SOIL SURVEY OF

Harrison County, Iowa

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

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1963–69. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1969. This survey was made cooperatively by the Soil Conservation Service, the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa. Funds appropriated by Harrison County were used to defray part of the cost. This survey is part of the technical assistance furnished to the Harrison County Soil Conservation District.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in numerical order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the capability unit to which the soil has been assigned.

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

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

Foresters, game managers, sportsmen, and others concerned with woodland, wildlife, and recreation can find information in the sections "Woodland," "Wildlife," and "Recreation."

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

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

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

Cover: **Floodwater retarding structure in Mill-Picayune Watershed on Monona-Ida-Napier soil association provides flood protection for the town of Dunlap and recreation for area residents.**

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SOIL SURVEY OF HARRISON COUNTY, IOWA

BY WILBUR M. JURY AND CHARLES S. FISHER

FIELDWORK BY WILBUR M. JURY, JEROME A. KOSTER, IVAL D. PERSINGER, AND ROBERT L. WARREN, SOIL CONSERVATION SERVICE

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

HARRISON COUNTY is in western Iowa. It is in the fourth tier of counties north of the Missouri border and is bounded on the west by the Missouri River, which is also the approximate Iowa-Nebraska boundary (fig. 1). It has an area of about 696 square miles, or 445,310 acres. Logan, the county seat, is about 35 miles northeast of Council Bluffs and 30 miles southwest of Denison.

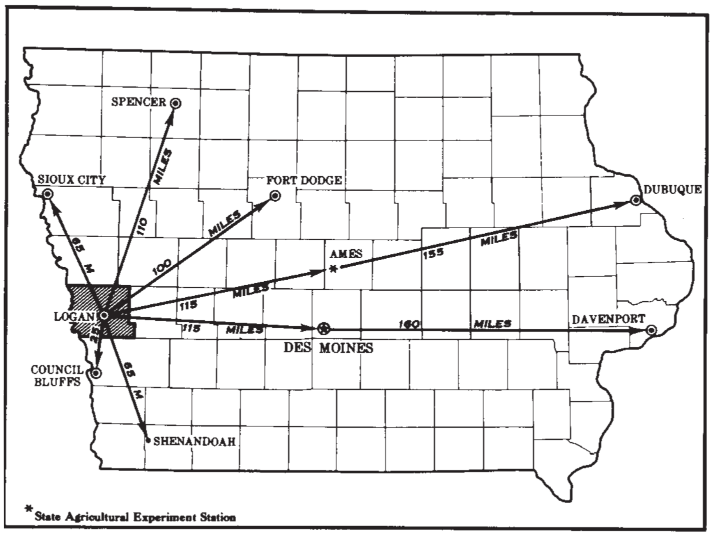

Figure 1.—**Location of Harrison County in Iowa.**

The county is chiefly rural. The principal crops wheat and popcorn are also grown. Livestock, dominantly beef cattle and hogs, are raised on many farms. grown are corn, oats, soybeans, hay, and pasture. Some

Much of the uplands of Harrison County are in organized watersheds. Harmony watershed was the first in Iowa for which the required land treatment and structures were completed.

How This Survey Was Made

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

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

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

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Monona silt loam, 9 to 14 percent slopes, moderately eroded, is one of several phases within the Monona series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication 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 the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Harrison County: soil complexes and undifferentiated groups.

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

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Blake and Haynie soils is an example.

In most areas surveyed, there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Riverwash is a land type in Harrison County.

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 soil. 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 such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

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

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

The six soil associations in Harrison County are described on the following pages. The terms for texture used in the title for several of the associations apply to the surface layer. For example, in the title for association 1, the words "sandy, loamy, and clayey" refer to texture of the surface layer.

The general soil map of Harrison County does not precisely join that of neighboring Shelby County because the pattern of soils changes near the county line. Marshall soils, mapped on ridgetops in Shelby County, were not mapped in Harrison County. The general soil map of Harrison County does not exactly join the general soil map of neighboring Monona County mainly because the detail shown on the maps and the names of the associations differ.

1. Sarpy-Albaton-Carr association

Excessively drained and poorly drained, nearly level to gently undulating, stratified sandy, loamy, and clayey soils on bottom lands of the Missouri River

The soils in this association are mainly nearly level, but in many places they are gently undulating and are in swales and depressions (fig. 2). These soils formed in alluvium deposited by the Missouri River.

This association makes up only about 2 percent of the county. It is about 50 percent Sarpy soils, 18 percent Albaton soils, 12 percent Carr soils, and 20 percent less extensive soils.

Sarpy soils are excessively drained and nearly level and gently undulating. In many places they are hummocky and contain blowouts. They are mainly stratified fine sand throughout, but some have a surface layer of fine sandy loam about 10 inches thick. The surface layer is very dark grayish brown or dark grayish brown. The material below the surface layer is generally grayish brown.

Albaton soils are lower on the landscape than the other major soils in the association. They are mainly

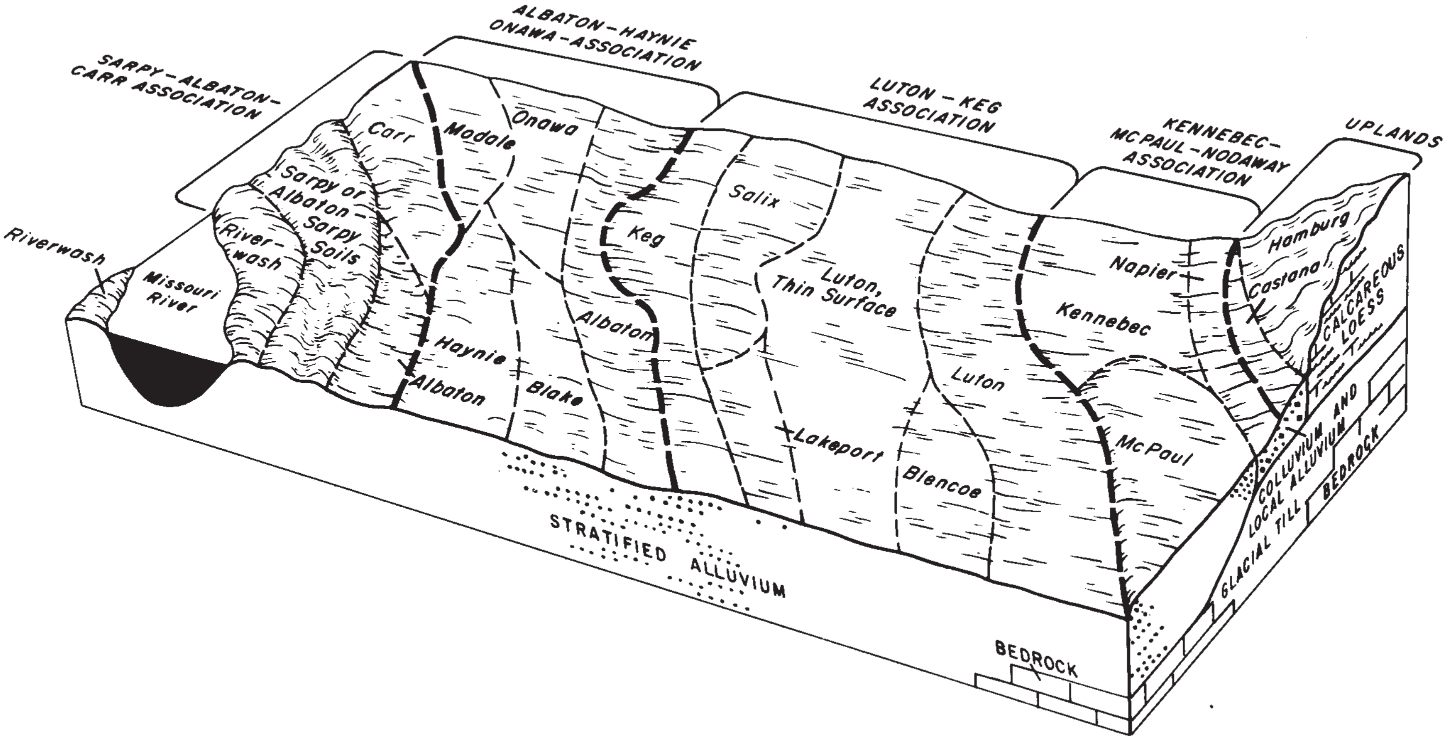

Figure 2.—Typical pattern of soils and parent material on bottom land along the Missouri River.

nearly level or in slight depressions and swales and are poorly drained. Albaton soils are mainly silty clay or clay throughout, but some have about 5 to 15 inches of silt loam overwash on the surface. They have a very dark grayish-brown, very dark gray, or dark grayish-brown surface layer and are generally dark grayish brown below.

Carr soils are nearly level and excessively drained. Typically the surface layer, about 8 inches thick, is dark grayish-brown very fine sandy loam. Beneath this is stratified grayish-brown very fine sandy loam that grades to loamy fine sand and fine sand at a depth of about 30 inches.

Less extensive are Onawa, Haynie, Kenmoor, Grable, and Modale soils and old lakes and oxbows, which are ponded much of the time. These soils mainly are nearly level, but in places Onawa soils are in slight depressions or swales.

Soils that have been cleared of timber and brush are farmed intensively. Some are irrigated. Corn and soybeans are the main crops. The trend in recent years has been to clear areas suitable for cultivation. Much of the land nearest the Missouri River, however, is in trees, brush, and grass and is used as pasture or is wasteland. Some of the soils in this association are wet. Flooding is a hazard in many places. The sandy soils are droughty and subject to soil blowing.

Few livestock are raised in the area, but some beef cattle are pastured. There are few farmsteads in the association and few improved roads. Farm fields are generally reached by field lanes.

2. *Albaton-Haynie-Onawa association*

Well drained to poorly drained, nearly level silty and clayey soils on bottom lands of the Missouri River

The soils in this association are mainly nearly level, but in places they are in somewhat depressed old oxbows or swales. A few old oxbows are ponded most or all of the time. A typical area is about 2 miles west of California Junction on both sides of U. S. Highway 30. These soils formed in alluvium deposited by the Missouri River.

This association makes up about 10 percent of the county. It is about 40 percent Albaton soils, 21 percent Haynie soils, 16 percent Onawa soils, and 23 percent less extensive soils.

Albaton soils are typically lower on the landscape than the other major soils in the association. They are mainly nearly level or are in slight depressions or swales and are poorly drained. They are mainly silty clay or clay throughout, but some have about 6 to 15 inches of silt loam overwash on the surface. They have a very dark grayish-brown, very dark gray, or dark grayish-brown surface layer and are generally dark grayish brown below.

Haynie soils are well drained and moderately well drained. Most areas are broad, nearly level, and are at slightly higher elevations on the landscape than other major soils in the association. Haynie soils are silt loam throughout. They have a very dark grayish-brown or dark grayish-brown surface layer and are mainly stratified dark grayish brown and grayish brown below.

Onawa soils are somewhat poorly drained and poorly drained. They are nearly level or occupy slightly depressed swales. They are silty clay to a depth of about 2 feet and silt loam below this, but some have about 6 to 15 inches of silt loam overwash on the surface. Onawa soils typically have a very dark grayish-brown surface layer and are mainly dark grayish brown below.

Less extensive in the association are Blake, Grable, Percival, Vore, and Modale soils. All are nearly level. Most are at slightly higher elevations than the Albaton or Onawa soils but are similar in position to Haynie soils.

The soils of this association are mostly cultivated. Corn and soybeans are the main crops, but wheat is grown. The major concern in management is providing drainage for the wet soils. Drainage ditches and land leveling are needed. Droughtiness and soil blowing are hazards on some of the less extensive soils. The hazard of flooding is slight.

Few livestock are raised on this soil association. Most farms are of the cash-grain type. There are some farmsteads in the association, but because the trend is toward larger farms, they are becoming fewer in number.

In some parts of the association roads are on the section lines. In many places fields are reached by field lanes.

3. Luton-Keg association

Well drained to very poorly drained, nearly level silty and clayey soils on bottom lands of the Missouri River

This association makes up about 13 percent of the county. It is about 58 percent Luton soils, 10 precent Keg soils, and 32 percent less extensive soils. A typical area is along Interstate Highway 29 from its intersection with U.S. Highway 30 north to Modale. The soils in this association formed in alluvium. The alluvium had been in place long enough that the soils formed a dark-colored and, in places, a thick surface layer.

Luton soils are nearly level and in some areas slightly depressional. They are poorly drained and very poorly drained. The surface layer is mainly black but grades to very dark gray in the lower part. The subsoil is mottled dark gray and gray. The soils are silty clay or clay, but in places have about 6 to 15 inches of very dark grayish-brown or dark grayish-brown silt loam overwash on the surface.

Keg soils are nearly level, well drained and moderately well drained, and are typically somewhat higher on the landscape than Luton soils. They have a black and very dark brown surface layer and a dark grayish-brown and brown subsoil. They are silt loam throughout.

Less extensive in this association are the Salix, Blencoe, Blend, Woodbury, Lakeport, Forney, and Solomon soils. Salix and Lakeport soils are at slightly lower elevations than Keg soils. Except for Solomon soils, the rest are typically lower than those soils, but somewhat higher on the landscape than Luton soils. Solomon soils are somewhat lower than Luton soils.

Almost all this association is cultivated. Corn and soybeans are the main crops. Some wheat is grown, mainly on the finest textured, very poorly drained soils (fig. 3). The major concern in management is providing drainage for the wet soils. Drainage ditches and land leveling are needed. If drainage is inadequate during wet periods, wetness delays tillage and replanting is necessary. During very dry weather and high winds in spring, soil blowing is a hazard.

Most farms in this association are of the cash-grain type. Livestock is kept on some farms, but is of minor importance as a source of income. Most farmsteads are on the higher lying Keg, Salix, or Lakeport soils.

Roads are mainly on section lines. A few are on half-mile lines.

4. Kennebec-McPaul-Nodaway association

Moderately well drained and well drained, nearly level silty soils on bottom lands

This association is mainly along streams other than the Missouri River, but one area about ½ to 2 miles wide is on the eastern part of the Missouri River bottom land. The soils are nearly level. An area typical of this association is along the Boyer River near Woodbine. These soils formed in alluvium (fig. 4).

This soil association makes up about 9 percent of the county. It is about 36 percent Kennebec soils, 28 percent McPaul soils, 20 percent Nodaway soils, and 16 percent less extensive soils.

Kennebec soils are silt loam throughout and are moderately well drained. They have a thick, black or very dark brown surface layer and are very dark brown or very dark grayish brown below. About half the acreage of Kennebec soils has 6 to 15 inches of very dark grayish-brown or dark grayish-brown overwash on the surface.

Along the eastern edge of the Missouri River bottom lands, McPaul soils are in desilting basins at the mouths of streams, along ditches, or in other places where sediment from adjacent uplands has been deposited. Here, in most places, McPaul soils occupy more acreage than other soils in the association. On other bottom lands they are in places where recent sediment has been deposited in upland drainageways and along smaller streams. McPaul soils are well drained and moderately well drained. They are calcaleous silt loam throughout, and stratification is evident. They have a very dark grayish-brown or dark grayish-brown surface layer and are dark grayish brown below.

Nodaway soils are moderately well drained and in many places are nearest the stream channels. They occupy only a small acreage along the eastern part of the Missouri bottom land. They are stratified and are silt loam throughout. They typically have a surface layer of very dark grayish brown. Below the surface layer they are mainly dark grayish brown with strata of grayish brown, dark gray, and very dark grayish brown. In many places black silt loam, once the surface layer of a now buried soil, is at a depth of about 3 feet.

Less extensive in this association are Colo, Moville,

Figure 3.—**Wheat on Luton silty clay. Drainage ditches are characteristic of this association.**

Monona, and Napier soils. In many places Colo soils are at some distance from the stream channels. Moville soils are in places where recently deposited silt loam alluvium has buried a black silty clay soil. Monona soils are on benches that are higher on the landscape than the adjacent bottom lands. Napier soils are mainly on foot slopes.

Most areas of this association are cultivated. Corn and soybeans are the main crops. Some small grain and meadow are grown, but are of minor extent. Occasional flooding early in spring before crops are planted is a hazard along most of the streams. In most places, however, the hazard is not severe enough to discourage intensive row cropping. In many places streams have been straightened, and in places dikes have been built for flood protection (fig. 5). A few of the less extensive soils are wet unless they are adequately drained.

Many farms are partly on this association and partly on foot slopes or uplands adjacent to the bottom lands. Farms wholly in this association are mainly of the cash-grain type. Most of those partly on uplands are of the general type, where some livestock are raised.

Roads do not generally follow section lines. They are generally on the bordering foot slopes at the edges of the valley and in places parallel to the streams. Stream crossings are some distance apart, particularly on the larger, wider river bottoms.

5. *Hamburg-Ida-Monona association*

Somewhat excessively drained and well drained, moderately sloping to very steep silty soils on uplands

This association is on the bluffs at the eastern edge of the Missouri River bottom lands (fig. 6). The bluffs are characterized by narrow rounded ridgetops, long steep or very steep side slopes, and numerous deep gullies (fig. 7). Typical areas are east of State Highway 183 north of the town of Missouri Valley. These soils formed in loess.

This association makes up only about 2 percent of the county. It is about 55 percent Hamburg soils, 25 percent Ida soils, 10 percent Monona soils, and 10 percent less extensive soils.

Hamburg soils are very steep and are prominent where they face the Missouri River Valley. They are somewhat excessively drained. They have characteristic small slump blocks called "catsteps." They are cal-

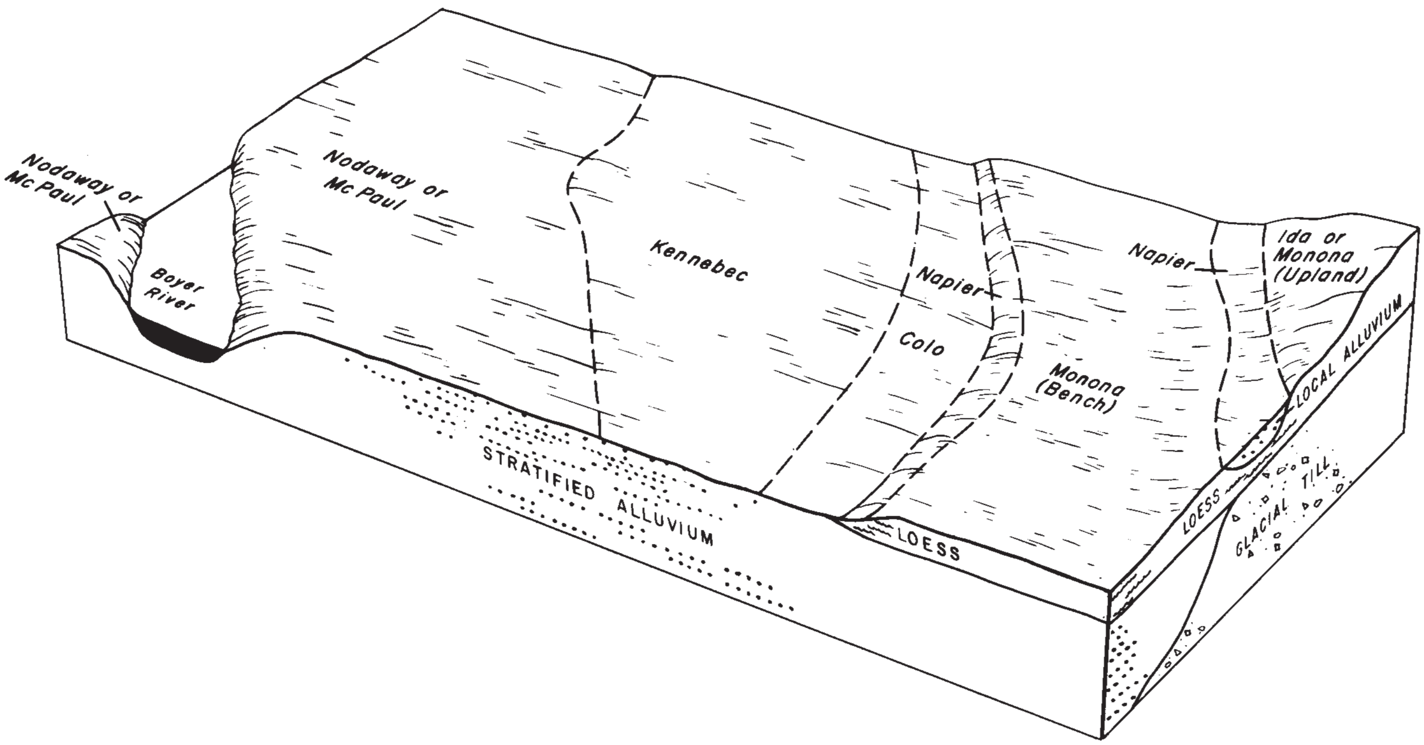

***Figure 4.*—Typical pattern of soils and parent material in the Kennebec-McPaul-Nodaway soil association.**

careous coarse silt loam throughout. They have a thin, brown surface layer and are yellowish brown below.

Ida soils are mainly steep on side slopes, but are strongly sloping or moderately steep on ridgetops. They are well drained. They are calcareous silt loam throughout. Typically they have a thin, very dark grayish-brown to brown surface layer and are yellowish brown below.

Monona soils are moderately sloping on narrow ridgetops and are moderately steep or steep on side slopes. They are well drained. They typically have a very dark brown surface layer and brown subsoil and are silt loam throughout.

Less extensive in this association are mainly Napier and Castana soils. Napier soils are along the small streams, gullies, and drainageways. Castana soils are on foot slopes, mainly at elevations below Hamburg soils, but in places at elevations below the Ida soils.

Most of this association supports grass and trees and is used as permanent pasture (fig. 8). Some ridgetops and less steep side slopes and some areas along drainageways and small streams are cultivated. Controlling erosion and gullying is a major management need.

General livestock farming is common in this association. Many farms extend into adjacent soil associations. This association has a larger acreage in pasture than other associations in the county, and therefore more beef cowherds. Many farmsteads have been abandoned, and the farm buildings are used for storage of hay or grain. Roads tend to follow ridgetops or drainageways or streams and are fewer in number than in some of the other associations.

6. Monona-Ida-Napier association

Well-drained, nearly level to steep silty soils on uplands

This association is characterized by nearly level to moderately sloping ridgetops and moderately sloping to steep side slopes. It is dissected by numerous drains, in which gullies are common. Typical areas are in the uplands west or east of the Boyer River Valley, between Dunlap and Logan. The soils formed in loess and local alluvium.

This association, the largest in the county, makes up about 64 percent of the total acreage. It is about 35 percent Monona soils (fig. 9), 30 percent Ida soils, 25 percent Napier soils, and 10 percent less extensive soils.

Monona soils typically have a very dark brown surface layer and brown subsoil and are silt loam throughout. They are on the tops and sides of ridges and are mainly gently sloping to steep. A few areas of nearly level Monona soils are on broad upland divides.

Ida soils are mainly strongly sloping or moderately steep and are on side slopes. They are silt loam and calcareous throughout. They have a thin, very dark grayish-brown to brown surface layer and are yellowish brown below.

Napier soils are gently sloping to strongly sloping. They are in most of the narrow drainageways and also on foot slopes and alluvial fans. They typically

Figure 5.—**Willow Creek in soil association 4.**

have a thick, black and very dark brown surface layer and a dark-brown and brown subsoil.

The less extensive soils in this association are mainly soils of the narrow stream valleys. Of these, Kennebec, McPaul, and Nodaway are the most extensive. Gullied land and Nodaway and Colo soils occur in intricate patterns with Napier soils. Steinauer soils are on the lower slopes.

Many soils of this association are suited to crops. Corn, soybeans, small grain, and hay are commonly grown in rotation. The steeper soils are in hay or pasture. Some are timbered, but most are used as pasture. Controlling erosion and gullying (fig. 10) is a major management need. Maintaining the level of fertility is also important.

Most farming in this association is of the general type. Raising and fattening beef cattle is fairly extensize. Much of the hay and grain produced is marketed through livestock. Some farmsteads have been abandoned and are used mainly for storing grain and hay.

Roads are mainly on section lines. Some are on the half-mile lines. In some highly dissected areas, roads follow ridge crests or parallel foot slopes.

Descriptions of the Soils

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

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, the colors mentioned in the description are those of a moist soil.

As mentioned in the section "How This Survey Was Made," not all mapping units are of a soil series. Riverwash, for example, does not belong to a soil

Figure 6.—**Hamburg soils on steep bluffs. Soils on the adjacent Missouri River bottom land are mainly McPaul and Luton soils.**

series, but nevertheless, is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit to which the mapping unit has been assigned. The page for the description of each capability unit can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*26*).[1]

Albaton Series

The Albaton series consists of nearly level, poorly drained soils on the Missouri River bottom land. These soils are on broad, low areas paralleling, and within a few miles of, the Missouri River. Many areas occur along and in old river channels or meanders. These soils formed in alluvium.

In a representative profile the surface layer is very dark grayish-brown silty clay about 8 inches thick. The substratum is dark grayish-brown, dark-gray, and olive-gray, firm silty clay mottled with brown and yellowish brown.

These soils are low in organic-matter content and are typically mildly alkaline and calcareous throughout. Permeability is very slow or slow. Available water capacity is moderate. The supply of available phosphorus is very low. The supply of available potassium is high.

Wetness is a major limitation, and some areas are ponded after rains. Before construction of large dams and levees, these soils were subject to flooding. Now, in most areas, the hazard of flooding is slight. Only some areas nearest the river, mapped as Albaton and Sarpy soils, are subject to flooding. Most of the acreage is used for crops. A few low-lying areas are in pasture or trees.

Representative profile of Albaton silty clay in a cultivated field 410 feet north and 110 feet east of the southwest corner of NE¼NW¼ sec. 9, T. 78 N., R. 45 W.:

[1] Italic numbers in parentheses refer to Literature Cited, p. 87.

