR 4/1) and black to very dark gray (N 2/0 to 3/0) light to medium silty clay, of which 70 percent is dark gray (10YR 4/1); material very dark gray (10YR 3/1) when kneaded; few, thin, discontinuous clay films on pressure faces; massive with some cleavage planes; firm; neutral; gradual boundary.

C2g—65 to 80 inches, dark-gray to gray (5Y 4/1 to 5/1) light silty clay; lower part of horizon has few light olive-brown (2.5Y 5/6) mottles and few dark reddish-brown (5YR 3/3) root channels; massive with some cleavage planes; firm; neutral.

The A horizon ranges from 40 to 44 percent in content of clay. In some places there is as much as 10 inches of coarser textured overwash on the surface. The subsoil ranges from 46 to 52 percent in content of clay. Colors with a value of 3 or less extend to a depth of 36 inches or more. Mottles having a high chroma are absent. This soil formed in fine-textured alluvium that is more than 3½ feet thick. The content of sand is very low.

The Wabash soils have a more clayey subsoil than have the Zook and Colo soils. Wabash soils lack an A2 horizon, which is characteristic of the Vesser and Humeston soils.

Wabash silty clay (0 to 2 percent slopes) (Wa).—This soil formed in low areas where floodwater often stands long enough to allow the clay in it to settle. Most areas of this soil are nearly level and occur on bottom lands adjoining foot slopes. Some areas are in the old bayous that have received deposits but that now are a considerable distance from the stream channel. Individual areas range from 5 to 50 acres in size, but the total acreage in the county is small.

This soil is silty clay throughout the profile. When it is dry, this soil is extremely hard and has many cracks that extend from the surface into the subsoil. The soil then absorbs rainfall at a moderate rate for a short time until it is saturated and the cracks seal. After the cracks seal, the surface soil is slowly permeable and the subsoil is very slowly permeable.

This soil is slightly acid and generally is medium in fertility. It is low in available nitrogen and medium in available phosphorus and potassium. It is high in organic-matter content.

Because this soil ponds after heavy rains, excess water usually delays field operations in the spring and fall, and seedbeds are very difficult to prepare. Flooding from the overflow of streams is only occasional. Tilth is improved by plowing in the fall and growing soybeans in place of corn. If this soil is drained and properly managed, it can be planted to row crops frequently. Crops are sometimes lost when rainfall is more than average. A system of open ditches and shallow surface drains are needed to reduce excess water. Because the subsoil is very slowly permeable, tile drains do not work. (Capability unit IIIw-2; woodland suitability group 7)

Zook Series

The Zook series consists of dark-colored, poorly drained soils on bottom lands. These soils developed from fine-textured alluvium. They are in slack water areas away from the stream channel. Zook soils occur with the Colo, Wabash, Chequest, and Vesser soils. They are extensive in the county and are good for farming if they are drained and protected from flooding.

In a typical profile, the surface layer is about 12 inches thick and consists of black silty clay loam that is friable to firm. The subsoil extends to a depth of about 40 inches. In the upper part, it is black firm silty clay, but in the lower part it grades to silty clay loam that is black and very dark gray. Mottling begins at a depth of about 32 inches and extends through the substratum. Mottles are generally brownish colored. The substratum is firm silty clay loam that is mixed dark gray and very dark gray and mixed gray and dark gray.

The Zook soils are subject to flooding and have a water table that seasonally is at or near the surface. These soils have high available moisture holding capacity and are slowly permeable.

Typical profile of Zook silty clay loam, on a slope of 1 percent on bottom land, 525 feet west and 20 feet south of the northeast corner of SE¼NE¼ section 3, T. 69 N., R. 21 W.:

Ap—0 to 6 inches, black (10YR 2/1 to N 2/0) light silty clay loam, dark gray (10YR 4/1) when dry; material is same color when kneaded; weak, fine, subangular blocky breaking to weak, very fine, granular structure; friable to firm; slightly acid; clear boundary.

A12—6 to 12 inches, black (N 2/0) medium to heavy silty clay loam; very dark gray (N 3/0) when dry; color has slightly higher chroma when material is kneaded; weak to moderate, very fine, subangular blocky structure; firm; few visible grains of fine sand on peds; medium acid; clear boundary.

B21—12 to 17 inches, black (N 2/0) light silty clay; color is same when material is kneaded; moderate, very fine, subangular blocky structure; firm; almost continuous pressure faces or clay films; few fine pores; medium to slightly acid; gradual boundary.

B22—17 to 24 inches, black (10YR 2/1) light silty clay; color is same when material is kneaded; weak, fine and very fine, subangular blocky structure; firm; common pressure faces or discontinuous clay films; common concretions of iron and manganese that are 1 to 3 millimeters in diameter; few fine pores; slightly acid; gradual boundary.

B23—24 to 32 inches, black (10YR 2/1) heavy silty clay loam; color is same when material is kneaded; weak, fine, prismatic breaking to weak, fine, subangular blocky and angular blocky structure; firm; few pressure faces or thin discontinuous clay films; few soft oxide concretions and hard concretions; few fine pores; slightly acid; gradual boundary.

B3g—32 to 40 inches, very dark gray (10YR 3/1) medium silty clay loam; few, fine, distinct mottles of dark yellowish brown (10YR 4/4); color is the same when material is kneaded; weak, fine, prismatic breaking to weak, fine, subangular blocky and angular blocky structure; firm; few hard concretions 1 to 3 millimeters in diameter; few fine pores; slightly acid; gradual boundary.

C1g—40 to 50 inches, mixed dark-gray (10YR 4/1) and very dark gray (10YR 3/1) light to medium silty clay loam; few, fine, faint mottles of light brownish gray (2.5Y 6/2); very dark gray (10YR 3/1) when material is kneaded; massive with some cleavage planes; firm; few, fine, hard concretions; few fine pores; neutral; gradual boundary.

C2g—50 to 65 inches, mixed gray and dark-gray (10YR 5/1 and 4/1) light silty clay loam; common, fine, distinct mottles of dark brown to brown (7.5YR 4/4); material dark grayish brown (2.5Y 4/2) when kneaded; massive with some cleavage planes; firm; few fine pores; neutral.

Typical profile of Zook silt loam, overwashed (mapped in a complex with Colo soils) on a slope of 1 percent on bottom land and, 300 feet south and 210 feet east of the northwest corner of SE¼SE¼ section 10, T. 69 N., R. 20 W., near new channel of stream below bridge:

Ap—0 to 5 inches, very dark gray to dark-gray (10YR 3/1 to 4/1) silt loam; few, fine, distinct mottles of strong brown (7.5YR 5/6); color slightly higher in chroma when kneaded; weak, fine, granular structure; friable; slightly acid; abrupt boundary.

C1—5 to 15 inches, stratified dark-gray (10YR 4/1) gritty silt loam; thin strata of gray (5Y 5/1) at depth of about 15 inches; loose fine sand and a strata of very dark gray (10YR 3/1) gritty silt loam at depth of 6 to 9 inches; very dark gray (10YR 3/1) streaks at 5 to 15 inches; common, fine and medium, distinct mottles of strong brown (7.5YR 5/8); weak, thin, platy structure; friable; neutral; clear boundary.

C2—15 to 20 inches, stratified dark-gray to gray (10YR 4/1 to 5/1) silt loam with a few gray to light-gray (10YR 6/1) lenses; common, fine, distinct mottles of strong brown (7.5YR 5/8); weak, thin, platy structure; friable; slightly acid; abrupt boundary.

IIA1—20 to 31 inches, black (N 2/0) heavy silty clay loam; few, fine, distinct mottles of strong brown (7.5YR 5/6); material very dark gray (10YR 3/1) when kneaded; weak, fine, granular and weak, fine, subangular blocky structure; friable to firm; medium acid; gradual boundary.

IIB1—31 to 40 inches, black (10YR 2/1) light silty clay; few, fine, distinct mottles of strong brown (7.5YR 5/6); material very dark gray (10YR 3/1) when kneaded; weak, fine, prismatic breaking to weak, fine, subangular blocky structure; firm; slightly acid; gradual boundary.

IIB2—40 to 58 inches, very dark gray (10YR 3/1) light silty clay; common, fine, distinct mottles of strong brown (7.5YR 5/6); very fine prismatic breaking to weak, fine, angular blocky structure; firm; few, hard, black (10YR 2/1) concretions; very slightly acid.

The A horizon is black (10YR 2/1 to N 2/0) to very dark gray (10YR 3/1) and ranges from 28 to 36 percent in content of clay. In most places texture is silty clay loam to a depth of 12 to 24 inches, but there is as much as 20 inches of stratified, lighter colored overwash on the surface in some places.

This overwash ranges from silt loam to loam to light silty clay loam. The B horizon is 40 to 45 percent clay. Except in the overwashed areas, colors that have a value of 3 or less extend to a depth of 36 inches or below.

The Zook soils have a finer textured subsoil than the Colo and Chequest soils. The subsoil of Zook soils is not so fine textured as that of the Wabash soils. Zook soils do not have a grayish colored A2 horizon, but the Humeston and Vesser soils have this horizon.

Zook silty clay loam (0 to 2 percent slopes) (Zo).—This soil is on bottom lands in the wider stream valleys of the county. It parallels the river channels in many places but is generally away from the channel and adjacent to the foot slopes. This soil is in areas of 30 acres or less and is not very extensive in Wayne County.

The silty clay loam surface layer ranges from 12 to 24 inches in thickness. It is underlain by a slowly permeable silty clay subsoil. This soil is generally farmed with soils that are better suited to cultivated crops.

This soil is acid unless recently limed. It is medium in available nitrogen and phosphorus and high in available potassium. Crop response to fertilizer is good.

Because of poor drainage and occasional floods, this soil has limited use. It puddles if it is worked when wet. If this soil is cultivated, it should be drained by open ditches. Fields that are artificially drained can be planted to row crops, but these crops grow only fairly well. Harvest is sometimes delayed because the crops mature slowly. Because of the very slowly permeable subsoil, proper spacing of tile drains is essential. Without drainage this soil is better suited to pasture than to crops. (Capability unit IIw-1; woodland suitability group 7)

Use and Management of the Soils

The soils of Wayne County are used mainly for crops, particularly corn, and for pasture. This section tells how the soils can be used for these purposes and also for managing woodland and building highways and other engineering structures.

First, predicted yields of principal crops are given. Next, the system of capability classification commonly used by the Soil Conservation Service is explained and management of soils by capability units is discussed. Then described are uses of soils as woodland. Most of the information on engineering is presented in tables in which properties that affect engineering are estimated and the soils are interpreted according to their suitability for engineering uses.

Predicted Yields

The predicted average yields of the principal crops in the county are given in table 3 for each soil in the county. The estimates are based on the corn yield study (Project 1377) 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.

Yields in table 3 are given for each soil in the county under two levels of management. In column A are the yields to be expected under common management, or the management most farmers were practicing when this soil survey was made. In columns B are the yields to be expected under a high level of management, or management used by only a small percentage of farmers in the county.

A variation in yields of about 20 percent can be expected from one year to another and between different areas in the county in any particular year. This sizable variation in yields results from the kind of management used and variations in the amount and timeliness of rainfall during the growing season. Variations in yields are also caused by insects, disease, and other factors.

The yields in table 3 may be outdated after several years, but they will be useful for many years if they are compared and used as a guide for production indexes. For example, the yields of corn on the Grundy and Colo soils were among the highest in the county at the time the estimates were made. These yields can be expected to remain among the highest in the future, even though yields on all soils have generally increased because of new technology and advances in agriculture. In other words, the relation between high-producing and low-producing soils shown in table 3 is expected to remain.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kind of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The classification does not apply to most horticultural crops, or to rice and other crops that have their own special requirements. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible major reclamation projects.

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

CAPABILITY CLASSES, the broadest grouping, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. Classes are defined as follows:

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

Class II. Soils have some limitations that reduce the choice of plants or 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 restrict the choice of plants, require very careful management, or both.

TABLE 3.—*Predicted average acre yields of principal crops under two levels of management*

[Yields in columns A are to be expected under common management; yields in columns B are to be expected under the highest feasible level of management. Absence of yields indicates soil is not suitable for the crop or that the crop ordinarily is not grown]

Soil	Corn		Soybeans		Oats		Alfalfa-grass		Pasture	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Animal-unit-days* [1]	*Animal-unit-days* [1]
Adair loam, 5 to 9 percent slopes	60	75	24	30	42	57	1.4	2.0	70	100
Adair loam, 5 to 9 percent slopes, moderately eroded	55	70	22	26	38	53	1.2	1.8	60	90
Adair loam, 9 to 14 percent slopes	45	60	18	22	32	47	1.2	1.4	60	70
Adair loam, 9 to 14 percent slopes, moderately eroded	40	55	16	20	28	43	1.0	1.2	50	60
Adair soils, 5 to 9 percent slopes, severely eroded	40	55	16	20	28	43	.8	1.0	40	50
Adair soils, 9 to 14 percent slopes, severely eroded							.8	1.0	40	50
Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded	45	60	16	20	22	37	1.6	2.0	80	100
Adair-Shelby complex, 9 to 14 percent slopes, severely eroded							1.4	1.8	70	90
Caleb loam, 9 to 14 percent slopes, moderately eroded	50	65	20	24	38	50	1.2	1.6	60	80
Caleb loam, 14 to 18 percent slopes, moderately eroded							.6	1.0	30	50
Caleb soils, 9 to 14 percent slopes, severely eroded							.8	1.2	40	60
Caleb soils, 14 to 18 percent slopes, severely eroded							.4	.5	20	25
Chequest silty clay loam	65	85	26	30	45	60	2.6	3.0	130	150
Clarinda silty clay loam, 5 to 9 percent slopes	50	65	20	24	33	48	1.3	1.8	65	90
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	40	55	16	20	28	43	1.0	1.5	50	75
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	30	45	12	15	20	36	.8	1.0	40	50
Clarinda soils, 5 to 11 percent slopes, severely eroded							.4	.5	20	25
Colo silty clay loam	85	100	34	38	60	75	3.0	3.5	150	175
Colo silty clay loam, 2 to 5 percent slopes	80	95	34	38	57	72	3.0	3.4	150	170
Colo-Zook silt loams, overwashed	80	95	34	38	55	75	2.7	3.2	135	160
Edina silt loam	75	90	30	35	53	68	2.2	3.0	110	150
Gara loam, 9 to 14 percent slopes, moderately eroded	55	70	22	25	38	55	2.0	2.5	100	125
Gara loam, 14 to 18 percent slopes							1.5	2.0	90	100
Gara loam, 14 to 18 percent slopes, moderately eroded							1.3	1.8	75	90
Gara loam, 18 to 24 percent slopes							1.3	1.8	75	90
Gara loam, 18 to 24 percent slopes, moderately eroded							1.0	1.4	50	70
Gara soils, 14 to 18 percent slopes, severely eroded							1.0	1.5	50	75
Grundy silty clay loam, 2 to 5 percent slopes	85	100	32	36	57	75	3.0	3.6	150	180
Grundy silty clay loam, 5 to 9 percent slopes	75	95	30	35	53	70	2.8	3.4	140	170
Grundy silty clay loam, 5 to 9 percent slopes, moderately eroded	70	90	28	33	50	65	2.6	3.2	130	160
Haig silt loam	80	95	32	36	55	70	2.6	3.4	130	170
Humeston silty clay loam	60	80	24	30	42	60	2.0	2.4	100	120
Humeston silty clay loam, 2 to 5 percent slopes	55	75	22	28	38	53	2.0	2.4	100	120
Kniffin silt loam, 2 to 5 percent slopes	70	85	26	30	45	60	2.6	3.2	130	160
Kniffin silt loam, 5 to 9 percent slopes	60	75	23	27	40	55	2.4	3.0	120	150
Kniffin silt loam, 5 to 9 percent slopes, moderately eroded	55	70	20	24	35	50	2.2	2.8	110	140
Lamoni silty clay loam, 5 to 9 percent slopes, moderately eroded	50	65	18	22	35	50	1.4	1.8	70	90
Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	40	55	15	20	30	45	1.0	1.2	50	60
Lamoni soils, 9 to 14 percent slopes, severely eroded							.5	.8	25	40
Lawson-Nodaway complex	90	110	36	40	60	75	3.2	3.6	160	180
Lindley loam, 18 to 30 percent slopes, moderately eroded							1.0	1.4	50	70
Lineville silt loam, 5 to 9 percent slopes	60	75	26	30	45	60	2.5	3.0	125	150
Lineville silt loam, 5 to 9 percent slopes, moderately eroded	55	70	22	26	40	55	2.2	2.8	110	140
Mystic silt loam, 5 to 9 percent slopes, moderately eroded	50	65	20	24	35	50	1.2	1.6	60	80
Olmitz loam, 2 to 5 percent slopes	80	100	32	36	55	70	3.0	3.4	150	170
Olmitz-Vesser-Colo complex, 2 to 5 percent slopes	80	95	32	36	55	70	3.0	3.4	150	170
Pershing silt loam, 5 to 9 percent slopes	70	90	26	32	45	60	2.8	3.2	140	160
Pershing silt loam, 5 to 9 percent slopes, moderately eroded	65	85	24	30	40	55	2.6	3.0	130	150
Pershing silt loam, benches, 2 to 5 percent slopes	75	95	30	34	50	70	3.0	3.4	150	170
Pershing silt loam, benches, 5 to 9 percent slopes, moderately eroded	65	85	24	30	40	55	2.6	3.0	130	150
Rathbun silt loam, 5 to 9 percent slopes	50	70	19	23	35	50	2.2	2.8	110	140
Rathbun silt loam, 5 to 9 percent slopes, moderately eroded	45	65	16	20	30	45	2.0	2.6	100	130
Seymour silt loam, 2 to 5 percent slopes	75	90	30	34	55	70	2.8	3.4	140	170
Seymour silty clay loam, 5 to 9 percent slopes	70	85	28	32	50	65	2.6	3.2	130	160
Seymour silty clay loam, 5 to 9 percent slopes, moderately eroded	60	75	25	28	43	58	2.4	3.0	120	150
Shelby loam, 9 to 14 percent slopes	65	85	26	30	45	60	2.0	2.6	110	130
Shelby loam, 9 to 14 percent slopes, moderately eroded	60	75	24	28	40	55	2.0	2.5	100	125

See footnote at end of table

Table 3.—*Predicted average acre yields of principal crops under two levels of management*—Continued

Soil	Corn		Soybeans		Oats		Alfalfa-grass		Pasture	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Animal-unit-days* [1]	*Animal-unit-days* [1]
Shelby loam, 14 to 18 percent slopes	50	65			35	50	2. 0	2. 4	100	120
Shelby loam, 14 to 18 percent slopes, moderately eroded	45	60			30	45	1. 6	2. 0	80	100
Shelby loam, 18 to 24 percent slopes, moderately eroded							1. 0	1. 5	50	75
Shelby soils, 9 to 14 percent slopes, severely eroded	50	65	18	22	35	50	1. 8	2. 4	90	120
Shelby soils, 14 to 18 percent slopes, severely eroded							1. 3	1. 9	65	95
Vesser silt loam	75	95	30	36	50	70	2. 8	3. 2	140	160
Vesser silt loam, 2 to 5 percent slopes	70	90	28	32	50	70	2. 8	3. 2	140	160
Wabash silty clay	55	70	22	26	35	50	1. 5	2. 5	75	125
Zook silty clay loam	70	90	30	34	50	65	2. 6	3. 2	130	160

[1] A term used to express the carrying capacity of pasture. It is the number of animal units carried per acre multiplied by the number of days the pasture is grazed during a single grazing season without injury to the sod. An acre of pasture that provides 30 days of grazing for two cows has a carrying capacity of 60 animal-unit-days. In estimating the animal-unit-days listed in this table, it was assumed that one mature animal consumes 40 pounds of dry forage per day.