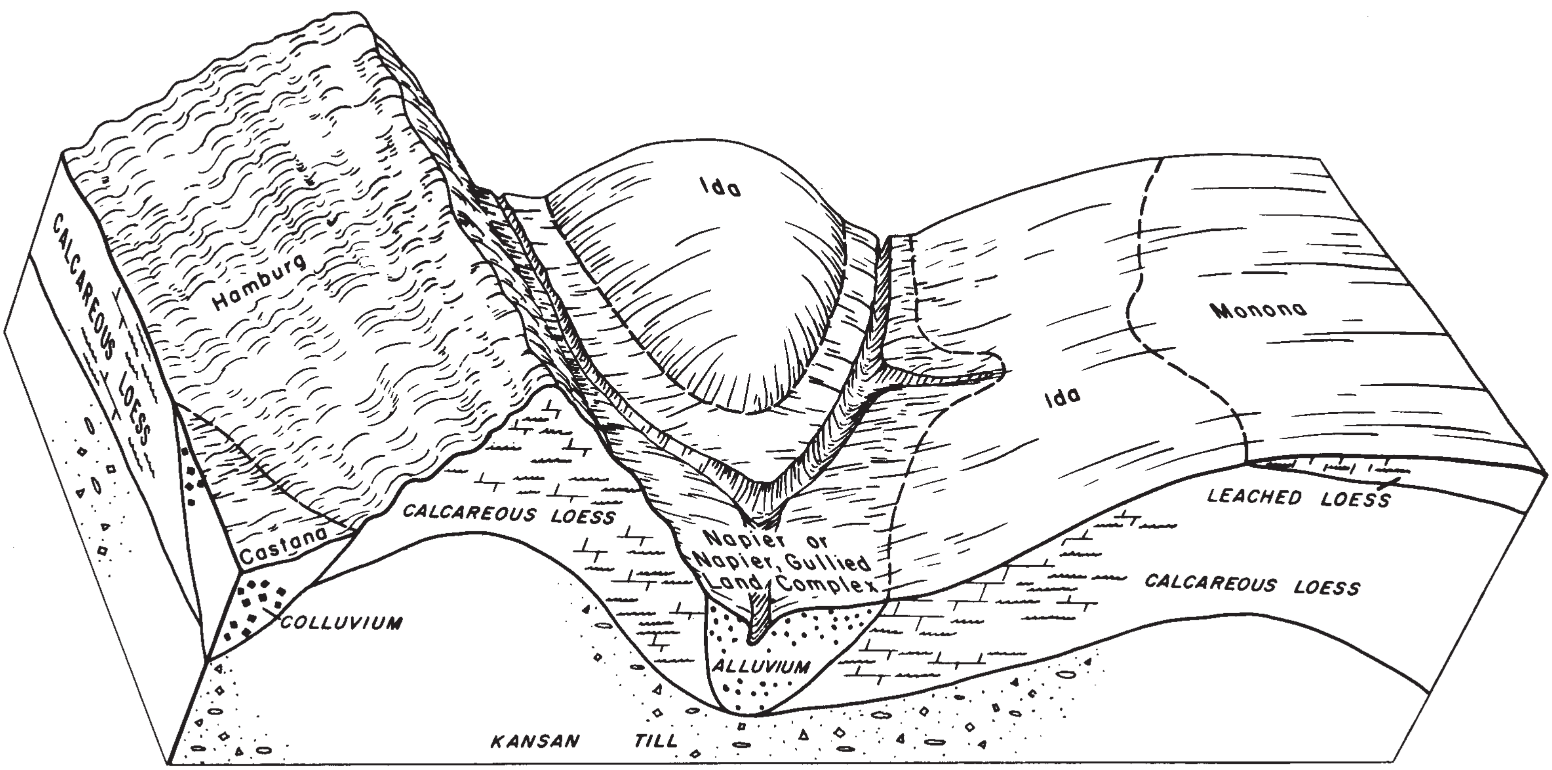

***Figure 7.*—Typical pattern of soils and parent material in Hamburg-Ida-Monona soil association.**

Ap—0 to 8 inches, very dark grayish-brown (2.5Y 3/2) silty clay; common, fine, faint, grayish-brown (2.5Y 5/2) mottles; weak, very fine, angular blocky structure and moderate, fine, subangular blocky; firm; few dark-brown (7.5YR 3/2) root stains; few fine dark oxides; mildly alkaline, strongly effervescent; clear, smooth boundary.

Cg—8 to 60 inches, dark grayish-brown (2.5Y 4/2), dark-gray (5Y 4/1), and olive-gray (5Y 5/3) silty clay; few, fine, distinct, brown (7.5YR 4/4) and yellowish-brown (10YR 5/4) mottles; moderate, fine, angular blocky structure; some horizontal cleavage; firm; few fine pores; few dark oxides; shiny coatings on most ped faces; mildly alkaline, strongly effervescent.

The A horizon is typically a plow layer 6 to 10 inches thick and ranges from very dark grayish brown (2.5Y 3/2) or very dark gray (10YR 3/1) to dark grayish brown (2.5Y 4/2). The Cg horizon is generally dark grayish brown (2.5Y 4/2) or olive gray (5Y 4/2), but ranges to olive gray (5Y 5/2), dark gray (N 4/0 or 5Y 4/1), and gray (5Y 5/1). In a few places, strata less than 10 inches thick that are black (10YR 2/1) or very dark gray (10YR 3/1 or N 3/0) are in the Cg horizon. Few to common mottles occur. They are in 5YR, 7.5YR, or 10YR hue and range in value from 3 through 6 and in chroma from 2 through 6. Albaton soils are typically silty clay or clay. Albaton silt loam has 6 to 15 inches of silt loam over the silty clay or clay. In places the Cg horizon has coarser textured strata less than 6 inches thick. Albaton soils are mildly alkaline or moderately alkaline throughout and generally are calcareous, but in places the Ap or A1 horizon is not calcareous.

Albaton soils formed in similar material and are associated on the landscape with the Onawa soils, but are more clayey in the C horizon. They are similar in texture to Luton soils, but are lighter colored in the A horizon, contain less organic matter, and are more alkaline.

Albaton silt loam (0 to 2 percent slopes) (157).—This soil is on bottom land. In most places it is associated with Albaton silty clay, or with Blake, Onawa, or Haynie soils. Areas range from a few acres to about 160 acres in size.

This soil is similar to the one described as representative of the series, but it has 6 to 15 inches of stratified, very dark grayish-brown or dark grayish-brown silt loam overwash on the surface. Recent floods from the Missouri River or adjacent drainage ditches have deposited these sediments.

Areas of Onawa and Blake soils are included with this soil in mapping. Also included is about 50 acres of a soil that has a buried silt loam layer 6 to 14 inches thick beginning at a depth of about 2 feet, and a thin dark layer below this depth that was once the surface layer of the now buried soil.

This Albaton soil is moderately well suited to row crops. It is wet, and poor internal drainage often limits yields. Soil tilth is generally good. This soil is easier to till and dries out sooner after rains than Albaton silty clay. Most of the acreage is cultivated. The rest is pastured or wooded. Capability unit IIIw-1.

Albaton silty clay (0 to 2 percent slopes) (156).—This soil is on bottom land and in places it is in depressions that were old channels or bayous. It is typically a little lower on the landscape than the associated Blake, Ona-

***Figure 8.*—Wooded pasture in Hamburg-Ida-Monona soil association.**

wa, Haynie, and Percival soils. It is also associated with Albaton silt loam, and in places with Carr or Sarpy soils. Individual areas range to as much as 640 acres or more. This Albaton soil has the profile described as representative of the series. Included in mapping is about 550 acres of a soil that has a buried silt loam layer 6 to 14 inches thick beginning at a depth of about 2 feet, and a thin dark layer below this depth that was once the surface layer of the now buried soil. Also included are small areas of Onawa, Albaton silt loam, or Blake soils.

This Albaton soil is moderately well suited to row crops, but wetness is a limitation, and some places are ponded after rains. Planting is often delayed in spring. Soil tilth is poor, particularly if the soil is tilled when wet. The soil tends to become cloddy and hard when it dries. Most of the acreage is cultivated. The rest is pastured or wooded. Capability unit IIIw–1.

Albaton and Sarpy soils (0 to 2 percent slopes) (315). —These soils formed in the most recent sediments deposited by the Missouri River during flood stages. The percentage of Albaton and Sarpy soils, the texture of the surface layer, and the amount and kind of included soils vary from one area to another. The surface layer of the Albaton soil is generally silty clay, silty clay loam, or silt loam. The Sarpy soil is generally fine sand, loamy fine sand, or fine sandy loam. Soils included in mapping generally are the Haynie, Carr, Blake, Onawa, Grable, and Percival soils. These soils parallel and adjoin the main channel of the Missouri River. Individual areas are large, and in places exceed 100 acres.

Most of the acreage is on the river side of protective dikes and is subject to flooding. Old oxbows and meanders that are filled with water and have no outlets occur in many places. Some areas are wooded with willows or cottonwoods and saplings. These soils have limited value in farming. They provide some food and cover for deer and habitat for other kinds of wildlife. Capability unit Vw–1.

Blake Series

The Blake series consists of nearly level, somewhat poorly drained soils on the Missouri River bottom land. These soils formed in alluvium. They are slightly elevated and adjacent to or within a few miles of the river.

In a representative profile the surface layer is very dark gray and very dark grayish-brown silty clay loam about 7 inches thick. The substratum, to a depth

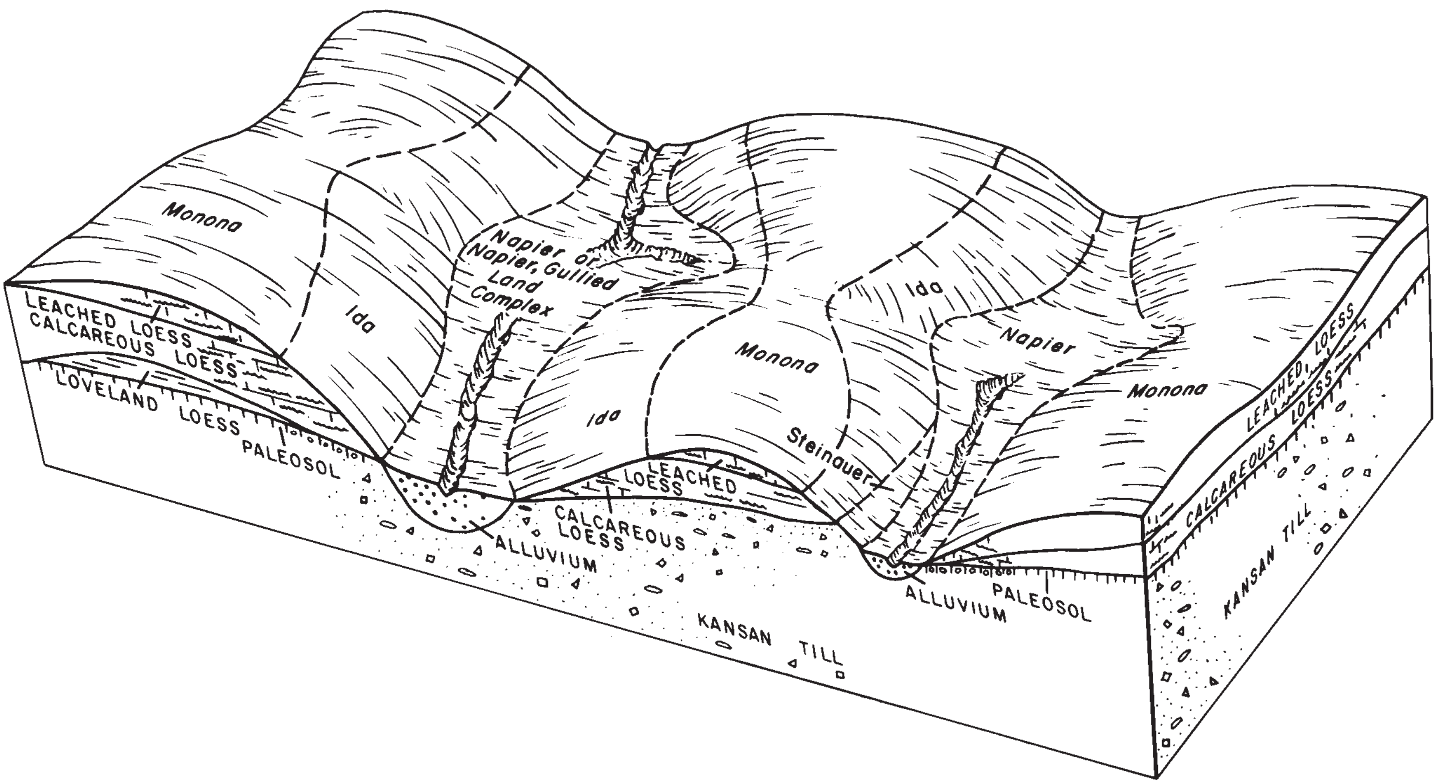

Figure 9.—**Typical pattern of soils and parent material in Monona-Ida-Napier soil association.**

of about 24 inches, is dark grayish-brown, firm silty clay loam. Beneath this, it is grayish-brown silt loam that has common strong-brown and few pale-brown and dark-gray mottles.

Blake soils are low in organic-matter content and are typically mildly alkaline and calcareous throughout. Available water capacity is high. Permeability is moderately slow or moderate in the silty clay loam layers and moderate or moderately rapid in the material below. The supply of available phosphorus is very low. The supply of available potassium is high.

These soils have no serious limitations. Before construction of large dams and levees, they were subject to flooding. Now, in most areas, the hazard of flooding is slight. Only some areas mapped as Blake and Haynie soils are subject to flooding. Most areas are cultivated.

Representative profile of Blake silty clay loam in a cultivated field 630 feet east and 140 feet south of the northwest corner of NE¼NW¼ sec. 16, T. 78 N., R. 45 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak, very fine, subangular blocky structure; friable; few fine pores; few dark stains around root channels; mildly alkaline, slightly effervescent; clear, smooth boundary.

C1—7 to 24 inches, dark grayish-brown (10YR 4/2) and dark-gray (10YR 4/1) silty clay loam, light brownish gray (10YR 6/2) dry; few, fine, faint, grayish-brown (2.5Y 5/2) and few, fine, dark yellowish-brown (10YR 4/4) mottles; very weak, fine, subangular blocky structure; firm; few fine dark oxides; mildly alkaline, slightly effervescent; clear, smooth boundary.

IIC2—24 to 60 inches, stratified grayish-brown (2.5Y 5/2) coarse silt loam; common, fine, strong-brown (7.5YR 5/6), few, fine, pale-brown (10YR 6/3), and few, fine, dark-gray (10YR 4/1) mottles; some horizontal cleavage that parts to very fine subangular blocky structure; very friable; common very fine pores; some streaks of calcium carbonate; mildly alkaline, strongly effervescent.

The A horizon, in most places the plow layer, is less than 10 inches thick. It ranges from very dark gray (10YR 3/1) or very dark grayish brown (10YR or 2.5Y 3/2) to dark grayish brown (2.5Y 4/2). The C1 horizon has a hue of 10YR or 2.5Y, value of 4 moist, and chroma of 2, 3, or 4. Mottles are few to common; hue is 2.5Y, 10YR, 7.5YR, and 5YR, value is 3 to 6, and chroma is 1 to 8. The IIC horizon is silt loam, loam, or very fine sandy loam; hue is 10YR or 2.5Y, value is 4 to 6, and chroma is 2. Mottles are similar in abundance and color to those in the C1 horizon. Reaction is typically mildly alkaline in the upper horizons and is mildly alkaline or moderately alkaline in the IIC horizon. In places the A1 or Ap horizon is neutral. Blake soils are typically calcareous throughout. In places the A1 or Ap horizon is not calcareous.

Blake soils formed in similar material and are associated with Haynie, Onawa, Percival, and Vore soils. They have more clay in the Ap and C1 horizons than Haynie soils and less clay in those horizons than Onawa and Percival soils. They are not underlain by sand as are Percival and Vore soils.

Blake silt loam (0 to 2 percent slopes) (844).—This soil is similar to the one described as representative of the series, but it has 6 to 15 inches of stratified, very dark grayish-brown to dark grayish-brown silt loam overwash deposited on the surface as a result of recent flooding. Individual areas are small. Closely

Figure 10.—**Terraces protect Ida soils in Mill-Picayune Watershed southeast of Dunlap. Watershed structure and pond are in the background.**

associated soils are Blake silty clay loam and Haynie, Vore, and Modale soils. Small areas of those soils are included with this soil in mapping.

This Blake soil is well suited to row crops. It has no serious limitations. Most of the acreage is cultivated. The rest is pastured or wooded. Capability unit I–2.

Blake silty clay loam (0 to 2 percent slopes) (144).—This soil is in irregularly shaped areas parallel to the nearby Missouri River. It has the profile described as representative of the series. Individual areas range in size from a few acres to as much as 200 acres or more. Associated soils are Blake silt loam, Onawa and Albaton soils at slightly lower elevations, Haynie, Grable, Modale, Vore, Carr, and Percival soils at similar elevations, and Sarpy soils at slightly higher elevations. In places small areas of those associated soils are included in mapping.

This Blake soil is well suited to row crops. In most areas it has no serious limitations. Most of the acreage is cultivated. The rest is pastured or wooded. Capability unit I–2.

Blake and Haynie soils (0 to 2 percent slopes) (38).—The percentages of the soils in this mapping unit, the texture of the surface layer, and the percentages and kinds of included soils vary from one area to another. Generally the surface layer of Blake soils is silt loam or silty clay loam, and that of Haynie soils is silt loam or very fine sandy loam. Individual areas seldom exceed 50 acres. Blake and Haynie soils are associated with mapped areas of Albaton and Sarpy soils and with Sarpy soils. They are mainly within a mile or two of the river channel. The soils included in mapping are mainly Albaton, Onawa, Grable, and Vore soils.

Much of the acreage has been cleared, leveled, and cultivated. Row crops, to which the soils are well suited, are grown often. The rest of the acreage is pastured or wooded. Some areas are subject to flooding. Capability unit IIw–2.

Blencoe Series

The Blencoe series consists of nearly level, somewhat poorly drained and poorly drained soils. These soils formed in alluvium on the Missouri River bottom land, in the central and eastern part.

In a representative profile the surface layer is black silty clay about 16 inches thick. The upper 8 inches of the subsoil is very dark grayish-brown, firm silty clay. The next 6 inches is dark grayish-brown, friable silty clay loam. The lower 6 inches is dark grayish-

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

Soil	Acres	Percent
Albaton silt loam	2,855	0.6
Albaton silty clay	15,890	3.6
Albaton and Sarpy soils	1,175	.3
Blake silt loam	975	.2
Blake silty clay loam	4,330	1.0
Blake and Haynie soils	1,000	.2
Blencoe silty clay	3,540	.8
Blend silty clay	875	.2
Borrow pits	295	.1
Burcham silt loam	1,705	.4
Carr very fine sandy loam	1,510	.3
Castana silt loam, 5 to 14 percent slopes	320	.1
Castana silt loam, 14 to 20 percent slopes	330	.1
Colo silt loam, overwash	780	.2
Colo silty clay loam	615	.1
Cooper silty clay loam	1,760	.4
Dow-Monona silt loams, 9 to 14 percent slopes, severely eroded.	205	(1)
Dow-Monona silt loams, 14 to 20 percent slopes, severely eroded	685	.2
Forney silty clay	1,330	.3
Grable silt loam	800	.2
Hamburg silt loam, 40 to 75 percent slopes	8,410	1.9
Haynie silt loam	10,010	2.2
Ida silt loam, 5 to 9 percent slopes	305	.1
Ida silt loam, 5 to 9 percent slopes, severely eroded	1,215	.3
Ida silt loam, 9 to 14 percent slopes	1,330	.3
Ida silt loam, 9 to 14 percent slopes, severely eroded	18,090	4.1
Ida silt loam, 14 to 20 percent slopes	2,060	.5
Ida silt loam, 14 to 20 percent slopes, severely eroded	41,370	9.3
Ida silt loam, 20 to 30 percent slopes	5,055	1.1
Ida silt loam, 20 to 30 percent slopes, severely eroded	11,555	2.6
Ida silt loam, 30 to 40 percent slopes	4,820	1.1
Keg silt loam	6,445	1.4
Kenmoor fine sand	475	.1
Kennebec silt loam	7,510	1.7
Kennebec silt loam, overwash	8,640	1.9
Lakeport silty clay loam	1,015	.2
Luton silt loam, overwash	1,370	.3
Luton silty clay	11,745	2.6
Luton silty clay, thin surface	17,575	4.0
McPaul silt loam	13,325	3.0
Modale very fine sandy loam	275	.1
Modale silt loam	1,685	.4
Monona silt loam, 0 to 2 percent slopes	790	.2
Monona silt loam, benches, 0 to 2 percent slopes	1,440	.3
Monona silt loam, 2 to 5 percent slopes	18,770	4.2
Monona silt loam, benches, 2 to 5 percent slopes	1,780	0.4
Monona silt loam, 5 to 9 percent slopes	15,530	3.5
Monona silt loam, 5 to 9 percent slopes, moderately eroded	20,580	4.6
Monona silt loam, 9 to 14 percent slopes	5,530	1.2
Monona silt loam, 9 to 14 percent slopes, moderately eroded	24,675	5.5
Monona silt loam, 9 to 14 percent slopes, severely eroded	865	.2
Monona silt loam, 14 to 20 percent slopes	5,160	1.2
Monona silt loam, 14 to 20 percent slopes, moderately eroded	10,750	2.4
Monona silt loam, 14 to 20 percent slopes, severely eroded	1,960	.4
Monona silt loam, 20 to 30 percent slopes	4,610	1.0
Monona silt loam, 20 to 30 percent slopes, moderately eroded	3,580	.8
Monona silt loam, 30 to 40 percent slopes	2,200	.5
Moville silt loam	2,400	.5
Napier silt loam, 2 to 5 percent slopes	31,590	7.1
Napier silt loam, 2 to 5 percent slopes, overwash	1,245	.3
Napier silt loam, 5 to 9 percent slopes	33,440	7.5
Napier silt loam, 9 to 14 percent slopes	6,380	1.4
Napier-Gullied land complex, 2 to 10 percent slopes	595	.1
Napier-Nodaway-Colo complex, 2 to 5 percent slopes	2,700	.6
Nodaway silt loam	8,940	2.0
Onawa silt loam	1,145	.3
Onawa silty clay	6,090	1.4
Percival silty clay	1,125	.2
Riverwash	735	.2
Salix silty clay loam	3,350	.8
Sarpy fine sand, 0 to 3 percent slopes	1,760	.4
Sarpy fine sand, 3 to 7 percent slopes	1,985	.4
Sarpy fine sandy loam, 0 to 3 percent slopes	2,605	.6
Solomon silty clay	350	.1
Steinauer clay loam, 9 to 14 percent slopes, moderately eroded	445	.1
Steinauer clay loam, 14 to 18 percent slopes, severely eroded	545	.1
Vore silty clay loam	580	.1
Woodbury silty clay	2,080	.5
Water	750	.2
Quarries	500	.1
Made land	500	.1
Total	445,310	100.0

[1] Less than 0.1 percent.

brown, very friable silt loam that has common, strong-brown mottles. The substratum is dark grayish-brown, grayish-brown, and yellowish-brown, very friable silt loam mottled with strong brown. Mottles increase in abundance with increasing depth.

Blencoe soils are typically slightly acid in the surface layer and neutral in the subsoil. They are very slowly permeable in the silty clay layers and moderately permeable in the material below. Available water capacity is high. Organic-matter content generally is high. The supply of available phosphorus is very low. The supply of available potassium is high.

Almost all the acreage is cultivated. The Blencoe soils are often wet in spring when the water table is high. Root growth is restricted in some years.

Representative profile of Blencoe silty clay in a cultivated field 1,030 feet north and 300 feet east of the southwest corner of SE¼SW¼ sec. 16, T. 78 N., R. 44 W.:

Ap—0 to 8 inches, black (10YR 2/1) medium silty clay; cloddy breaking to weak, medium, subangular blocky structure; firm; slightly acid; clear, smooth boundary.

A12—8 to 16 inches, black (10YR 2/1) medium silty clay; very dark gray (10YR 3/1) crushed; moderate, very fine and fine, subangular blocky structure; firm; slightly acid; gradual, smooth boundary.

B1—16 to 24 inches, very dark grayish-brown (10YR 3/2) silty clay; faces of peds very dark gray (10YR 3/1); moderate, fine, subangular blocky structure; firm; few fine tubular pores; neutral; gradual, smooth boundary.

B2—24 to 30 inches, dark grayish-brown (10YR 4/2) light silty clay loam; very few, very fine, faint, strong-brown (7.5YR 5/6) mottles; weak, fine, subangular blocky structure; friable; few fine tubular pores; some very dark gray (10YR 3/1) organic coatings on ped faces; neutral; gradual, smooth boundary.

IIB3—30 to 36 inches, dark grayish-brown (10YR 4/2) silt loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, fine and medium, subangular blocky structure; very friable; few fine tubular pores; many brown (10YR 4/3) coatings of coarse silt; some dark-gray (10YR 4/1) ped faces; very dark gray (10YR 3/1) material in channels and pores; neutral; gradual, smooth boundary.

IIC1—36 to 41 inches, dark grayish-brown (2.5Y 4/2) silt loam; common, medium, distinct, strong-brown (7.5YR 5/6) and few, fine, faint, grayish-brown (2.5Y 5/2) mottles; massive; some vertical cleavage; very friable; many fine tubular pores; common, fine, distinct stains; very dark gray (10YR 3/1) root fillings; mildly alkaline, slightly effervescent; abrupt boundary.

IIC2—41 to 60 inches, yellowish-brown (10YR 5/4) and grayish-brown (2.5Y 5/2) silt loam; many, medium, distinct, strong-brown (7.5YR 5/6) mottles; lower 6 inches is light brownish-gray (2.5Y 6/2) matrix and many, coarse, prominent, strong-brown (7.5Y 5/6) mottles; massive; very friable; many, fine, distinct oxide stains; many fine tubular pores; many fine distinct stains; some grayish-brown (2.5Y 5/2) ped faces; mildly alkaline, strongly effervescent.

The A horizon is typically 12 to 20 inches thick. The A3 or B1 horizons are very dark gray (10YR A/1) or very dark grayish brown (10YR 3/2). The B2 horizon is typically dark grayish brown (10YR or 2.5Y 5/2). Colors of 3 value occur below a depth of 24 inches only as coatings or fills in channels and pores. The silty clay texture extends to a depth of 20 to 30 inches. In places a thin silty clay loam layer occurs between the silty clay material and the underlying silt loam material. The silt loam contains strata ¼ to 6 inches that are finer and coarser textured. The IIB3 and IIC horizons range from dark grayish brown (10YR or 2.5Y 4/2) to yellowish brown (10YR 5/4). Few to common mottles and stains dominantly range from dark brown (7.5YR 3/2) to strong brown, but some are grayish brown (2.5Y 5/2) to olive brown (2.5Y 5/4). Reaction is neutral or slightly acid in the A horizon, neutral or mildly alkaline in the B horizon, and mildly alkaline in the C horizon. The C horizon is calcareous.

Blencoe soils have less clay below a depth of about 2 feet than Luton or Blend soils. They have more clay in the A and B horizons than Salix soils. Compared with Woodbury soils, they are silt loam instead of silty clay loam below a depth of about 2 feet. In contrast with Cooper soils, they do not have a silty clay IIC horizon. All of those soils formed in alluvium and are associated on the landscape.

Blencoe silty clay (0 to 2 percent slopes) (44).—This soil is on bottom land. Associated soils are Luton and Woodbury soils at slightly higher elevations, Blend soils at about the same elevation, and Salix, Lakeport, and Keg soils at somewhat higher elevations. Individual areas range from 10 to about 200 acres or more in size.

Small areas of Woodbury, Blend, and Luton soils are included with this soil in mapping. Also included are small areas where 6 to 15 inches of very dark grayish-brown or dark grayish-brown silty overwash has been deposited on the surface.

This Blencoe soil is well suited to row crops, but tends to be wet in spring and during rainy seasons. In some years wetness delays tillage and planting. Some areas are slightly depressional and at times are ponded after heavy rains. If worked when wet, this soil dries out cloddy and hard, and tilth is poor. Most of the acreage is cultivated. Capability unit IIw–1.

Blend Series

The Blend series consists of nearly level, poorly drained soils on fairly broad areas in the central and eastern parts of the Missouri River bottom lands.

In a representative profile the surface layer is black and very dark gray silty clay about 14 inches thick. The subsoil, which extends to a depth of about 32 inches, is dark grayish-brown and dark-gray, friable silty clay loam that has many strong-brown and a few reddish-brown mottles. The substratum is mainly grayish-brown and light brownish-gray and light olive-brown silty clay.

Blend soils are high in organic-matter content and are typically slightly or medium acid in the surface layer. They are very slowly permeable. Available water capacity is moderate or high. The supply of available phosphorus is low. The supply of available potassium is high.

Most of the acreage is cultivated. Wetness and a frequent high water table are limitations.

Representative profile of Blend silty clay in a bluegrass pasture 450 feet south and 135 feet west of the northeast corner of NE¼NW¼ sec. 21, T. 78 N., R. 44 W.:

Ap—0 to 7 inches, black (10YR 2/1) silty clay; strong, medium and fine, subangular blocky structure; firm; very few, very fine, inped tubular pores; medium acid; clear, smooth boundary.

A3—7 to 14 inches, very dark gray (10YR 3/1) silty clay; faces of peds black (10YR 2/1); very few, very fine, faint, strong-brown (7.5YR 5/6) mottles; moderate, fine and very fine, subangular blocky structure; firm; few, very fine, inped tubular pores; slightly acid; gradual, smooth boundary.

IIB2—14 to 22 inches, dark grayish-brown (10YR 4/2) silty clay loam; faces of peds very dark gray (10YR 3/1); common, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, fine, subangular blocky structure; friable; very few, very fine, inped tubular pores; common, very fine, soft oxides; slightly acid; clear, smooth boundary.

IIB3—22 to 32 inches, dark grayish-brown (10YR 4/2) and dark-gray (10YR 4/1) light silty clay loam; many, fine, distinct, strong-brown (7.5YR 5/6) and few, fine, distinct, dark reddish-brown (5YR 3/3) mottles; very weak, fine, subangular and angular blocky structure; friable; many very fine inped tubular pores; common very dark gray (10YR 3/1) ped coatings; few, very fine, soft oxides; neutral to mildly alkaline; clear, smooth boundary.

IIIACgb—32 to 43 inches, very dark grayish-brown (2.5Y 3/2) silty clay, grading to mottled grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4); common, fine, distinct, yellowish-brown (10YR 5/6) and few, fine, distinct, dark reddish-brown (5YR 3/3) mottles; moderate, medium, subangular blocky structure; firm; very few, very fine, inped tubular pores; thin, discontinuous, dark-gray (10YR 4/1) shiny coats on ped faces; very few lime concretions in lower part; slightly acid grading to neutral; gradual, smooth boundary.

IIICg—43 to 60 inches, mottled light brownish-gray (2.5Y 6/2) and light olive-brown (2.5Y 5/4) silty clay; few, fine, faint, strong-brown (7.5YR 5/6) mottles; moderate, medium and coarse, subangular blocky structure; firm; many, very fine, inped tubular pores; few, very fine, soft oxides; thick, discontinuous, shiny coatings of dark gray (10YR 4/1) on ped faces; abundant lime concretions; mildly alkaline, slightly effervescent.

The A horizon is typically black (10YR 2/1) or very dark gray (10YR 3/1) but is very dark brown (10YR 2/2) in places. It is 10 to 18 inches thick and is silty clay or clay. In places the silty clay or clay is as thick as 24 inches and extends into a B horizon. The IIB horizon, about 8 to 18 inches thick, is light to heavy silty clay loam. The IIB horizon, or IIC horizon if present, centers on dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) but ranges to 3 or 4 chroma with mottles. At a depth of 24 to 36 inches is a silty clay or clay layer generally of grayish brown (2.5Y 5/2), light brownish gray (2.5Y 6/2), and dark gray (10YR 4/1) or gray (10YR 5/1). In places the upper few inches is very dark gray (10YR 3/1) or very dark grayish brown (2.5Y 3/2). Mottles generally range from 10YR to 5YR in hue, 3 to 6 in value, and 3 to 6 in chroma. Soil reaction is generally slightly acid or medium acid in the A horizon and slightly acid to mildly alkaline in the IIB horizon. The upper part of the silty clay or clay IIIC horizon is slightly acid to mildly alkaline. The lower part is mildly alkaline or moderately alkaline and calcareous.

Blend soils have more clay in the A horizon than Cooper soils and are more poorly drained. They have three distinct layers, whereas Blencoe and Woodbury soils have only two. They formed in similar parent material and are associated on the landscape with the Blencoe, Cooper, and Woodbury soils.

Blend silty clay (0 to 2 percent slopes) (244).—This soil is at slightly higher elevations on the bottom lands than the associated Woodbury and Luton soils. Blencoe soils are in similar positions, but other associated soils such as Lakeport, Salix, and Keg soils are at somewhat higher elevations. Individual areas of Blend soils typically do not exceed 100 acres, but some are larger. Some areas of Woodbury, Blencoe, and Luton soils are included with this soil in mapping.

This Blend soil is moderately suited to row crops, and most areas are cultivated. Wetness and a water table that is frequently high are limitations. Runoff is very slow. Wetness delays fieldwork or planting at times and reduces yields. If tilled when wet, the soil tends to dry out cloddy and hard and tilth is poor. Wetness often influences the choice of crops and the methods of drainage. Capability unit IIIw–1.

Borrow Pits

Borrow pits (550) are excavations along Interstate Highway 29, which dissects the Missouri River bottom land from north to south. They occur where silty and sandy material have been removed for highway construction.

These pits range to as much as 4 acres in size and are generally 3 to 10 feet deep. They are often ponded, especially in spring or during rainy seasons. Migrating waterfowl often use these areas as resting places. Capability unit Vw–1.

Burcham Series

The Burcham series consists of nearly level, moderately well drained soils in the central part of the Missouri River bottom lands. These soils formed in alluvium.

In a representative profile the surface layer is black silt loam about 11 inches thick. Beneath this is a 3-inch layer of very dark gray and dark grayish-brown, very friable silt loam. The subsoil, which extends to a depth of about 26 inches, is friable silt loam. It is grayish brown in the upper part and dark grayish brown and olive brown in the lower part. It is mottled with strong brown and light gray. The substratum is dark grayish-brown and dark-gray silty clay that has some dark reddish-brown, brown, and grayish-brown mottles.

Burcham soils are moderate or high in organic-matter content. Their surface layer is typically neutral, and the upper part of the subsoil is neutral or mildly alkaline. They are moderately permeable in the upper part but are slowly permeable or very slowly permeable in the underlying silty clay. Available water capacity is high. The supply of available phosphorus is very low. The supply of available potassium is high.

Most of the acreage is cultivated. These soils have no serious limitations.

Representative profile of Burcham silt loam in a cultivated field 640 feet north and 123 feet west of the southeast corner of SW1/4 sec. 15, T. 78 N., R. 45 W.:

Ap—0 to 7 inches, black (10YR 2/1) heavy silt loam; weak, fine, subangular blocky structure; friable; some root stains; neutral; clear, smooth boundary.

A12—7 to 11 inches, black (10YR 2/1) silt loam, very dark brown (10YR 2/2) crushed; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

AB—11 to 14 inches, very dark gray (10YR 3/1) and dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) crushed; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, very fine, subangular blocky structure; very friable, very fine pores; mildly alkaline; clear, smooth boundary.

B2—14 to 17 inches, grayish-brown (2.5Y 5/2) silt loam: common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, very fine, subangular blocky structure; very friable; common very fine pores; some very dark gray (10YR 3/1) organic fillings; mildly alkaline; clear, smooth boundary.

B3—17 to 26 inches, dark grayish-brown (2.5Y 4/2) and olive-brown (2.5Y 4/4) silt loam; common, fine, distinct, strong-brown (7.5YR 5/6) and few, fine, faint, light-gray (10YR 6/1) mottles; weak, very fine, subangular blocky structure; very friable; many very fine and few fine pores; some very dark gray (10YR 3/1) worm casts; moderately alkaline, strongly effervescent; abrupt, smooth boundary.

IICg—26 to 60 inches, dark grayish-brown (2.5Y 4/2) and dark-gray (5Y 4/1) silty clay; common, fine, distinct, brown (7.5YR 4/4), few, fine, prominent, dark reddish-brown (5YR 3/4), and few, fine, faint, grayish-brown (2.5Y 5/2) mottles; moderate, fine, subangular blocky structure; very firm; common very fine pores; shiny coatings on some peds; few dark oxides; mildly alkaline, slightly effervescent.

The A horizon is about 10 to 16 inches thick. In places it is silty clay loam. In places the soil has no AB horizon. In places the color value is 3 to a depth of about 20 to 24 inches. The B horizon has colors of 10YR or 2.5Y hue, 4 or 5 value, and 2 to 4 chroma. Mottles in the B horizon are 10YR or 7.5YR hue with values of 4 to 6 and chroma of 1 to 8. In places a C1 horizon is present that is similar in color and texture to the B horizon. The IIC horizon is at a depth of 20 to 30 inches in most places. It is of 2.5Y or 5Y hue, typically with values of 4 or 5 and chroma of 1 or 2, but values of 6 and chroma of 3 or 4 make up part of the matrix color in places. Mottles range in hue from 5YR to 2.5Y, in value from 3 to 6, and in chroma from 2 to 8. The A horizon and the upper part of the B horizon range from neutral to mildly alkaline. The B3 horizon, the C1 horizon where present, and the IICg horizon are mildly or moderately alkaline and calcareous.

Burcham soils are less clayey in the solum than Cooper soils. They have silty clay beginning at a depth of 20 to 30 inches, whereas Keg soils do not. They are associated on the landscape with Cooper and Keg soils and formed in similar parent materials.

Burcham silt loam (0 to 2 percent slopes) (446).—This soil is on bottom land. In most places it is associated with Keg, Salix, Cooper, and Lakeport soils. Individual areas range up to 200 acres or more in size. Areas of Keg, Salix, Cooper, and Lakeport soils are included in mapping.

This Burcham soil is well suited to row crops, and most of the acreage is cultivated. The clayey substratum sometimes causes wetness, but fieldwork seldom is delayed for long periods. Capability unit I–1.

Carr Series

The Carr series consists of nearly level, excessively drained soils on bottom lands near or within a few miles of the Missouri River. These soils formed in alluvium.

In a representative profile the surface layer, about 8 inches thick, is a dark grayish-brown very fine sandy loam plow layer that has a few very dark gray and strong-brown mottles. The substratum to a depth of about 29 inches is stratified grayish-brown, very friable very fine sandy loam. Below this, it is stratified grayish-brown loamy fine sand to fine sand that has a few strong-brown mottles.

Carr soils are very low or low in organic-matter content. They are mildly alkaline or moderately alkaline and calcareous throughout. Permeability is moderately rapid or rapid. Available water capacity is low or moderate. The supply of available phosphorus is very low. The supply of available potassium is high.

These soils are somewhat droughty, and soil blowing is a hazard. Before construction of large dams and levees, the soils were subject to flooding. Now in most areas the hazard of flooding is slight. Only a few areas closest to the river or on the river side of protective levees are subject to flooding. Most of the acreage is cultivated.

Representative profile of Carr very fine sandy loam in a cultivated field 310 feet west and 154 feet north of the southeast corner of SE¼ sec. 19, T. 78 N., R. 45 W.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) very fine sandy loam; few, fine, faint, very dark gray (10YR 3/1) and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; very weak, fine, subangular blocky structure; very friable; few, fine, soft oxides; mildly alkaline, strongly effervescent; clear, smooth boundary.

C1—8 to 29 inches, stratified grayish-brown (2.5Y 5/2) very fine sandy loam; weak, thin, platy structure; very friable; few, fine, distinct, soft dark oxides on horizontal plate faces; moderately alkaline, violently effervescent; gradual, smooth boundary.

C2—29 to 60 inches, stratified grayish-brown (2.5Y 5/2) loamy fine sand and fine sand; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, thin, platy structure that parts easily to single grained; loose; many, fine, distinct, soft dark oxides; moderately alkaline, violently effervescent.

The A horizon is less than 10 inches thick and is the plow layer in many places. It ranges from very dark grayish brown (10YR 3/2) to brown (10YR 4/3). The C horizon is dark grayish brown (10YR or 2.5Y 5/2) to light olive brown (2.5Y 5/4). Mottles of dark yellowish brown (10YR 4/4) to strong brown (7.5YR 5/6) and dark reddish brown (5YR 3/3) are present throughout. In places the Ap and C1 horizons are fine sandy loam. The C2 horizon ranges from very fine sandy loam or loamy very fine sand to fine sandy loam, loamy fine sand, or fine sand. Thin strata of silty or clayey materials are present in places. The A horizon is typically mildly alkaline or moderately alkaline and calcarerous. It is neutral in places. The C horizon is mildly alkaline or moderately alkaline and calcareous.

The Carr soils in Harrison County have a higher content of fine sand and sand coarser than fine sand between depths of 10 and 40 inches than is defined as the range for the Carr series. This difference, however, does not greatly affect their use and behavior.

Between depths of 10 and 40 inches, Carr soils have less sand and more clay than Sarpy soils. They contain more sand to depths of about 2 feet than Grable soils. They formed in similar parent materials and are associated on the landscape with Sarpy and Grable soils.

Carr very fine sandy loam (0 to 2 percent slopes) (538).—This soil is on bottom lands. In most places it is associated with Sarpy, Haynie, Grable, Percival, or Vore soils. Most areas range from 10 to 80 acres in size, but a few are much larger.

Included with this soil in mapping are areas of Sarpy, Haynie, or Grable soils. Also included are areas where the surface layer is silt loam or sand.

This soil is moderately well suited to row crops. Most areas are cultivated but some are pastured or wooded. Droughtiness often reduces yields. Soil blowing injures young plants at times. This soil is well suited to irrigation. It dries out and can be tilled fairly soon after rains. Capability unit IIIs–1.

Castana Series

The Castana series consists of moderately sloping to steep, well-drained soils of the uplands. They are on high foot slopes mainly along the bluffs at the eastern edge of the Missouri River Valley. These soils formed in silty local alluvium that washed or slumped from the adjacent hillsides.

In a representative profile the surface layer is very dark grayish-brown, very friable silt loam about 17 inches thick. Beneath this is brown, very friable silt loam.

Castana soils are moderate in organic-matter content. They are mildly alkaline or moderately alkaline and calcareous throughout. They are moderately permeable. Available water capacity is high. The supply of available phosphorus is very low. The supply of available potassium is low.

Larger acreages generally are cultivated. Small areas associated with the more sloping Hamburg soils are typically pastured. These soils are subject to erosion and to siltation and gullying. In places large gullies have formed in the valleys and cut back into areas of these soils.

Representative profile of Castana silt loam, 5 to 14 percent slopes, in a pasture 240 feet west and 500 feet north of the southeast corner of NE¼SW¼ sec. 2, T. 79 N., R. 44 W.:

Ap—0 to 6 inches, very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) crushed, brown (10YR 5/3) dry; weak, fine, granular structure; very friable; mildly alkaline, strongly effervescent; clear, smooth boundary.

A12—6 to 13 inches, very dark grayish-brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; weak, very fine, subangular blocky structure and weak, very fine, granular; very friable; many very fine pores; moderately alkaline, strongly effervescent; gradual, smooth boundary.

AC—13 to 17 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) crushed, pale brown (10YR 6/3) dry; weak, fine and very fine, granular structure; very friable; many fine pores; moderately alkaline, strongly effervescent; clear, smooth boundary.

C1—17 to 32 inches, brown (10YR 4/3) silt loam; weak, very fine, subangular blocky structure that parts to weak, very fine, granular; very friable; many very fine and fine pores; some flecks of calcium carbonate; moderately alkaline, violently effervescent; gradual, smooth boundary.

C2—32 to 60 inches, brown (10YR 4/3) silt loam; weak, fine, subangular blocky structure that parts to weak, very fine, granular; friable; many very fine and fine pores; some calcium carbonate streaks; moderately alkaline, violently effervescent.

The A horizon is 10 to 20 inches thick. In places the AC horizon is brown (10YR 4/3) when crushed. The C horizon ranges to brown (10YR 5/3) and yellowish brown (10YR 5/4) and in places to dark grayish brown (10YR 4/2) in the upper part. Castana soils are typically mildly alkaline or moderately alkaline and calcareous throughout, but in places they are noncalcareous to a depth of about 12 inches.

Castana soils have a thinner A horizon than the associated Napier soils and are not leached so deeply. They have a thicker A horizon than the associated Ida and Hamburg soils.

Castana silt loam, 5 to 14 percent slopes (3D).—This soil is mainly on foot slopes that are upslope from the Napier and McPaul soils and downslope from the Hamburg and Ida soils. It has the profile described as representative of the series. Included in mapping are small areas of Napier soils that have a thicker surface layer and are not calcareous and areas of Ida soils that have a very thin surface layer. Areas generally range from 5 to 50 acres in size.

This soil is cultivated or pastured, depending on the slope, size of the area, and the associated soils. It generally is in small areas and is farmed with the adjacent soils. Steep slopes make it subject to severe erosion. Runoff from steeper soils causes gullies and severe rill erosion in places. This soil is moderately well suited to row crops if erosion is controlled, but many farmers grow row crops only when stands of grasses and legumes have to be plowed and reseeded. Capability unit IIIe–1.

Castana silt loam, 14 to 20 percent slopes (3E).—This soil is mainly on high foot slopes upslope from Napier and McPaul soils and downslope from Ida and Hamburg soils. Individual areas range from 5 to 50 acres in size.

In most places this soil has a slightly thinner surface layer than the one described as representative of the series. Included in mapping are small areas of Napier and Ida soils. Also included is about 50 acres of a soil that has a surface layer about 24 inches or more thick.

This soil is mainly used for pasture. A few cultivated areas are generally farmed with adjacent soils. The strong slopes and nature of the associated soils make most areas better suited to hay or pasture than to row crops. Erosion and gullying are serious hazards. Capability unit IVe–1.

Colo Series

The Colo series consists of poorly drained, nearly level soils of the bottom lands. These soils are near all major streams and tributaries except the Missouri River, but they are most extensive along the Boyer River. They are also mapped with other soils in narrow upland drainageways. They formed in alluvium.

In a representative profile the surface layer is black, friable or firm silty clay loam about 35 inches thick. The substratum is very dark gray silty clay loam.

These soils are high in organic-matter content. They are typically slightly acid or neutral in the surface layer. Permeability is moderately slow. Available water capacity is high. The supply of available phosphorus and potassium is medium.

Most areas are cultivated. They are subject to overflow of varying frequency, but water typically does not stand for long periods. In places old shallow channels or depressions are ponded in spring or when rainfall is heavy.

Representative profile of Colo silty clay loam in a cultivated field 900 feet east and 200 feet north of the southwest corner of NW¼ sec. 4, T. 79 N., R. 42 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; moderate, fine, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

A12—8 to 17 inches, black (N 2/0) silty clay loam; weak, fine, subangular blocky structure that parts to weak, fine, granular; friable; slightly acid; gradual, smooth boundary.

A13—17 to 26 inches, black (N 2/0) silty clay loam; moderate, very fine and fine, subangular blocky structure; firm; slightly acid; gradual, smooth boundary.

AC—26 to 35 inches, black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) kneaded; moderate, fine, subangular blocky structure; firm; few, fine, iron-manganese oxides and stains; neutral; clear, smooth boundary.

C—35 to 60 inches, very dark gray (10YR 3/1) silty clay loam; weak, fine and medium, subangular blocky structure; firm; few, fine, iron-manganese oxides and stains; neutral.

The A horizon is 24 to 40 inches thick and is black (10YR 2/1 or N 2/0) or very dark gray (10YR 3/1). The value is 2 or 3 to a depth of 36 inches or more. Very dark grayish-brown (10YR 3/2) or dark grayish-brown (10YR 4/2) silt loam overwash that is 6 to 14 inches thick is present in places. Also in places is a B horizon that has weak structure. In places there is no AC horizon. The C horizon, or B horizon if present, is dark gray (10YR 4/1) in places. Few to common dark-brown (10YR 3/3) to strong-brown (7.5Y 5/6) or olive-gray (5Y 5/2) mottles occur, mainly below a depth of 3 feet. Colo soils are typically slightly acid or neutral throughout, but in places the upper 1 foot of the soils is medium acid.

Colo soils are more clayey throughout than the associated Kennebec soils and are more poorly drained. They are less clayey throughout than Luton soils. All formed in alluvium.

Colo silt loam, overwash (0 to 2 percent slopes) (133+).—This soil is on low-lying first bottom lands where flooding and siltation have occurred more frequently than on other Colo soils. In many places it is adjacent to Colo silty clay loam. It is slightly lower in elevation than the associated Kennebec and Nodaway soils. Individual areas range from about 10 acres to 200 acres or more in size.

This soil has the profile described as representative of the series, but 6 to 15 inches of stratified, very dark grayish-brown or dark grayish-brown silt loam overwash overlies the original black surface layer. Included in mapping is about 100 acres of a soil that is silty clay instead of silty clay loam below a depth of about 20 inches.

Most of the acreage is in row crops, for which the soil is well suited. Wetness and the hazard of overflow are limitations. This soil generally is somewhat easier to till than Colo silty clay loam, and tilth is typically good. Capability unit IIw–1.

Colo silty clay loam (0 to 2 percent slopes) (133).—This soil is on bottom land. This soil has the profile described as representative of the series. It generally is associated with the Napier soils that are upslope. It is also associated with Kennebec and Nodaway soils, but is at slightly lower elevations. It generally is farther from the river channels than Nodaway soils. Individual areas are mostly less than about 75 acres in size. Included in mapping is about 80 acres of a soil that is silty clay, instead of silty clay loam, below a depth of about 20 inches.

Almost all the acreage is in row crops for which the soil is well suited. A small acreage is in permanent pasture or timber. The water table is seasonally high, and the soil is subject to flooding. In places, wetness reduces yields or crops are damaged by flooding. If worked when wet, this soil dries out cloddy and hard and tilth is poor. Capability unit IIw–1.

Cooper Series

The Cooper series consists of nearly level, somewhat poorly drained soils on broad, slightly elevated areas in the central part of the Missouri River bottom land. These soils formed in alluvium of silty clay loam texture and the underlying, older silty clay sediment.

In a representative profile the surface layer is black and very dark gray silty clay loam about 14 inches thick. The subsoil extends to a depth of about 26 inches. The upper part is dark grayish-brown, friable silty clay loam. The lower part is grayish-brown, friable light silty clay loam that has strong-brown, dark-brown, and gray mottles. The substratum to a depth of 41 inches is dark grayish-brown and dark-gray silty clay mottled with strong brown and dark brown. Below 41 inches is very dark gray silty clay mottled with gray and dark grayish brown.

Cooper soils are high in organic-matter content. They are typically neutral in the surface layer and upper part of the subsoil. Available water capacity is high. Permeability is moderate in the silty clay loam surface layer and subsoil and slow or very slow in the silty clay substratum. The supply of available phosphorus is very low. The supply of available potassium is high.

Almost all the acreage is cultivated. Fieldwork is sometimes delayed in years of above average rainfall. Some areas are slightly depressed and are ponded after rains.

Representative profile of Cooper silty clay loam in a cultivated field 150 feet north and 270 feet east of the southwest corner of SE¼ sec. 15, T. 78 N., R. 45 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A3—8 to 14 inches, very dark gray (10YR 3/1) silty clay loam; common, fine, distinct, dark grayish-brown (10YR 4/2) mottles; moderate, fine, subangular blocky structure; friable; some dark organic coatings; neutral; clear, smooth boundary.

B1—14 to 19 inches, dark grayish-brown (2.5Y 4/2) silty clay loam; faces of peds very dark gray (10YR 3/1); moderate, fine, subangular blocky structure; friable; few dark organic coatings; neutral; clear, smooth boundary.

B2—19 to 26 inches, grayish-brown (2.5Y 5/2) light silty clay loam; common, fine, distinct, strong-brown (7.5YR 5/6), few, fine, distinct, dark-brown (7.5YR 3/2), and few, fine, faint-gray (10YR 5/1) mottles; weak, fine, subangular blocky structure; friable; mildly alkaline, slightly effervescent; abrupt, smooth boundary.

IICg—26 to 41 inches, dark grayish-brown (2.5Y 4/2) and dark-gray (5Y 4/1) silty clay; common, fine, distinct, strong-brown (7.5YR 5/6) and common, fine, distinct, brown (7.5YR 4/4) mottles; weak, fine and very fine, angular blocky structure; firm; shiny coatings on ped faces; few, fine, dark oxides; mildly alkaline, strongly effervescent; abrupt, smooth boundary.

IIA1b—41 to 60 inches, very dark gray (10YR 3/1) silty clay; common, fine, distinct, gray (10YR 5/1) and few, fine, distinct, dark grayish-brown (2.5Y 4/2) mottles; weak, fine, angular blocky structure; firm; some dark oxides; mildly alkaline, slightly effervescent.

The A horizon is 10 to 20 inches thick and ranges from black (10YR 2/1) to very dark brown (10YR 2/2), very dark gray (10YR 3/1), and very dark grayish brown (10YR 3/2). The B horizon ranges from dark grayish brown (10YR or 2.5Y 4/2) to grayish brown (10YR or 2.5Y 5/2) and light olive brown (2.5Y 5/4). In places it contains a layer of loam, silt loam, or very fine sandy loam. The IICg horizon, which begins at a depth of 20 to 30 inches, is dark grayish brown (2.5Y 4/2) to light brownish gray (2.5Y 6/2) and gray (5Y 5/1) in color. The Ab horizon, which is at a depth of 41 inches in the representative profile, is not present in all places. In some places, it is in the upper part of the silty clay Cg horizon. Cooper soils generally are neutral or slightly acid in the A horizon, neutral to mildly alkaline and calcareous in the B horizon, and mildly or moderately alkaline and calcareous in the IICg horizon.