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

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

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

Class VIII. Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in Wayne 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 Wayne 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 subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, 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 IIw-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral specifically identifies the capability unit within each subclass. In the following pages the capability units in Wayne County are described and suggestions for the use and management of the soils are given. All the soils in the county have been placed in capability units according to their suitability for dryland use.

Management by capability units

In the following pages the capability units in Wayne County are described and suggestions for use and management of the soils are given. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all soils of a given series appear in the unit. To find the names of all the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1

Only the soils in Lawson-Nodaway complex are in this capability unit. These soils occur on bottom lands and are nearly level. Lawson soils are somewhat poorly drained and Nodaway soils are moderately well drained. They have a moderately dark colored silt loam surface layer. Permeability is moderate, and most of the rain that falls in normal amounts is readily absorbed. Available moisture holding capacity is high. These soils are easily worked and are easily kept in good tilth. Because they warm up quickly in the spring, they can be worked somewhat sooner than can associated soils on bottom lands.

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

These soils are well suited to cultivated crops. Although the soils are nearly level, they have only slightly restricted internal drainage and are seldom wet. They are sloping enough to prevent ponding. Erosion is not a problem.

In much of the acreage these soils are cultivated, but some areas are used for pasture and woodland. Corn and soybeans are the major crops, but oats and hay are also grown. The pasture or woodland is generally along the main channel of streams and is flooded more often than cultivated fields.

On these soils row crops can be planted year after year, but protection from floods is needed in some years. In some places, old bayous can be drained with open ditches and stream channels straightened to reduce the hazard of flooding.

Crops on these soils respond well to fertilizer. Corn that does not follow a legume needs nitrogen and, in smaller amounts, phosphate and potash. A legume seeding responds well to phosphate. These soils need lime in some places.

CAPABILITY UNIT IIe–1

This capability unit consists of gently sloping soils that are moderately well drained to somewhat poorly drained. They are soils in the Grundy and Olmitz series. They have a dark-colored silty clay loam and loam surface layer. Much of the rainfall is absorbed and is held available for plants. Permeability of the subsoil is moderate in the Olmitz soil and is slow in the Grundy soil. Tilth is generally good in both soils.

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

The soils in this unit are well suited to cultivated crops but are subject to sheet erosion because of slope. Wetness generally is not a problem. The Olmitz soils are on foot slopes and receive about as much soil material from soils above as they lose through erosion.

In much of the acreage, the soils in this unit are used for cultivated crops. Corn and soybeans are the main crops, but oats, hay, or pasture also grows well.

If these soils are protected by terraces and tilled on the contour, they are suited to row crops grown intensively. If row crops are grown year after year, it may be difficult to eliminate weeds and insects and to maintain soil tilth. The Olmitz soils can be protected from runoff by diversion terraces.

The soils in this unit respond very well to fertilizer. Corn that does not follow a legume generally needs nitrogen. Small grains and legumes respond very well to applications of phosphate and potash. In most places these soils require additions of lime for optimum yields.

CAPABILITY UNIT IIw–1

This capability unit consists of nearly level and gently sloping, poorly drained soils on first bottoms along drainageways and on low foot slopes. These soils are in the Olmitz, Vesser, Colo, Zook, and Chequest series. They have a dark and moderately dark colored silt loam and silty clay loam surface layer. The subsoil is also dark and moderately dark colored. It ranges from silty clay loam to silty clay and is moderately slow to slow in permeability except in the moderately permeable Olmitz soils.

The soils in this unit are excessively wet because of a high water table, flooding, or both. The movement of water and air in them is slightly restricted. They dry out somewhat slowly in the spring and must be worked later after rains than soils of capability units I–1 and IIe–1. Tilth is generally good if wetness is controlled, but the soils puddle if they are worked when wet. Available water-holding capacity is high.

These soils are medium and high in content of organic matter. The Colo soils and soils in the Olmitz-Vesser-Colo complex are slightly acid to medium acid, but the rest of the soils in this unit are medium acid to strongly acid.

Erosion is a hazard only where an active gully or a stream channel forms. Before entering a major stream or river channel, water from runoff collects on these soils and drains across them. Because the soils of this unit are flooded occasionally, they are damaged by sediments and by excess water.

The soils in this unit are well suited to cultivated crops but require artificial drainage. Much of the acreage could be drained by tile or by surface ditches and farmed intensively. Most areas of these soils are large enough to be managed separately, but the soils in the Olmitz-Vesser-Colo complex in small drainageways are often farmed with adjacent soils on uplands.

Corn and soybeans are suited to these soils and are the main crops. Also suitable are small grains, hay, and pasture. Crop growth is medium to good. It is increased and the soils are easier to manage if drainage is improved, but these soils are farmed in many places without drainage or protection from overflow.

These soils are suited to intensive row cropping. If tilth becomes poor, a rotation that includes 1 year of oats seeded with a green-manure crop is beneficial. All crop residues should be returned to the soil so as to maintain the content of organic matter and to improve tilth.

To divert runoff from some areas of these soils, diversion terraces are built at the base of upland slopes. Some fields are plowed in the fall, especially if wetness delays planting in the spring.

Where row cropping is intensive, these soils need additions of fertilizer and lime for continued good growth of crops. Corn not preceded by a legume generally requires nitrogen. Small grains and legumes respond well to applications of phosphate and potash.

CAPABILITY UNIT IIw–2

Haig silt loam is the only soil in this capability unit. This nearly level soil occurs on uplands, where it was derived from loess. It is poorly drained and has a fine-textured, mottled subsoil that is slowly permeable. The surface layer is dark-colored silt loam. Surface runoff is slow. The water table is usually high in spring and autumn, but it falls somewhat during July or August.

Tilth is generally good, but the surface layer puddles easily if worked when wet. The available moisture holding capacity is high. This soil warms up slowly in spring and dries out more slowly after rains than soils in capability units IIe-1, IIIe-3, and IIIe-4.

The soil in this unit is high in organic-matter content and is medium acid to slightly acid. It is medium in available nitrogen and potassium and is low in available phosphorus.

This soil is well suited to row crops if wetness is reduced by surface drainage. The soil is also suited to oats, hay, or pasture. Crops grow well if artificial drainage is used. Corn and soybeans are the main row crops.

If surface drains are not installed, the slow runoff and restricted drainage may delay planting and cause crops to mature late. In years of high rainfall, crops that mature early should be planted. Many areas that are farmed do not have surface drains. In these places crops generally are not lost, but they do not grow well.

This soil is intensively row cropped. If tilth is poor, a rotation that includes 1 year of oats seeded with a green-manure crop can be used. All crop residues must be returned to the soil to maintain organic matter. Shallow surface ditches are needed to remove excess surface water.

Applications of fertilizer are needed for continued good growth of crops. Corn that does not follow a legume needs additions of nitrogen. If the surface is drained, crop response to fertilizer is good. This soil requires additions of lime.

CAPABILITY UNIT IIIe-1

This capability unit consists of moderately sloping soils that were derived from loess on uplands. These soils are moderately well drained. They are in the Rathbun series. They have a moderately light colored to moderately dark colored silt loam surface layer and a very slowly permeable silty clay subsoil. They absorb water slowly and have high moisture holding capacity.

These soils can be worked only within a narrow range of moisture content if a good seedbed is to be established. They have rapid runoff and are susceptible to serious sheet erosion. Content of organic matter is low, and the surface layer tends to crust after rains.

These soils are low in available nitrogen and potassium and medium in available phosphorus. Unless limed within the past 5 years, these soils generally need lime for profitable hay and pasture.

Much of the acreage of these soils is planted to cultivated crops. Corn, oats, and hay or pasture are the principal crops. These crops are commonly grown in rotation with 1 or 2 years of corn, 1 year of oats seeded to a grass-legume, and then left in meadow for 2 or more years and used for hay or pasture. Where terraced, these soils can be cropped more often to row crops without excess soil loss. Terraces that expose the fine-textured subsoil may require special treatment of fertilizer and manure to restore productivity. Crops grown on these soils respond to applications of fertilizer.

CAPABILITY UNIT IIIe-2

This capability unit consists of gently sloping soils that were derived from loess on uplands. These soils are moderately well drained to somewhat poorly drained. They are in the Kniffin, Pershing, and Seymour series. Their surface layer is moderately dark colored silt loam in the upper part and, except for the Seymour soil, is light colored in the lower part. The subsoil is highly mottled, and permeability is very slow. The Pershing soil is slowly permeable. The soils in this unit absorb rainfall slowly but have moderately high to high available moisture holding capacity. They are moderately well aerated to somewhat poorly aerated. Tilth is generally good but can be destroyed if the soils are worked when wet.

These soils are medium in available potassium. In most places they are low in available phosphorus and nitrogen. Reaction is slightly acid to very strongly acid.

Use is somewhat limited by erosion, but these soils are well suited to cultivated crops if erosion is controlled. If these soils are terraced and tilled on the contour, row crops can be planted for 3 years in 5. If only contour tillage is used, row crops can be planted 1 year in 3 on the Kniffin and Seymour soils and 2 years in 5 on the Pershing soils. If row crops are grown year after year, it is difficult to control weeds and insects and to maintain tilth and fertility.

Most of the acreage of the soils in this unit is used for cultivated crops. Corn and soybeans are the main crops, but oats, hay, or pasture is also well suited.

Crops on these soils respond very well to fertilizer. Where corn does not follow a legume, additions of nitrogen are generally needed. Small grain and legumes respond very well to applications of phosphate and potash. Additions of lime are needed for maximum crop growth.

CAPABILITY UNIT IIIe-3

This capability unit consists of moderately sloping, moderately well drained to somewhat poorly drained soils that were derived from loess on uplands. These soils are in the Kniffin, Pershing, Lineville, Seymour, and Grundy series. They have a moderately dark colored and dark colored silt loam and silty clay loam surface layer. The subsoil is highly mottled. Except for the Grundy soils, permeability is slow to very slow. Grundy soils are moderately slow to slow in permeability. The soils in this unit absorb rainfall slowly, but most of them have high available moisture holding capacity. Available moisture holding capacity is moderately high in the Seymour and Kniffin soils. The soils in this unit are moderately well aerated to somewhat poorly aerated. Tilth is generally good. If these soils are worked when wet, they puddle easily and are cloddy and hard when they dry.

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

These soils are moderately well suited to cultivated crops, but erosion is a hazard. If row crops are planted, contour tillage and terracing are needed.

Much of the acreage of these soils is planted to cultivated crops. Corn, soybeans, and hay are the main crops, but oats or pasture is also well suited. A rotation suitable on terraces is 2 years of corn, 1 year of oats, and 3 years of meadow. Meadow could be reduced 1 year on the Grundy soils. Where subsoil material is exposed in the terrace channels, additions of topsoil and manure are needed.

Crops on these soils, especially row crops that are planted frequently, respond well to applications of fertilizer. Corn that does not follow a legume needs additions of nitrogen. Oats and meadow respond well to a phosphate fertilizer. These soils require liming, especially for legumes.

CAPABILITY UNIT IIIe-4

This capability unit consists of somewhat poorly drained to moderately well drained, moderately sloping soils that were derived from till and old alluvium. These soils are in the Adair, Lamoni, and Mystic series. They have a moderately dark colored to moderately light colored loam to silty clay loam surface layer. The subsoil is clayey, and permeability is very slow to slow. Aeration is seasonally poor. Narrow seepage bands occur where these soils border the soils upslope that were derived from loess. In years when rainfall is normal, wetness is generally not a serious problem. Erosion is the most serious hazard.

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

They are medium to low in organic-matter content and are medium acid to very strongly acid. Available nitrogen is low to very low. Available phosphorus is very low, and available potassium is medium to very low.

These soils are not well suited to cultivated crops. They are subject to sheet erosion and gully erosion because they are on moderate slopes and take in water slowly. Further erosion should be controlled because these soils are difficult to manage if the original surface soil is gone.

Permanent pasture or scattered stands of trees are on some areas of the uneroded soils. In some areas these soils are not cultivated, because they are surrounded by other soils that are suited only to pasture or trees.

Corn, soybeans, oats, hay, and pasture plants can be grown. Corn and soybeans are not well suited but are commonly grown in a rotation.

If terraces are used, a suitable rotation is 2 years of corn, 1 year of oats, and 3 years of meadow. If contour tillage is used, a suitable rotation is 1 year of corn, 1 year of oats, and 2 years of meadow. If these soils are used for row crops, contour tillage or terracing is needed to prevent excessive loss of soil and water. All of these soils, however, are better suited to semipermanent pasture or hay than to cultivated crops. Where subsoil material is exposed in the terrace channels, additions of topsoil and manure are needed. Interceptor tile drains are needed in many places to control seepage and should be placed upslope from and parallel to the seep line.

These soils require fertilizer for good crop growth. Oats respond well to applications of nitrogen and phosphate. Additions of lime and phosphate are necessary for good stands of meadow. Corn that does not follow a legume responds well to additions of nitrogen and phosphate.

CAPABILITY UNIT IIIe-5

This capability unit consists of moderately well drained, strongly sloping soils that were derived from till. These soils are in the Shelby series. They have a moderately dark colored loam surface layer. The subsoil is clay loam and is moderately slow in permeability. Moisture and air generally move easily in these soils, and wetness is not a hazard. These soils are easy to work, and they warm up quickly in spring. They can be worked fairly soon after rains. Available moisture holding capacity is high. Because slopes are strong, some of the water that falls on the surface is not absorbed.

These soils are medium to low in organic-matter content. They are low in available nitrogen, very low in available phosphorus, and medium in available potassium. Reaction is medium.

These soils are moderately well suited to cultivated crops, but erosion is a serious hazard. If row crops are planted, they should be planted on the contour and the field should be terraced.

Some areas of these soils are not used for cultivated crops, because they are surrounded by areas of other soils that are suited only to pasture. Forage crops grow well on the soils of this unit. Individual areas are generally large enough to be managed separately.

Corn and soybeans are the main row crops, but oats, hay, and pasture are also suited. If these soils are terraced, a suitable rotation is 1 year of corn, 1 year of oats, and 2 years of meadow. If the soils are not terraced, they can be seeded for hay or pasture. Before a depleted pasture or hay meadow is reseeded, these soils usually are plowed on the contour and planted to a row crop.

Fertilizer is needed for good crop growth. All corn needs a phosphate fertilizer, and corn that does not follow a legume generally needs additions of nitrogen. Oats may require some nitrogen and large amounts of phosphate. Legumes need additions of phosphate and lime. These soils require lime in varied amounts.

CAPABILITY UNIT IIIw-1

This capability unit consists of nearly level to gently sloping, poorly drained to very poorly drained soils on bottom lands and low foot slopes. These soils are in the Humeston series. They have a moderately dark colored to moderately light colored silt loam surface layer that is underlain by a leached layer. The subsoil is a mottled silty clay that is very slowly permeable.