Cooper soils have less clay in the A horizon than Blend soils and are better drained. In contrast with Lakeport and Salix soils, they have a silty clay IIB or IIC horizon at a depth of about 2 feet. All formed in alluvium and are associated on the landscape.

Cooper silty clay loam (0 to 2 percent slopes) (255).—This soil is on bottom land. In most places it is associated with Burcham, Keg, Salix, and Lakeport soils. It is also associated with Blencoe, Luton, Blend, and Woodbury soils. Individual areas are typically less than 50 acres in size. Included in mapping are areas of Lakeport and Burcham soils.

This Cooper soil is well suited to row crops, and most areas are cultivated. The water table is high in many places in spring. Some slightly depressed areas are ponded at times, and tillage and planting are delayed. Tilth is typically good, but if this soil is worked when wet, it tends to dry out cloddy and hard. Capability unit IIw–1.

Dow Series

The Dow series consists of well-drained soils on uplands. These soils formed in thick, calcareous loess. Slopes are 9 to 20 percent.

In a representative profile the surface layer is dark grayish-brown silt loam about 4 inches thick. The substratum is grayish-brown to light brownish-gray, friable and very friable silt loam containing iron oxides and mottles of yellowish brown and strong brown.

Dow soils are very low in organic-matter content. They are typically moderately alkaline and calcareous throughout, except for the surface layer which is neutral or mildly alkaline in places. They are moderately permeable and have high available water capacity. The supply of available phosphorus and potassium is very low.

These soils are generally cropped or used for hay or pasture along with adjacent soils. They are highly susceptible to erosion and gullying.

The Dow soils in Harrison County are mapped only with Monona soils.

Representative profile of Dow silt loam in an area of Dow-Monona silt loams, 9 to 14 percent slopes, severely eroded, about 380 feet north and 180 feet east of the southwest corner of NW¼NE¼ sec. 20, T. 80 N., R. 42 W.:

Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak, very fine, subangular blocky structure that parts to weak, very fine and fine, granular; friable; mildly alkaline, strongly effervescent; gradual, smooth boundary.

C1—4 to 10 inches, grayish-brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; few, fine, distinct, strong-brown (7.5YR 5/6) and few, fine, faint, light-gray (10YR 6/1) mottles; weak, very fine and fine, subangular blocky structure; friable; few small lime nodules; moderately alkaline, strongly effervescent; smooth boundary.

C2—10 to 30 inches, grayish-brown (2.5Y 5/2) to light brownish-gray (2.5Y 6/2) silt loam; common, fine and medium, distinct yellowish-brown (10YR 5/6) and 5/8) and medium, prominent, strong-brown (7.5YR 5/6 and 5/8) mottles; very weak, medium, subangular blocky structure to massive; very friable; common soft oxide accumulations; few small lime nodules; moderately alkaline, violently effervescent; gradual, smooth boundary.

C3—30 to 60 inches, light brownish-gray (10YR 6/2) silt loam; common, fine, distinct, strong-brown (7.5YR 5/6 and 5/8) mottles; massive; very friable; common soft oxide accumulations; common fine and few medium lime nodules; moderately alkaline, violently effervescent.

The A horizon, in most places the plow layer, is typically 4 to 10 inches thick. It ranges from very dark grayish brown (10YR 3/2) to brown (10YR 4/3). The C horizon typically has a hue of 2.5Y, but ranges from 10YR to 5Y. Value is 5 or 6, and chroma is generally 2. In many places the C horizon contains pipestems or nodules high in iron. The A horizon and the AC horizon, where present, range from neutral to moderately alkaline.

Dow soils are grayer than Ida and Monona soils, and they lack the B horizon that is typical of those soils. All are associated on the landscape, and all formed in loess.

Dow-Monona silt loams, 9 to 14 percent slopes, severely eroded (22D3).—This complex is about 60 percent Dow soil and 40 percent Monona soil. Percentages vary from one area to another. The Dow soil is in narrow bands between upslope and downslope areas of Monona soils. Individual areas vary in size, but most range from 10 to 20 acres.

The Dow soil has the profile described as representative of the series. The surface layer of the Monona soil is mostly dark-brown or brown subsoil material. The subsoil is thinner than that in the profile described as representative of the series, and the depth to mottles is less. The soil is calcareous at a depth of 30 to 40 inches in many places. Included in mapping are small areas of Ida soils.

These soils are moderately well suited to row crops if erosion is controlled. They are subject to sheet and gully erosion. Most areas are cultivated. The Dow soil is very low in fertility. The lack of available nutrients often limits crop growth. Capability unit IIIe–2.

Dow-Monona silt loams, 14 to 20 percent slopes, severely eroded (22E3).—This complex is about 60 percent Dow soil and 40 percent Monona soil. The Dow soil is in narrow bands between upslope and downslope areas of Monona soils. Typical areas are about 10 to 20 acres in size.

The surface layer of the Monona soil is mostly dark-brown or brown subsoil material. The subsoil is generally thinner than that in the profile described as representative of the series, and the depth to mottles is less. The soil is calcareous at a depth of 24 to 30 inches in many places.

These soils are moderately well suited to row crops if erosion is controlled. If row cropped, they are highly susceptible to sheet and gully erosion. Adequate erosion control is essential. Most areas of these soils are cultivated or have been cultivated. Use of the surrounding soils influences use of these soils because they are seldom farmed separately. A common practice is to use them for hay or pasture much of the time and to grow a crop of corn just before the meadow has to be reseeded. The Dow soil is low in fertility. Lack of available phosphorus often limits the growth of legumes. Capability unit IVe–1.

Forney Series

The Forney series consists of nearly level, poorly drained soils of the Missouri River bottom land. These soils are mostly in fairly broad areas near the middle part of the bottom land. They formed in alluvium.

In a representative profile the surface layer is very dark gray and very dark grayish-brown silty clay about 8 inches thick. The subsoil, which extends to a depth of about 19 inches, is dark grayish-brown, firm silty clay or clay that has a few yellowish-brown and brown mottles. Below this is a 10-inch layer of black and very dark gray, firm silty clay or clay mottled with olive and strong brown. This layer is the surface layer of an older soil buried by river sediment. The subsoil of this buried soil to a depth of 60 inches is gray and dark-gray, very firm silty clay or clay that has olive and strong-brown mottles.

Forney soils are low in organic-matter content. They are typically neutral in the surface layer and upper part of the subsoil, but in places the plow layer is slightly acid. Permeability is very slow. Available water capacity is moderate. The supply of available phosphorus is very low. The supply of available potassium is high.

Most areas of Forney soils are cultivated. Wetness and poor tilth are major limitations.

Representative profile of Forney silty clay in a cultivated field 110 feet south and 730 feet east of the northwest corner of NE¼NW¼ sec. 19, T. 78 N., R. 44 W.:

Ap—0 to 5 inches, very dark gray (10YR 3/1) silty clay, dark gray (5Y 4/1) dry; few, fine, distinct, very dark grayish-brown (10YR 3/2) mottles; clods that part to moderate, very fine, subangular blocky structure; firm; slightly acid; clear, smooth boundary.

A3—5 to 8 inches, very dark grayish-brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) crushed, gray (5Y 5/1) dry; few, fine, distinct, brown (10YR 4/3) mottles; weak, fine, subangular blocky structure; firm; some very fine blocky peds of black (10YR 2/1) and some black (10YR 2/1) material in channels and voids; neutral; clear, smooth boundary.

B2g—8 to 15 inches, dark grayish-brown (2.5Y 4/2) silty clay or clay; few, fine, distinct, brown (10YR 4/3) mottles; moderate, fine, subangular blocky structure; very firm; few black (10YR 2/1) channel fillings; ped faces have high sheen; very few, very fine pores; neutral; gradual, smooth boundary.

B3g—15 to 19 inches, dark grayish-brown (2.5Y 4/2) silty clay or clay; faces of peds dark gray (5Y 4/1); few, fine, distinct, yellowish-brown (10YR 5/4) and few, fine, faint, brown (7.5YR 4/4) mottles; moderate, fine, subangular blocky structure; very firm; some black (10YR 2/1) channel fillings; ped faces have high sheen; neutral; abrupt, smooth boundary.

IIA1b—19 to 25 inches, black (N 2/0) silty clay, dark gray (5Y 4/1) dry; few, fine, faint, olive (5Y 5/3) mottles; moderate, fine, subangular blocky structure; firm; ped faces smooth and have high sheen; very few, very fine pores; neutral; clear, smooth boundary.

IIA3b—25 to 29 inches, black (5Y 2/1) and very dark gray (5Y 3/1) silty clay or clay, dark gray (5Y 4/1) dry; few, fine, faint, olive (5Y 5/3) and few fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, fine and medium, subangular blocky structure; firm; ped faces smooth and have high sheen; very few, very fine pores; mildly alkaline; clear, smooth boundary.

IIB2gb—29 to 34 inches, dark-gray (5Y 4/1) silty clay or clay, olive gray (5Y 4/2) crushed; few, fine, faint, olive (5Y 5/3) and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, fine, subangular blocky structure; very firm; some black (5Y 2/1) stainings on peds; ped faces smooth and have high sheen; few soft dark oxides; mildly alkaline; gradual, smooth boundary.

IIB3gb—34 to 60 inches, gray (5Y 5/1) silty clay or clay; common, fine, distinct, strong-brown (7.5YR 5/8) mottles; some vertical cleavage; very firm; few fine soft dark oxides; mildly alkaline.

The Ap or A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). In places the A3 horizon is not present, and the Ap horizon abruptly overlies a Bg horizon. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The IIAb horizon ranges from 10 to 16 inches in thickness and begins at a depth of 15 to 24 inches. Hue is neutral or 2.5Y or 5Y. Value is 3 or less, and chroma is 1 or less. The IIBg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. Reaction is neutral to mildly alkaline throughout, but in places the Ap horizon is slightly acid.

Forney soils differ from Albaton soils and Luton silty clay, thin surface, in having, within a depth of 24 inches, a dark buried layer that was once the A horizon of a now buried soil. They have a thinner A horizon than Luton silty clay, thin surface. They have a thinner and less dark A horizon than Luton or Woodbury soils. All of these soils formed in alluvium and are associated on the landscape.

Forney silty clay (0 to 2 percent slopes) (553).—This soil is on bottom land. It is mainly in fairly broad areas at somewhat lower elevations than the associated Salix, Lakeport, Blencoe, Blend, and Luton soils. Included in mapping are small areas of Luton, thin surface, and Luton, Blend, and Blencoe soils. Individual areas are about 160 acres in size, but a few are larger.

This soil is moderately well suited to row crops. Most of the acreage is cultivated. Runoff is very slow. Wetness often reduces crop yields and delays fieldwork. The soil dries out cloddy and hard if tilled when wet; therefore it is often in poor tilth. Wetness often influences the choice of crops and methods of tillage and drainage. Capability unit IIIw-1.

Grable Series

The Grable series consists of nearly level, well-drained to somewhat excessively drained soils in the western part of the Missouri River bottom lands. These soils formed in recently deposited alluvium.

In a representative profile the surface layer is very dark grayish-brown coarse silt loam about 6 inches thick. The substratum to a depth of about 23 inches is stratified grayish-brown and dark grayish-brown, very friable coarse silt loam that has a few strong-brown mottles. Below this, to a depth of 60 inches, is stratified grayish-brown, loose fine sand that has common strong-brown and few light-gray mottles.

Grable soils are low in organic-matter content. They are mildly alkaline or moderately alkaline and are calcareous throughout. Permeability is moderate in the upper part and rapid in the underlying sand. Available water capacity is moderate. The supply of available phosphorus is very low. The supply of available potassium is high.

Most areas of Grable soils are cultivated. Before the construction of large dams and levees, these soils were subject to flooding. Now the hazard of flooding is slight in most areas. Only a few areas near the river or on the river side of protective levees are subject to flooding. The soils are droughty, and lack of available water often reduces yields.

Representative profile of Grable silt loam in a cultivated field 350 feet west and 1,100 feet south of the northeast corner of SW1/4 sec. 33, T. 79 N., R. 45 W.:

Ap—0 to 6 inches, very dark grayish-brown (2.5Y 3/2) coarse silt loam; few, fine, faint, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure that parts to weak, fine, granular; very friable; few very fine pores; some very fine sand grains; mildly alkaline, strongly effervescent; clear, smooth boundary.

C1—6 to 23 inches, stratified grayish-brown (2.5Y 5/2) and dark grayish-brown (2.5Y 4/2) coarse silt loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles at a depth of 10 to 17 inches; some strata are not mottled; weak, very thin to medium, platy structure; very friable; few fine pores; 1-inch stratum of dark grayish-brown silty clay loam at a depth of about 15 inches; few dark oxide stains; some organic coatings around root channels; some very fine sand on horizontal ped faces; mildly alkaline, strongly effervescent; abrupt, smooth boundary.

IIC2—23 to 60 inches, stratified grayish-brown (2.5Y 5/2) fine sand; common, fine, distinct, strong-brown (7.5YR 5/6) and few, fine, distinct, light-gray (5Y 6/1) mottles at a depth of 49 to 52 inches; some strata are not mottled; single grained; loose; silt loam lens at a depth of 49 to 52 inches; some dark oxide stains; moderately alkaline, strongly effervescent.

The A horizon, in most places the plow layer, is less than 10 inches thick. It is very dark gray (10YR or 2.5Y 3/1) or very dark grayish brown (10YR or 2.5Y 3/2) to dark grayish brown (10YR or 2.5 4/2). The C1 and IIC horizons are dark grayish brown (10YR or 2.5Y 4/2) or grayish brown (10YR or 2.5Y 5/2). The A and C1 horizons are typically silt loam, but range to very fine sandy loam. In places strata as much as 2 inches thick of finer or coarser material are in the C1 horizon. The IIC horizon is fine sand, sand, or loamy sand and is at a depth of 18 to 30 inches. Grable soils are mildly alkaline or moderately alkaline and dominantly calcareous throughout. In places the A horizon is noncalcareous.

Grable soils contain less clay in the A and C1 horizons than Vore and Percival soils and have more sand below a depth of 18 to 30 inches than Haynie soils. They have more silt and less sand in the A and C1 horizons than Carr soils. All are associated on the landscape.

Grable silt loam (0 to 2 percent slopes) (514).—This soil is on bottom land. It is in narrow areas at about the same elevation as the associated Haynie, Carr, Blake, and Vore soils. It is slightly higher on the landscape than Albaton or Onawa soils. Individual areas range mainly from about 40 to 100 acres, but a few are larger. Small areas of Haynie or Vore soils are included in mapping.

This soil is well suited to row crops, and most areas are cultivated. Droughtiness often reduces yields. This soil is well suited to irrigation. If the surface layer is dry, soil blowing is a hazard, particularly if the associated soils are also subject to blowing. Capability unit IIs–1.

Hamburg Series

The Hamburg series consists of somewhat excessively drained upland soils on bluffs at the east edge of the Missouri River Valley (fig. 11). These soils formed in very thick loess. Slopes range from 40 to 75 percent.

In a representative profile the surface layer is brown coarse silt loam about 4 inches thick. The substratum extends to a depth of many feet. It is yellowish-brown, very friable coarse silt loam that has some light brownish-gray and strong-brown mottles.

Hamburg soils are very low in organic-matter content. They are typically moderately alkaline and calcareous throughout. Permeability is moderately rapid. Available water capacity is high, but runoff is so rapid that the soil seldom soaks up enough moisture to reach capacity. The supply of available phosphorus and potassium is very low.

These soils are used for pasture. Erosion and gullying are serious hazards. Maintaining a good plant cover is important.

Representative profile of Hamburg silt loam, 40 to 75 percent slopes, in a native grass pasture 475 feet east of the southwest corner of SE¼NE¼ sec. 11, T. 79 N., R. 44 W.:

Figure 11.—Hamburg silt loam, 40 to 75 percent slopes.

A1—0 to 4 inches, brown (10YR 4/3) coarse silt loam; weak, fine, granular structure; very friable; many fine roots; moderately alkaline, strongly effervescent; clear, smooth boundary.

C1—4 to 16 inches, yellowish-brown (10YR 5/4) coarse silt loam; weak, very fine and fine, granular structure; very friable; common roots; moderately alkaline, strongly effervescent; diffuse, smooth boundary.

C2—16 to 65 inches, yellowish-brown (10YR 5/4) coarse silt loam; common, very fine, distinct, grayish-brown (10YR 5/2) and light brownish-gray (10YR 6/2) and few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, very fine, granular structure grading to massive to a depth of about 30 inches, massive below; very friable; many dark oxide stains throughout; few, round lime nodules in upper part, many below a depth of 3 feet; moderately alkaline, strongly effervescent.

The A horizon is generally less than 6 inches thick. It ranges from dark brown (10YR 3/3) to yellowish brown (10YR 5/4) and dark grayish brown (10YR 4/2). The C horizon ranges from brown (10YR 4/3) to pale brown (10YR 6/3) and light yellowish brown (10YR 6/4). It contains few to common mottles of grayish brown, light brownish gray, brown, and strong brown. The soils are mildly alkaline or moderately alkaline and calcareous throughout.

Hamburg soils have less clay and more very fine sand than the associated Ida soils. The small slump blocks, or "catsteps," characteristic of Hamburg soils, are not in Ida soils.

Hamburg silt loam, 40 to 75 percent slopes (2G).—This soil is on dissected uplands, east of the Missouri River Valley. Slump blocks, often called "catsteps," are a prominent feature. In most places downslope, this soil grades to the Castana or Napier soils. In places it is adjacent to areas of Ida soils. In some small areas the slope is as much as 90 percent. Tracts of this soil range widely in size; some are 1,000 acres or more. Some areas extend for several miles in continuous tracts 1/4 to 1 mile wide.

Included in mapping are small areas of less sloping Ida soils. Also included are small areas of Castana soils.

The entire acreage is in native grasses and scattered brushy plants and small trees. It is used mainly for pasture. Establishing and keeping a good stand of native grasses for pasture is a major concern of management. Erosion and gullying are serious hazards. Deer and other wildlife find habitat in areas of this soil. Use of the soil for parks and recreation is a possibility for the future. Capability unit VIIe-1.

Haynie Series

The Haynie series consists of nearly level, moderately well drained and well drained soils that are mainly on broad areas near, or within a few miles of, the Missouri River. These soils formed in recently deposited alluvium.

In a representative profile the surface layer is very dark grayish-brown silt loam about 6 inches thick. The substratum to a depth of about 25 inches is dark grayish-brown, very friable silt loam that has a few strata of very dark grayish brown. Below this is stratified dark grayish-brown and grayish-brown, very friable coarse silt loam that has common mottles of dark yellowish brown, reddish brown, and strong brown.

Haynie soils are low in organic-matter content. They are mildly alkaline or moderately alkaline and calcareous throughout. Permeability is moderate. Available water capacity is high. The supply of available phosphorus is very low. The supply of available potassium is high.

Most of the acreage is cultivated. Before the construction of large dams and levees, the soils were subject to flooding. Now the hazard of flooding is slight in most areas. Only a few areas near the river, particularly those mapped as Blake and Haynie soils, are subject to flooding.

Representative profile of Haynie silt loam in a cultivated field 430 feet east and 165 feet south of the northwest corner of SW1/4NW1/4 sec. 17, T. 78 N., R. 45 W.:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak, fine, subangular blocky structure and weak, very fine, granular; friable; few brown (10YR 5/3) coatings; mildly alkaline, strongly effervescent; clear, smooth boundary.

C1—6 to 25 inches, stratified dark grayish-brown (10YR 4/2) and some very dark grayish-brown (10YR 3/2) silt loam; weak, very thin, platy structure caused by stratification; friable; common, fine, distinct, dark yellowish-brown (10YR 4/4) stains and few dark-gray (10YR 4/1) organic stains, moderately alkaline, strongly effervescent; clear, smooth boundary.

C2—25 to 60 inches, stratified dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) coarse silt loam; common, fine and medium, distinct, dark yellowish-brown (10YR 4/4), common, fine, prominent, dark reddish-brown (5YR 3/4), and common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium and thin, platy structure caused by stratification; very friable; 38- to 40-inch layer is distinctly stratified silt and silty clay loam; moderately alkaline, violently effervescent.

The A horizon, generally the plow layer, is less than 10 inches thick. It ranges from very dark grayish brown (10YR or 2.5Y 3/2) to dark grayish brown (10YR or 2.5Y 4/2). The C horizon ranges from dark grayish brown (10YR or 2.5Y 4/2) to grayish brown (10YR or 2.5Y 5/2) and has strata of very dark grayish brown (10YR or 2.5Y 3/2) in places. Mottles generally have hue of 7.5YR or 10YR, value of 3 through 5, and chroma of 4 to 8, but in some places hue is 5YR or chroma is 1. The A horizon is typically silt loam, but in places it ranges to very fine sandy loam. The C horizon is typically silt loam, but some places have thin strata of material that ranges from fine sand to clay.

Haynie soils are higher in sand content and tend to have more strata of contrasting textures than McPaul soils. They are associated with Grable and Modale soils on the landscape. They are not underlain by sand as are the Grable soils. They lack the clayey textures that are below a depth of about 2 feet in Modale and Moville soils. All of these soils formed in alluvium.

Haynie silt loam (0 to 2 percent slopes) (137).—This soil is on bottom land. In some areas old shallow channels have been smoothed and now are farmed. Individual areas are as much as 300 acres in size. Onawa, Albaton, and Percival soils are associated with Haynie soils but are at slightly lower elevations. Also associated, but at about the same elevation, are Blake, Grable, Carr, Modale, Vore, and Kenmoor soils.

Included with this soil in mapping are small areas of Blake, Grable, Vore, and Carr soils. Sedimentation, soil blowing, or tillage have changed the texture of the surface layer in places. Also included, therefore, are a few places where the surface layer is loamy fine sand or sand.

This soil is well suited to row crops, and most areas are cultivated. It is also well suited to irrigation. It has no serious limitations for crops. If dry and barren of vegetation, it is subject to soil blowing. Soil blowing is most likely if the associated soils are also subject to blowing. Capability unit I–2.

Ida Series

The Ida series consists of well-drained soils that are extensive in the uplands. These soils are dominant on the sides of ridges in the western half of the uplands, and in many places they are on narrow, convex ridgetops. In the eastern part of the county, Ida soils are on side slopes along with Monona soils. Small areas of Ida soils are not uncommon within areas of Monona soils. These areas are shown on the soil map as calcareous spots. The soils formed in thick loess. Slopes are 5 to 40 percent.

In a representative profile the surface layer is dark grayish-brown to brown silt loam about 7 inches thick. The substratum is yellowish-brown, very friable silt loam that has a few grayish-brown and yellowish-brown mottles and a few small lime nodules.

Ida soils are low or very low in organic-matter content. They are moderately alkaline and are calcareous throughout. Permeability is moderate. Available water capacity is high. Fertility is very low. The supply of available phosphorus and potassium is very low.

Moderately sloping Ida soils are mostly cultivated. The moderately steep soils tend to be used more for hay and pasture than for row crops. The steep and very steep soils are used for pasture. In many places young trees and brush are growing in pastured areas. Sheet and gully erosion are serious hazards.

Representative profile of Ida silt loam, 14 to 20 percent slopes, severely eroded, in a cultivated field 83 feet west of the southeast corner of NE¼SE¼ sec. 4, T. 80 N., R. 43 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) to brown (10YR 4/3) silt loam, same color crushed; weak, fine, granular structure; very friable; moderately alkaline, strongly effervescent; clear, smooth boundary.

C1—7 to 19 inches, brown (10YR 4/3) to yellowish-brown (10YR 5/4) silt loam, yellowish brown (10YR 5/4) crushed; few, fine, faint, yellowish-brown (10YR 5/6) mottles; weak, very fine, granular structure to massive; very friable; many very fine pores; few small lime nodules; moderately alkaline, violently effervescent; gradual, smooth boundary.

C2—19 to 60 inches, yellowish-brown (10YR 5/4) silt loam; few, fine, faint, yellowish-brown (10YR 5/6) and few, fine, distinct, grayish-brown (10YR 5/2) mottles; massive but with some vertical cleavage; very friable; few worm casts and fine pores; very few dark oxides; few small lime nodules; moderately alkaline, violently effervescent.

The A horizon is less than 10 inches thick and is generally very dark grayish brown (10YR 3/2). In cultivated areas it is an Ap horizon generally about 6 to 8 inches thick. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to brown (10YR 4/3 or 5/3), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4). The C horizon has colors of 10YR hue, value of 4 or 5, and chroma of 3 to 6. It has few to common mottles of yellowish brown (10YR 5/6 or 5/8), strong brown (7.5YR 5/6 or 5/8), grayish brown (10YR or 2.5Y 5/2), and light brownish gray (10YR or 2.5Y 6/2). In places the Ap or A1 horizon is noncalcareous.

Ida soils have more clay but less very fine sand and coarse silt throughout than Hamburg soils. They are browner below the Ap horizon than the Dow soils. They do not have the B horizon characteristic of Monona soils and are not leached of calcium carbonates. All formed in loess and are associated on the landscape.

Ida silt loam, 5 to 9 percent slopes (IC).—This soil is mostly on convex ridgetops, but in places it is on the sides of ridges. It is typically upslope from more sloping Ida and Monona soils. A few areas are on short slopes at the edge of benches occupied by Monona soils. Areas are mainly small and narrow and 5 to 10 acres in size.

The surface layer of this soil is typically a very dark grayish-brown or brown plow layer. In a few places it is brown to yellowish brown, and in uncultivated areas it is typically very dark grayish brown and about 3 to 6 inches thick. In other respects this soil has a profile similar to that described as representative of the series.

This soil is moderately well suited to row crops if erosion is controlled. Most of the acreage is cultivated. Many grassy and wooded areas are used for pasture. This soil is very low in fertility. Lack of available nutrients often limits crop growth. Capability unit IIIe–2.

Ida silt loam, 5 to 9 percent slopes, severely eroded (IC3).—This soil is mostly on convex ridgetops and in many places is on the noses of these ridges. It is also in narrow bands on the shoulders of some convex side slopes. A few areas are on short slopes at the edge of benches occupied by Monona soils. In most places this soil is upslope from more sloping Ida or Monona soils. Individual areas are mostly long and narrow and range from 5 to 15 acres in size. The plow layer is generally dark grayish brown or brown. In a few areas it is very dark grayish brown or dark yellowish brown.