The water table is high at times, but it falls somewhat in the summer. The movement of air and water in these soils is restricted, but available moisture holding capacity is high and moderately high. These soils are generally in good tilth unless they are worked when wet.

The organic-matter content is medium to low. Reaction is medium acid to very strongly acid. Available nitrogen and phosphorus are low, and available potassium is medium.

These soils are only moderately well suited to cultivated crops. Use is limited mostly by wetness. The water table may be very close to the surface at times because internal drainage is very slow. In undrained areas these soils are better suited to permanent vegetation than to row crops. Row crops can be grown where these soils are drained.

Much of the acreage is not drained and is in permanent vegetation. Tile drainage does not work well in these soils, but shallow ditches can be used on the bottom lands. Diversion terraces above the soils on foot slopes will divert some water and reduce wetness.

Corn, soybeans, small grains, hay, and pasture are grown on these soils. Soybeans are generally grown more frequently than corn.

If these soils are drained, a suitable rotation is 2 years of corn, 1 year of oats, and 1 year of meadow. If tilth becomes poor, additional organic matter may be needed.

Additional plant nutrients are needed where these soils are used for row crops. Crop response to fertilizer is generally moderate. Corn that does not follow a legume needs added nitrogen. Both corn and legumes need a phosphate fertilizer and may need some potassium. These soils require additions of lime, especially for legumes.

CAPABILITY UNIT IIIw-2

Wabash silty clay is the only soil in this capability unit. This soil occurs on bottom lands and is poorly drained. It has a dark-colored silty clay surface layer and subsoil in most places. This soil absorbs rainfall very slowly and has high available moisture holding capacity. It is poorly aerated. It warms up slowly in spring and needs to be worked later after normal rains than surrounding soils. The water table is high at times. Runoff is very slow, and water is often ponded on the surface.

This soil is difficult to work, and it puddles easily even if it is drained. The surface soil becomes cloddy and hard when it dries, and it cracks deeply in midsummer.

This soil is fertile and slightly acid. It contains large amounts of organic matter. It is generally low in available nitrogen and medium in available phosphorus and potassium.

If this soil is drained, it is moderately well suited to cultivated crops. Areas that are not drained are suited to pasture. The use of this soil is severely limited by excess water. Floodwater from adjacent streams and runoff from uplands are generally received more frequently than on most other soils on the bottom lands. The growth of roots is restricted by wetness and by poor aeration.

Most areas of this soil are large and can be farmed separately. Drained fields are used for corn or soybeans and sometimes for small grains or meadow. Soybeans are generally better suited than corn.

This soil can be planted to row crops frequently. A suitable rotation is 3 years of row crop and 1 year of oats planted with a green-manure crop. Growth of crops depends on artificial drainage. Shallow ditches that are properly graded remove excess water, but tile drainage does not work in this fine-textured soil. Protection from runoff and flooding is difficult. This soil is usually plowed in fall so that workability is improved by freezing and thawing. Planting is often delayed, even when this soil is plowed in the fall.

If it is planted to row crops frequently, this soil needs additions of lime and potash.

CAPABILITY UNIT IIIw-3

Edina silt loam is the only soil in this capability unit. This nearly level soil is poorly drained and very slowly permeable. It was derived from loess on uplands. It has a moderately dark colored silt loam surface layer that is underlain by a bleached layer. The subsoil is mottled. This soil does not absorb moisture readily. It is poorly drained because surface runoff is slow and the water table is high at times. It is slower to warm up in spring than soils in capability units IIe-1 and IIIe-2, and it dries out more slowly after rains.

This soil is normally in good tilth, but it puddles if worked when wet and is cloddy and hard when it dries. Available moisture holding capacity is high.

This soil is medium to high in content of organic matter. It is medium acid to strongly acid. It is normally low in available nitrogen and phosphorus and medium in available potassium.

This soil is well suited to cultivated crops if its surface is drained. Erosion is not a hazard.

In years of high rainfall, the slow runoff and restricted drainage may delay planting and cause crops to mature late. Although most of the acreage is in cultivated crops, many cultivated fields do not have surface drains. Crops do not grow so well in these areas, but generally they are not lost.

Corn, soybeans, oats, hay, and pasture are suited to this soil. Corn and soybeans are the main row crops. Crop growth is moderate to high if drainage is improved.

Row crops can be grown intensively. If tilth becomes poor, the rotation should provide 1 year of oats seeded with a green-manure crop. Also all crop residues are returned to the soil to maintain organic-matter content. Shallow ditches should be dug to improve surface drainage.

If row crops are planted frequently, applications of fertilizer are needed for maintaining crop growth. Added nitrogen is needed for corn that does not follow a legume. Corn, small grains, and legumes respond well to additions of phosphate and potash. This soil requires lime, especially for legumes.

CAPABILITY UNIT IVe-1

This capability unit consists of moderately well drained soils that are strongly sloping to moderately steep. These soils are in the Gara and Shelby series. They have a moderately dark colored surface layer that is loam in most places. The subsoil is moderately fine textured and is moderately slow in permeability. The movement of air and water within these soils is fairly good, and wetness is generally not a problem. Most of these soils have high available moisture holding capacity. The uneroded soils are generally in good tilth, but the eroded soils have poor tilth in some places.

These soils are medium acid to strongly acid. Most of them are low to very low in available nitrogen and phosphorus and are medium in available potassium.

These soils are poorly suited to cultivated crops and in most places probably should be used for hay or pasture. They can be planted to corn for 1 year when pasture is renovated. They are strongly sloping to moderately steep and are susceptible to severe sheet erosion.

Most of the moderately eroded to severely eroded areas have been farmed, but now many of these areas are used only for pasture. Alfalfa mixed with bromegrass is suitable for semipermanent hay or pasture. Suitable for permanent pasture are birdsfoot trefoil and orchardgrass or bluegrass. Corn, soybeans, and oats are also grown on these soils, but they do not grow well.

Semipermanent hay or pasture is a good use for these soils. If good stands of alfalfa or alfalfa mixed with bromegrass are established, the fields should not be plowed until stands become poor. If these soils are tilled on the contour, a suitable rotation is 1 year of corn followed by a small grain and 4 to 6 years of meadow. Birdsfoot trefoil and orchardgrass or bluegrass live longer and are productive longer than alfalfa.

If the strongly sloping soils are terraced, a rotation of corn for 1 year, oats for 1 year, and meadow for 3 years is suitable. The moderately steep soils generally are not terraced.

Applications of manure and fertilizer are needed in fields used for row crops. Mixtures of legumes and grasses respond well to a phosphate fertilizer and to lime. Crop growth can be increased by topdressing with phosphate. Pastures that are mainly in grass respond well to added nitrogen and phosphate.

CAPABILITY UNIT IVe–2

This capability unit consists of strongly sloping soils in the Adair, Caleb, Clarinda, Lamoni, and Shelby series. Except for the moderately well drained Caleb soils, these soils are poorly drained to somewhat poorly drained. The surface layer of the soils in this unit is of various color and texture, but it is generally moderately dark colored loam or silty clay loam. The subsoil is fine textured and is moderately slow to very slow in permeability. These soils are wet and seepy in the spring. Aeration is poor. Cultivated areas are very susceptible to erosion because the intake of water is somewhat slow and runoff is rapid. Except for the Clarinda soil, these soils have high available moisture holding capacity. The Clarinda soil has moderately high available moisture holding capacity. Much of the water that falls on the surface of these soils is not absorbed.

These soils are slightly acid to strongly acid. In most places they are low to very low in available nitrogen and phosphorus and are medium in available potassium.

The soils in this group are well suited to hay or pasture. They are poorly suited to row crops but can be planted to corn for 1 year when pasture is renovated. They should be tilled on the contour because they are strongly sloping and are susceptible to severe sheet erosion. Gullies are common in the severely eroded soils. Runoff is rapid.

Narrow bands and other small areas of these soils are within large fields that are used for cultivated crops. These small areas should be left in permanent vegetation until the crop in the large field is harvested. Then they can be seeded to pasture along with the rest of the field. Erosion must be controlled in these small areas because seeding and establishing a stand is difficult if the subsoil is exposed.

Alfalfa mixed with orchardgrass grows fairly well on these soils. Birdsfoot trefoil mixed with orchardgrass or bluegrass can be seeded for pasture that is to be grazed for a long time. Corn, soybeans, and small grains are also grown on these soils, but they generally grow poorly.

If a mixture of alfalfa and bromegrass or orchardgrass is established, these soils should not be plowed until stands become poor. A suitable rotation is 1 year of corn planted on the contour and a small grain then 4 to 6 years of alfalfa-grass meadow. Birdsfoot trefoil and orchardgrass or bluegrass live longer and are productive longer than alfalfa.

Terraces are not desirable on these soils, because the fine-textured subsoil is exposed in the terrace channels. If terracing is used on these soils, manure or topsoil should be spread in the terrace channels.

Fertilizer and lime are normally required on these soils for all crops. Lime and phosphate are needed for legume seedings.

CAPABILITY UNIT IVw–1

This capability unit consists of moderately sloping soils that have a fine-textured subsoil and are poorly drained and seepy. These soils are in the Clarinda series. These soils have a moderately dark colored silty clay loam surface layer. The fine-textured subsoil is firm to very firm when moist and plastic when wet. Water is absorbed and moves through the soils very slowly. Aeration is poor. Cultivation is often delayed in the spring by wetness. Parts of these soils may be extremely wet until midsummer because there is a narrow, wet, seepy band at their upper border in some places. These soils are cold and slow to warm up in spring. Tilth generally is good, but it is easily destroyed by working the soils when they are wet. Deep cracks can be seen in many places when these soils dry out in summer.

Organic-matter content is usually medium to low in these soils. Available nitrogen is low, available phosphorus is very low, and available potassium is medium. These soils are strongly acid, and they have moderately high available moisture holding capacity.

These soils are suited to cultivated crops, but crops do not grow well, particularly in eroded areas. Wetness is the main hazard, but the soils are also susceptible to erosion because they are saturated quickly when it rains and runoff is rapid (fig. 14). Some areas that are too small to be farmed separately are in permanent pasture, but many areas are farmed with the Grundy and Seymour soils.

If these soils are used for row crops, erosion can be controlled by terracing. The subsoil is clay, however, and terracing is not a good practice unless the exposed subsoil is redressed with topsoil or large amounts of manure. If terraces are built, a rotation of corn, oats, and meadow, each grown for 1 year, is suitable. If only contour tillage is used, a rotation that consists of 1 year of corn, 1 year of oats, and 2 years of meadow is suitable. It may be desirable to plant a crop of corn before reseeding areas that are generally used only for hay or pasture.

Figure 14.—**The recent deposits of silt in the foreground have been eroded from a cornfield on Clarinda soils in the background.**

The very slowly permeable subsoil prohibits tile drainage in these soils, but interceptor tile can be placed upslope in adjacent soils.

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

Even if eroded areas are fertilized, crops generally do not grow well. Row crops and small gains may require additions of nitrogen, phosphorus, and potassium. Most areas require large amounts of lime.

CAPABILITY UNIT VIe-1

This capability unit consists of moderately well drained soils that are moderately steep to steep. These soils are in the Caleb, Gara, and Shelby series. Their surface layer is loam to clay loam that has varied colors but is generally moderately dark. The subsoil is a clay loam and absorbs water moderately slowly. Available moisture holding capacity is high. Runoff is rapid because slopes are moderately steep to steep. These soils contain only medium to very small amounts of plant nutrients. They are medium acid to strongly acid.

These soils are not suited to cultivated crops but are moderately well suited to pasture (fig. 15). They are extremely erodible.

Areas on these soils are generally fairly large and can be used separately. Most areas are in pasture, but some areas, especially those of the Gara soils, are in scattered timber. The timber generally is of poor quality and of little value. Much of this woodland is grazed, but where the pasture is unimproved, its carrying capacity is moderate to low. These soils can be used for permanent pasture or tree planting.

Most of the permanent pasture is in bluegrass and in native grasses of low quality, but forage can be increased by seeding a mixture of alfalfa and orchardgrass or birdsfoot trefoil and grasses. In Iowa, where grazing trials have been carried out for a long time, the beef produced on improved or renovated pasture has averaged two and one-half times as much as that produced on unimproved pasture.

Reseeding pastures to more productive legumes and grasses generally requires some tillage that weakens or destroys existing plants and that prepares a seedbed. Although some slopes are steep, farm machinery can be

***Figure 15.*—Proper land use of soils in capability unit VIe–1. Shelby soils are dominant.**

operated safely in most places. Oats are generally grown as a cover crop when pastures are renovated. The oats can be clipped or can be grazed lightly the first year.

In addition to reseeding, pasture is improved by adding fertilizer. A pasture that does not contain legumes responds to nitrogen. All pasture plants respond to phosphate fertilizers. Pastures of alfalfa, birdsfoot trefoil, or other legumes need additions of phosphate and lime.

In addition to reseeding and adding lime and fertilizer, proper grazing and control of undesirable vegetation also improve pasture. A combination of the practices discussed may be used.

Areas now in trees should be protected from grazing, and other areas can be planted to suitable trees. Specialists at the local office of the Soil Conservation Service or the forester assigned to the county by the State Conservation Commission will be glad to help you plan tree planting and other woodland management.

CAPABILITY UNIT VIe–2

This capability unit consists of severely eroded soils that are moderately sloping to moderately steep. These soils are in the Adair, Caleb, Clarinda, Lamoni, and Shelby series. They are severely eroded and have a clay loam to silty clay surface layer. The subsoil is moderately slow to very slow in permeability. Runoff is rapid, and gullies are common. Except for the Clarinda soils, the available moisture holding capacity is high. Clarinda soils have moderately high available moisture holding capacity.

These soils are in poor tilth and are difficult to work and to manage. The surface tends to seal during rains, and runoff is increased. These soils are hard and cloddy when they dry. In the spring the Clarinda soils are seepy in much of their acreage, especially near the border of the soils upslope that were derived from loess.

The soils in this unit are low to very low in organic-matter content and are medium acid to strongly acid. They are normally very low in available nitrogen and phosphorus and are medium to very low in available potassium.

These soils are unsuited to cultivated crops. Erosion is a serious hazard, but wetness is also a problem in many places. Good seedbeds are difficult to prepare. These soils are better suited to hay or pasture than to grain. Terraces can be built to control erosion, but crops do not grow well on these soils.

Alfalfa is not well suited to the fine-textured soils of this unit, but it grows fairly well on the Shelby soils. A suitable mixture for pasture is birdsfoot trefoil and orchardgrass or bluegrass. Corn or soybeans are not suited.

The soils in this unit should be kept in permanent vegetation. Small areas within fields planted to cultivated crops should be seeded and left idle or should be used for pasture if cultivated crops are grazed. Small areas within large fields of better soils that are used mainly for hay or pasture can be seeded to pasture and grazed along with the rest of the field.

Seedings often fail because these soils are in poor tilth. Gullies should be filled before seeding, and lime and fertilizers should be applied. Heavy applications of manure help to improve tilth and to prevent further erosion. Control of grazing is needed until seedings are well established.

CAPABILITY UNIT VIIe-1

This capability unit consists of moderately steep, steep, and very steep, eroded soils. These soils are in the Caleb, Gara, and Lindley series. Limitations to use are severe because of the slopes, severe erosion, or gullies. The available moisture holding capacity is high, but water runs off rapidly and only a small amount enters the soils. Aeration may be somewhat restricted in these soils. Fertility is low to very low.

These soils are not suited to cultivated crops, and they are only fairly well suited to pasture. They can be used as woodland and as wildlife habitat. Except for the Caleb soils, they are in moderately large areas and can be used separately. Many areas are in permanent pasture or trees, and a few are used for wildlife habitat.

Pasture cannot be practically renovated, because of the trees, noncrossable gullies, or steep or very steep slopes. On these soils, ordinary farm machinery is difficult and dangerous to use.

Birdsfoot trefoil and orchardgrass or bluegrass and mixtures of alfalfa and orchardgrass are suitable for permanent pasture. The carrying capacity of pasture is low, however, and grazing should be controlled.

Areas now in trees should be protected from grazing, and other areas can be planted to suitable trees.

Woodland Uses of the Soils

Most of Wayne County was in prairie grasses when it was settled. Trees grew mainly in narrow belts on bottom lands and along streams in the uplands. The trees in the uplands were mostly hardwoods and included white oak, red oak, black oak, elm, shagbark hickory, and green ash. The trees on the bottom lands were mostly soft maple, walnut, green ash, and cottonwood.

Most of the original timber has been cut over or cleared so that the soils could be used for crops and pasture. Some trees remain, however, in scattered tracts, mainly on steep soils in small areas bordering stream valleys. Most of the existing trees in the uplands grow on the Lindley, Gara, Rathbun, Pershing, Caleb, or Kniffin soils (fig. 16). Wooded areas on the bottom lands are on the soils in Lawson-Nodaway complex and on the Vesser soils.

A large part of the present woodland is pastured. In most areas grazing and poor logging practices have hindered restocking of trees, and stands produce less than half of their capacity. Grazing and poor logging practices also seriously threaten the remaining stands of timber.

Woodland management

Local practices commonly used in the native woodland have caused gradual deterioration in the quality of trees. The early settlers used the trees for fuel, posts, and poles and for building houses and barns and repairing implements. They harvested the best trees and left the less desirable ones. Gradually, the less desirable trees became dominant in the woodland. Because most woodland is used as pasture and is seriously overgrazed, improving it for timber production is difficult.