This soil is subject to sheet and gully erosion, but it is moderately well suited to row crops if erosion is controlled. Most areas are cultivated along with the surrounding soils. This soil is very low in fertility. Lack of available nutrients often limits crop growth. Capability unit IIIe–2.

Ida silt loam, 9 to 14 percent slopes (ID).—This soil is on the narrow tops and the sides of ridges. A few areas are on short slopes at the edge of benches occupied by Monona soils. This soil is mainly associated with other Ida soils or with Monona soils. Individual areas are long and narrow and generally are 5 to 15 acres in size.

In most places the surface layer is very dark grayish brown and about 3 to 6 inches thick. In small areas, however, it is dark brown or dark yellowish brown. In other respects the profile is similar to that described as representative of the series. Included in mapping are small areas of Napier or Monona soils.

This soil is subject to sheet and gully erosion, but it is moderately well suited to row crops if erosion is controlled. Most areas are in grass or grass and trees and are used for pasture, but some areas are cultivated. This soil is very low is fertility. Lack of available nutrients often limits crop growth. Capability unit IIIe–2.

Ida silt loam, 9 to 14 percent slopes, severely eroded (ID3).—This soil occupies entire side slopes in some places. In other places it is associated with other Ida soils or Monona soils. In some places it is on ridgetops. Monona soils are generally upslope, and in most places Napier soils or the Napier-Nodaway-Colo complex is downslope. In places this soil is mapped with Dow soils. A few areas are on short slopes at the edge of benches occupied by Monona soils. Individual areas of this soil are mainly long and narrow and range from about 5 to 30 acres in size.

The surface layer of this soil has been mixed with the substratum in plowing. It is generally brown or dark yellowish brown, but in a few areas it is very dark grayish brown. Otherwise the profile is similar to that described as representative of the series. Included in mapping are small areas of Monona or Napier soils.

This soil is subject to severe sheet and gully erosion, but it is moderately well suited to row crops if erosion is controlled. Most areas are cultivated, but some areas are in hay or pasture. This soil is very low in fertility. Lack of available nutrients often limits crop growth. Capability unit IIIe–2.

Ida silt loam, 14 to 20 percent slopes (1E).—This soil is mostly on the lower parts of side slopes, but in some places it occupies the entire slope. In many places the slopes form a cove at the head of upland drainageways. Monona or other Ida soils are upslope in most places, and Napier soils or soils of the Napier-Nodaway-Colo complex typically are downslope. Individual areas range from 5 to 30 acres in size.

The surface layer of this soil is typically less than 6 inches thick and generally is very dark grayish brown. In places, however, it is dark grayish brown, and in some small areas it is brown or dark yellowish brown. In other respects the profile is similar to that described as representative of the series. Included in mapping are small areas of Monona or Napier soils.

This soil is moderately well suited to row crops if erosion is controlled. The hazard of sheet and gully erosion is severe. Much of the acreage, particularly in the western part of the uplands, is grassy or wooded and is used as pasture. Some areas that have been cleared are used for crops. A common practice is to use this soil for hay or pasture much of the time and to grow a crop of corn just before the meadow has to be reseeded. This soil is very low in fertility. Lack of available phosphorus often limits growth of legumes. Capability unit IVe–1.

Ida silt loam, 14 to 20 percent slopes, severely eroded (1E3).—This soil mainly occupies entire side slopes that grade downslope to Napier soils or soils of the Napier-Nodaway-Colo complex. Monona or other Ida soils are mostly on the ridges upslope. In many places these slopes form a cove at the heads of upland drainageways. In a few places this soil occupies short breaks below Monona soils on benches. This is the most extensive soil in the county. It is throughout the uplands. Individual tracts range from 5 to 100 acres in size and are long and narrow.

This soil has the profile described as representative of the series. In places the plow layer is mixed with substratum material and is dark yellowish brown or yellowish brown. Included in mapping are small areas that have a darker colored surface layer. These are mostly near the boundary of Napier soils downslope. Also included are small areas of Monona, Dow, and Napier soils.

This soil is moderately well suited to row crops if erosion is controlled. The hazard of sheet and gully erosion is severe. Most areas are cultivated, but the trend is to use them for hay and pasture much of the time. A common practice is to grow a crop of corn just before the meadow has to be reseeded. This soil is very low in fertility. Lack of available phosphorus often limits the growth of legumes. Capability unit IVe–1.

Ida silt loam, 20 to 30 percent slopes (1F).—This Ida soil mainly occupies entire side slopes and is of greatest extent in the western part of the uplands. In places these slopes form a cove at the heads of upland drainageways. Monona or other Ida soils are mostly on the ridge crests upslope. This soil is adjacent to Hamburg soil in places. Napier soils or soils of the Napier-Nodaway-Colo complex are generally downslope. Individual areas typically range from 5 to 30 acres in size.

The surface layer of this soil is typically very dark grayish brown, dark grayish brown, or dark brown and is about 6 inches thick. In other respects the profile is similar to that described as representative of the series. In places are some severely eroded areas where this layer is thinner or is brown to dark yellowish brown. Included in mapping are small areas of Monona and Dow soils.

Steep slopes and the severe hazard of erosion make this soil poorly suited to row crops. It is better suited to hay or pasture. Most areas of this soil are in permanent or semipermanent pasture (fig. 12). Many wooded areas are managed as pasture. Legume-grass pasture has been established in places. A few areas are cultivated along with the soils that are not so steep. In places gullies have formed. This soil is very low in fertility. Steep slopes make the use of farm machinery risky. In many places renovating existing pastures to increase productivity is possible. Capability unit VIe–1.

Ida silt loam, 20 to 30 percent slopes, severely eroded (1F3).—This soil is in all parts of the county where the landscape is highly dissected, but it is most extensive in the western part of the uplands. It occupies the same landscape position and is associated with the same soils as Ida silt loam, 20 to 30 percent slopes. Individual tracts range from 5 to about 90 acres in size.

The surface layer is typically very thin. In most places it is brown or dark grayish brown and 3 to 4 inches thick. In places it consists mostly of substratum material and is brown to yellowish brown. In small areas that are not so severely eroded the surface layer is thicker and darker. In many places small areas of Monona soils are included in mapping. Downslope, small areas of Napier soils are included in places.

Steep slopes and the severe erosion hazard make this soil poorly suited to row crops. Hay or pasture are better suited. Most areas are in permanent or semipermanent pasture. Many areas have been cultivated, but now only a few areas are cultivated along with less sloping soils. Many wooded areas are managed as pasture. Legume-grass pasture has been established in places. Gullies have formed in places. The soil is very

Figure 12.—**Bluegrass pasture in an area of steep Ida soils.**

low in fertility. The steep slopes make use of farm machinery risky. In many places pastures can be renovated to increase their productivity. Capability unit VIe–1.

Ida silt loam, 30 to 40 percent slopes (1G).—This soil is mainly in the western part of the uplands near the bluffs along the Missouri River Valley. It typically occupies entire side slopes. In places these slopes form a cove at the heads of drainageways. Other Ida soils or Monona soils are typically upslope, but in places this soil is adjacent to Hamburg soils. Napier soils are generally downslope.

In about 60 percent of the areas the surface layer is typically about 3 to 6 inches thick and is very dark grayish brown or dark grayish brown. Most of the rest is severely eroded, and the surface layer is very thin and brown to yellowish brown. In other respects the profile is similar to that described as representative of the series. Included in mapping is about 140 acres where the surface layer is very dark grayish brown and thicker than typical.

This soil is not suited to cultivation and is mainly used for pasture. Many areas in grass are also wooded, but they are managed as pasture. The soil provides habitat for deer and other wildlife and has potential for the further development of wildlife habitat or for recreation areas Capability unit VIIe–1.

Keg Series

The Keg series consists of nearly level, well drained and moderately well drained soils that formed in alluvium. These soils are in broad areas at the highest elevations in the middle and eastern parts of the bottom land along the Missouri River.

In a representative profile the surface layer is silt loam about 18 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil extends to a depth of 35 inches. It is dark grayish-brown, friable silt loam to a depth of about 30 inches and brown, friable silt loam below. The substratum is brown silt loam.

Keg soils have moderate organic-matter content, high available water capacity, and moderate permeability. They are typically neutral in the surface layer and upper part of the subsoil. The subsoil is very low in available phosphorus and high in available potassium.

These soils have no serious limitations. Almost all areas are cultivated.

Representative profile of Keg silt loam in a cultivated field 935 feet south and 140 feet west of the northeast corner of NE¼ sec. 35, T. 78 N., R. 45 W.:

Ap—0 to 8 inches, black (10YR 2/1) silt loam, very dark brown (10YR 2/2) crushed; weak, medium, subangular blocky structure parting to weak, fine, granular; friable; neutral; clear, smooth boundary.

A12—8 to 18 inches, very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) crushed; weak, fine, subangular blocky structure parting to fine granular and very fine, subangular blocky; friable; neutral; gradual, smooth boundary.

B1—18 to 23 inches, dark grayish-brown (10YR 4/2) silt loam; faces of peds very dark grayish brown (10YR 3/2) and some very dark brown (10YR 2/2); weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B21—23 to 30 inches, dark grayish-brown (10YR 4/2) silt loam; weak, fine and very fine, subangular blocky structure; friable; some very dark brown (10YR 2/2) worm casts in upper part; few, fine, faint oxide stains; mildly alkaline; gradual, smooth boundary.

B22—30 to 35 inches, brown (10YR 4/3) silt loam; faces of peds dark grayish brown (10YR 4/2); weak, fine, subangular blocky structure; friable; few, fine, faint mottles or oxide stains; mildly alkaline, strongly effervescent; gradual, smooth boundary.

C—35 to 60 inches, brown (10YR 4/3) silt loam; faces of peds dark grayish brown (10YR 4/2); very weak, medium, subangular blocky structure to massive; friable; few, fine, faint oxide stains; few, fine, soft lime concretions; few worm casts; mildly alkaline, strongly effervescent.

The A horizon is typically 12 to 18 inches thick and ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). In some places the soil has a very dark grayish-brown (10 YR 3/2) A3 horizon. The B horizon ranges from 10YR to 2.5Y in hue, from 4 to 5 in value, and from 2 to 4 in chroma. Soft oxide stains and mottles begin between depths of 20 and 30 inches. They are generally few in number, are commonly 10YR in hue but range to 7.5YR and 2.5Y, and are typically 4 to 6 in value and 3 to 8 in chroma. Low-chroma mottles occur in places. The B3 horizon, where present, and the C horizon range from silt loam to very fine sandy loam. The C horizon has a range in color similar to that in the B horizon. Reaction is typically neutral or slightly acid in the A horizon and ranges from slightly acid to moderately alkaline in the B horizon.

Keg soils are associated with Salix, Burcham, and Lakeport soils. All formed in alluvium. Keg soils are silt loam to a depth of 60 inches, whereas Salix soils are silty clay loam to a depth of about 24 inches and Burcham soils are silty clay below a depth of 20 to 30 inches. Keg soils are less clayey throughout and are better drained than Lakeport soils.

Keg silt loam (46).—This nearly level soil is in slightly elevated areas on bottom land. It is typically at the same elevation or at slightly higher elevations on the landscape as the associated Salix, Lakeport, and Burcham soils, and it is higher than the associated Blencoe, Blend, Luton, and Woodbury soils. Individual areas are large. A few are up to 1,000 acres or more in size. Small areas of Salix, Lakeport, and Burcham soils are included with this soil in mapping.

This Keg soil is well suited to row crops (fig. 13). It is also well suited to irrigation. It has no serious limitations. Almost all the acreage is cultivated. Capability unit I–1.

Kenmoor Series

The Kenmoor series consists of stratified, nearly level, moderately well drained soils that formed in about 2 feet of sandy alluvium and the underlying silty clay. These soils are on bottom land within a mile or two of the Missouri River.

In a representative profile the surface layer is dark grayish-brown fine sand about 6 inches thick. The substratum to a depth of about 25 inches is stratified grayish-brown and dark grayish-brown, very friable fine sand. Below this, it is dark grayish-brown silty clay that has a few reddish-brown and brown mottles.

Kenmoor soils are very low or low in organic-matter content. They are typically mildly alkaline and calcareous throughout. Permeability is rapid in the upper part, but it is slow or very slow in the underlying silty clay. Available water capacity is low or moderate. The supply of available phosphorus is very low. The supply of available potassium is high.

Most areas of this soil are cultivated. A few are wooded and grassy and are in pasture. Droughtiness and soil blowing are hazards. In seasons of excessive rainfall the clayey substratum causes some areas to be wet for a time, but this is not a serious hazard in most places. Before construction of large dams and levees, these soils were subject to flooding. Now, only a few areas close to the river or on the river side of dikes are subject to flooding.

Representative profile of Kenmoor fine sand in a cultivated field 2,700 feet west and 1,360 feet south of the northeast corner of sec. 33, T. 79 N., R. 45 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) fine sand; single grained; loose; mildly alkaline, strongly effervescent; gradual, smooth boundary.

C1—6 to 25 inches, dark grayish-brown (10YR 4/2) fine sand; single grained; loose; few mottles of dark gray (10YR 4/1); mildly alkaline, strongly effervescent; abrupt, smooth boundary.

IIC1—25 to 60 inches, dark grayish-brown (2.5Y 4/2) silty clay; many, fine, distinct, brown (7.5YR 4/4) and few, fine, prominent, dark reddish-brown (2.5YR 3/4) mottles; moderate, fine, subangular blocky structure; firm; some dark organic stains on faces of peds; mildly alkaline, slightly effervescent; clear, smooth boundary.

The A horizon, in most places a plow layer, is less than 10 inches thick. It is very dark grayish brown (10YR or 2.5Y 3/2) or dark grayish brown (10YR or 2.5Y 4/2). It ranges from loamy fine sand to fine sand. The C1 horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2. It is fine sand or loamy fine sand. Mottles are few to common in this horizon and have hue of 10YR, 7.5YR, or 5YR, value of 3 to 6, and chroma of 3 to 8. The combined thickness of the A and C1 horizons is 20 to 30 inches. The IIC1 horizon has colors in hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2. It is silty clay or clay. Kenmoor soils are mildly alkaline or moderately alkaline and calcareous throughout.

In contrast with Carr soils, Kenmoor soils are underlain by silty clay at a depth of about 2 feet and have coarser textured A and C1 horizons. They are fine sand in the C1 horizon, whereas Modale soils are silt loam or very fine sandy loam. All formed in alluvium and are associated on the landscape.

Kenmoor fine sand (0 to 2 percent slopes) (849).—This soil is on bottom land, on slight rises mainly in

***Figure 13.*—Corn on Keg silt loam.**

association with Modale, Haynie, Sarpy, Grable, and Carr soils. Most areas are less than 75 acres in size, but a few are larger.

Included with this soil in mapping are places where the fine sand is about 16 to 20 inches thick. Also included are small areas of Modale very fine sandy loam and some areas where the material below a depth of 40 inches is silt loam.

This soil is moderately well suited to row crops. Much of the acreage is cultivated, but some is in pasture. Soil blowing is a serious hazard and at times young plants are damaged by blowing sand. Droughtiness often reduces yields. Capability unit IIIs–1.

Kennebec Series

The Kennebec series consists of moderately well drained soils on bottom land. These soils are along foot slopes at the eastern edge of the Missouri River bottom land and along most of the tributary streams on uplands. Kennebec soils formed in alluvium.

In a representative profile the surface layer to a depth of 10 inches is very dark grayish-brown silt loam. Between depths of 10 and 18 inches it is black, friable heavy silt loam, and to a depth of 42 inches it is very dark brown, friable heavy silt loam. The substratum is very dark grayish-brown and very dark gray silt loam that has a few reddish-brown mottles.

Kennebec soils are high in organic-matter content. They are typically about neutral in the surface layer. Permeability is moderate. Available water capacity is very high. The supply of available phosphorus is low. The supply of available potassium is medium.

Most of the acreage is cultivated. In many places these soils are subject to flooding and to the deposition of sediment.

Representative profile of Kennebec silt loam, overwash, in a cultivated field 880 feet south and 140 feet west of the northeast corner of NW¼ sec. 21, T. 81 N., R. 41 W.:

Ap—0 to 10 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine, subangular blocky structure; friable; few fine roots; some individual black (10YR 2/1) peds in lower part of horizon; mildly alkaline, weakly effervescent; abrupt, smooth boundary.

A12—10 to 18 inches, black (10YR 2/1) heavy silt loam, very dark brown (10YR 2/2) crushed; weak, medium, subangular blocky structure that parts to weak, very fine, subangular blocky and fine granular; friable; many fine pores; neutral; gradual, smooth boundary.

A13—18 to 29 inches, very dark brown (10YR 2/2) heavy silt loam, very dark brown crushed; weak, fine, subangular blocky structure; friable; many fine pores; neutral; gradual, smooth boundary.

AC—29 to 42 inches, very dark brown (10YR 2/2) heavy silt loam, very dark grayish brown (10YR 3/2) crushed; weak or moderate, very fine and fine, subangular blocky structure; friable; common fine pores; few grayish silt coatings evident on peds when dry; neutral; gradual, smooth boundary.

C—42 to 60 inches, very dark grayish-brown (10YR 3/2) and very dark gray (10YR 3/1) silt loam, very dark grayish brown (10YR 3/2) crushed; few, fine, distinct, reddish-brown (5YR 4/4) mottles; weak, medium, subangular blocky structure; friable; common fine pores; neutral.

The A horizon is typically more than 36 inches deep. The boundary between the surface layer and substratum is indistinct and gradual or diffuse in most places. The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), and very dark grayish brown (10YR 3/2). Silt loam overwash 6 to 15 inches thick that is very dark grayish brown (10YR 3/2) or dark grayish brown (10YR 4/2) is on the surface in places. Colors below the A1 horizon typically are very dark brown (10YR 2/2) to dark grayish brown (10YR 4/2), but hue is 2.5Y in places. Mottles are few and range in hue from 5YR to 2.5Y, in value from 4 to 6, and in chroma from 2 to 8. Texture is silty clay loam throughout. In places Kennebec soils range to slightly acid or medium acid in the A horizon.

Kennebec soils lack the distinct stratification characteristic of McPaul soils and are darker colored throughout. They are dark colored to a greater depth than Napier soils and lack colors of 3 chroma at a depth of less than 36 inches. They have less clay throughout than Colo soils and are better drained. All formed in alluvium and are associated on the landscape.

Kennebec silt loam (0 to 2 percent slopes) (212).—This soil is mainly associated with Moville and McPaul soils on the Missouri River bottom land. It is also in most other stream valleys, where it is mainly associated with Nodaway and Colo soils. Individual areas range to as much as about 300 acres in size. This soil has a profile similar to the one described as representative of the series, but it lacks the overwash.

Included with this soil in mapping are small areas of Nodaway or Colo soils. Also included is about 950 acres of a soil that is similar in texture but is dark grayish brown, instead of very dark grayish brown or darker, below a depth of about 24 to 30 inches, and about 50 acres of a soil that is similar but calcareous throughout.

This soil is well suited to row crops, and most areas are cultivated. Many areas are subject to flooding, but generally flooding occurs in spring before planting and crops are seldom damaged. This soil has no other serious limitations. Capability unit I–1.

Kennebec silt loam, overwash (0 to 2 percent slopes) (212+).—This Kennebec soil is on bottom land where flooding has deposited about 6 to 15 inches of very dark grayish-brown or dark grayish-brown silt loam overwash on the surface. It is associated with Kennebec silt loam and with Nodaway, Colo, and McPaul soils.

This soil has the profile described as representative of the series. Included in mapping is about 60 acres of a soil that is similar but calcareous throughout.

This soil is well suited to row crops, and most areas are cultivated. Most areas are subject to some flooding and the deposition of overwash. Flooding generally occurs before planting, but in some places in some years flooding damages crops. The overwash is somewhat lower in organic-matter content and in fertility than the rest of the surface layer. Capability unit I–1.

Lakeport Series

Lakeport soils are nearly level, somewhat poorly drained soils at slightly elevated positions in the central and eastern part of the Missouri River bottom land. They formed in alluvium.

In a representative profile the surface layer, about 21 inches thick, is black silty clay loam that grades to very dark gray and very dark grayish brown at a depth of about 14 inches. The subsoil, which extends to a depth of about 42 inches, is mainly dark grayish-brown and grayish-brown, firm silty clay loam that grades to light silty clay in the lower part. It has common to many brown and yellowish-brown mottles. The substratum to a depth of 60 inches is light brownish-gray silt loam that has many brown and yellowish-brown mottles.

Lakeport soils are high in organic-matter content. They are typically neutral in the surface layer and in the upper part of the subsoil. Permeability is moderately slow in the surface layer and subsoil. Available water capacity is high. The supply of available phosphorus is very low. The supply of available potassium is high.

Most areas of Lakeport soils are cultivated. There are no serious hazards to their use for crops.

Representative profile of Lakeport silty clay loam in a cultivated field 680 feet north and 660 feet east of the southwest corner of SW¼ sec. 30, T. 78 N., R. 44 W.:

Ap—0 to 6 inches, black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; cloddy, parting to moderate, fine, subangular blocky structure; friable; many very fine inped tubular pores; compacted; neutral; clear, smooth boundary.

A12—6 to 14 inches, black (10YR 2/1) silty clay loam, very dark brown (10YR 2/2) crushed; grayish brown (10YR 5/2) dry; moderate, fine and very fine, subangular blocky structure; friable; many very fine inped tubular pores; neutral; gradual, smooth boundary.

A3—14 to 21 inches, very dark gray (10YR 3/1) and some very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate, fine and very fine, subangular blocky structure; firm; few fine, distinct, brown (7.5YR 4/4) stains on peds; many very fine inped tubular pores; neutral; gradual, smooth boundary.

B21—21 to 27 inches, dark grayish-brown (2.5Y 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; common, fine, distinct, yellowish-brown (10YR 5/6) mottles and few, fine, distinct, brown (7.5YR 4/4-5/4) mottles; moderate, very fine, subangular blocky structure; firm; many very fine inped tubular pores; some very dark grayish-brown (2.5Y 3/2) ped coatings; neutral; gradual, smooth boundary.

B22—27 to 35 inches, dark grayish-brown (2.5Y 4/2) and grayish-brown (2.5Y 5/2) silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/4) mottles and few, fine, distinct, brown (7.5YR 4/4) mottles; moderate, fine, subangular blocky structure; firm; many very fine inped tubular pores; neutral; gradual, smooth boundary.

B3—35 to 42 inches, grayish-brown (2.5Y 5/2) with some dark grayish-brown (2.5Y 4/2) and dark-gray (10YR to 5Y 4/1) light silty clay; many, fine, distinct, yellowish-brown (10YR 5/4) mottles and many, very fine, distinct, brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure to massive; many very fine inped tubular pores; neutral; gradual, smooth boundary.

C1—42 to 48 inches, light brownish-gray (2.5Y 6/2) silt loam; many, medium, prominent, brown (7.5YR 4/4) mottles and common, fine, distinct, yellowish-brown (10YR 5/4) mottles; massive; friable; many fine pores; many fine soft oxides; mildly alkaline; clear, smooth boundary.

C2—48 to 60 inches, light brownish-gray (2.5Y 6/2) silt loam; many, medium, prominent, brown (7.5YR 4/4) mottles and common, fine, distinct, yellowish-brown (10YR 5/4) mottles; massive; friable; many fine pores; common vertical fillings which seem to be silty clay loam; few small lime nodules in lower part of horizon; mildly alkaline, strongly effervescent.

The A1 horizon is about 12 to 18 inches thick. It is black (10YR 2/1) or very dark brown (10YR 2/2). In places the soil has a very dark gray (10YR 3/1) or very dark grayish-brown (10YR 3/2) B1 horizon. Matrix colors of 3 value extend to a depth of about 24 inches in places, and they occur as coatings on peds to a depth of about 30 inches. The lower part of the B horizon ranges to light olive brown (2.5Y 5/4) and gray (5Y 5/1) or olive gray (5Y 5/2). Mottles are common and typically have hue of 10YR or 7.5YR, value of 3 to 6, and chroma of 3 to 8. In some places less contrasting mottles occur. The B horizon ranges from medium silty clay loam to light silty clay. In places the C horizon is similar in color and texture to the B horizon. In other places it ranges to silt loam, loam, clay loam, or very fine sandy loam and from yellowish brown (10YR 5/4) to light brownish gray (2.5Y 6/2). The common to many soft oxides and mottles in the C horizon have about the same range of color as those in the B horizon. In places the A horizon is slightly acid. In places the B3 horizon is mildly alkaline. In places carbonates are absent to a depth of 5 feet or more.

Lakeport soils have less clay throughout than Luton soils and less clay to a depth of about 2 to 3 feet than Woodbury soils. They have more clay below a depth of about 2 feet than Salix soils. All of these soils formed in alluvium on the Missouri River bottom land.

Lakeport silty clay loam (0 to 2 percent slopes) (436).—This soil is on bottom land. It is typically associated with, and at about the same elevation as, Keg and Salix soils. It is at slightly higher elevations than the associated Luton, Woodbury, Blencoe, and Blend soils. Individual areas range from 10 to 80 or more acres in size. Included in mapping are small areas of Salix and Keg soils.

This soil is well suited to row crops, and most areas are cultivated. The water table is high at times, but seldom long enough to seriously limit crop growth. A few slightly depressed areas are ponded for a short time after rains, but this seldom seriously harms crops or delays fieldwork. Where this soil is in fields along with wetter soils, tillage and other fieldwork are delayed at times. Capability unit I–1.

Luton Series

The Luton series consists of nearly level, very poorly drained and poorly drained soils in the central and eastern parts of broad areas on the Missouri River bottom land. These soils formed in alluvium.

In a representative profile the surface layer, about 26 inches thick, is mainly black silty clay, but grades to very dark gray silty clay or clay in the lower part. The subsoil, which extends to a depth of about 42 inches, is dark-gray and gray firm silty clay that is mottled with olive brown, brown, and strong brown. The substratum is gray and olive-gray silty clay or clay mottled with strong brown.

Luton soils are high in organic-matter content. They are typically neutral in the surface layer and subsoil. Permeability is very slow. Available water capacity mainly is moderate, but in areas that have silt loam overwash the capacity is somewhat higher than in those without the overwash. The supply of available phosphorus is very low. The supply of available potassium is high.

Most of the acreage is cultivated. Wetness is the main hazard. Some areas are subject to flooding from large ditches that carry water from tributary streams, but this hazard is not serious in most areas. Water ponds in some areas.