Figure 16.—**A stand of black locust 12 years after trees were cut for posts. The soil is Kniffin silt loam.**

Native trees still growing in woodland yield a fair quantity of wood products if management is good. Good basic management consists of protecting woodland from grazing and fire, gradually improving the composition of the woodland, and regulating the cut or harvest to balance tree growth. The first step in good management is selecting suitable crop trees and allowing them to grow. The next step is removing inferior trees so that they do not compete with the crop trees. Maturing crop trees are harvested selectively, and other crop trees are designated for the next crop or cutting cycle.

Some woodland may be of such poor quality that the best procedure is converting it from the hardwood type of woodland to the relatively valuable conifer type. Before such conversion, competition from inferior trees and shrubs must be eliminated by mowing or by spraying them with some kind of chemical that kills brush.

Soils vary in their suitability for trees. Generally, the deep, well drained or moderately well drained soils that are moderately to highly fertile are well suited to trees. The subsoil should have moderate to moderately slow permeability.

Permeability of the subsoil has much to do with development of tree roots. In most places tree roots growing in a slowly to very slowly permeable, plastic subsoil are poorly developed. If roots are underdeveloped because of poor aeration and poor drainage, trees do not develop normally above the ground. In this county some of the soils with a slowly to very slowly permeable subsoil are the Adair, Mystic, Edina, Clarinda, Rathbun, Seymour, and Pershing.

Native hardwoods grow better on soils that have not been cultivated than on formerly cultivated soils. They generally are not suited to soils that have been cultivated or that are moderately or severely eroded. On soils of this kind, pines are better suited.

Landowners can get help from the Soil Conservation District in judging the best use of their land. Help in managing woodland is available from farm foresters of the State Conservation Commission.

Woodland suitability groups

The soils of Wayne County have been placed in woodland suitability groups to assist owners of woodland in planning the use of their soils. Each group is made up of soils that have about the same available moisture holding capacity and other characteristics that influence growth of trees. Soils in a woodland group also have similar limitations and are subject to the same hazards when used for trees. All of the soils in a group, therefore, support similar kinds of trees, have about the same potential productivity, and require similar kinds of management.

In this subsection woodland suitability groups are described. For most of the groups, site index ratings are given for suitable trees. The site index is the total height of the dominant and codominant trees in the stand at 50 years of age. It is a rating of potential productivity. The kinds of trees that grow well on each group of soils are given. The mention of soil series in the description of a group does not mean that all the soils in the series are in the group. To determine the soils in a woodland suitability group, refer to the "Guide to Mapping Units" at the back of this survey.

WOODLAND SUITABILITY GROUP 1

This group consists of medium-textured and moderately fine textured, deep, moderately well drained soils that are in the Caleb, Gara, Olmitz, and Shelby series. Slopes range from 2 to 18 percent. Permeability is moderate and moderately slow, and available moisture holding capacity is high. The Olmitz soils occur on gently sloping foot slopes below the moderately sloping Shelby, Gara, and Caleb soils. Surface runoff is medium on the Caleb and Gara soils but is slower on the Olmitz soils.

The suitability of the soils in this group for producing wood crops is good to very good. Trees that should be favored in existing stands are red oak, white oak, green ash, black walnut, basswood, hackberry, and hard maple. The average site index for upland hardwoods ranges from 56 to 75. Soils on which timber now grows produce from 180 to 230 board feet per acre per year.

Erosion is a moderate hazard on Gara, Caleb, and Shelby soils, but there is little or no erosion on the Olmitz soils except in a few places where runoff concentrates and cuts small rills or gullies. Seedling mortality is generally slight and depends on the damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is slight to moderate. The hazards from pests and disease are generally slight.

Trees most suitable for planting on these soils are the *conifers* eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, and Douglas-fir and the *hardwoods* black walnut, green ash, and hackberry. Trees most suitable for windbreaks are the *conifers* eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, and Douglas-fir and the *hardwoods* Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. The conifers listed are especially well suited for farmstead windbreaks and the hardwoods for field windbreaks. Suitable for wildlife plantings are honeysuckle, viburnums, ninebark, lilac, and dogwood.

WOODLAND SUITABILITY GROUP 2

This group consists of medium-textured, deep, moderately well drained soils on uplands. Slopes range from 18 to 30 percent and have an aspect that is dominantly north and northeast. Permeability is moderately slow, and available moisture holding capacity is high. Surface runoff is rapid. These soils are in the Shelby, Gara, and Lindley series.

The suitability of these soils for producing wood crops is good. Except for the Shelby soils, many areas of these soils have existing stands of trees, but the trees generally are of low quality. Trees that should be favored in existing stands are red oak, white oak, green ash, black walnut, basswood, hackberry, and hard maple. The average site index for upland hardwoods ranges from 56 to 65. Soils on which timber now grows produce from 150 to 200 board feet per acre per year.

Erosion is a severe hazard. Seedling mortality is generally slight and depends on the damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is moderate. The hazards from pests and disease are generally slight.

Trees most suitable for planting on these soils are the *conifers* eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, and Douglas-fir and the *hardwoods* black walnut, green ash, and hackberry. Trees most suitable for windbreaks are the *conifers* eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, and Douglas-fir and the *hardwoods* Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. The conifers listed are especially well suited for farmstead windbreaks and the hardwoods for field windbreaks. Suitable for wildlife plantings are honeysuckle, viburnums, ninebark, lilac, and dogwood.

WOODLAND SUITABILITY GROUP 3

This group consists of medium-textured to moderately fine textured, moderately well drained to somewhat poorly drained soils on uplands. Slopes range from 2 to 9 percent. Permeability is slow and very slow. Available moisture holding capacity is high. Surface runoff is moderate. The soils are in the Grundy, Kniffin, Pershing, Seymour, and Rathbun series.

The suitability of these soils for producing wood crops is fair. Trees are growing on the Pershing, Kniffin, and Rathbun soils, but they are of low quality in many places. Trees that should be favored in existing stands are green ash, hackberry, red oak, and white oak. The average site index for upland hardwoods ranges from 46 to 55. Soils on which timber now grows produce from 100 to 150 board feet per acre per year.

Erosion is a slight to moderate hazard. Seedling mortality is generally slight and depends on the damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is moderate. The hazards from pests and disease are generally slight.

Trees most suitable for planting on these soils are the *conifers* eastern white pine, Scotch pine, eastern redcedar, and Norway spruce and the *hardwoods* cottonwood, soft maple, green ash, and hackberry. Trees most suitable for windbreaks are the *conifers* eastern white pine, Scotch pine, eastern redcedar, and Norway spruce and the *hardwoods* cottonwood, Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. The conifers listed are especially well suited for farmstead windbreaks and the hardwoods for field windbreaks. Suitable for wildlife planting are honeysuckle, viburnums, ninebark, lilac, and dogwood.

WOODLAND SUITABILITY GROUP 4

This group consists of moderately fine textured, deep, somewhat poorly drained and poorly drained Clarinda and Lamoni soils on uplands. Slopes range from 5 to 14 percent. These soils do not occupy entire slopes, but commonly occur in bands around the hillsides almost on a contour. Permeability is very slow, and runoff is moderate. Available moisture holding capacity is moderately high to high. These soils are often seepy and wet.

The suitability of these soils for producing commercial wood crops is fair to poor. Few areas have existing stands of timber. The average site index for upland hardwoods is less than 45. On these soils production of upland hardwoods is less than 100 board feet per year.

Erosion is a moderate hazard. Seedling mortality is slight and depends on damage caused by insects and rodents. Competition from grasses, weeds, or undesirable species of trees is slight. The hazards of pests and disease are generally slight.

Trees most suitable for planting on these soils are the *conifers* redcedar and Scotch pine (fig. 17) and the *hardwoods* green ash, hackberry, and cottonwood. The conifers listed are especially well suited for farmstead windbreaks and the hardwoods for field windbreaks. Suitable for wildlife plantings are dogwood, buttonbush, and pussy willow.

WOODLAND SUITABILITY GROUP 5

This group consists of medium-textured, moderately well drained and somewhat poorly drained soils. Slopes range from 5 to 14 percent. These soils are in the Adair, Lineville, Mystic, and Shelby series. Except for the Mystic soil, which has very slow permeability, permeability is moderately slow to slow. Available moisture capacity is moderate to high. Surface runoff is moderate to rapid.

The suitability of these soils for producing commercial wood crops is fair to poor. Some of the soils have existing stands of trees, but the trees are generally of low quality. Trees that should be favored in existing stands are green ash, hackberry, red oak, and white oak. The average site index for hardwood trees is less than 45. Production of hardwoods is less than 100 board feet per acre per year.

Erosion is a moderate to severe hazard. Seedling mortality is slight and depends on the damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is slight. The hazards from pests and disease are generally slight.

Trees most suitable for planting on these soils are the *conifers* eastern white pine, Scotch pine, eastern redcedar, and Norway spruce and the *hardwoods* green ash and hackberry. Trees most suitable for windbreaks are

Figure 17.—**Scotch pine planted for Christmas trees and wildlife cover. The soils are Seymour in the foreground and Clarinda and Lamoni in the background.**

the *conifers* eastern white pine, Scotch pine, eastern redcedar, and Norway spruce and the *hardwoods* Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. The conifers listed are especially well suited for farmstead windbreaks and the hardwoods for field windbreaks. Suitable for wildlife planting are dogwood, buttonbush, and pussy willow.

WOODLAND SUITABILITY GROUP 6

This group consists of deep, moderately well drained and somewhat poorly drained, medium-textured soils that are nearly level and occur on bottom lands. These soils are in the Lawson, Nodaway, and Vesser series. Permeability is moderate to moderately slow, and available moisture holding capacity is high. These soils are periodically flooded.

The suitability of these soils for producing bottom-land hardwoods is high; from 300 to 700 board feet is produced per acre per year.

Erosion is not a hazard. Seedling mortality is slight and depends on the damage caused by insects and rodents. Plant competition from grasses, weeds, and undesirable trees is moderate.

Trees most suitable for producing wood crops on these soils are the bottom-land *hardwoods* cottonwood, soft maple, and green ash. These soils are not well suited to upland hardwoods or conifers. Trees most suitable for windbreaks are cottonwood, soft maple, and green ash. Windbreak site quality is high for cottonwood and soft maple. Suitable for wildlife planting are dogwood, buttonbush, and pussy willow.

WOODLAND SUITABILITY GROUP 7

This group consist of medium-textured to fine-textured soils on uplands and bottom lands. These soils are in the Chequest, Colo, Edina, Haig, Humeston, Olmitz, Vesser, Wabash, and Zook series. Except for the moderately well drained Olmitz soils, these soils are somewhat poorly drained to very poorly drained. Permeability is slow to very slow. Seasonally, the water table is at or near the surface. The soils on bottom lands are flooded periodically.

The suitability of these soils for producing commercial wood crops is only fair, but the soils on bottom lands are more suitable than those on uplands. The soils on bottom lands produce 200 to 500 board feet of hardwoods per acre per year.

Trees most suitable on the soils of this group are soft maple, cottonwood, sycamore, willow, green ash, and hackberry. Conifers are not well suited. Trees most suitable for windbreaks are cottonwood, soft maple, and green ash. Cottonwood and soft maple grow well in windbreaks. Suitable for wildlife planting are dogwood, buttonwood, and pussy willow.

Engineering Properties of Soils

Engineers have studied soil characteristics that affect construction and have devised systems of soil classification based on these characteristics. Most of these studies have been at the site of construction because general information about the engineering properties of the soils of an area has not been readily available.

This soil survey contains information that engineers can use to—

1. Make studies of soil and land use that will aid in selecting and developing sites for industries, business, residences, and recreational areas.
2. Assist in planning and designing drainage and irrigation structures and in planning dams and other structures for water and soil conservation.
3. Make reconnaissance surveys of soil and ground conditions that will aid in selecting locations for highways and airports and in planning more detailed soil surveys for the intended locations.
4. Locate probable sources of sand and gravel for use in structures.
5. Correlate pavement performance with soil mapping units, and thus develop information that will be useful in designing and maintaining pavements.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and from aerial photographs.

With the use of the soil map for identification, the interpretations made in this soil survey can be useful to the planning engineer. It should be emphasized, however, that these interpretations are not a substitute for the sampling and testing needed at a site chosen for a specific engineering work where heavy loads are involved or at a site where the excavations are to be deeper than the depth here reported. Also, engineers should not apply specific values to estimates of bearing capacity given in this survey. Nevertheless, by using this survey, an engineer can select and concentrate on those soil units most important for the proposed kind of construction, and in this way reduce the number of soil samples taken for laboratory testing and complete an adequate investigation at minimum cost.

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, and sand—may have special meanings in soil science. These and other special terms used in the soil survey are defined in the Glossary in the back of this survey.

Engineering classification systems

Most highway engineers classify soil materials in accordance with the systems approved by the American Association of State Highway Officials (AASHO) (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1, consisting of gravelly soils having high bearing capacity, to A–7, which is made up of clayey soils having low strength when wet.

Some engineers prefer to use the Unified soil classification system (*19*). In this system, soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic. An approximate classification can be made in the field. Estimated classifications of the soils in Wayne County under both systems are given in table 4.

Soil engineering data and interpretations

Information and interpretations of most significance to engineers are given in tables 4, 5, and 6. In table 4 are estimates of soil properties significant to engineering. The data in table 4 are based on information in other parts of the survey and on experience with similar soils in other counties. Table 5 gives engineering interpretations of the soils in this county. Table 6 presents laboratory test data for samples taken from nine soil profiles in Wayne County. Additional information can be obtained from other parts of the survey, especially from the sections "General Soil Map," "Descriptions of the Soils," and "Formation and Classifications of Soils."

The percentage passing sieves shown in table 4 is the normal range of soil particles passing the respective screen sizes.

Permeability refers to the rate of movement of water through an undisturbed soil. Permeability depends largely on soil texture and structure.

Available moisture capacity is the amount of water that, in a moist soil, at field capacity, can be removed by plants. These ratings, expressed in inches of water per inch of soil depth, are of particular value to engineers engaged in irrigation.

Reaction given in table 4 was determined in the field. It is the estimated range in pH value for each major horizon. The pH value indicates the acidity or alkalinity of the soil. A pH of 7, for example, indicates a neutral soil, a lower value indicates acidity, and a higher value indicates alkalinity.

Shrink-swell potential is a rating of the ability of soil material to change volume when subjected to changes in moisture. Those soil materials rated high are normally undesirable from the engineering standpoint, since the increase in volume when the dry soil is moistened generally is accompanied by a loss in bearing capacity. In general, soils classed as CH and A–7 have a high shrink-swell potential. Clean sands and gravels (single–grain structure) and soils containing a small amount of nonplastic to slightly plastic fines have a low shrink-swell potential.

In table 5 are estimates of suitability of the soils in the county as a source of topsoil. Most of the soils are poor or fair as topsoil, but the Nodaway and Lawson soils are excellent, and the Olmitz soils are good.

Most of the soils are not suitable as sources of sand and gravel, but the Caleb soils are fair as a source of sand and fair to poor as a source of gravel. Pockets of well-graded sand and of gravel occur in the substratum of Caleb soils, but in many places films are excessive.

Most of the soils in the county make very poor or poor road fill, because the volume change is high, the soils are elastic and have low bearing capacity, and they are difficult to compact. The Caleb, Gara, Lindley, and Shelby soils, however, make good road fill.

Also given in table 5 are soil features that affect the selection of highway location. Among these features are topography, seepage, susceptibility to flooding and frost action, and availability of borrow material.

Depth to bedrock is greater than 10 to 20 feet from the surface of all the soils except for some small areas that are indicated with a spot symbol. Shale or limestone is close to the surface or crops out in areas where the spot symbol occurs.

Soil features affecting foundations for low buildings are compressibility of the soil, wetness, susceptibility to frost action, susceptibility to flooding, bearing capacity, and a high water table.

Soil features affecting both the reservoir areas and embankments for ponds are given in table 5. Among the features that affect the reservoir area are permeability, compactibility, shrink-swell potential, and imperviousness. Embankments are affected by stability of the soil material, shrink-swell potential, and imperviousness of the soil material.

Most of the soils in the county have severe or very severe limitations to use as septic tank disposal fields because the soils are very slowly permeable, have a seasonal high water table, and are susceptible to flooding.

Agricultural drainage is affected by permeability, availability of outlets, and seepage.

High available water holding capacity affects use of soils for irrigation. Also important are the rate of water intake and susceptibility to erosion.

Terraces and diversions can be constructed in many places, but they are hard to maintain on the coarser textured material. Terrace ridges and channels are difficult to keep in good condition. Soil material accumulates in the channels, and some is blown out of ridges by wind. Also, the soils in terraces and diversions should be capable of supporting good plant growth.

Grassed waterways should be in areas of fertile soils that are easy to vegetate. In some places a topdressing may be required. Also needed in some places is tile drainage so that seepage is controlled until vegetation is established.

Soil features affecting highway work[3]

Many of the soils in Wayne County formed in loess that overlies glacial till of Kansan age. The loess ranges from as much as 8 feet thick on the nearly level uplands, or what is often called the Edina flats, to a very thin layer in the more sloping dissected areas. In many places in the uplands the loess is absent, and the parent material is weathered glacial till.

The Edina, Seymour, Grundy, Haig, and other soils that were derived from loess in nearly level and gently sloping areas have a B horizon, or subsoil, that is classified as A-7 (CH or CL) material. This material has a high group index, and it is not suitable for use in the upper 5 feet of embankments. The surface layer of these soils is high in organic matter and is hard to compact to good density. The subsoil is mainly plastic silty clay that expands readily and does not make a good upper subgrade. The Seymour, Grundy, Kniffin, Pershing, and Rathbun soils developed from loess on slopes that erode readily where runoff is concentrated. Sodding, paving, or check dams may be needed in gutters and ditches so as to prevent excessive erosion.

[3] DONALD A. ANDERSON, soil engineer, Iowa State Highway Commission.

TABLE 4.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Adair (AaC, AaC2, AaD, AaD2, AdC3, AdD3, AsD2, AsD3). (For properties of the Shelby soil in mapping units AsD2 and AsD3, refer to the Shelby series.)	2-5	0-14	Loam	CL	A-6(8-12)
		14-44	Clay loam to clay	CL or CH	A-7-6(15-20)
		44-56	Clay loam	CL	A-6(8-12)
Caleb (CaD2, CaE2, CbD3, CbE3)	5-10	0-8	Loam and silt loam	CL	A-6(6-10)
		8-46	Clay loam and sandy clay loam.	CL or SC	A-4(4) to A-6(10)
		46-66	Sandy loam	SC or ML-CL	A-4(1-4)
Chequest (Ch)	1-3	0-11	Silty clay loam	CH or MH	A-7-5(16-20)
		11-55	Silty clay loam	CH	A-7-6(16-20)
Clarinda (ClC, ClC2, ClD2, CmC3)	0-3	0-11	Silty clay loam	CL or CH	A-6(6-10) to A-7-6(14).
		11-47	Silty clay and clay	CH	A-7-6(20)
		47-67	Clay	CH	A-7-6(20)
Colo (Co, CoB, Cz) (For properties of Zook soil in mapping unit Cz, refer to the Zook soil series.)	1-3	0-44	Silty clay loam	OH or CH or CL	A-7-6(14-19)
		44-55	Silty clay loam	CH or CL	A-7-6(14-19)
Edina (Ed)	0-3	0-12	Silt loam	ML or CL	A-6(8-10)
		12-18	Silt loam	ML or CL	A-6(6-10)
		18-48	Silty clay loam and silty clay.	CH	A-7-6(20)
		48-61	Silty clay loam	CH	A-7-6(20)
Gara (GaD2, GaE, GaE2, GaF, GaF2, GrE3)	>10	0-12	Loam	CL	A-4(3) to A-6(8)
		12-45	Clay loam	CL	A-6(9) to A-7-6(14)
		45-60	Clay loam	CL	A-6(10) to A-7-6(14).
Grundy (GuB, GuC, GuC2)	2-5	0-15	Silt loam to silty clay loam.	ML or CL	A-7-6(10-12)
		15-36	Silty clay	CH	A-7-6(16-20)
		36-48	Silty clay loam	CH or CL	A-7-6(13-16)
Haig (Ha)	0-3	0-17	Silt loam and silty clay loam.	ML or CL	A-7-6(10-12)
		17-34	Silty clay	CH	A-7-6(20)
		34-70	Silty clay loam	CH or CL	A-7-6(13-16)
Humeston (Hu, HuB)	0-3	0-13	Silty clay loam and silt loam.	ML or CL	A-6(8-10)
		13-24	Silt loam	ML or CL	A-4(6) to A-6(12)
		24-80	Silty clay and silty clay loam.	CH	A-7-6(20)
Kniffin (KnB, KnC, KnC2)	1-3	0-9	Silt loam to silty clay loam.	ML or CL	A-4(8) to A-6(10).
		9-35	Silty clay and silty clay loam.	CL	A-7-6(20)
		35-57	Silty clay loam	CL	A-6(10) to A-7-6 (14).
Lamoni (LaC2, LaD2, LmD3)	0-11	0-11	Silty clay loam to clay loam.	CL	A-6(10) to A-7-6(12).
		11-42	Clay to clay loam	CH	A-7-6(16-20)
		42-80	Clay loam	CL	A-6(10) to A-7-6 (15).
Lawson (Ln) (For properties of Nodaway soils in this mapping unit, refer to the Nodaway series.)	3-6	0-28	Silt loam	CL or OL	A-6(8) to A-7-5 (10).
		28-48	Silt loam	CL	A-6(8-12)
		48-60	Silt loam to loam	CL	A-6(10-12)

significant in engineering

Percentage passing sieve—			Permeability	Available moisture capacity	Reaction	Shrink-swell potential
No. 4	No. 10	No. 200				
			Inches per hour	*Inches per inch of soil*	*pH value*	
95–100	80–95	60–80	0. 2–0. 63	0. 17	5. 1–5. 5	Moderate.
95–100	80–95	55–80	0. 63–0. 2	. 15	5. 1–6. 0	High.
95–100	80–95	55–80	0. 2–0. 63	. 15	6. 1–6. 5	Moderate.
90–100	80–100	60–80	0. 63–2. 0	. 17	4. 5–6. 5	Moderate.
85–100	80–100	45–75	0. 63–2. 0	. 15	4. 5–6. 5	Moderate.
85–100	80–100	35–60	2. 0–6. 3	. 10	5. 1–6. 0	Low.
----------	100	95–100	0. 2–0. 63	. 18	6. 6–7. 3	High.
----------	100	95–100	0. 2–0. 63	. 16	5. 1–6. 0	High.
100	95–100	85–100	0. 2–0. 63	. 18	4. 5–5. 5	Moderate to high.
100	95–100	85–100	<0. 063	. 15	5. 1–6. 5	High.
95–100	90–100	75–90	<0. 063	. 15	6. 1–6. 5	High.
100	100	85–100	0. 2–0. 63	. 21	5. 6–6. 5	High.
100	100	85–100	0. 2–0. 63	. 19	6. 1–6. 5	High.
----------	100	95–100	0. 63–2. 0	. 20	5. 6–6. 5	Moderate.
----------	100	95–100	0. 63–2. 0	. 18	5. 6–6. 0	Moderate.
----------	100	95–100	<0. 063	. 18	5. 6–6. 5	High.
----------	100	95–100	0. 063–2. 0	. 16	6. 1–7. 3	High.
85–95	80–90	55–65	0. 63–2. 0	. 18	5. 6–6. 0	Moderate.
85–95	80–90	50–65	0. 2–0. 63	. 17	4. 5–6. 5	Moderate.
85–95	80–90	50–65	0. 2–0. 63	. 16	6. 6–7. 3	Moderate.
----------	100	95–100	0. 63–2. 0	. 20	5. 6–6. 5	Moderate to high.
----------	100	95–100	0. 063–0. 2	. 16	5. 6–6. 5	High.
----------	100	95–100	0. 2–0. 63	. 17	6. 6–7. 3	High.
----------	100	95–100	0. 63–0. 2	. 20	5. 6–6. 5	Moderate to high.
----------	100	95–100	0. 063–0. 2	. 15	5. 6–6. 5	High.
----------	100	95–100	0. 2–0. 63	. 17	6. 6–7. 3	High.
----------	100	95–100	0. 63–2. 0	. 20	5. 6–6. 5	Moderate.
----------	100	95–100	0. 63–2. 0	. 18	4. 5–5. 5	Moderate.
----------	100	95–100	<0. 063	. 16	4. 5–6. 0	High.
----------	100	95–100	0. 63–2. 0	. 18	4. 5–5. 5	Moderate.
----------	100	95–100	<0. 063	. 15	4. 5–6. 5	High.
----------	100	95–100	0. 2–0. 63	. 16	6. 1–7. 3	Moderate to high.
95–100	95–100	70–95	0. 2–0. 63	. 19	5. 1–6. 5	Moderate to high.
95–100	95–100	85–100	<0. 063	. 15	5. 6–6. 5	High.
85–100	85–100	55–85	0. 2–0. 63	. 16	6. 1–7. 3	High.
100	95–100	80–100	0. 63–2. 0	. 22	6. 1–6. 5	Moderate to high.
100	95–100	80–100	0. 63–2. 0	. 19	5. 5–6. 5	Moderate.
95–100	90–100	75–100	0. 63–2. 0	. 15	5. 6–6. 0	Moderate.

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TABLE 4.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Lindley (LoF2)	>10	0–8	Loam	CL	A-4(3) to A-6(8)
		8–38	Clay loam	CL	A-6(9) to A-7-6 (14).
		38–42	Clay loam	CL	A-6(6-10)
Lineville (LvC, LvC2)	2–5	0–10	Silt loam	CL or ML	A-4(6) to A-6(10)
		10–23	Silty clay loam and clay loam.	CL	A-7-6(10-14)
		23–58	Clay loam and loam	CH	A-6(11) to A-7-6(18).
		58–72	Clay loam	CL	A-6(10-12)
Mystic (MyC2)	2–5	0–10	Silt loam	CL	A-6(8-12)
		10–43	Clay loam	CL or CH	A-6(8-12) to A-7-6(11-15).
		43–64	Sandy clay loam and sandy loam.	CL or SC	A-4(1-4) to A-6 (4-8).
Nodaway (Mapped only in complex with Lawson soils.)	3–6	0–26	Silt loam, very fine sandy loam, fine sand, and loam.	ML or CL	A-4(8) to A-6(10)
		26–57	Silt loam	CL or OL	A-6(8-10)
Olmitz (OmB, OvB) (For properties of Vesser and Colo soils in mapping unit OvB, refer to their respective series.)	5–10	0–24	Loam	OL or CL	A-6(6-10)
		24–55	Clay loam	CL	A-6(8) or A-7-6(12).
Pershing (PeC, PeC2, PhB, PhC2)	2–5	0–9	Silt loam	ML or CL	A-4(18) to A-6(10)
		9–34	Silty clay loam and silty clay.	CH	A-6(10) to A-7-6(14).
		34–60	Silty clay loam	CL or CH	A-6(10) to A-7-6(14).
Rathbun (RaC, RaC2)	1–3	0–15	Silt loam	ML	A-4(6) to A-6(8)
		15–35	Silty clay loam and silty clay.	CH	A-7-6(20)
		35–75	Silt loam to silty clay loam.	CL to CH	A-6(12) to A-7-6(15).
Seymour (SeB, SfC, SfC2)	1–3	0–11	Silt loam and silty clay loam.	CL	A-7-6(10-14)
		11–36	Silty clay loam and silty clay.	CH	A-7-6(20)
		36–64	Silty clay loam	CH	A-7-6(18-20)
Shelby (ShD, ShD2, ShE, ShE2, ShF2, SoD3, SoE3).	>10	0–12	Loam and clay loam	CL	A-4(8) to A-6(12)
		12–34	Clay loam	CL	A-6(10) to A-7-6(14).
		34–62	Clay loam	CL	A-6(6) to A-7-6(10).
Vesser (Ve, VeB)	1–3	0–12	Silt loam	ML or CL	A-6(8-12)
		12–31	Silt loam	ML or CL	A-6(8-10)
		31–60	Silty clay loam	CL or CH	A-7-6(14-17)
Wabash (Wa)	0–3	0–39	Silty clay	OH or CH	A-7-6(18) to A-7-5(20).
		39–80	Silty clay	CH	A-7-6(20)
Zook (Zo)	0–3	0–24	Silty clay loam and silty clay.	MH or CH	A-7-6(16) to A-7-5(20).
		24–65	Silty clay loam	CH	A-7-6(16-20)

significant in engineering—Continued

Percentage passing sieve—			Permeability	Available moisture capacity	Reaction	Shrink-swell potential
No. 4	No. 10	No. 200				
			Inches per hour	*Inches per inch of soil*	*pH value*	
85-95	80-90	55-65	0. 63-2. 0	. 17	4. 5-6. 0	Moderate.
85-95	80-90	50-65	0. 2-0. 63	. 16	4. 5-6. 5	Moderate.
85-95	8-090	50-65	0. 2-0. 63	. 16	6. 1-7. 3	Moderate.
	100	95-100	0. 63-2. 0	. 18	5. 1-6. 5	Moderate.
	100	95-100	0. 2-0. 63	. 18	5. 1-5. 5	Moderate to high.
100	80-100	65-90	<0. 063	. 15	5. 6-7. 3	High.
95-100	80-100	55-80	0. 2-0. 63	. 16	6. 1-7. 3	Moderate to high.
95-100	90-100	90-95	0. 63-2. 0	. 17	4. 5-6. 0	Moderate.
90-100	80-100	55-75	<0. 063	. 15	5. 1-6. 5	Moderate to high.
85-100	80-100	40-60	0. 63-2. 0	. 12	6. 1-6. 5	Moderate.
100	95-100	90-100	0. 63-2. 0	. 19	6. 1-7. 3	Moderate.
100	95-100	90-100	0. 63-2. 0	. 22	6. 6-7. 3	Moderate to high.
100	90-100	60-80	0. 63-2. 0	. 18	5. 1-6. 5	Moderate.
100	90-100	60-80	0. 63-2. 0	. 17	6. 1-7. 3	Moderate.
	100	95-100	0. 63-2. 0	. 18	6. 1-7. 3	Moderate.
	100	95-100	0. 063-0. 2	. 15	5. 1-6. 5	High.
	100	95-100	0. 2-0. 63	. 16	6. 1-6. 5	Moderate to high.
	100	95-100	0. 63-2. 0	. 18	4. 5-6. 0	Moderate.
	100	95-100	<0. 063	. 15	4. 5-5. 5	High.
	100	95-100	0. 2-0. 63	. 15	5. 1-6. 5	Moderate to high.
	100	95-100	0. 63-2. 0	. 22	5. 6-6. 5	Moderate to high.
	100	95-100	<0. 063	. 18	5. 6-6. 5	High.
	100	95-100	0. 063-0. 2	. 18	6. 1-7. 4	High.
90-95	80-90	55-65	0. 63-2. 0	. 18	6. 6-7. 3	Moderate.
85-95	80-90	50-65	0. 2-0. 63	. 16	5. 6-6. 0	Moderate.
85-95	80-90	50-65	0. 2-0. 63	. 15	6. 1-7. 8	Moderate.
	100	95-100	0. 63-2. 0	. 20	5. 6-6. 5	Moderate.
	100	95-100	0. 63-2. 0	. 18	5. 1-6. 0	Low to moderate.
	100	95-100	0. 2-0. 63	. 19	5. 6-6. 5	Moderate to high.
	100	95-100	<0. 063	. 18	6. 1-7. 3	High.
	100	95-100	<0. 063	. 16	6. 1-7. 3	High.
	100	90-100	0. 063-0. 2	. 19	5. 6-6. 5	High.
	100	90-100	0. 063-0. 2	. 18	6. 6-7. 3	High.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Adair (AaC, AaC2, AaD, AaD2, AdC3, AdD3, AsD2, AsD3). (For properties of the Shelby soils in mapping units AsD2 and AsD3, refer to the Shelby series.)	Poor	Not suitable	Not suitable	Very poor in subsoil; subsoil has high shrink-swell potential and is highly elastic; substratum fair; easily compacted to high density.	Rolling topography; seepage in cut can be expected seasonally; difficult to vegetate; highly susceptible to frost action.	Slight compressibility; uneven consolidation; often seepy and wet; highly susceptible to frost action; limitations moderate.
Caleb (CaD2, CaE2, CbD3, CbE3).	Poor	Fair; pockets of well graded sand may be in substratum.	Fair to poor; pockets of gravel in substratum in some places; commonly excess of fines.	Good; fair to good bearing capacity and shear strength; slight compressibility; easily compacted to a high density; moderate to low shrink-swell potential.	Good potential as borrow material; some cuts may be seasonally seepy; surface layer low in organic matter; need for cuts and fills; difficult to vegetate cuts.	Good bearing capacity and shear strength; slight compressibility; uneven consolidation; limitations slight.
Chequest (Ch)	Poor	Not suitable	Not suitable	Poor to unsuitable; high shrink-swell potential; poor bearing capacity when wet; difficult to compact to high density; high compressibility.	Poor potential as borrow material; high water table; subject to flooding; surface layer high in organic matter.	High shrink-swell potential; high compressibility; poor shear strength; high water table; subject to flooding; limitations severe.
Clarinda (ClC, ClC2, ClD2, CmC3).	Very poor to unsuitable.	Not suitable	Not suitable	Unsuitable; highly elastic; moderate to high shrink-swell potential; difficult to compact to high density.	Poor potential as borrow material; seepage often occurs in cuts; surface layer is high in organic matter.	Poor shear strength; fair to poor bearing capacity; moderate to high shrink-swell potential; uneven consolidation; limitations severe.
Colo (Co, CoB, Cz). (For properties of the Zook soil in mapping unit Cz, refer to the Zook series.)	Fair	Not suitable	Not suitable	Very poor; poor bearing capacity and shear strength; seasonal high water table; high compressibility; high in organic matter to depth of 3 feet or more.	Seasonal high water table; subject to some flooding in some places; poor foundation for high fills; poor potential as borrow material.	Seasonal high water table; usually subject to some flooding; high compressibility with uneven consolidation; limitations severe.