Representative profile of Luton silty clay in a cultivated field 2,200 feet south and 160 feet east of the northwest corner of NW¼ sec. 4, T. 78 N., R. 44 W.:

Ap—0 to 6 inches, black (10YR 2/1) silty clay; cloddy, parting to weak, medium, subangular blocky structure; firm; neutral; clear, smooth boundary.

A12—6 to 14 inches, black (10YR 2/1) silty clay; few, very fine, faint, very dark brown (10YR 2/2) mottles; moderate, fine and very fine, subangular blocky structure; firm; very few, very fine, inped tubular pores; thin, discontinuous shiny coatings on ped faces; neutral; gradual, smooth boundary.

A13—14 to 21 inches, black (10YR 2/1) silty clay; common, very fine, faint, very dark brown (10YR 2/2) mottles; strong, fine, subangular blocky structure; firm; very few, very fine tubular pores; thin, discontinuous shiny coatings on ped faces; neutral; gradual, smooth boundary.

A3—21 to 26 inches, very dark gray silty clay or clay; common, fine, distinct, dark grayish-brown (2.5Y 4/2) and few, fine, distinct, brown (7.5YR 4/4) mottles; moderate, fine and medium, subangular blocky structure; firm; very few, very fine tubular pores; thin, nearly continuous shiny coatings on ped faces, most prominent on vertical faces; neutral; clear, smooth boundary.

B1g—26 to 30 inches, dark-gray (5Y 4/1) silty clay or clay; many, fine, distinct, olive-brown (2.5Y 4/4) and common, fine, distinct, brown (7.5YR 4/4) mottles; weak, fine and medium, subangular blocky structure; firm; patchy black (5Y 2/1) channel fillings; thin, nearly continuous shiny coatings on ped faces are most prominent on the vertical faces; neutral; gradual, smooth boundary.

B2g—30 to 42 inches, gray (5Y 5/1) silty clay or clay; many, fine, distinct, strong-brown (7.5YR 5/6) and common, fine, distinct, brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure; firm; few soft dark oxides; thin, patchy shiny coatings on peds; some small lime nodules; neutral; gradual, smooth boundary.

Cg—42 to 60 inches, mixed gray (5Y 5/1) and olive-gray (5Y 5/2) silty clay or clay; many, fine, distinct, strong-brown (7.5YR 5/6 and 5/8) mottles; massive; firm; many soft dark oxides; some small lime nodules; very dark gray (5Y 3/1) layer in lower 2 inches of horizon; mildly alkaline.

The A horizon is black (10YR 2/1 or N 2/0) but grades to very dark gray (N 3/0, 10YR 3/1, or 5Y 3/1) in the A3 horizon in most places. In Luton silty clay, thin surface, the A horizon is 10 to 20 inches thick; in Luton silty clay it is about 20 to 30 inches thick. Luton silt loam, overwash, has 6 to 15 inches of very dark grayish-brown (10YR 3/2) or dark grayish-brown (10YR 4/2) silt loam overwash on the surface. The Bg horizon is typically dark gray (5Y 4/1), gray (5Y 5/1), or olive gray (5Y 5/2) and has common mottles that range in hue from 7.5YR to 5Y, in value from 4 to 6, and in chroma from 2 to 8. Colors in the Cg horizon are similar to those of the B horizon. The thin buried A horizons or strata of darkened sediment in the B or C horizons in a few places are within the range of the series. Luton soils are neutral to mildly alkaline in the A horizon and upper part of the B horizon. The lower part of the B horizon and the Cg horizon range from neutral and noncalcareous to moderately alkaline and calcareous.

Luton soils lack the silty clay loam layer characteristic of Blend soils. They do not have the silty clay loam texture within a depth of 40 inches as do Woodbury soils, and they are more clayey below a depth of about 2 feet than Blencoe soils. All these soils formed in alluvium and are associated on the landscape.

Luton silt loam, overwash (66+).—This soil is on bottom land, in areas that have had overwash deposited by floodwaters from drainage ditches or from streams that drain the uplands. In places, embankments along the ditches have broken, allowing the sediment to be deposited. These soils are mainly associated with Moville, McPaul, and other Luton soils. Individual areas range from about 25 acres to several hundred acres in size.

This soil has a profile similar to that described as representative of the series, but it has 6 to 15 inches of very dark grayish-brown or dark grayish-brown silt loam overwash on the surface. Included in mapping are small areas of Moville soils. Also included is about 380 acres of Luton silty clay, thin surface, that has an overwash similar to this soil.

This soil is moderately well suited to row crops, and most areas are cultivated. A high water table and very slow runoff commonly reduce crop yields and delay planting or tillage. This soil is subject to flooding unless protected. Power requirements for tillage are lower and tilth generally is better on this soil than on the other Luton soils that do not have the silty overwash. Capability unit IIIw–1.

Luton silty clay (66).—This soil is on bottom land, in low, nearly level areas, some of which are slightly depressional. It is associated with other Luton soils or with Blencoe, Blend, Woodbury, and Solomon soils in most places. Most individual areas are large, some as much as 1,500 or more acres.

This soil has the profile described as representative of the series. Included in mapping are small areas that have 6 to 15 inches of very dark grayish-brown, silty overwash deposited on the surface. Also included are small areas of Luton silty clay, thin surface, and areas of Solomon and Blend soils.

This soil is moderately well suited to row crops, and most areas are cultivated. A high water table and very slow runoff make wetness a serious limitation. Adequate drainage is needed. Delay in planting and other fieldwork is common. In some places in years of excessive rainfall, seeds fail to germinate and replanting is necessary. It is often necessary to till the soil wet. The soil dries out cloddy and hard resulting in poor tilth. Wetness and the clay content of the soil influence the choice of crops and the kinds of tillage and drainage. Some areas are subject to flooding. Capability unit IIIw–1.

Luton silty clay, thin surface (866).—This nearly level soil is in broad areas on the central and eastern parts of the Missouri River bottom land. Other Luton soils are associated with this soil and are typically slightly lower in elevation. Also associated are Forney, Salix, Keg, Blend, Blencoe, and Woodbury soils. This soil is the most extensive of those on the Missouri River bottom land. Areas are typically large, and some areas occupy about 1,200 or more acres.

This soil has a profile similar to that described as representative of the series, but it has a surface layer 10 to 20 inches thick. Included in mapping are some small areas of Luton silty clay.

This soil is moderately suited to row crops, and most areas are cultivated. Very slow runoff and a high water table make wetness a serious limitation, but not so serious as on Luton silty clay. Few, if any, areas are subject to flooding. Wetness commonly reduces crop yields and in some seasons delays planting and other fieldwork. If tilled when wet, this soil tends to dry out cloddy and hard and tilth is poor. Capability unit IIIw–1.

McPaul Series

The McPaul series consists of stratified, nearly level, well drained and moderately well drained soils at the extreme eastern edge of the Missouri River bottom land where it parallels the uplands. These soils are mostly in desilting basins and along drainage ditches that flow across the bottom land. They are also along flood plains of tributaries that flow onto bottom land. They formed in alluvium washed from the nearby uplands.

In a representative profile the surface layer is very dark grayish-brown and grayish-brown silt loam about 7 inches thick. The substratum to a depth of 44 inches is stratified dark grayish-brown, very friable and friable silt loam mottled and stained with dark yellowish brown, gray, and grayish brown. From a depth of 44 to 60 inches it is very dark gray, friable heavy silt loam that was once the surface layer of a now buried soil. This layer has a few yellowish-brown and dark-brown mottles and stains.

These soils are low in organic-matter content. They are moderately alkaline and are calcareous throughout. Permeability is moderate. Available water capacity is high. The supply of available phosphorus is very low. The supply of available potassium is medium.

Most areas of McPaul soils are cultivated. In places the soils are subject to flooding and in some areas they are subject to receiving silty deposition on the surface. In most areas they have no serious limitations.

Representative profile of McPaul silt loam in a cultivated field 240 feet north and 420 feet east of the southwest corner of NE¼NE¼ sec. 27, T. 78 N., R. 44 W.:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) and about 30 percent dark grayish-brown (10YR 4/2) silt loam; evident stratification with weak thick plates that appear to have been broken by plowing and that part to weak, fine, granular structure; friable; moderately alkaline, slightly effervescent; clear, smooth boundary.

C1—7 to 31 inches, stratified dark grayish-brown (10YR 4/2) and common, thin strata of very dark grayish-brown (10YR 3/2) silt loam; common, fine, dark yellowish-brown (10YR 3/4 and 4/4) and few, fine, faint, gray (10YR 5/1) and grayish-brown (10YR 5/2) stains or mottles on plates; stratified, thin and medium plates that part to weak, fine, subangular blocky structure; very friable; top 4 inches is most strongly stratified; moderately alkaline, strongly effervescent; abrupt, smooth boundary.

C2—31 to 44 inches, stratified dark grayish-brown (10YR 4/2) coarse silt loam; few to common, fine, distinct, dark yellowish-brown (10YR 4/4) stains or mottles on plates; weak, horizontal cleavage that parts to weak, medium, platy in lower part; friable; few very dark gray (10YR 3/1) fills in fine channels and voids; mildly alkaline, strongly effervescent; clear, smooth boundary.

IIA1b—44 to 60 inches, very dark gray (10YR 3/1) heavy silt loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles and some dark-brown (7.5YR 3/2) stains; weak, fine, angular blocky structure; friable; mildly alkaline, slightly effervescent.

The A horizon, in most places the plow layer, is less than 10 inches thick and is very dark grayish brown (10YR 3/2) or dark grayish brown (10YR 4/2). The C horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. Thin strata of very dark grayish brown (10YR 3/2) are also in the range. Common mottles and stains in the C horizon range from dark brown (7.5YR 3/2) to yellowish brown (10YR 5/8); a few are grayish brown (10YR 5/2) or gray (10YR 5/1). The texture is silt loam throughout, but buried darkened layers are silty clay loam in places. Darkened buried layers are present below a depth of about 2 feet in some places. McPaul soils are mildly alkaline or moderately alkaline throughout and are calcareous.

McPaul soils are associated with and resemble Nodaway soils, but are calcareous throughout. They have a higher sand content than Haynie soils and typically have few strata of contrasting textures. They formed in similar parent materials.

McPaul silt loam (0 to 2 percent slopes) (70).—In most places this soil is in desilting basins on the eastern part of the Missouri River bottom land. It is also along drainage ditches that cross the bottom land. In some places it is in long, narrow areas that parallel the uplands. It is associated with Kennebec, Luton, Napier, and Moville soils in this area. It is also along tributaries that flow onto the bottom land. Here it is mainly associated with Napier soils or, in places, with Nodaway soils. Areas of this soil range from small to large in size. Some areas extend for several miles along streams and occupy several hundred acres.

About 1,100 acres of this soil has a black or very dark gray silt loam or light silty clay loam layer, beginning at a depth of about 2 to 3 feet, that was once the surface layer of a now buried soil. Included in mapping are areas of Moville and Nodaway soils.

This soil is well suited to row crops, and most areas are cultivated. Many areas are subject to some flooding and to the deposition of silty sediment. Flooding generally occurs early in spring or is not severe, and therefore is not a serious limitation. Capability unit I–2.

Modale Series

The Modale series consists of nearly level, moderately well drained and somewhat poorly drained soils on the Missouri River bottom land, near the main stream channel. Many areas are along and above old stream meanders. These soils formed in alluvium.

In a representative profile the surface layer is very dark grayish-brown silt loam about 7 inches thick. The substratum to a depth of about 22 inches is stratified dark grayish-brown, very friable silt loam that has few brown and common strong-brown mottles. To a depth of 60 inches it is dark grayish-brown silty clay that has few strong-brown and yellowish-brown mottles.

Modale soils are low in organic-matter content. They are mildly alkaline throughout. Permeability is moderate or moderately rapid in the upper part, but is very slow or slow in the underlying silty clay. Available water capacity is moderate or high. The supply of available phosphorus is very low. The supply of available potassium is high.

Most of the acreage is cultivated. Before the construction of large dams and levees, these soils were subject to flooding. Now the hazard in most areas is slight. Only few areas very near the river or on the river side of protective levees are subject to flooding. Soil blowing is a hazard at times, particularly on Modale very fine sandy loam.

Representative profile of Modale silt loam in a cultivated field 210 feet south and 135 feet west of the northwest corner of NW¼NE¼ sec. 19, T. 78 N., R. 45 W.:

Ap—0 to 7 inches, very dark grayish-brown (2.5Y 3/2) silt loam; weak, fine, subangular blocky structure that parts to weak, very fine, granular; friable; mildly alkaline, strongly effervescent; clear, smooth boundary.

C1—7 to 22 inches, stratified dark grayish-brown (2.5Y 4/2) silt loam; few, fine, distinct, brown (7.5YR 4/4) and few to common, fine, distinct, strong-brown (7.5YR 5/6) mottles; some horizontal cleavage; very friable; weak, thin strata of silty clay loam in a few places; common light brownish-gray (2.5Y 6/2) coatings on faces of peds in upper part of horizon; mildly alkaline, strongly effervescent; clear, smooth boundary.

IIC2—22 to 60 inches, dark grayish-brown (2.5Y 4/2) silty clay; few, fine, distinct, strong-brown (7.5YR 5/6) and few, fine, faint, yellowish-brown (10YR 5/4) mottles; moderate, fine and medium, subangular blocky structure; firm; some shiny coatings on faces of peds from a depth of 30 to 37 inches; mildly alkaline, strongly effervescent; clear, smooth boundary.

The A horizon, in many places the plow layer, is less than 10 inches thick. It ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR or 2.5Y 4/2). The C1 horizon has hue of 10YR or 2.5Y and value of 4 or 5. Chroma of 2 is dominant, but individual strata range to chroma of 3 or 4. Mottles in the C1 horizon have hue of 10YR, 2.5Y, or 5Y, value of 3 to 6, and chroma of 1 to 8. The A and C1 horizons are silt loam or very fine sandy loam, and in places thin strata of loamy fine sand are in the C1 horizon. The IIC horizon begins at a depth of 18 to 30 inches. It is silty clay or clay. It has hue of 10YR, 2.5Y, or N, value of 3, 4, or 5, and chroma of 2 or less. Except for a few random strata, only the upper 10 inches of the IIC horizon has color value of 3. Modale soils are mildly alkaline or moderately alkaline and are typically calcareous throughout. In places the A horizon is noncalcareous.

Modale soils have less fine sand in the A and C1 horizons than Kenmoor soils. They differ from Haynie soils in having a IIC horizon of silty clay at a depth of about 2 feet. They are associated with Haynie and Kenmoor soils on the landscape and formed in similar parent material.

Modale very fine sandy loam (0 to 2 percent slopes) (549).—This soil is on bottom land. It is most commonly associated with Modale silt loam and Kenmoor, Haynie, and Vore soils.

This soil has a profile similar to that described as representative of the series, but in most places the surface layer and material above the silty clay is very fine sandy loam. In places the plow layer is loam or loamy fine sand. Included in mapping are areas of Kenmoor and Haynie soils and Modale silt loam.

Most of the acreage is cultivated. Soil blowing is a hazard, particularly if the surface is dry and barren of vegetation, and at times young plants are injured. Available water capacity is somewhat less on this soil than on Modale silt loam. The soil tends to be droughty in years of less than average precipitation. It is suited to irrigation. Capability unit IIs–1.

Modale silt loam (0 to 2 percent slopes) (149).—This soil is on bottom land. It is most commonly associated with Modale very fine sandy loam and Haynie, Kenmoor, Vore, and Blake soils.

This soil has the profile described as representative of the series. Included in mapping are small areas of Kenmoor, Vore, Haynie, and Blake soils.

This soil is well suited to row crops, and most areas are cultivated. In some seasons the water table is perched above the clayey part of the substratum. In years of above average rainfall, root growth is restricted and yields of some crops are reduced. In most years this hazard is not a serious one. Soil blowing occurs if the soil is dry or barren of vegetation, especially if the surrounding soils are sandy and subject to blowing. Capability unit I–2.

Monona Series

The Monona series consists of well-drained soils on crests and sides of ridges and some high benches. Slopes range from 0 to 40 percent. These soils formed in thick loess.

In a representative profile the surface layer is about 15 inches thick and is mainly very dark brown silt loam. The subsoil, which extends to a depth of about 30 inches, is brown, friable silt loam. The substratum to a depth of 60 inches is brown, very friable silt loam that has a few grayish-brown and common brown mottles.

The organic-matter content is moderate or low, depending on the landscape position and the amount of erosion that has taken place. Reaction is typically slightly acid in the surface layer and neutral in the subsoil. Permeability is moderate. Available water capacity is high. The supply of available phosphorus is typically very low. The supply of available potassium is low or very low.

Most areas of nearly level to moderately steep Monona soils are cultivated; steeper areas are generally in pasture. Monona soils are subject to erosion, and the hazard increases with increasing slope.

Representative profile of Monona silt loam, 0 to 2 percent slopes, in a cultivated field 220 feet north and 1,044 feet east of the southwest corner of SW1/4 sec. 13, T. 80 N., R. 41 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam, very dark brown crushed; weak, fine, subangular blocky structure that parts to weak, fine, granular; friable; few very fine pores; slightly acid; clear, smooth boundary.

A3—7 to 15 inches, very dark brown (10YR 2/2) and dark-brown (10YR 3/3) silt loam, very dark grayish brown (10YR 3/2) crushed; weak, fine, subangular blocky structure that parts to very fine, granular; friable; few very fine pores; slightly acid; clear, smooth boundary.

B1—15 to 21 inches, brown (10YR 4/3) silt loam; weak, fine, subangular blocky structure; friable; common very fine pores; neutral; gradual, smooth boundary.

B2—21 to 30 inches, brown (10YR 4/3) silt loam; weak, fine, subangular blocky structure; friable; many fine pores; few very fine soft dark oxides; neutral; gradual, smooth boundary.

C—30 to 60 inches, brown (10YR 4/3) silt loam; common, very fine, faint, brown (7.5YR 4/4) mottles and few, fine, distinct, grayish-brown (2.5Y 5/2) mottles; massive; very friable; few very fine pores; many very fine soft dark oxides; neutral to mildly alkaline.

The A horizon is generally 10 to 18 inches thick on nearly level soils or on uneroded soils. It is black (10YR 2/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). Typically the B1 horizon is dark brown (10YR 3/3) or brown (10YR 4/3), and the B2 horizon is brown (10YR 4/3) to yellowish brown (10YR 5/4). The B horizon is generally 12 to 24 inches thick. The A and B horizons are typically silt loam, but thin layers of light silty clay loam in the lower part of the A horizon or upper part of the B horizon are in the range. The C horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4) and has few common mottles of grayish brown, light brownish gray, yellowish brown, or strong brown. The A horizon ranges to medium acid in places. The C horizon is neutral to moderately alkaline. Monona soils are commonly calcareous at a depth of about 4 feet, but the extreme range is 2 to 6 feet.

Monona silt loam, 9 to 14 percent slopes, severely eroded (10D3) and Monona silt loam, 14 to 20 percent slopes, severely eroded (10E3) have an A horizon that is thinner or lighter colored, or both, than is defined as the range of the series, but this does not greatly affect their use and behavior.

Monona soils have a B horizon, whereas Ida soils do not. They are not calcareous throughout as are the Ida and Dow soils. They are dark brown and yellowish brown, whereas Dow soils are light brownish gray or olive gray below the Ap horizon. All formed in loess and are associated on the landscape.

Monona silt loam, 0 to 2 percent slopes (10).—This soil is mainly on broad upland divides. In many places it is associated with, and surrounded by, Monona silt loam, 2 to 5 percent slopes, downslope. Many areas are oval shaped and range from 5 to 40 acres in size. This soil has the profile described as representative of the series.

This soil is well suited to row crops and has no serious limitations for crops. Most of the acreage is cultivated, generally along with the soils that surround it. Because this soil is leached more deeply and is more acid in the surface layer, it is more likely to need additions of lime than the sloping Monona soils. Capability unit I–3.

Monona silt loam, benches, 0 to 2 percent slopes (T10).—This soil is dominantly on broad, high, loess-covered benches near the Boyer, Soldier, and Willow Rivers. Small scattered areas are on loess-mantled benches along other smaller streams. This soil generally is surrounded by Monona silt loam, benches, 2 to 5 percent slopes, which is downslope. Tracts are irregular in shape and range in size mainly from 5 to about 75 acres, but a few areas are larger.

The profile of this soil is similar to that described as representative of the series, but the loess in which this soil formed is underlain by alluvial sediment instead of glacial till. Included in mapping are small areas less than 2 acres in size that are slightly depressional and ponded for very short periods. These small areas are shown on the soil map by a wet spot symbol.

This soil is well suited to row crops and has no serious limitations for crops. Most of the acreage is cultivated. Because this soil in many places is leached more deeply and is more acid in the surface layer, it is more likely to need additions of lime than the sloping Monona soils. Capability unit I–3.

Monona silt loam, 2 to 5 percent slopes (10B).—This soil occupies the tops of convex ridges in the uplands. It is typically downslope from areas of the nearly level Monona soils and upslope from the more sloping Monona and Ida soils. It occupies areas that range from about 5 acres to as much as about 100 acres in size and in places extend for a mile or more along the crests of some divides.

This soil has a profile similar to that described as representative of the series, but it typically has a surface layer a few inches thinner. Included in mapping are small moderately eroded areas that have a dark-brown or very dark grayish-brown plow layer.

This soil is subject to erosion, but it is well suited to row crops if erosion is controlled. Most of the acreage is cultivated. Capability unit IIe–2.

Monona silt loam, benches, 2 to 5 percent slopes (T10B).—This soil is on loess-covered benches near the Boyer, Willow, and Soldier Rivers. Some scattered areas are on benches near smaller streams. Downslope in most places are steeper Monona soils that are on short sloping positions at the edge of benches. In places Ida soils are downslope, and in other places such soils of the foot slopes or bottom lands as Napier, Nodaway, or Kennebec are downslope. The irregularly shaped areas of this soil range mainly from 10 to about 80 acres in size but some are larger.

This soil has a profile similar to that described as representative of the series, but the surface layer is typically a few inches thinner. In contrast with the loess-derived soils of the uplands that overlie glacial till, this soil formed in loess that overlies alluvial sediment.

This soil is subject to erosion, but is well suited to row crops if erosion is controlled. Most of the acreage is cultivated. Capability unit IIe–2.

Monona silt loam, 5 to 9 percent slopes (10C).—This Monona soil is mainly on the tops and sides of convex ridges. Areas on the sides of ridges are mainly below the less sloping Monona soils on ridges. The areas on ridges generally are upslope from steeper Ida or Monona soils and in places extend for a mile or more along some ridges. Most areas are between 10 and 80 acres in size, but a few are larger or smaller.

About 450 acres of this soil is in areas of short slopes at the edge of benches. Napier soils or such bottom land soils as those of the Kennebec series are generally downslope. Less sloping Monona soils are upslope. The areas at the edge of benches generally range from about 5 to 15 acres in size.

The surface layer is very dark brown to very dark grayish brown and is generally 7 to 12 inches thick. The subsoil is generally somewhat thinner than that of the less sloping Monona soil, and it is generally calcareous at a depth of 3 to 4 feet. In contrast with the upland soils that overlie glacial till and that formed in loess, the soils on benches overlie alluvial sediment.

Included with this soil in mapping are small areas that have a thinner eroded surface layer that is very dark grayish brown or dark brown. Also included are small areas of Ida soils.

This soil is subject to erosion but is moderately well suited to row crops if erosion is controlled. Most areas of this soil are cultivated, but some that are on ridges upslope from steep soils are pastured. Some areas on benches are on short, irregular sloping positions that complicate the application of soil-conserving practices. Capability unit IIIe–1.

Monona silt loam, 5 to 9 percent slopes, moderately eroded (10C2).—This soil is mainly on the sides and tops of convex ridges. Areas on the sides of ridges are typically below less sloping Monona soils on the tops of ridges. Areas on ridgetops generally are upslope from steeper Ida or Monona soils and may extend for a mile or more. Most areas range from about 10 to 80 acres in size, but a few are larger or smaller.

About 900 acres of this soil is in areas of short slopes at the edge of benches. Napier soils or such bottom land soils as those of the Kennebec series are generally downslope. Less sloping Monona soils are upslope. Individual areas are long and narrow and generally range from 5 to 25 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is thinner and lighter colored. The surface layer is a very dark grayish-brown plow layer in most places. This soil is calcareous at a depth of 3 to 4 feet in most places. In contrast with upland soils that formed in loess and overlie glacial till, the soils at the edge of benches overlie alluvial sediment.

Included in mapping are small, severely eroded areas where the plow layer is mostly dark-brown or brown subsoil material and is thinner than that of the profile described for the series in most places.

This soil is subject to erosion, but is moderately well suited to row crops if erosion is controlled. Most of the acreage is cultivated. Some areas on benches are on short, irregular slopes that complicate the application of soil-conserving practices. Capability unit IIIe–1.

Monona silt loam, 9 to 14 percent slopes (10D).—This soil in many places is in bands on side slopes, generally between less sloping Monona soils upslope and steeper Ida or Monona soils downslope. In places it occupies entire side slopes that are upslope from Napier soils or such soils of the bottom lands as those of the Kennebec series. Most areas range from about 5 to 40 acres in size.

The surface layer of this soil is generally very dark brown to very dark grayish brown and is about 7 to 12 inches thick. The subsoil is typically thinner and mottles are shallower than in the profile described as representative of the series. The soil is calcareous at a depth of 30 to 40 inches in many places.

Included in mapping are small areas of eroded soils that have a thinner surface layer. Also included are small areas of Ida and Dow soils.

This soil is moderately well suited to row crops if erosion is controlled. Some areas of this soil are cultivated. Much of it is in permanent pasture. It is subject to sheet erosion and gullying. Capability unit IIIe–1.

Monona silt loam, 9 to 14 percent slopes, moderately eroded (10D2).—This soil in many places is in bands on side slopes, generally between less sloping Monona soils upslope and steeper Ida or Monona soils downslope. In places it occupies entire side slopes that are upslope from Napier soils or such soils of the bottom lands as those of the Kennebec series. Most areas range from about 5 to 40 acres in size.

About 300 acres of this soil is in areas of short slopes at the edge of benches. Napier soils or such bottom land soils as those of the Kennebec series are generally downslope. Less sloping Monona soils are upslope. Most areas range from about 5 to 25 acres in size.

The surface layer, in most places a plow layer, is very dark grayish brown. Some dark-brown or brown subsoil is mixed in the plow layer in places. The subsoil is typically thinner and the depth to mottles is less than in the Monona silt loam, 0 to 2 percent slopes. The soil is calcareous at a depth of between 30 and 40 inches in many places. In contrast with the upland soils that formed in loess and overlie glacial till, the soils at the edge of benches overlie alluvial sediment.