interpretations

Soil features affecting—Continued						
Farm ponds		Septic tank disposal field	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Very slow permeability when compacted; easily compacted; suitable sites common; good suitability.	Impervious material; fair to good stability; moderate to high shrink-swell potential; good for impervious cores; easily compacted to high density; fair to good suitability.	Very slow permeability; limitations severe.	Wetness due to seepage; interceptor tile placed above the seepage areas is helpful.	Very slow permeability; subject to erosion; soils have little value for farming.	Subsoil unfavorable for crop growth as it is difficult to vegetate where exposed; terrace channels likely to be seepy and wet; limitations severe.	Low fertility; tile helpful in controlling seepage.
Slow permeability when compacted but coarse strata are below 4 feet in some places; fair to good suitability.	Good stability; easily compacted to high density; moderate to low shrink-swell potential; good suitability.	Slopes commonly more than 10 percent; poor filtering material below 4 feet; limitations moderate.	Generally not needed.	Moderate available water holding capacity; fair suitability; soils have little value for farming.	Commonly slopes are more than 10 percent; low fertility in subsoil; limitations severe.	Tile may be needed to control seepage; low fertility; difficult to vegetate.
Subject to flooding; fair for dugout ponds.	Poor compaction, except at optimum moisture; high shrink-swell potential.	Subject to overflow; slowly permeable; seasonal high water table; limitations severe.	Tiles function satisfactorily but outlets may be difficult to obtain; most areas need protection from flooding.	High available water holding capacity; drainage required before irrigation.	Diversions properly placed to control local runoff may reduce wetness in some areas; terraces not needed due to topography.	Not needed due to topography.
Very slow permeability when compacted; good suitability.	Fair stability on flat slopes; moderate to high shrink-swell potential; medium compressibility; fair suitability.	Very slow permeability; seasonal high water table; limitations severe.	Use of interceptor tile properly placed helps control seepage in some areas.	Slow intake rate and very slow permeability; soils have little value for farming.	Subsoil has low fertility and is difficult to vegetate if exposed where terraces are constructed; diversions properly placed can be beneficial; limitations severe.	Difficult to vegetate where subsoil is exposed; topdressing often required; limitations severe.
High in organic matter; some areas have potential for dugout ponds; fair to poor suitability.	High in organic matter in top 3 or more feet; poor embankment foundation; very poor suitability.	Seasonal high water table; usually subject to some degree of flooding; moderately slow permeability; limitations severe.	Moderately slow permeability; tiles function satisfactorily; in some places outlets may not be available; may need protection from floods.	Medium intake rate; high available water holding capacity; often needs artificial drainage; usually subject to some degree of flooding.	Diversions properly placed are beneficial in preventing local flooding and siltation.	Generally not needed.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Edina (Ed)	Fair, but thin layer suitable.	Not suitable	Not suitable	Unsuitable; poor shear strength; high plasticity; moderate to high shrink-swell potential; elastic; poor bearing capacity when wet; difficult to compact to high density.	Level topography; poor potential as borrow material; high water table; surface layer high in organic matter; poor workability.	Poor shear strength; slight compressibility; uniform consolidation; moderate to high shrink-swell potential; limitations severe.
Gara (GaD2, GaE, GaE2, GaF, GaF2, GrE3).	Fair, only thin layer with organic matter.	Not suitable	Not suitable	Good; fair to good bearing capacity; good workability and compaction; easily compacted to high density.	Rolling topography; variable materials in cuts; some cuts may be seepy; good potential as borrow material.	Good bearing capacity and shear strength; slight compressibility; uneven consolidation; limitations slight.
Grundy (GuB, GuC, GuC2).	Fair to good	Not suitable	Not suitable	Very poor; highly elastic; moderate to high shrink-swell potential; poor bearing capacity when wet; poor shear strength; range of moisture content narrow for suitable compaction.	Poor potential as borrow material; seasonal high water table; surface layer high in organic matter.	Moderate to high shrink-swell potential; high compressibility; seasonal high water table; limitations severe.
Haig (Ha)	Fair	Not suitable	Not suitable	Very poor; highly elastic; moderate to high shrink-swell potential; poor bearing capacity when wet; poor shear strength; range of moisture content narrow for suitable compaction.	Poor potential as borrow material; seasonal high water table; surface layer high in organic matter; low relief; nearly level topography.	Moderate to high shrink-swell potential; high compressibility; high water table; fair bearing capacity; uniform consolidation; limitations severe.

interpretations—Continued

Soil features affecting—Continued						
Farm ponds		Septic tank disposal field	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Level topography on high elevation or stream divides; little watershed potential; poor suitability.	Fair stability; impervious when compacted; moderate to high shrink-swell potential; high compressibility; slight creep can be expected in fills; poor workability when wet; fair to poor suitability.	Very slow permeability in subsoil; seasonal high water table; limitations very severe.	Surface drains are suitable, but tile drainage is not.	High available water holding capacity; moderate intake rate but very slow permeability; difficult to get adequate drainage.	Not needed due to topography.	Not needed due to topography.
Slow permeability when compacted; good sites usually available; good suitability.	Adequate stability; easily compacted to high density; good workability; good for cores; good suitability.	Moderately slow permeability; moderate limitations on slopes of less than 10 percent.	Drainage not needed.	Subject to high rate of runoff; high available water holding capacity; erosion control practices needed.	Suitable on slopes of less than 12 percent; cuts should be held to a minimum because of the less productive subsoil.	Tile needed to keep waterways dry so that vegetation can be established.
Uniform material of slow permeability; good suitability.	Low stability when wet; moderate to high shrink-swell potential; impervious when compacted; range of moisture content narrow for suitable compaction; slight creep of embankments can be expected; poor suitability.	Seasonal high water table; slow permeability; limitations very severe.	Tile may not drain all areas satisfactorily; blinding is required prior to backfilling.	High available water holding capacity; moderate intake rate; slow permeability in subsoil; irrigation should be limited to approximately 2 feet in depth; difficult to obtain adequate drainage.	Seepage water may occur in terrace channels; cuts should be held to a minimum depth to prevent exposure of fine-textured subsoil.	Tile may be needed to prevent seepage so that vegetation can be established; few limitations.
Suitable sites unlikely; slow permeability when compacted.	Moderate to low stability when wet; high shrink-swell potential; impervious when compacted; narrow moisture range for suitable compaction; poor suitability.	Seasonal high water table; slow permeability; limitations very severe.	Tile may not drain all areas satisfactorily; blinding is required prior to backfilling; use surface drainage in depressional areas.	High available water holding capacity; moderate to slow intake rate; adequate drainage difficult to obtain.	Not needed due to topography.	Not needed due to topography.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Humeston (Hu, HuB)	Fair	Not suitable	Not suitable	Very poor; highly elastic; moderate to high shrink-swell potential; poor bearing capacity when wet; poor shear strength.	Poor potential as borrow material; nearly level topography subject to flooding and seasonal high water table; moderately high in organic matter to a depth of as much as 4 feet or more; poor foundation for high fills.	Subject to flooding; moderate to high shrink-swell potential; limitations severe.
Kniffin (KnB, KnC, KnC2).	Poor	Not suitable	Not suitable	Very poor; highly elastic; moderate to high shrink-swell potential; poor bearing capacity when wet; difficult to compact to high density.	Poor potential as borrow material; seasonal high water table; often high moisture content in cuts.	Moderate to high shrink-swell potential; high compressibility; uniform consolidation; seasonal high water table; limitations severe.
Lamoni (LaC2, LaD2, LmD3).	Very poor	Not suitable	Not suitable	Poor, elastic; moderate to high shrink-swell potential; difficult to compact properly; low stability at high moisture content.	Seasonal high water table; moderately high in organic matter; often high moisture content in cuts; poor potential as borrow material.	Moderate to high shrink-swell potential; fair bearing capacity; uneven consolidation; limitations severe.
Lawson (Ln) (For properties of Nodaway soils in mapping unit Ln, refer to the Nodaway series.)	Excellent	Not suitable	Not suitable	Very poor; poor bearing capacity when wet; low stability at high moisture content; difficult to compact to high density; range of moisture content narrow for satisfactory compaction.	Subject to flooding; seasonal high water table; surface layer high in organic matter; poor potential as borrow material; poor foundation for high fills.	Medium to high compressibility; uneven consolidation; subject to flooding; subject to liquification when saturated; limitations moderate to severe.
Lindley (LoF2)	Poor	Not suitable	Not suitable	Good; fair to good bearing capacity; slight compressibility; easily compacted to high density; moderate shrink-swell potential.	Rolling and steep topography; good source of borrow material; some cuts may be seepy; surface layer low in organic matter.	Fair to good bearing capacity and shear strength; slight compressibility; uneven consolidation; limitations severe.

interpretations—Continued

Soil features affecting—Continued						
Farm ponds		Septic tank disposal field	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Suitable sites unlikely; slow permeability when compacted; subject to flooding; fair suitability.	Fair stability; slow permeability; moderate to high shrink-swell potential; high compressibility; fair suitability.	Subject to flooding; high water table; slow permeability; limitations very severe.	Protection from stream overflow required; tile may not drain all areas satisfactorily; surface drains needed when depressional.	High available water holding capacity; susceptible to stream overflow; adequate drainage difficult to obtain.	Terraces not needed; diversions properly placed help to reduce local ponding and wetness.	Not needed due to topography.
Uniform material of slow permeability; good suitability.	Low stability when wet; moderate to high shrink-swell potential; narrow moisture range for suitable compaction; slight creep of embankments can be expected; poor suitability.	Very slow permeability; seasonal high water table; limitations very severe.	Tile not recommended.	High available water holding capacity; slow intake rate; difficult to get adequate drainage; erosion control practices needed.	Seepage water may occur in terrace channels; cuts should be held to a minimum depth to prevent exposure of the fine-textured subsoil that is low in fertility; some limitations.	Tile may be needed on sides of waterways to control seepage so that vegetation can be established.
Very slow permeability when compacted; good suitability.	Fair to good stability on flat slopes; impervious when compacted; suitable for cores; moderate to high shrink-swell potential; fair to good suitability.	Very slow permeability; seasonally seepy and wet; limitations severe.	Interceptor tile properly placed helps control seepage in some areas.	Slow intake rate and very slow permeability; soils have little value for farming.	Subsoil is very low in fertility and is difficult to vegetate where exposed.	Difficult to vegetate where subsoil is exposed; topdressing often required; limitations severe.
Suitable sites unlikely; reservoir bottom should be scarified and compacted; seepage can be expected; sand strata in some places; fluctuation in water table; subject to flooding; very poor suitability.	Low stability; difficult to compact to high density; high organic-matter content; moderate to high shrink-swell potential; subject to piping.	Seasonal high water table and subject to overflow; limitations severe.	Tiles function well; some areas need protection from overflow.	High available water holding capacity; may require drainage and flood protection.	Terraces not needed; diversions properly placed can improve wetness hazard.	Generally not needed due to topography.
Good sites likely; slow permeability; very good suitability.	Good stability; easily compacted to high density; usable for core material; slow permeability when compacted; good workability; good suitability.	Slopes exceed 10 percent in most places; slowly permeable subsoil; limitations severe.	Generally not needed.	High available water holding capacity; subject to high rate of runoff and erosion; low natural fertility.	Slopes are generally irregular and steep; limitations severe.	Difficult to vegetate; low fertility.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Lineville (LvC, LvC2)	Poor	Not suitable	Not suitable	Poor; poor bearing capacity when wet; moderate to high shrink-swell potential; elastic subsoil difficult to compact properly.	Poor potential as borrow material; generally high need for cuts and fills; seasonally seepy and wet; highly susceptible to frost action.	Moderate to high shrink-swell potential; fair shear strength; uneven consolidation; limitations severe.
Mystic (MyC2)	Poor	Fair to poor; some areas have pockets and strata of well-graded sand in the subsoil.	Poor	Fair to poor in subsoil; subsoil has poor bearing capacity when wet; moderate to high shrink-swell potential; good in substratum; easily compacted to high density.	Substratum makes good borrow material; high moisture in some cuts; highly susceptible to frost action; seasonally wet and seepy; difficult to vegetate cuts.	Good bearing capacity in substratum; highly susceptible to frost heave and loss of bearing capacity on thawing; limitations moderate.
Nodaway	Excellent	Not suitable	Not suitable	Very poor; low bearing capacity and moderate to high shrink-swell potential; low stability when wet; difficult to compact to high density.	Nearly level topography; subject to frequent overflow; soil high in organic matter below depth of about 3 feet; poor foundation for high fills.	High compressibility; subject to frequent flooding; low bearing capacity; limitations severe.
Olmitz (Omb, OvB) (For properties of the Vesser and Colo soils in mapping unit OvB, refer to the Vesser and Colo series.)	Good; a thick surface layer that is high in organic matter.	Not suitable	Not suitable	Poor; high in organic matter to 2 to 3 feet; fair to poor bearing capacity; moderate shrink-swell potential.	High in organic matter to a depth of 2 to 3 feet; poor source of embankment material.	Fair to poor bearing capacity; fair shear strength; medium compressibility; moderate shrink-swell potential; limitations moderate.
Pershing (PeC, PeC2, PhB, PhC2).	Poor	Not suitable	Not suitable	Very poor; highly elastic; moderate to high shrink-swell potential; low bearing capacity when wet; poor workability; difficult to compact properly.	Poor potential as borrow material; generally high need for cuts; high moisture can be expected in cuts.	Moderate to high shrink-swell potential; high compressibility; uniform consolidation; limitations severe.

interpretations—Continued

Soil features affecting—Continued						
Farm ponds		Septic tank disposal field	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Slow permeability when compacted; good suitability.	Low stability; moderate to high shrink-swell potential; impervious when compacted; fair suitability.	Very slow permeability; seasonal high water table; limitations severe.	Interceptor tile properly placed helps control seepage.	High available water holding capacity; very slow permeability in subsoil; very difficult to get adequate drainage.	Cuts must be held to a minimum depth to prevent exposure of subsoil that has low fertility; limitations severe.	Generally not needed due to topography.
Slow permeability when compacted; coarse-textured strata below 4 to 5 feet in some places; fair to good suitability.	Good stability; semiimpervious to impervious when compacted; good workability; slight compressibility; good suitability.	Slow permeability in subsoil; poor filtering material below depth of 5 feet; limitations severe.	Generally not needed but interceptor tile properly placed reduces seepage.	Moderate to high available water holding capacity; slow permeability in subsoil; soil has little value for farming.	Subsoil has very low fertility and low tilth where exposed; limitations severe.	Generally not needed due to topography.
Reservoir area needs to be compacted and some seepage can be expected; fair to poor suitability.	Low stability at high moisture; poor compaction above optimum moisture; suitable for shell but not for core; moderate to high shrink-swell potential; poor resistance to piping; fair suitability.	Subject to frequent flooding; limitations severe.	Most areas do not need tile; may need protection from flooding.	Moderate intake rates; high available water holding capacity; subject to flooding.	Not needed due to topography.	Not needed due to position on the landscape.
Reservoir area needs to be compacted; fair suitability.	High in organic matter to 2 to 3 feet; fair stability; fair to poor workability and compaction; medium to high compressibility; poor suitability.	Moderate permeability; limitations severe.	Not needed	High available water holding capacity; medium intake rate; subject to erosion and gullying.	Soil properties are favorable; no limitations.	No limitations; soil properties are favorable.
Good sites common; uniform material of slow permeability; good suitability.	Low stability when wet; moderate to high shrink-swell potential; difficult to compact properly; slight creep in fills can be expected; poor suitability.	Slow permeability; seasonally wet and seepy; limitations severe.	Interceptor tile properly placed reduces seepage.	High available water holding capacity; slow permeability; difficult to get adequate drainage; erosion control practices needed.	Subsoil has low fertility and is fine textured; cuts must be held to a minimum to prevent exposure of subsoil; limitations severe.	Tile may be needed on sides of waterways to control seepage so that suitable vegetation can be established.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Rathbun (RaC, RaC2)	Poor	Not suitable	Not suitable	Very poor; highly elastic; moderate to high shrink-swell potential; low bearing capacity when wet; poor workability; difficult to compact properly.	Poor potential as borrow material; generally high need for cuts and fills; high moisture can be expected in some cuts.	Moderate to high shrink-swell potential; high compressibility; uniform consolidation; limitations severe.
Seymour (SeB, SfC, SfC2).	Fair to poor	Not suitable	Not suitable	Very poor; highly elastic; moderate to high shrink-swell potential; low bearing capacity when wet; poor shear strength; difficult to compact properly.	Poor potential as borrow material; seasonal high water table; surface layer high in organic matter.	Moderate to high shrink-swell potential; seasonal high water table; poor shear strength; limitations severe.
Shelby (ShD, ShD2, ShE, ShE2, ShF2, SoD3, SoE3).	Fair	Not suitable	Not suitable	Good; fair to good bearing capacity; slight compressibility; good workability and compaction; easily compacted to high density.	Rolling topography; variable material in cuts; some cuts may be seepy; good potential as borrow material.	Good bearing capacity and shear strength; slight compressibility; uneven consolidation; limitations slight.
Vesser (Ve, VeB)	Fair to good	Not suitable	Not suitable	Fair to poor; poor bearing capacity; moderate to high shrink-swell potential; difficult to compact to high density; range of moisture content narrow for satisfactory compaction.	Subject to flooding; seasonal high water table; poor potential as borrow material; surface layer high in organic matter.	High compressibility; subject to short duration flooding and seasonal high water table; limitations severe.
Wabash (Wa)	Not suitable	Not suitable	Not suitable	Unsuitable; poor bearing capacity; high shrink-swell potential; elastic; difficult to compact; range of moisture content narrow for suitable compaction.	Surface layer high in organic matter; high water table; subject to flooding; poor potential as borrow; poor foundation for high fills.	Poor bearing capacity and shear strength; medium to high compressibility; high shrink-swell potential; limitations severe.

interpretations—Continued

Soil features affecting—Continued							
Farm ponds		Septic tank disposal field	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Suitable sites common; uniform material of slow permeability; good suitability.	Low stability when wet; slow permeability; slight creeps can be expected in fills; poor suitability.	Slow permeability in subsoil; seasonally wet and seepy; limitations severe.	Interceptor tile properly placed reduces seepage.	High available water holding capacity; slow intake rate; slow permeability; difficult to get adequate drainage.	Subsoil has low fertility and is fine textured; cuts must be held to a minimum to prevent exposure of subsoil; some limitations.	Tile may be helpful on sides of waterways to control seepage so that suitable vegetation can be established.
Uniform material of slow permeability; good suitability.	Low stability when wet; impervious; moderate to high shrink-swell potential; slight creep can be expected in fills; poor suitability.	Very slow permeability; seasonal high water table; limitations severe.	Tile not recommended because subsoil is very slowly permeable, but interceptor tile properly placed can reduce seepage.	High available water holding capacity; very slow permeability in subsoil; difficult to provide adequate drainage.	Subsoil is highly plastic and fine textured; cuts must be held to a minimum; limitations severe.	Difficult to vegetate; waterways tend to be wet and seepy; tile carefully placed may help control seepage.
Slow permeability when compacted; good sites usually available; good suitability.	Adequate stability; easily compacted to high density; good workability; suitable for cores; good suitability.	Moderately slow permeability; limitations moderate on slopes of less than 10 percent; severe limitations on slopes of more than 10 percent.	Not needed.	High available water holding capacity; erosion control practices needed.	Cuts should be held to a minimum due to less productive subsoil; suitable on slopes of less than 12 percent.	Tile needed to keep waterways dry so vegetation can be established.
Slow permeability when compacted but good site locations unlikely; some areas may be satisfactory for dugout ponds; poor suitability.	Fair to poor stability; moderate to high shrink-swell potential; poor compaction when wet; some areas may be susceptible to piping; fair suitability.	Subject to flooding and seasonal high water table; limitations very severe.	Tiles function satisfactorily where outlets can be obtained.	Moderate water intake; high available water holding capacity; tile drainage needed before irrigation.	Diversions properly placed are beneficial in preventing local flooding and siltation; terraces not needed due to topography.	Generally not needed; tile needed along sites to prevent seepage so vegetation can be established.
Suitable site unlikely; may be suitable for dugout ponds; subject to flooding; very slow permeability; fair suitability.	Impervious; fair stability on flat slopes; poor compaction and workability; high shrink-swell potential; fair to poor suitability.	Very slow permeability and high water table; limitations very poor.	Surface ditches are needed across predominant slopes.	Water intake rate varies with amount of vertical cracking; high available water holding capacity; very slow permeability; difficult to obtain suitable drainage.	Not needed due to topography.	Not needed due to topography.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Zook (Zo)	Not suitable	Not suitable	Not suitable	Unsuitable; high shrink-swell potential; bearing capacity reduced when wet; highly elastic; difficult to compact properly.	Level to depressed topography; high organic content in upper layers; high water table; poor potential as borrow; poor foundation for high fills.	Poor bearing capacity and shear strength; medium to high compressibility; high water table; high shrink-swell potential; limitations severe.

TABLE 6.—*Engineering test data [1] for soil*

Soil name and location	Parent material	Iowa report No.	Depth	Moisture-density [2]		Mechanical analysis [3]		
				Maximum dry density	Optimum moisture	Percentage passing sieve—		
						1-in.	¾-in.	⅜-in.
			Inches	*Lb. per cu. ft.*	*Percent*			
Clarinda silty clay loam: 700 feet west and 240 feet south of NE. corner, NW¼, section 24, T. 69 N., R. 22 W.	Yarmouth-Sangamon paleosol (glacial till).	AAD9-7490	0–5	93	24			
		AAD9-7491	19–34	98	22			
		AAD9-7492	47–67	113	16			
Gara loam: 270 feet south and 420 feet west of center of NW¼, section 23, T. 67 N., R. 23 W.	Glacial till.	AAD2-304	0–7	108	15	100	99	98
		AAD2-305	17–24	108	18			
		AAD2-306	45–60	112	15	100	97	97
Lamoni silty clay loam: 110 feet east and 72 feet south of NW. corner of NW¼ NE¼, section 22, T. 70 N., R. 22 W.	Yarmouth-Sangamon paleosol (glacial till).	AAD2-301	0–6	98	20			
		AAD2-302	19–28	104	18			
		AAD2-303	48–60	109	14			
Seymour silt loam: 342 feet west and 497 feet south of NE. corner, SW¼, section 3, T. 68 N., R. 20 W.	Wisconsin loess.	AAD3-1244	0–15	97	21			
		AAD3-1245	15–36	94	24			
		AAD3-1246	36–54	101	19			

[1] Tests performed by the Iowa State Highway Commission in accordance with standard procedures of the American Association of State Highway Officials (AASHO).

[2] Based on AASHO Designation: T 99–57, Method A(*1*).

[3] Mechanical analyses according to the AASHO Designation T 88. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, teh fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material,

interpretations—Continued

Soil features affecting—Continued						
Farm ponds		Septic tank disposal field	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Suitable sites unlikely; level to depressed topography; subject to flooding; very slow permeability; fair suitability.	Impervious material; low stability when wet; poor compaction; high shrink-swell potential; fair to poor suitability.	Slow permeability and subject to flooding; limitations very poor.	Tile may not drain all areas satisfactorily; proper spacing and depth are important; most areas need flood protection.	Intake rate varies with amount of vertical cracking; high available water holding capacity; requires drainage before irrigation.	Terraces not needed due to topography; diversions properly placed can improve wetness and reduce siltation.	Not needed due to topography.

samples taken from selected soil profiles

Mechanical analysis [3]—Continued									Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued					Percentage smaller than—						AASHO [4]	Unified [5]
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.	0.001 mm.				
---------	100	99	95	88	82	35	27	20	46	20	A-7-6(16)	CL.
---------	100	98	95	88	84	56	51	47	66	40	A-7-6(20)	CH.
100	99	96	91	79	73	44	38	35	52	32	A-7-6(18)	CH.
98	97	90	78	53	45	16	12	7	29	10	A-4(4)	CL.
100	99	89	78	61	54	36	33	30	44	24	A-7-6(11)	CL.
97	96	90	85	70	63	37	32	27	43	27	A-7-6(14)	CL.
---------	100	94	87	75	67	34	28	26	41	17	A-7-6(11)	ML-CL.[6]
100	99	95	90	76	72	45	41	37	55	32	A-7-6(19)	CH.
100	99	94	89	72	62	40	35	31	45	27	A-7-6(15)	CL.
---------	100	99	98	97	95	32	23	15	39	16	A-6(10)	CL.
---------	100	98	98	97	93	53	45	39	66	41	A-7-6(20)	CH.
---------	100	99	99	98	95	46	38	33	57	37	A-7-6(19)	CH.

including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

[4] Based on AASHO Designation: M 145–49 (*1*).

[5] Based on the Unified Soil Classification System (*19*).

[6] Soil Conservation Service and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within 2 points from A-line are to be given a borderline classification.

In the soils derived from loess, the seasonal high water table generally is above the contact of the loess and the highly weathered glacial till, which is called gumbotil. In the nearly level soils, such as the Edina and Haig, a perched water table occurs above the B horizon in spring and in other wet periods. In these soils, the density of the loess in place is fairly low and the moisture content is high. The moisture may cause instability in embankments unless it is controlled enough to permit the soil to be compacted to high density.

Underlying the loess is weathered Kansan till that is fairly uniform and of poor quality for construction work. In the nearly level to gently rolling uplands, this till is the remains of the original Kansan till plains. The upper layer is very plastic clay, or gumbotil, and is classified as A-7-6(20). It is not stable enough to be used for highway subgrades, and it should not be used in parts of fills within 5 feet of a finished grade. This plastic clay crops out in sloping areas where the loess is thin. It is the parent material of the Adair and Clarinda soils. The Clarinda soils are not suitable for highway subgrades. The Adair soils have a clayey subsoil and generally are not suitable for highway subgrade. If this clayey material occurs at grade in a roadcut, it should be replaced with a backfill of less weathered glacial till, such as that in the Shelby, Gara, and Lindley soils.

Below these clayey layers is a heterogeneous Kansan till that is classified primarily A-6(CL). This till crops out on the lower part of slopes and is the parent material of the Gara, Shelby, and Lindley soils. If this till occurs in or along grading projects, it normally is placed in the upper subgrade in unstable areas. Pockets and lenses of sand are commonly interspersed throughout the till and in many places are water bearing. Frost heaving is likely if the road grade is only a few feet above these deposits of sand and the deposits are overlain by loess or loamy till. Frost heaving can be prevented by draining these deposits, or by replacing the soil above them with a backfill of coarse-textured material or with good glacial till.

The soils on the bottom lands developed from recent alluvium. Of these soils, the Colo, Wabash, Zook, and Lawson have a thick surface layer that is high in organic-matter content. These soils may consolidate erratically under the load of a heavy embankment. The Zook, Colo, Wabash, Chequest, and Humeston soils are classified A-7 (CH). They have low densities in place and a high content of moisture.

If an embankment is to be more than 15 feet high, these alluvial soils should be carefully analyzed so as to insure that they are strong enough to support the embankment. Roadways through bottom lands should be constructed on continuous embankments that extend above the level of floods.

The bedrock in Wayne County is at such a depth below the glacial and loess deposits that it plays no major part in development of soils, and it is not an important concern in road building. In the northeastern part of the county, along the South Fork Chariton River, limestone, bedrock, and some shale crop out on the steeper slopes.

Conservation engineering [4]

In Wayne County the engineering that is performed for soil conservation consists mainly of building structures for control of erosion, building ponds for better grassland management, and carrying out practices such as drainage and irrigation for increasing productivity.

Erosion Control Structures

Used for controlling erosion in Wayne County are terraces, diversions, grassed waterways, and other structures that help stabilize gullies and hold water. These are discussed in the paragraphs that follow.

Terraces.—A terrace is a ridge and channel built across a slope to intercept runoff and seepage and control erosion. Graded terraces can be used on some soils in Wayne County to discharge runoff water at a nonscouring velocity (fig. 18). Terraces help to control erosion by reducing the length of slope and thus permitting more intensive cultivation of the soils without excessive loss of soil. In the western three townships of the northern tier of townships, the slope can be varied on the Grundy soils so that parallel terraces can be built.

Terracing in Wayne County cannot be used to any great extent, because the subsoil is unfavorable. Except in a few places, soils in the Grundy-Haig soil association area are suitable for a maximum of three terraces. The third terrace is in the Clarinda soils and in some places the second terrace is partly in the Clarinda soils. In most places only two parallel terraces should be used. In the rest of the county the slopes that can be terraced are in the Seymour-Edina soil association. Here one terrace, and in some places a second parallel terrace, generally can be used to keep the water from eroding the Clarinda, Adair, Gara, and Shelby soils on the hillsides while they are being seeded to meadow. In only a few places should terraces be built on slopes of more than 8 percent, be-

[4] By Clarence Beem, area engineer, Soil Conservation Service.

***Figure 18.*—Contour cultivation of soybeans on a graded terrace. The Seymour soils are dominant above the terrace, and the Clarinda soils are dominant below it.**

cause the fine-textured subsoil is exposed in most places on these steeper slopes.

Diversions.—A diversion is a channel built across a slope to intercept surface water and channel it to a safe outlet. Diversions can be used in Wayne County to protect nearly level soils on bottom lands from being flooded by surface runoff from higher lying soils. Soils on bottom land that would benefit by building a diversion upslope are in the Vesser, Zook, and Colo series and in Lawson-Nodaway complex. If meadow is maintained on that part of the hillside between the terraces at the top of the hill and a diversion along the bottom, little soil material will wash into the channel of the diversion.

Grassed waterways and outlets.—A grassed waterway is a channel, covered by grass for protection against erosion, that conducts runoff water away from cropland to a stable outlet. Waterways also provide outlets for graded terraces and diversions. Because most of the waterways in the uplands in Wayne County are subject to erosion, many miles of grassed waterways are needed. Care should be taken to design and construct waterways so that cutting is prevented and grass can be established. In some places grade stabilization structures are needed to hold the water to a nonerosive velocity. Dominant in the waterways in Wayne County are the Olmitz, Vesser, and Colo soils. These soils support good vegetation if fertilizer is added. Because infertile soil materials are exposed during construction and topsoil is lacking, it is necessary in almost all places to use manure and a mulch and to divert the water from the waterway until the seeding is established.

In some areas, particularly in those kept wet by seepage, the waterways need to be drained by tile lines.

Where a waterway is an outlet that leads to a pond, or where an outlet is constructed, Reed canarygrass or a similar grass should be included in the seeding mixture because in some periods a trickle of water is continuous. Where outlets of ponds, diversions, or terraces are to be constructed, a sod should be established before the outlets are built. In some places tile outlets are needed for terraces.

Farm ponds.—Farm ponds are constructed mostly in Lamoni, Shelby, Lindley, and Gara soils. Because establishing grass in the outlet is difficult, a bleeder pipe is needed in some ponds so as to lower the level of the water and eliminate the continuous trickle of water over the outlet.

Drop inlets controlling a head of 10 to 18 feet are commonly used in Wayne County to stabilize waterways. Most of these drop inlets are constructed in areas of the Clarinda, Shelby, and Adair soils.

Earthen dams can be built easily in Wayne County because suitable borrow material is available. This material is generally glacial till or subsoil material derived from glacial till. It normally has a Unified soil classification of CL. In some places soil materials classified CH occur and some soils have pockets of sand.

Impervious earthen fills normally can be built by using a core and by carefully building the fill. Soils classified CH compact to a high density and make good fills, but the downstream toe of the fill and the berm on the backslope should be kept dry by artificial means.

Many ponds in Wayne County help to stabilize the waterways above them, and many drop inlets are built to control erosion and to furnish water for livestock (fig. 19). In many places ponds can be built for grade

***Figure 19.*—A farm pond that is used to water livestock in a pasture. The backslope of the earthen dam to the right is well seeded. Shelby and Clarinda are the dominant soils in the background.**

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***Figure 20.*—This farm pond constructed near a building site furnishes water for livestock and for fire protection.**

stabilization, livestock water, fire protection, and recreation (fig. 20). They are also built to reduce runoff across bottom lands.

Each structure and pond presents different problems. Technical assistance should be obtained before major structures are planned. Such assistance is available through the Wayne County Soil Conservation District.

Drainage and Irrigation

Drainage is the chief engineering conservation practice in Wayne County, though there is some irrigation. These practices are discussed in the paragraphs that follow. Some features that affect the suitability of the soils for these uses are shown in table 5.

Drainage.—Many soils of Wayne County require artificial drainage. The Edina and Haig soils can be improved by surface drains that have outlets leading into an established terrace or waterway. These soils benefit if a land leveler is used in preparing a seedbed.

Tile drainage can be used on the soils on bottom lands in the county. Zook soils can be drained by tile, but drainage by tile is slow in some places. Surface drainage is needed to remove ponded water. Some land grading will be helpful in places. The Colo, Chequest, and Vesser soils benefit from the use of tile. Lawson-Nodaway complex can be tiled, but the tile is not required in many of the areas of the complex if these areas are protected from flooding.

Most areas of the Colo, Chequest, and Vesser soils need protection from overflow. Information on specific depth and spacing can be obtained from the local Soil Conservation office.

Irrigation.—The use of irrigation for farming is limited in Wayne County because the supply of water is inadequate. The flow of streams is small, adequate wells are not available, and reservoirs are generally impractical to build. Table 5 shows the available moisture holding capacity and suitability of the soils for irrigation if water is available.

Formation and Classification of Soils

In this section the factors that affected the formation of the soils in Wayne 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 materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material (*4*).

Climate and vegetation are the active factors in the formation of soil. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into 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 unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material and its geologic origin

Most of the soils in Wayne County developed from glacial till (ice-laid material), loess (windblown material), and alluvium (water-laid material). A few small areas of eolian sands are along South Fork Chariton River. In this county parent material is less effective in developing the general character of the profiles than are the other factors of soil formation.

Glacial till.—In Wayne County the major Pleistocene deposits of pre-Wisconsin age are Nebraskan and Kansan drift (*14*). The Kansan drift is identifiable throughout the county, and on side slopes it forms an extensive part of the landscape. The Nebraskan drift, however, is not readily identifiable on the surface in Wayne County.

In some of the deep road cuts and along some of the major stream valleys, a gumbotil can be seen below the Kansan glacial till. This is called Aftonian gumbotil (*5, 6*). It consists mainly of glacial till made up of coarse fragments in a clay loam matrix. The upper part of this till consists of yellowish-brown material that is oxidized and leached. Below this zone is dark-gray material that is calcareous, contains limestone and dolomite particles, and is neither oxidized nor leached.