Included with this soil in mapping are small areas of Napier, Ida, or Dow soils. Also included are small, severely eroded areas where the surface layer is mainly brown or dark-brown subsoil material.

This soil is moderately well suited to row crops if erosion is controlled. Most of the acreage is cultivated. It is subject to further sheet erosion and gullying. Capability unit IIIe–1.

Monona silt loam, 9 to 14 percent slopes, severely eroded (10D3).—This soil is on side slopes. It is generally downslope from other Monona soils and upslope from Ida and Napier soils. Individual areas range generally from 3 to 10 acres in size.

The surface layer of this soil is mostly dark-brown or brown subsoil material. The subsoil is thinner and the depth to mottles is less than in the profile described as representative of the series. The soil is calcareous at a depth of 30 to 40 inches in many places.

Included in mapping are a few less eroded areas that have a somewhat darker surface layer. Also included are small areas of Ida and Dow soils

This soil is moderately well suited to row crops if erosion is controlled (fig. 14). Most of the acreage is cultivated. It is subject to further erosion and in places is gullied. It is lower in organic-matter content than the less eroded Monona soils and generally needs more fertilizer. Capability unit IIIe–1.

Monona silt loam, 14 to 20 percent slopes (10E).—This soil, in many places, is in narrow bands at the heads of steep coves or on the sides of ridges below less sloping ridgetops. In most places it occupies entire side slopes. Napier soils in upland drainageways or such bottom land soils as those of the Kennebec series are generally downslope. This soil is most extensive in the western half of the uplands of Harrison County. It is in irregularly shaped tracts and ranges mainly from 5 to 40 acres in size.

The surface layer of this soil is generally very dark brown to very dark grayish brown and is about 7 to 12 inches thick. The subsoil is typically thinner and depth to mottles is less than in the Monona silt loam, 0 to 2 percent slopes. The substratum is calcareous between a depth of 30 and 40 inches in many places.

Included in mapping are small areas of Ida, Dow, and Napier soils. Also included is about 200 acres of a soil that is similar to Monona soils in most respects but is calcareous at a depth of about 12 to 24 inches.

This soil is moderately well suited to row crops if erosion is controlled. Most areas of this soil are grassy or wooded and are used for pasture. Some cultivated areas are generally adjacent to soils that are better suited to cultivation. The hazard of further sheet erosion and gullying is severe. Capability unit IVe–1.

Monona silt loam, 14 to 20 percent slopes, moderately eroded (10E2).—This soil is on side slopes that in many places form a cove at the heads of drainageways. In places this soil occupies all of the side slope. In other places it is associated with other Monona soils or Ida soils or with Dow-Monona silt loams.

The surface layer, in most places the plow layer, is very dark grayish brown. Some of the subsoil is mixed in the plow layer in places. The subsoil is typically thinner, and depth to mottles is less than in the Monona silt loam, 0 to 2 percent slopes. This soil is calcareous at a depth of about 24 to 30 inches in many places.

Included in mapping is about 185 acres of a soil that is calcareous at a depth of 12 to 24 inches, but in other respects is similar to this soil. Also included are small areas of Ida or Dow soils.

This soil is moderately well suited to row crops if erosion is controlled. It is also suited to crops for hay and pasture. Most of the acreage is cultivated or has been cultivated in the past. Some areas are in permanent pasture. Slope and the surrounding soils often influence the use of this soil. The hazard of further erosion and gullying is severe. Capability unit IVe–1.

Monona silt loam, 14 to 20 percent slopes, severely eroded (10E3).—This soil is in long, narrow areas on side slopes, generally in association with other Monona soils or with Ida and Napier soils. In places it is adjacent to Dow-Monona silt loam soils. Most areas range from 5 to 20 acres in size, but a few are smaller.

The surface layer of this soil is mostly dark-brown or brown subsoil. The subsoil is generally thinner, and depth to mottles generally is less than in Monona silt loam, 0 to 2 percent slopes. The soil is calcareous at a depth of 24 to 30 inches in many places. Included in mapping are small areas of Ida and Dow soils.

This soil is moderately well suited to row crops if erosion is controlled. It is also suited to crops for hay or pasture. This soil generally is managed along with the surrounding soils. Most of the acreage is cultivated. The hazard of further erosion and gullying is serious. In places gullies have formed. This soil is lower in fertility and organic-matter content than the less-eroded Monona soils. Capability unit IVe–1.

Monona silt loam, 20 to 30 percent slopes (10F).—This soil is on side slopes that in places form a cove at the head of upland drainageways. In most places it grades downslope to less sloping Ida or Monona soils, or to Napier soils. In places it is associated with the Hamburg soils. Most areas range from about 5 to 60 acres in size, but a few are larger or smaller.

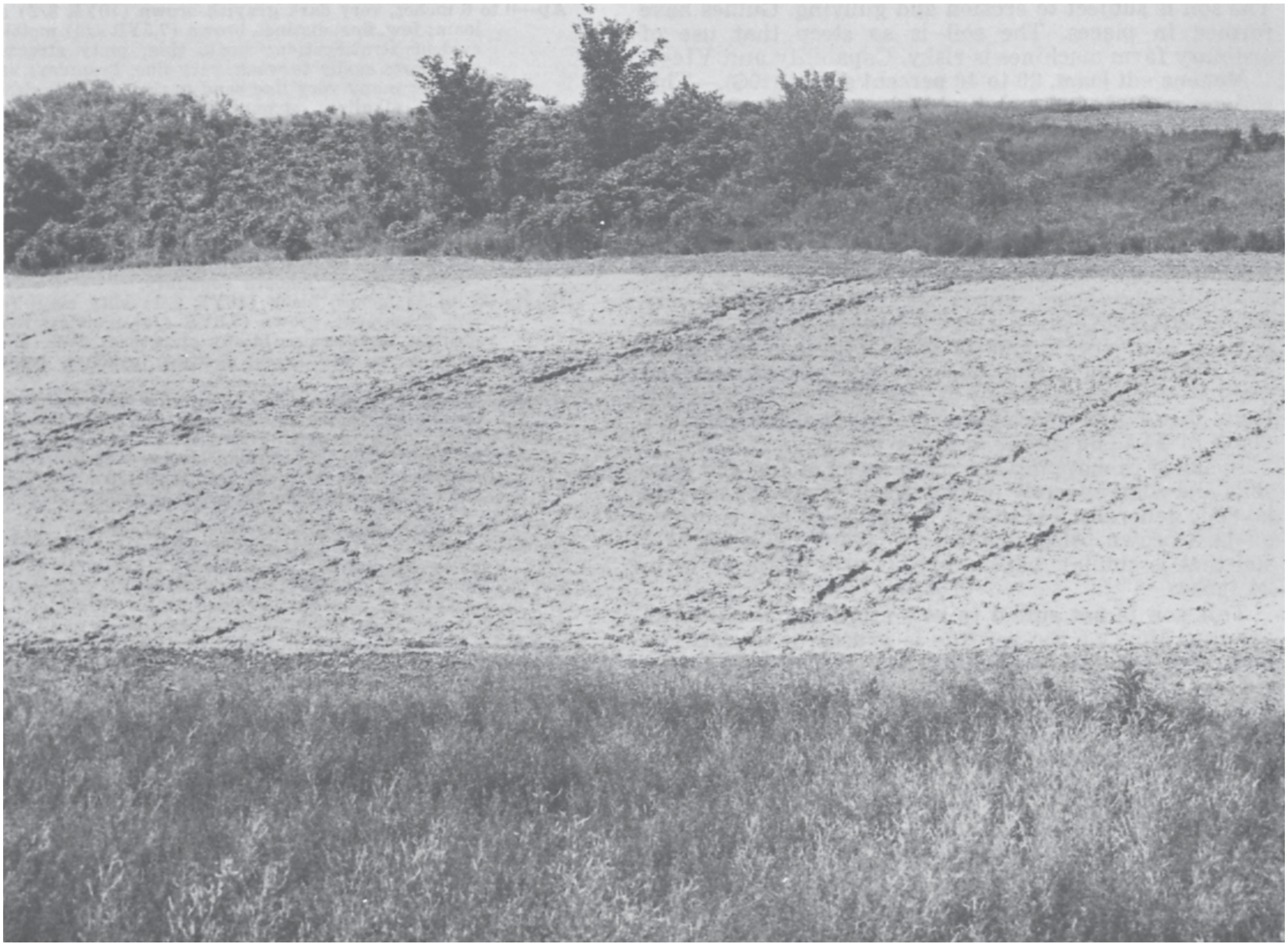

Figure 14.—**Monona silt loam, 9 to 14 percent slopes, severely eroded.**

The surface layer of this soil, about 7 to 12 inches thick, is very dark brown to very dark grayish brown in most places. The subsoil is typically thinner, and depth to mottles generally is less than in Monona silt loam, 0 to 2 percent slopes. This soil is calcareous at a depth of between 24 and 30 inches in many places.

Included in mapping is about 270 acres of a soil that is similar, but calcareous at a depth of about 12 to 24 inches. Also included are small, moderately or severely eroded areas that have a thinner or lighter colored surface layer.

This soil is poorly suited to row crops. It is better suited to hay or pasture. It is grassy and wooded, and most of the acreage is in permanent pasture. This soil is so steep that use of ordinary farm machines is risky. Very little of the acreage is cultivated. Capability unit VIe–1.

Monona silt loam, 20 to 30 percent slopes, moderately eroded (10F2).—This soil is on the same part of the landscape and is associated with the same soils as Monona silt loam, 20 to 30 percent slopes. Most areas range from 5 to 40 acres in size.

In most places the surface layer, about 3 to 7 inches thick, is very dark brown or very dark grayish brown. In about 25 percent of the areas it is mostly subsoil material, generally less than 3 inches thick, and is dark brown or brown. The subsoil is typically thinner and depth to mottles generally is less than in Monona silt loam, 0 to 2 percent slopes. This soil is calcareous at a depth of 24 to 30 inches in many places.

Included in mapping is about 470 acres of a soil that is similar to this soil but calcareous at a depth of 12 to 24 inches. Also included are small areas of Ida and Dow soils.

This soil is poorly suited to row crops. It is better suited to use as hay or pasture. In cultivated areas it is generally associated with less sloping soils. Most areas are in permanent pasture and some are wooded.

The soil is subject to erosion and gullying. Gullies have formed in places. The soil is so steep that use of ordinary farm machines is risky. Capability unit VIe–1.

Monona silt loam, 30 to 40 percent slopes (10G).—This soil generally is in bands on hillsides, is at the heads of steep coves, and in places occupies all of the side slopes. It is generally downslope from the less sloping Monona soils and upslope from the adjacent, less sloping Monona, Ida, or Napier soils. It is adjacent to the Hamburg soils in places. It is mainly in the western part of the uplands.

This soil has a surface layer that is generally about 7 to 10 inches thick and is very dark brown to very dark grayish brown. About 25 percent of the acreage is moderately eroded and the surface layer is only about 3 to 7 inches thick. The subsoil is typically thinner and depth to mottles generally is less than in Monona silt loam, 0 to 2 percent slopes. The soil is calcareous at a depth of 24 to 30 inches in many places.

Included in mapping are small areas of Ida and Dow soils and some severely eroded areas where the surface layer is generally less than 3 inches thick and is brown or dark brown. Also included are about 450 acres of a soil that is similar, but calcareous at a depth of 12 to 24 inches.

This soil is not suited to row crops but is suited to pasture. Most of the acreage is grassy or wooded, or both, and is thus partly protected from erosion. The timber has very limited commercial value at present. The soil is so steep that the use of ordinary farm implements for pasture renovation is impractical. It is well suited to wildlife habitat. Capability unit VIIe–1.

Moville Series

The Moville series consists of moderately well drained and somewhat poorly drained soils. These soils are mainly on the Missouri River bottom land, but they are also near the channels of tributary streams, generally not far from where they flow into the Missouri River. They formed in recently deposited alluvium, which has buried a dark-colored, clayey soil that also formed in alluvium.

In a representative profile the surface layer, about 6 inches thick, is very dark grayish-brown silt loam. The substratum to a depth of about 27 inches is stratified dark grayish-brown and brown, very friable silt loam. Below this, to a depth of 60 inches, is black, firm silty clay and clay that was once the surface layer of a soil now buried by more recent sediment.

These soils are typically mildly alkaline and calcareous in the silt loam. Permeability is moderate in the upper part of the soil and very slow in the underlying silty clay and clay. Available water capacity is high. The supply of available phosphorus is very low. The supply of available potassium is medium. The organic-matter content is low in the surface layer.

Most areas of these soils are cultivated. A high water table causes wetness, and many areas are subject to flooding and to deposition of fresh sediment.

Representative profile of Moville silt loam in a cultivated field 650 feet east and 150 feet north of the southwest corner of NW¼SE¼ of sec. 4, T. 78 N., R. 44 W.:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam; few, fine, distinct, brown (7.5YR 4/4) mottles; evident stratification; weak, thin, platy structure that parts easily to weak, very fine, granular; very friable; many very fine sand grains on plate faces; mildly alkaline, strongly effervescent; gradual, smooth boundary.

C—6 to 27 inches, stratified dark grayish-brown (10YR 4/2) and brown (10YR 4/3) silt loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, thin and medium, platy structure caused by stratification that parts easily to weak, very fine, granular; very friable; many very fine sand grains on plate faces; few dark soft oxides; mildly alkaline, strongly effervescent; abrupt, smooth boundary.

IIA1b—27 to 33 inches, black (10YR 2/1) silty clay; few, fine, prominent, brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure; firm; shiny coatings on ped faces; neutral; gradual, smooth boundary.

IIA12b—33 to 60 inches, black (N 2/0) clay; few, fine, prominent, brown (7.5YR 4/4) and very fine, distinct, dark grayish-brown (2.5Y 4/2) mottles; moderate, fine, subangular blocky structure; firm; shiny coatings on peds; few snail shell fragments and many small lime concretions; mildly alkaline.

The A horizon, generally the plow layer, is less than 10 inches thick. It is very dark grayish brown (10YR or 2.5Y 3/2) or dark grayish brown (10YR or 2.5Y 4/2). The C horizon has hue of 10 YR or 2.5Y, value of 4, 5, or 6, and chroma of 2 or 3. Layers of very dark grayish-brown (10YR or 2.5Y 3/2) soil material as much as 6 inches thick are in some places in the upper part of the C horizon. Few to many mottles that are generally 7.5YR in hue occur in most places. The combined thickness of the A and C horizons is 18 to 30 inches. The IIAb horizon has hue of N, 10YR, 2.5Y, or 5Y, value of 3 or less, and chroma of 1 or less. The IIBb horizon, not shown in the representative profile, has hue of 2.5Y or 5Y, value of 4, 5, or 6, and chroma of 1 or less. These buried horizons are silty clay or clay. The A and C horizons are mildly or moderately alkaline and calcareous, but in a few places the A horizon is neutral. The buried horizons are neutral to mildly alkaline.

Moville soils have a buried clayey soil at a depth of 18 to 30 inches, whereas McPaul soils do not. They have less sand in the upper part of the profile than Modale soils, and the underlying clayey material is darker colored. They are associated on the landscape with McPaul soils and are similar in texture to the Modale soils. All formed in alluvium.

Moville silt loam (0 to 2 percent slopes) (275).—In places this soil is adjacent to foot slopes occupied by Napier soils. These foot slopes are below the bluffs at the eastern edge of the Missouri River Valley. This soil is also along manmade ditches in and near desilting basins. Luton, McPaul, and Kennebec soils are common landscape associates in these places. Kennebec, Colo, Nodaway, and McPaul soils are the most common associates in other places. Some areas are as large as 400 acres in size, but most are smaller.

Included within areas of this soil in the Missouri River bottom land are small areas of McPaul soils. Included along the tributary streams are small areas of McPaul or Nodaway soils. Also included in mapping are about 180 acres of a soil that is similar in texture to this soil, but the silt loam in the upper part of the soil profile is mainly very dark grayish brown or very dark brown.

This soil is well suited to row crops, but many areas are subject to occasional flooding and to the addition of silty sediment on the surface. Most of the acreage is cultivated. In some years a high water table keeps this soil wet. Capability unit IIw–2.

Napier Series

The Napier series consists of well-drained soils on low foot slopes and alluvial fans where water flows from upland drains onto the bottom land. These soils are also in narrow upland drainageways. They formed in local alluvium. The slope range is 2 to 14 percent.

In a representative profile the surface layer is silt loam about 30 inches thick. It is black in the upper 14 inches and very dark brown in the lower 16 inches. The subsoil to a depth of about 40 inches is dark-brown, friable silt loam. Below this it is brown friable silt loam.

Napier soils are high in organic-matter content and are typically neutral in the surface layer. They are moderately permeable. Available water capacity is very high. The supply of available phosphorus is very low. The supply of available potassium is low.

Most areas are cultivated. The principal concern in management is gullying, especially in the middle of drainageways. Runoff from soils upslope washes across these soils. Some gullies have cut deep channels, and in some areas these soils have been almost destroyed.

Representative profile of Napier silt loam, 2 to 5 percent slopes, in a cultivated field about 920 feet south and 450 feet east of the northwest corner of SE¼SW¼ sec. 11, T. 78 N., R. 44 W.:

Ap—0 to 7 inches, black (10YR 2/1) tending to very dark brown (10YR 2/2) silt loam, very dark brown (10YR 2/2) when crushed; weak, fine, subangular blocky structure that parts to weak, very fine, granular; friable; neutral; gradual, smooth boundary.

A12—7 to 14 inches, black (10YR 2/1) tending to very dark brown (10YR 2/2) silt loam, very dark brown (10YR 2/2) tending to very dark grayish brown (10YR 3/2) when crushed; weak, fine, subangular blocky structure that parts to weak, fine, granular; friable; many worm casts; neutral; clear, smooth boundary.

A13—14 to 21 inches, very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) when crushed; weak, fine, subangular blocky structure; friable; many worm casts; neutral; gradual, smooth boundary.

A3—21 to 30 inches, very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) when crushed; weak, fine and medium, subangular blocky structure; friable; many worm casts; neutral; gradual, smooth boundary.

B2—30 to 40 inches, dark-brown (10YR 3/3) silt loam; faces of some peds very dark grayish brown (10YR 3/2); weak, fine, subangular blocky structure; friable; many worm casts; neutral; gradual, smooth boundary.

B3—40 to 60 inches, brown (10YR 4/3) silt loam; weak, fine, subangular blocky structure to massive; friable; common worm casts; mildly alkaline, slightly effervescent in lower part.

The A horizon is 24 to 36 inches thick. It is dominantly very dark brown (10YR 2/2) but ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). In places it is covered with 6 to 15 inches of very dark grayish-brown (10YR 3/2) or dark grayish-brown (10YR 4/2) overwash of silt loam texture. The B horizon extends to a depth of 36 to 60 inches. The C horizon is brown (10YR 4/3) to yellowish-brown (10YR 5/4) silt loam. No C horizon is shown in the representative profile. Napier soils are typically neutral or slightly acid in the A and B horizons and neutral to moderately alkaline and calcareous in the C horizon. In places, the Ap or A1 horizon is medium acid.

Napier soils have a thicker A horizon than Castana soils and are not calcareous at or near the surface. They are not dark colored so deep in the profile as Kennebec soils. All formed in similar parent materials and are associated on the landscape.

Napier silt loam, 2 to 5 percent slopes (12B).—This soil has the profile described as representative of the series. It is on alluvial fans, on foot slopes, and in narrow drainageways of the uplands. In some areas it extends 2 miles or more along the foot slopes and in the drainageways. It makes up a large acreage in the county.

In places this Napier soil is associated with the more sloping Napier soils upslope. Also upslope in many places are the associated Monona and Ida soils. Downslope are the Monona soils on benches and the McPaul, Kennebec, and Colo soils on bottom land.

Included with this soil in mapping are small areas of Colo and Kennebec soils. Also included are small areas of a soil that has a recently deposited silt loam overwash 6 to 15 inches thick. This overwash is very dark grayish brown or dark grayish brown.

This Napier soil is well suited to row crops. Most areas are farmed along with associated soils. Most are cultivated. Some are pastured. The main hazards to use of this soil for crops are erosion and gullying caused by water that runs across it from upslope. Gullies are actively cutting in some places. Capability unit IIe–1.

Napier silt loam, 2 to 5 percent slopes, overwash (12B+).—This soil has a profile similar to the one described as representative of the series, but it has 6 to 15 inches of very dark grayish-brown or dark grayish-brown silt loam overwash on the surface. Most areas are on alluvial fans or foot slopes that are adjacent to the bottom land. Some are in upland drainageways. Individual areas range from 5 to 40 acres in size. Associated soils upslope are Ida and Monona soils and other Napier soils. Downslope are the McPaul, Kennebec, and Colo soils on bottom land.

This Napier soil is well suited to row crops. Most areas are cultivated. The main hazards to use of this soil for crops are erosion and gullying caused by water that runs across it from upslope. Capability unit IIe–1.

Napier silt loam, 5 to 9 percent slopes (12C).—This soil is on foot slopes and in upland drainageways. In places it extends 2 or more miles along watercourses. It makes up a large acreage in the county. Most areas are below the associated Monona and Ida soils.

Included with this soil in mapping are small areas that have a recently deposited silt loam overwash 6 to 15 inches thick on the surface. This overwash is very dark grayish brown or dark grayish brown.

This Napier soil is moderately well suited to row crops. Most areas are cultivated. Some are pastured. Use of this soil is generally affected by the steepness of the associated soils and the way they are used, by the width of the areas, and by how much the stream channel meanders. Erosion and gullying are hazards. Gullies are actively cutting in some places. Capability unit IIIe–1.

Napier silt loam, 9 to 14 percent slopes (12D).—This soil has a profile similar to the one described as representative of the series, but the surface layer is a few inches thinner. It is in the more dissected parts of the uplands. Generally it occurs as a narrow band between the less sloping Napier soils downslope and the Ida or

Monona soils upslope. Some areas occupy all of a drainageway. Most areas are 5 to 25 acres in size. Included in mapping are a few areas that have 6 to 15 inches of recently deposited, very dark grayish-brown or grayish-brown silt loam overwash on the surface.

This soil is moderately well suited to row crops if runoff and erosion are controlled. Most areas are cultivated. Some adjacent steeper areas are pastured. Capability unit IIIe–1.

Napier-Gullied land complex, 2 to 10 percent slopes (717C).—This mapping unit is a Napier silt loam, along drainageways and small streams, that has been cut by deep, active gullies. In places up to half or more of an area is gullied (fig. 15). In many places, along both sides of the main gully, side gullies are eroding into bordering hillsides. This mapping unit occurs throughout Harrison County. In many places, the gully banks are overgrown with trees and brush.

Areas of this mapping unit are not suited to cultivation, and they are severely limited for other uses. Many areas are wooded and grassy and provide suitable wildlife habitat. Capability unit VIIe–1.

Napier-Nodaway-Colo complex, 2 to 5 percent slopes (17B).—This mapping unit is 50 to 60 percent Napier soils, 30 to 40 percent Nodaway soils, and 10 to 20 percent Colo soils. The percentages vary from place to place. Nodaway and Colo soils are described under their respective series.

The gently sloping Napier soils are near the base of uplands. The nearly level Nodaway and Colo soils are adjacent to stream channels or drainageways. All are associated with Ida and Monona soils and other upland soils.

These soils are well suited to row crops, but tillage equipment cannot cross areas cut by meandering channels and gullies. Gully erosion is the greatest hazard because runoff water erodes the watercourses. Most of the acreage is cultivated. Capability unit IIe–1.

Nodaway Series

The Nodaway series consists of stratified, nearly level, moderately well drained soils. These soils are on first bottoms along the Boyer River and many of the other streams in the county, generally adjacent to the stream and subject to occasional overflow. They formed in silty alluvium. These soils are also in narrow drainageways in the uplands where they are mapped with

***Figure 15.*—Typical gully in Napier-Gullied land complex.**

Napier and Colo soils. In these areas they formed in recent alluvium washed from nearby hillsides and carried in by the streams.

In a representative profile the surface layer is very dark grayish-brown silt loam about 9 inches thick. The substratum to a depth of 36 inches is stratified, very friable silt loam that is mainly dark grayish brown, but in places is grayish brown, dark gray, very dark grayish brown, and very dark gray. It has common brown and few reddish-brown mottles. Below 36 inches and extending to a depth of 60 inches is black, friable silt loam that was once the surface layer of a soil now buried by more recent sediment.

These soils are moderately low or low in organic-matter content. They are typically neutral throughout. Permeability is moderate. Available water capacity is high. The supply of available phosphorus and potassium is low.

Most of the acreage is cultivated. Flooding is the main hazard. A few small areas are cut up by old stream meanders and noncrossable old channels.

Representative profile of Nodaway silt loam in a cultivated field 50 feet east of the northwest corner of SW¼SE¼ sec. 4, T. 79 N., R. 42 W.:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak, fine, granular structure; very friable; some dark grayish-brown (10YR 4/2) and very thin, very dark gray (10YR 3/1) strata; neutral; clear, smooth boundary.

C1—9 to 16 inches, weakly stratified dark grayish-brown (10YR 4/2), very dark grayish-brown (10YR 3/2), and very dark gray (10YR 3/1) silt loam; weak, medium, platy structure; very friable; common very fine pores; neutral; clear, smooth boundary.

C2—16 to 36 inches, stratified dark grayish-brown (10YR 4/2), grayish-brown (10YR 5/2), and dark-gray (10YR 4/1) silt loam; some very dark gray (10YR 3/1) thin strata; common, fine, distinct, brown (7.5YR 4/4) and few, fine, distinct, reddish-brown (5YR 4/4) mottles; very friable; common fine pores; neutral; abrupt, smooth boundary.

A1b—36 to 60 inches, black (10YR 2/1) silt loam; weak, very fine, subangular blocky structure that parts to weak, very fine, granular; friable; neutral.

The A horizon in cultivated areas is commonly very dark grayish brown (10YR 3/2), but ranges to include very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2). This horizon, in many places the plow layer, is less than 10 inches thick. Matrix colors in the underlying C horizon are dominantly dark grayish brown (10YR 4/2), but some strata have 10YR hue, value of 4 or 5, and chroma of 2, 3, or 4. Some strata have chroma of 1. Layers 1 to 6 inches thick of black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2) are present in places. The A1b horizon, where present, ranges to silty clay loam and to very dark gray (10YR 3/1). Few to common mottles that generally have hue of 5YR, 7.5Y, or 10YR, values of 3 to 6, and chroma of 3 to 8 are in the C horizon. Thin strata of silty clay loam are in the C horizon in places. Nodaway soils are neutral or slightly acid in reaction throughout.