Soils developed 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 consisting of gumbotil. This gumbotil remains; it is several feet thick and very slowly permeable. The Clarinda soils developed in this gumbotil and are extensive throughout Wayne County. Because the gumbotil in the Lamoni soils is partly truncated, the clay material is not so thick as that in the Clarinda soils. Geologic erosion has cut below the Yarmouth-Sangamon paleosol and into the Kansan till and older deposits. At the depth to which this erosion has cut, generally there is a stone line or subjacent till that is overlain by pedisediment (*9, 11*). A paleosol formed in the pedisediment stone line and in the subjacent till. The Adair soils formed in this material.

Geologic erosion removed the loess from many slopes and exposed strongly eroded weathered paleosols. In some places the palesols have been leveled or truncated and only the lower part of the strongly weathered materials remains. In other places erosion removed all of the paleosols and exposed till that is only slightly weathered. The period during which erosion cut through below the Yarmouth-Sangamon paleosol is called Late Sangamon (*9, 10*). The material below the paleosols consists of loamy sediments over a stone line that, in turn, is over a highly weathered, clayey, reddish-brown, acid till. Material formed in the Late Sangamon period is exposed on the narrow, slightly lowered interstream divides and on some side slopes.

The Adair soils formed in this Late Sangamon material. The Lineville soils developed where the loamy pedisediment is 2 feet or more thick over the glacial till. The Caleb and Mystic soils formed in pre-Sangamon sediments of valley fills. These sediments are of glacial origin, and they have variable texture (*10*). Caleb and Mystic are of low, stepped interfluves above the present drainage system. They owe their landscape partly to valley fill, but their surface merges with the present erosional uplands. Caleb and Mystic soils are distinctly higher than the soils on the flood plain but are lower than the Gara, Shelby, and Lindley soils, which formed on dissection slopes of Late Wisconsin age. These pre-Sangamon erosional sediments appear to have been angularly truncated in many places. As a result, they generally consist of an irregular mixture of materials that have contrasting textures.

Loess of Wisconsin age covers most of Wayne County and is an extensive parent material (*12, 13*). It consists of accumulated particles of silt and clay that have been deposited by wind. Variations in soils are related to the distance of the soils from the source of loess. The source of loess in Wayne County is probably the Missouri River bottoms in the western part of Iowa (*3*).

On the stable upland divides, the loess is about 8 feet thick. It is slightly thicker in the northwestern part of the county, where Grundy and Haig soils are the dominant loessal soils, than it is in the southeastern part, where the Edina and Seymour soils are the dominant loessal soils. In this county Pershing, Kniffin, and Rathbun soils also were derived from loess. Some of the high benches along the South Fork Chariton River are covered with loess. The loess on these benches contains slightly less clay and slightly more sand than does the loess covering uplands. Along this stream a few deposits of sand are mixed with the loess.

Alluvium consists of sediments that have been removed and laid down by water. As they move, these sediments are sorted to some extent, but they are as well sorted as loess in only a few places. Also, alluvium does not have the wide range of particle sizes that occurs in glacial drift. Because the alluvium in Wayne County is derived from loess and glacial drift, it is largely a mixture of silt and clay, of silt and sand, or of sand and gravel. The coarse sand and gravel generally occur only in the pre-Sangamon alluvial sediments in the stream benches. Sediments accumulated at the foot of the slope on which they originated are called colluvium or local alluvium.

Alluvial sediments are the parent materials for the soils on flood plains, on terraces, and along drainageways. As the river overflows its channels and the water spreads over the flood plains, coarse-textured materials such as the sand and coarse silt are deposited first. As the flooding water continues to spread, it moves more slowly, and finer textured sediments are deposited. After the flood has passed, the finest particles, or clay, settle from the water that is left standing in the lowest part of the flood plain.

The Lawson and Nodaway soils commonly occur closest to the stream channel and are coarser textured than the other soils on bottom land. The Vesser and Chequest soils are fairly extensive along the South Fork Chariton River, where commonly they are away from the meanders of the stream. The Colo and Humeston soils occur mainly along the smaller streams in the county. The Wabash and Zook soils commonly occur in the lower part of the bottom land and are the finest textured soils derived from alluvium in the county. The Colo and Vesser soils are widely distributed throughout the county. In some places they developed in local alluvium at the base of upland slopes. The Olmitz soils are the dominant soils developed in local alluvium in the county, and commonly they contain more sand than the other soils developed from alluvium.

Climate

The soils in Wayne County have been developing under a midcontinental, subhumid climate for the past 5,000 years. The morphology and properties of most of the soils indicate that this climate was similar to the present climate. From 6,500 to 16,000 years ago, however, the climate probably was cool and moist and conducive mostly to growth of forest vegetation (*12*, *9*). Lane's pollen study (*7*) indicates that the climate during the Sangamon period of the Pleistocene epoch was cool and moist and conducive to growth of conifers.

The influence of the general climate in a region is modified by local conditions in or near the developing soils. For example, soils on south-facing slopes formed under a microclimate that is warmer and drier than the average climate of nearby areas. The low-lying, poorly drained soils on bottom lands formed under a wetter and colder climate than that in most areas around them. These local differences influence the characteristics of the soil and account for some of the differences among soils in the same general climatic region.

Vegetation

Many changes in climate and vegetation took place in Iowa during the postglacial period (*7*, *9*). Spruce grew on the soils from 12,000 to 8,000 years ago and was followed by coniferous-deciduous forest that lasted until about 6,500 years ago. Then grass began to dominate in the State.

For the past 5,000 years, the soils of Wayne County appear to have been influenced by two main kinds of vegetation, prairie grasses and trees. Big bluestem and little bluestem were the main prairie grasses. The main trees were deciduous, mainly oak, hickory, ash, elm, and maple.

The effects of vegetation on soils similar to those in Wayne County have been studied recently.[5]

Evidence shows that vegetation shifted while soils developed in areas bordering trees and grasses. The morphology of the Pershing, Kniffin, Lineville, and Gara soils reflects the influence of both trees and grasses. The Rathbun and Lindley soils formed under the influence of trees (*8*). Grasses influenced the development of the Grundy, Haig, Seymour, Edina, Shelby, Clarinda, Lamoni, Adair, Olmitz, Colo, Zook, and Wabash soils.

In most places soils formed under trees are lighter colored, are more acid, and have thinner surface layers than soils formed under grasses. The few soils in the county that formed under shifting vegetation or mixed grasses and trees have properties that are intermediate between the properties of soils formed under grasses and those of soils formed under trees.

Relief

Relief is an important cause of differences among soils. It indirectly influences soil development through its effect on drainage. In Wayne County soils range from level to steep. In many areas of the bottom lands the nearly level soils are frequently flooded and have a permanently or periodically high water table. In depressions water soaks into the nearly level soils that are subject to flooding. Much of the rainfall runs off the steep soils.

Level soils occur on the broad upland flats and on the stream bottoms. The steepest soils in the county are generally on the southern and western sides of the 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, the soils in Wayne County that formed where the water table is high have a subsoil that is dominantly grayish. Examples of such soils are the Haig, Wabash, Zook, Chequest, and Edina. The Grundy, Seymour, Pershing, Adair, and similar soils formed where the water table fluctuated and was periodically high. The

[5] These are unpublished Ph.D. theses in the Iowa State University Library, Ames, Iowa. They are—

CARDOSO, J. SEQUENCE RELATIONSHIPS OF CLARION, LESTER, AND HAYDEN SOIL CATENAS. 1957.

CORLISS, J. F. GENESIS OF LOESS-DERIVED SOILS IN SOUTHEASTERN IOWA. 1958.

MCCRACKEN, R. SOIL CLASSIFICATION IN POLK COUNTY, IOWA. 1956.

PRILL, R. VARIATIONS IN FOREST-DERIVED SOILS FORMED FROM KANSAN TILL. 1955.

Gara, Lindley, and other soils developed where the water table was below the subsoil, and their subsoil is yellowish brown. The Haig, Wabash, Colo, Zook, and similar soils that developed under prairie grasses and that have a high water table contain more organic matter in the surface layer than do well-drained soils formed under prairie grasses. Clay accumulates in the subsoil of soils, such as the Edina, that are slightly depressional or nearly level. This is because a large amount of water enters the soils and carries clay particles downward. Edina soils are called claypan soils because a pan forms where the greatest amount of clay accumulates.

A study of Seymour soils was made to determine the effect of the relief on the soils. Tests showed that, from the stable to the unstable slopes, there was an increase in content of clay in the A horizon and a decrease in thickness of the A1 horizon. In the unstable landscape the zone of maximum clay accumulation was at a shallow depth. The Seymour soils on the most stable landscape had some grainy coats in the lower part of the A horizon and the upper part of the B horizon and have more dark clay films in the B2 horizon. This indicates that more soil development has taken place on the most stable kind of landscape.

In the Shelby, Gara, Lindley, and similar soils that have wide slope ranges and many kinds of slopes, depth to carbonate is shallowest where slopes are steepest, are convex, or are most unstable.

Time

The length of time required for a soil to develop 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, only weakly defined ones. Most soils on the flood plains are of this kind because they have not been in place long enough for distinct horizons to develop.

From the steeper soils, material is generally removed 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 may still be immature because much of the water runs off the slopes rather than through the soil material. Ruhe (*9*, *10*) states that the Shelby, Gara, and Lindley soils developed on recently dissected slopes of the Late Wisconsin age. These soils therefore are no older than 11,000 to 14,000 years and probably are much younger.

According to Ruhe and Scholtes (*10*, *11*), the Adair, Lineville, Clarinda, Lamoni, and Mystic are among the oldest soils in the county. The Clarinda and Lamoni soils developed in Kansan glacial till during the Yarmouth-Sangamon period. The Adair, Lineville, and Mystic soils formed from materials deposited during the Late Sangamon interglacial stage. These materials are much older than the loessal parent material of the Edina, Seymour, Pershing, Kniffin, and Rathbun soils. These soils are no older than 14,000 to 16,000 years, and they may be considerably younger (*10*).

Radiocarbon studies of wood fragments and soil organic matter found in the loess and glacial till have made it possible to determine the approximate ages of soils and of the loessal and glacial deposits in Iowa. In Wayne County the loess is thickest in the nearly level soils on stable upland divides, and it is underlain by a Yarmouth-Sangamon paleosol that is on the Kansan till surface. In many places below the stable uplands, there is an organic layer at the base of the loess. Ruhe and others recently studied the loess and organic matter below the solum of the Edina and Haig soils in Wayne County and obtained radiocarbon ages of 19,000 to 20,000 years. The Kansan till surface is 8 feet below the present land surface.

Man's influence on the soil

Important changes take place in the soil when it is cultivated. Some of these changes have little effect on productivity; others have drastic effect.

Changes caused by water erosion generally are the most apparent. On many of the cultivated soils in the county, particularly the gently rolling to hilly ones, part or all of the original surface layer has been lost through sheet erosion. In some places shallow to deep gullies have formed.

In many continuously cultivated fields, the granular structure that was apparent when the grassland was undisturbed is no longer present. In these fields the surface tends to bake and harden when it dries. Fine-textured soils that have been plowed when too wet tend to puddle and are less permeable than similar soils in undisturbed areas.

Man has done much to increase productivity of the soils and to reclaim areas not suitable for crops. He has made large areas of bottom land suitable for cultivation by digging drainage ditches and constructing diversions at the foot of slopes. Broad flats consisting of Edina soils have been greatly improved for cultivation by installing some kind of a drainage system.

By adding commercial fertilizers, man has counteracted deficiencies in plant nutrients and has made some soils more productive than they were in their natural state.

Classification of Soils

Soils are classified so that we may more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationships to one another and to the whole environment, and to develop principles that help us in understanding 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.

Thus, in classification soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and later revised (*16*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in developments of this system should search the latest literature available (*15*, *18*). In table 7 the soil series represented in Wayne County are placed in some categories of the current system and in the great soil groups of the older systems. The classes in the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates.

The three orders in Wayne County are Mollisols, Alfisols, and Entisols. Mollisols have dark-colored surface horizons that have high base saturation and that are at least 1 percent organic matter. They have genetic subsurface horizons that vary in degree of development. In Wayne County this order includes soils previously classified as Brunizems, Humic Gleys, and Planosols.

Alfisols have clay-enriched B horizons that are high in base saturation. In Wayne County this order includes soils that were formerly classified as Gray-Brown Podzolic solis that intergrade to Brunizems.

Entisols have either no natural genetic horizons or only the beginnings of such horizons. The Entisols in Wayne County were formerly classified as Alluvial soils.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of those characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of wetness, or soil differences resulting from the climate or vegetation.

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in kinds and sequences of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown

TABLE 7.—*Soil series classified according to current and old systems of classification*

Series	Current classification			1938 classification
	Family	Subgroup	Order	
Adair	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols	Brunizems.
Caleb	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols	Gray-Brown Podzolic soils intergrading to Brunizems.
Chequest	Fine, montmorillonitic, noncalcareous mesic.	Typic Haplaquolls	Mollisols	Humic Gley soils intergrading to Alluvial soils.
Clarinda	Fine, montmorillonitic, noncalcareous, mesic, sloping.	Vertic Argiaquolls	Mollisols	Humic Gley soils.
Colo	Fine-silty, mixed, noncalcareous, mesic.	Cumulic Haplaquolls	Mollisols	Humic Gley soils intergrading to Alluvial soils.
Edina	Fine, montmorillonitic, mesic	Typic Argialbolls	Mollisols	Planosols.
Gara	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols	Gray-Brown Podzolic soils intergrading to Brunizems.
Grundy	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols	Brunizems.
Haig	Fine, montmorillonitic, noncalcareous, mesic.	Typic Argiaquolls	Mollisols	Humic Gley soils.
Humeston	Fine, montmorillonitic, mesic	Argiaquic Argialbolls	Mollisols	Planosols.
Kniffin	Fine, montmorillonitic, mesic	Udollic Ochraqualfs	Alfisols	Gray-Brown Podzolic soils intergrading to Brunizems.
Lamoni	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols	Brunizems.
Lawson	Fine-silty, mixed, mesic	Aquic Cumulic Hapludolls.	Mollisols	Brunizems intergrading to Alluvial soils.
Lindley	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols	Gray-Brown Podzolic soils.
Lineville	Fine-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols	Gray-Brown Podzolic soils intergrading to Brunizems.
Mystic	Fine, montmorillonitic, mesic	Aquollic Hapludalfs	Alfisols	Gray-Brown Podzolic soils intergrading to Brunizems.
Nodaway	Fine-silty, mixed, nonacid, mesic	Typic Udifluvents	Entisols	Alluvial soils.
Olmitz	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols	Brunizems.
Pershing	Fine, montmorillonitic, mesic	Udollic Ochraqualfs	Alfisols	Gray-Brown Podzolic soils intergrading to Brunizems.
Rathbun	Fine, montmorillonitic, mesic	Aeric Ochraqualfs	Alfisols	Gray-Brown Podzolic soils.
Seymour	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols	Brunizems.
Shelby	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols	Brunizems.
Vesser	Fine-silty, mixed, mesic	Argiaquic Argialbolls	Mollisols	Planosols.
Wabash	Fine, montmorillonitic, noncalcareous, mesic.	Vertic Haplaquolls	Mollisols	Humic Gley soils.
Zook	Fine, montmorillonitic, noncalcareous, mesic.	Cumulic Haplaquolls	Mollisols	Humic Gley soils.

separately in table 7, 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 may 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.

FAMILY: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. An example is the fine-loamy, mixed, mesic family of Typic Hapludalfs.

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 soil, are similar in differentiating characteristics and in arrangement in the profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

New soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until review of the series concept at National, State, and regional levels of responsibility for soil classification results in a judgment that the new series should be established. Most of the soil series described in this publication have been established earlier. Seven of the soil series used in this survey had tentative status when the survey was sent to the printer. They are the Caleb, Kniffin, Lamoni, Lineville, Mystic, Vesser, and Rathbun series.

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Glossary

Acidity. (See Reaction.)

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available moisture capacity. The difference between the amount of water in a soil at field capacity, and the amount in the same soil at the permanent wilting point. Commonly expressed as inches of water per inch of soil depth. (Also called moisture-holding capacity or water-holding capacity.)

Bench position. A high, shelflike position.

Bottom land. The normal flood plain of a stream and the old alluvium plain that is seldom flooded. (See Bottoms, first.)

Bottoms, first. The normal flood plain of a stream; land along the stream subject to overflow.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

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 films. A thin coating of clay on the surface of a soil aggregate. Synonyms: Clay coat, clay skin.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour tillage. Cultivation that follows the contour of the land, generally almost at right angles to the slope.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Friable. (See Consistence, soil.)

Gumbotil. Leached deoxidized clay containing siliceous stones; the product of thorough chemical decomposition of clay-rich till.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major soil horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

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 by (1) accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon; or (4) some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Leaching, soil. The removal of materials in solution by the passage of water through the soil.

Parent material. The weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

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 rocks or sediment of the upland, is barren or mantled with alluvium, and displays a longitudinal profile, normally concave upward.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Reaction. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour" soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words the degree of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Sand. As a soil separate, individual rock or mineral fragments ranging from 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but they may be any mineral composition. As a textural class, 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 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 parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops); *blocky* (angular or subangular), and *granular.* Structureless soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (structural). An enbankment or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so that they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also clay, sand, and silt.) The basic textural classes, in order of increasing proportions of fine particles are as follows: sand, loamy sand, sandy loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water-holding capacity. (See Available moisture capacity.)

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