Nodaway soils are not calcareous throughout as are the Haynie and McPaul soils. They are lighter colored than the Kennebec soils and are distinctly stratified. All formed in alluvium.

Nodaway silt loam (0 to 2 percent slopes) (220).—This soil is on bottom land. In places individual areas extend several miles along streams and occupy several hundred acres. This soil is mainly associated with the Kennebec, Colo, and McPaul soils.

This Nodaway soil in many places consists of old shallow channels that have been filled and are now being farmed. Straightening the channels of nearby rivers and creeks and clearing underbrush and trees have converted many areas on first bottoms to cropland.

Included with this soil in mapping are small areas that have a black silty clay loam buried soil below a depth of 36 inches. Also included are small areas of Kennebec or McPaul soils.

This soil is well suited to row crops, and most of it is used for this purpose. It is subject to flooding, but it seldom remains wet for long and can be tilled soon after rains. Flooding often occurs in spring before crops are planted. Capability unit I–2.

Onawa Series

The Onawa series consists of nearly level, somewhat poorly drained or poorly drained soils near, or within a few miles of, the river channel on the Missouri River bottom land. Some areas are slight depressions. They formed in alluvium. They are mainly associated with the Albaton, Percival, and Blake soils and are bordered by areas of Haynie, Carr, and Sarpy soils, which are at slightly higher elevations.

In a representative profile the surface layer is dark grayish-brown silty clay about 6 inches thick. The substratum to a depth of 26 inches is dark grayish-brown firm silty clay or clay that has a few brown mottles. Below this to a depth of 60 inches is dark grayish-brown and grayish-brown, stratified silt loam mottled with brown, yellowish red, and light brownish gray.

Onawa soils are low in organic-matter content. They are mildly alkaline. Permeability is slow in the upper part of the soil and moderate or moderately rapid in the underlying silt loam. Available water capacity is high. The supply of available phosphorus is very low. The supply of available potassium is high.

Most of the acreage is cultivated. Runoff is slow, the water table is seasonally high, and wetness is a hazard. Before the construction of large dams and levees, these soils were subject to flooding. Now the hazard in most areas is slight. Only a few areas near the river or on the river side of protective levees are subject to flooding.

Representative profile of Onawa silty clay in a cultivated field 600 feet north and 86 feet west of the southeast corner of NW¼SE¼ sec. 8, T. 78 N., R. 45 W.:

Ap—0 to 6 inches, very dark grayish-brown (2.5Y 3/2) silty clay; very weak, fine, subangular blocky structure; firm; some fine sand grains on faces of peds; mildly alkaline, slightly effervescent; clear, smooth boundary.

C1—6 to 26 inches, dark grayish-brown (2.5Y 4/2) silty clay or clay; few, fine, distinct, brown (7.5YR 4/4) mottles; weak, very fine, angular blocky structure; firm; some reddish-brown (5YR 4/4) root stains; dark-gray (5Y 4/1) shiny coatings on most peds; few dark oxides; mildly alkaline, strongly effervescent; abrupt, smooth boundary.

IIC2g—26 to 60 inches, stratified dark grayish-brown (2.5Y 4/2) and grayish-brown (2.5Y 5/2) coarse silt loam; common, fine, distinct, brown (7.5YR 4/4), few, fine, distinct, yellowish-red (5YR 4/6), and few, fine, faint, light brownish-gray (2.5Y 6/2) mottles; stratified weak, thin and medium, platy structure; very friable; streaks of dark gray (5Y 4/1); mildly alkaline, violently effervescent.

The A horizon, in most places a very dark grayish brown (10YR or 2.5Y 3/2) plow layer, is less than 10 inches thick. It is very dark gray (10YR 3/1) to dark grayish brown (10YR or 2.5Y 4/2). It ranges from silty clay to clay, but 6 to 15 inches of silt loam overwash is on the surface in places. The C1 horizon is silty clay or clay. It commonly has 2.5Y hue, but strata range from 10YR or neutral to 5Y. The IIC2 horizon has colors like those of the C1 horizon, but in places value is 4 and chroma is 1. The IIC2 horizon begins at a depth of 18 to 30 inches and is generally silt loam, but in places it is very fine sandy loam or loam that contains much very fine sand. Mottles in the C1 and IIC2 horizons have a wide range in hue, value, and chroma. Most are 10YR to 2.5YR in hue and have value of 4 to 6 and chroma of 4 to 6, but some range to 2.5Y hue and have lower chroma. Onawa soils are typically mildly alkaline to moderately alkaline and calcareous throughout, but in places are mildly alkaline and noncalcareous in the plow layer.

In contrast with Albaton soils, Onawa soils have a IIC horizon of silt loam. They are more clayey in the C1 horizon than Blake soils. They have a thinner, lighter colored A horizon than Blencoe soils and are calcareous. They are associated with Albaton and Blake soils on the landscape. They are similar in texture throughout to Blencoe soils. All of these soils formed in alluvium.

Onawa silt loam (0 to 2 percent slopes) (145).—This soil is on bottom land where flooding has deposited overwash on the surface. It is mainly associated with Onawa silty clay and with Blake, Albaton, or Haynie soils. Areas range in size from about 10 acres to 160 acres or more.

This soil has a profile similar to that described as representative of the series, but it has 6 to 15 inches of stratified dark grayish-brown silt loam on the surface. Included in mapping are a few small areas of Onawa silty clay or Albaton soils.

This soil is well suited to row crops. Almost all the acreage is cultivated, but a few acres are pastured or wooded. A high water table and slow runoff make wetness a hazard. This soil dries out more quickly and is easier to till than Onawa silty clay. A few areas are subject to flooding from manmade ditches, but in most areas this hazard is slight. Capability unit IIw–2.

Onawa silty clay (0 to 2 percent slopes) (146).—This soil is on bottom land in nearly level areas or slightly depressed swales. In most places it is associated with the Albaton and Percival soils in similar landscape positions and the Blake and Haynie soils at slightly higher elevations. Individual areas range to as much as 250 acres or more in size.

This soil has the profile described as representative of the series. Included in mapping are some small areas of Albaton, Blake, and Percival soils. Also included is about 325 acres of a soil in which the depth to the underlying silt loam is 30 to 40 inches.

If adequately drained, this soil is well suited to row crops. Most of the acreage is cultivated and generally is in row crops. The soil is flooded if drainage ditches overflow, but the hazard is slight in most areas. Some depressions are ponded after rains. At times tillage is delayed. If worked wet, the soil dries out cloddy and hard and tilth is poor. Capability unit IIw–2.

Percival Series

The Percival series consists of nearly level, somewhat poorly drained soils within a few miles of the stream channel in the western part of the Missouri River bottom land. In places these soils are in narrow areas at the edge of old stream meanders. In places they are in slightly depressed swales. They formed in silty clay alluvium that is underlain by loamy fine sand and fine sand.

In a representative profile the surface layer is very dark gray silty clay about 8 inches thick. The substratum to a depth of about 24 inches is grayish-brown and dark-gray firm silty clay that has a few reddish-brown and strong-brown mottles. Below this is stratified grayish-brown loamy fine sand and fine sand.

Percival soils are low in organic-matter content. They are mildly or moderately alkaline and calcareous throughout. Permeability is slow in the clayey upper part and rapid in the underlying sandy material. Available water capacity is low. The supply of available phosphorus is very low. The supply of available potassium is high.

Most of the acreage is cultivated. Some areas next to the river are wooded. Wetness is a hazard in spring or in wet seasons. In some dry seasons droughtiness reduces yields. Before the construction of large dams and levees, these soils were subject to flooding. Now the hazard is slight in most areas. Only a few areas near the river or inside protective levees are subject to flooding.

Representative profile of Percival silty clay in a cultivated field 490 feet south and 90 feet east of the northwest corner of NE¼ sec. 9, T. 78 N., R. 45 W.:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silty clay, very dark grayish brown (2.5Y 3/2) crushed; weak, fine, subangular blocky structure; firm; few fine pores; few strong-brown (7.5YR 5/6) root stains; mildly alkaline, slightly effervescent; clear, smooth boundary.

C1g—8 to 24 inches, grayish-brown (2.5Y 5/2) and dark-gray (5Y 4/1) silty clay, dark grayish brown (2.5Y 4/2) crushed; few, fine, distinct, dark reddish-brown (5YR 3/4) and strong-brown (7.5YR 5/6) mottles; weak and moderate, fine and very fine, angular and subangular blocky structure; firm; few very fine pores; mildly alkaline, strongly effervescent; abrupt, smooth boundary.

IIC2—24 to 60 inches, stratified grayish-brown (2.5Y 5/2) loamy fine sand and fine sand; few, fine, distinct, strong-brown (7.5YR 5/6) and brown (7.5YR 4/4) and few, fine, faint, gray (10YR 5/1) mottles; single grained; loose; common fine dark oxides; mildly alkaline to moderately alkaline, strongly effervescent.

The A horizon, in most places a very dark grayish-brown (10YR or 2.5Y 3/2) plow layer, is less than 10 inches thick. It ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR or 2.5Y 4/2). The C1g horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay or clay. It is mottled with colors in hue of 5YR, 7.5YR, or 10 YR and high value and chroma. The IIC2 horizon has hue of 2.5Y, value of 4, 5, or 6, and chroma of 2. Mottles are similar to those in the C1g horizon. Reaction ranges from mildly alkaline to moderately alkaline throughout. In places the A horizon is noncalcareous.

Percival soils are sandy below a depth of about 2 feet, whereas Albaton soils are clayey throughout. They are sandy in the IIC horizon, whereas Onawa soils are silt loam or very fine sandy loam in that horizon.

Percival silty clay (0 to 2 percent slopes) (515).—Some areas of this soil are in slightly depressed swales, others are on narrow rims at the edge of old stream meanders, and still others are on slight rises on the bottom land. This soil is associated mainly with Albaton and Onawa soils at similar elevations, and with Haynie, Sarpy, Blake, Grable, and Vore soils, generally at slightly higher elevations. Most areas range from about 10 to 160 acres in size. Included in mapping are a few small areas of Vore or Onawa soils.

This soil is well suited to row crops. Most of the acreage is cultivated and generally is in row crops. A few areas near the river are wooded. A seasonal high water table and slow runoff make wetness a hazard. In dry seasons lack of available water reduces yields. If tilled when wet, the surface layer dries out cloddy and hard and tilth is poor. A few areas are subject to flooding from manmade ditches, but in most areas this hazard is slight. Capability unit IIw–2.

Riverwash

Riverwash (53) consists of sandy deposits along the Missouri River channel. It is mainly sand or loamy sand and is gravelly in places. It is usually flooded during every high water stage.

Some areas support thin stands of grass and willow trees. Others are subject to blowing, have dunelike topography, and are barren of vegetation.

Riverwash is not suited to crops. It has little or no value for farming. It is used by some kinds of wildlife and has some potential for recreational development. Capability unit VIIs–1.

Salix Series

The Salix series consists of nearly level, moderately well drained soils on the Missouri River bottom land. These soils are at some of the highest elevations on the bottom land, mainly in the central and eastern parts. They formed in alluvium.

In a representative profile the surface layer is black silty clay loam about 17 inches thick. The subsoil extends to a depth of about 30 inches. It is dark grayish-brown, friable light silty clay loam in the upper part and dark grayish-brown, friable silt loam mottled with strong brown in the lower part. The substratum is light olive-brown silt loam that is mottled with light brownish gray and grayish brown.

These soils are moderate in organic-matter content. They are typically slightly acid or neutral in the surface layer and neutral in the subsoil. Available water capacity is high. Permeability is moderate. The supply of available phosphorus is very low. The supply of available potassium is high.

Most of the acreage is cultivated and is used for row crops. There are no serious hazards to the use of these soils for row crops.

Representative profile of Salix silty clay loam in a cultivated field 1,060 feet north and 100 feet east of the southwest corner of SW¼ sec. 4, T. 78 N., R. 44 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure; friable tending to firm; neutral; clear, smooth boundary.

A12—8 to 17 inches, black (10YR 2/1) light silty clay loam, very dark brown (10YR 2/2) crushed; weak, fine and medium, subangular blocky structure; friable; few very fine inped tubular pores; slightly acid; gradual, smooth boundary.

B2—17 to 24 inches, dark grayish-brown (10YR 4/2) light silty clay loam; faces of peds very dark grayish brown (10YR 3/2); weak, medium, subangular blocky structure that parts to fine subangular blocky; friable; few very fine inped tubular pores; neutral; gradual, smooth boundary.

B3—24 to 30 inches, dark grayish-brown (2.5Y 4/2) silt loam; few, fine, faint, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; very few very fine inped tubular pores; neutral; clear, smooth boundary.

C—30 to 60 inches, light olive-brown (2.5Y 5/4) silt loam, yellowish brown (10YR 5/6) crushed; few, fine, faint, grayish-brown (10YR 5/2) and light brownish-gray (10YR 6/2) mottles; massive; very friable; few fine inped tubular pores; mildly alkaline, strongly effervescent.

The A horizon is 12 to 20 inches thick. The Ap or A1 horizon is generally black (10YR 2/1) or very dark brown (10YR 2/2), but ranges to very dark gray (10YR 3/1). The A3 horizon, where present, is generally very dark grayish brown (10YR 3/2). The B horizon, which extends to a depth of 24 to 36 inches, has 10YR hue in the upper part but grades to 2.5Y in the lower part. Value is 4 or 5 and chroma is 2 or 3. Mottles are few to common and are generally dark yellowish brown (10YR 4/4) to strong brown (7.5YR 5/6). The C horizon is similar in color and mottling pattern to the B horizon, but in many places light brownish gray or light gray mottles are present, and colors of higher chroma predominate. The C horizon ranges to very fine sandy loam or loam in places. Salix soils are generally neutral or slightly acid in the A and B2 horizons and neutral to mildly alkaline and calcareous in the B3 horizon. The C horizon is mildly alkaline or moderately alkaline and calcareous.

Salix soils are silty clay loam to a depth of about 2 feet, whereas Keg soils are silt loam to that depth. They are silt loam below a depth of about 2 feet, and Lakeport soils are silty clay loam to a depth of more than 40 inches. All are associated on the landscape.

Salix silty clay loam (0 to 2 percent slopes) (36).—This soil is in some of the highest areas on the bottom land. It is at elevations similar to those of the associated Keg soils. It is generally at higher elevations than the associated Blencoe, Luton, Lakeport, Blend, Cooper, and Burcham soils. Most areas range from 10 to 75 acres in size, but a few are larger.

Included with this soil in mapping is about 175 acres of a soil that is similar but has fine sand at a depth of about 24 to 30 inches. Also included are small areas of Keg or Lakeport soils.

This soil is well suited to row crops and has no serious limitations to such use. Most of the acreage is cultivated and is mostly in row crops. Capability unit I–1.

Sarpy Series

The Sarpy series consists of excessively drained soils that formed in coarse-textured, recently deposited sandy alluvium near the Missouri River channel. Slopes are 0 to 7 percent. Some areas are dune shaped from wind action.

In a representative profile the surface layer is dark grayish-brown fine sand about 2 inches thick. The substratum to a depth of 60 inches is stratified grayish-brown, loose fine sand.

Sarpy soils are very low or low in organic-matter content. They are typically moderately alkaline and calcareous. Available water capacity is low or very low. Permeability is rapid or very rapid. The supply of available phosphorus is very low. The supply of available potassium is high.

Some of the less sloping areas are cultivated if they are in fields of other soils that are cultivated. Other areas are pastured or wooded. These soils are droughty and are subject to soil blowing. Before the construction of large dams on the Missouri River, these soils were subject to almost yearly flooding. Now, only areas very near the river or low on the landscape are subject to flooding.

Representative profile of Sarpy fine sand, 3 to 7 percent slopes, in a wooded pasture, 940 feet south and 1,340 feet west of the northeast corner of sec. 24, T. 78 N., R. 46 W.:

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) fine sand; single grained; loose; few fine roots; moderately alkaline, strongly effervescent; clear, smooth boundary.

C—3 to 60 inches, stratified grayish-brown (2.5Y 5/2) fine sand; weak, thin, platy structure that parts very easily to single grained; loose; moderately alkaline, strongly effervescent.

The A horizon is generally less than 10 inches thick. It is very dark grayish brown (10YR 3/2) or dark grayish brown (10YR or 2.5Y 4/2) and is fine sandy loam to fine sand. Where the texture is fine sandy loam, this horizon generally extends to a depth of about 10 inches. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. The range includes those soils that have a few high chroma mottles in this horizon. The C horizon ranges to loamy fine sand. In places it is thinly stratified with finer textures. Sarpy soils are mildly alkaline or moderately alkaline and calcareous.

Sarpy soils have more sand and less clay to depths of about 2 feet than Grable or Percival soils. They have more sand and less clay between depths of 10 and 40 inches than Carr soils. All are associated on the landscape.

Sarpy fine sand, 0 to 3 percent slopes (237).—This soil is mainly adjacent to, or within a mile or two of, the river channel. It is at about the same elevation as the associated Sarpy fine sandy loam and Haynie, Grable, Kenmoor, and Carr soils. It is generally at higher elevations than Albaton, Percival, or Onawa soils. In places Riverwash or areas of Albaton and Sarpy soils are adjacent to areas of this soil. Most areas are fairly large; some are as large as 320 acres. Included in mapping are small areas of Sarpy fine sandy loam or Carr soils.

Some areas of this soil are in fields with soils better suited to cultivation and are cropped along with them. Most of the acreage is grassy and wooded and is in pasture. Some areas are wooded and furnish wildlife habitat. The soil is very droughty and is subject to soil blowing. In places there are blowouts that are barren of vegetation. Yields of row crops seldom are satisfactory unless the soil is irrigated. Areas low on the landscape or very near the river are subject to flooding. Capability unit IVs–1.

Sarpy fine sand, 3 to 7 percent slopes (237B).—This soil is in hummocky areas adjacent to, or within a mile or two of, the river channel (fig. 16). It is higher in elevation than the associated Albaton, Percival, or Onawa soils. It is typically slightly higher on the landscape and is more hummocky than Sarpy fine sand or Sarpy fine sandy loam and Haynie, Grable, or Carr soils. In places it is adjacent to areas of Riverwash or Albaton and Sarpy soils. Most areas are large; some as large as 320 acres or more.

This soil has the profile described as representative of the series. Included in mapping are some areas that have a few inches of loamy fine sand or fine sandy loam on the surface. Also included are small areas of Carr soils. Most areas of this soil are grassy and wooded and are in pasture. Some areas are wooded and furnish wildlife habitat. This soil is droughty and is subject to soil blowing. Blowouts that are barren of vegetation are common. Capability unit IVs–1.

Sarpy fine sandy loam, 0 to 3 percent slopes (238).—This soil is mainly adjacent to, or within a mile or two of, the river channel. It is at about the same elevation as the associated Sarpy fine sand and Haynie, Grable, Kenmoor, Carr, and Blake soils. It is generally higher on the landscape than Albaton, Percival, or Onawa soils. In places Riverwash or areas of Albaton and Sarpy soils are adjacent to areas of this soil. Most areas are fairly large; some as large as 320 acres.

This soil has a profile similar to that described as representative of the series, but the surface layer is fine sandy loam about 10 inches thick. Included in mapping are small areas of Sarpy fine sand or Carr soils.

Some areas of this soil are in fields with soils better suited to row crops, and generally are cropped along with them. This soil is droughty and is subject to soil blowing. Yields of row crops are seldom satisfactory unless the soil is irrigated. Many areas are in pasture. Some areas are wooded and furnish wildlife habitat. Areas very near the river or low on the landscape are subject to flooding. Capability unit IVs–1.

Solomon Series

The Solomon series consists of poorly drained and very poorly drained soils in nearly level to depressional areas that are at the lowest elevations in the eastern part of the Missouri River bottom land. These soils formed in clayey alluvium in slack-water areas.

In a representative profile the surface layer is black silty clay about 17 inches thick. The subsoil extends to a depth of about 33 inches. The upper part to a depth of about 26 inches is very dark gray firm silty clay that has a few olive-gray and olive mottles. The lower part is gray, firm silty clay that has common brown and few reddish-brown mottles. The substratum to a depth of 60 inches is gray, very firm light clay.

Solomon soils have high organic-matter content. They are moderately alkaline and calcareous throughout. Available water capacity is moderate. Perme-

Figure 16.—**Hummocky, undulating Sarpy fine sand, 3 to 7 percent slopes.**

ability is very slow. Runoff is very slow. The supply of available phosphorus is very low. The supply of available potassium is high.

Most of the acreage is cultivated, but some is in permanent pasture. The soils are wet, and the water table frequently is high. In wet seasons water tends to stand in fields and road ditches. Crops frequently drown, and replanting is necessary. Some areas are subject to overflow from ditches, but in most areas the hazard is not severe.

Representative profile of Solomon silty clay in a cultivated field 300 feet west and 100 feet south of the northeast corner of SE¼NE¼ sec. 28, T. 80 N., R. 44 W.:

Ap—0 to 9 inches, black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; cloddy that parts to moderate, very fine and fine, subangular blocky and fine granular structure; firm; very few fine pores; abundant very fine snail shell fragments and very few large snail shells; moderately alkaline, strongly effervescent; gradual, smooth boundary.

A12—9 to 17 inches, black (N 2/0) silty clay, dark gray (10YR 4/1) dry; few, fine, distinct, dark grayish-brown (2.5Y 4/2) mottles; strong, fine, subangular blocky structure; firm; very few fine pores; very few fine soft dark oxides; thin, discontinuous shiny coatings on faces of peds; many fine snail shell fragments and very few large snail shells; moderately alkaline, strongly effervescent; clear, smooth boundary.

B1g—17 to 26 inches, very dark gray (5Y 3/1) silty clay, dark gray (10YR 4/1) dry; moderate, fine, subangular blocky structure; few, very fine, faint olive-gray (5Y 5/2) and olive (5Y 5/3) mottles; firm; very few fine pores; discontinuous shiny coatings on faces of most peds; very few very fine soft dark oxides; common fine snail shell fragments; moderately alkaline, strongly effervescent; clear, smooth boundary.

B2g—26 to 33 inches, gray (5Y 5/1) silty clay; common, fine, prominent, brown (7.5YR 4/4) mottles and few, fine, distinct, dark reddish-brown (5YR 3/4) mottles; weak to moderate, very fine or fine, subangular blocky structure; firm; very few shiny faces on peds; few snail shell fragments in lower part of horizon; distinct iron oxide band at a depth of 34 to 36 inches; few small lime concretions below a depth of 38 inches; mildly alkaline, weakly effervescent; gradual, smooth boundary.

Cg—33 to 60 inches, gray (5Y 5/1) light clay; common, fine, prominent, brown (7.5YR 4/4) mottles and few, fine, distinct, dark reddish-brown (5YR 3/4) mottles; weak, fine, subangular blocky structure to massive; very firm; very few shiny faces on peds; few small lime concretions; mildly alkaline, weakly effervescent.

The A horizon ranges in thickness from 10 to 30 inches and is black (10YR 2/1 or N 2/0) or very dark gray (N 3/0 or 10YR 3/1 to 5Y 3/1). In places colors of 3 value extend to a depth of about 36 inches. The Bg horizon, which extends to a depth of about 30 to 50 inches, ranges in hue from 10YR to 5Y. Value is 3 to 5, and chroma is 1 or 2. Few to common mottles that have a wide range of hue, value, and chroma are present in most places. The Cg horizon has about the same color and mottling pattern as the Bg horizon. Texture throughout the profile is silty clay or clay, reaction throughout is mildly alkaline or moderately alkaline, and this soil is calcareous.

The Solomon soils are calcareous throughout, but Woodbury and Luton soils are not. They differ from Woodbury soils in that they do not overlie silty clay loam within a depth of 40 inches. All these soils formed in alluvium and are associated on the landscape.

Solomon silty clay (0 to 2 percent slopes) (466).—This soil is in slack-water areas or in slight depressions on bottom land. It is associated with Luton, Blencoe, and Woodbury soils and with Keg, Salix, and Lakeport soils, which are at slightly higher elevations. Areas of this soil are relatively few, but most are fairly large. Included in mapping are small areas of Luton soils.

This soil is moderately well suited to row crops, and most of the acreage is cultivated. The water table is high, runoff is slow, and some places are ponded. Adequate drainage is needed. Planting and other fieldwork are often delayed. In places, in years of above-average rainfall, seeds fail to germinate and replanting is necessary. If tilled when wet, the soil dries out cloddy and hard and tilth is poor. Wetness and the high clay content influence the choice of crops and the methods of tillage and drainage. Capability unit IIIw-1.

Steinauer Series

The Steinauer series consists of calcareous, well-drained soils on uplands. These soils are at elevations below Ida, Monona, and Hamburg soils. They formed in glacial till. Slopes are 9 to 18 percent.

In a representative profile the surface layer is dark grayish-brown and very dark grayish-brown clay loam about 6 inches thick. The substratum to a depth of about 18 inches is firm yellowish-brown clay loam. Below this to a depth of 60 inches it is firm light olive-brown clay loam. A few strong-brown and light brownish-gray mottles are present in the substratum. Pebbles and small stones occur throughout.

Steinauer soils are low in organic-matter content. They are moderately alkaline and calcareous throughout. Permeability is moderately slow. Available water capacity is high, but the soils are seldom at capacity because so much of the water runs off. The supply of available phosphorus is very low. The supply of available potassium is low.

Steinauer soils in the steeper areas are used mainly for pasture. They are cultivated in many places only if the surrounding soils are cropped. The hazard of erosion is severe.

Representative profile of Steinauer clay loam, 14 to 18 percent slopes, severely eroded, in a cultivated field about 300 feet east and 50 feet north of the southwest corner of sec. 1, T. 79 N., R. 41 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) and some very dark grayish-brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) kneaded; cloddy that parts to weak, fine, granular structure; friable; few small pebbles; moderately alkaline, strongly effervescent; abrupt, smooth boundary.

C1—6 to 18 inches, yellowish-brown (10YR 5/4) clay loam; few, very fine, distinct, strong-brown (7.5YR 5/6) and few, fine, distinct, light brownish-gray (10YR 6/2) mottles; weak and moderate, medium, subangular blocky structure; firm; few soft lime accumulations; few, fine, soft, dark oxides and stains; few ½- to 1-inch pebbles; moderately alkaline, strongly effervescent; diffuse, smooth boundary.

C2—18 to 60 inches, light olive-brown (2.5Y 5/4) that has a tendency to yellowish-brown (10YR 5/4) clay loam; few, very fine, distinct, strong-brown (7.5YR 5/6) mottles and iron stains; moderate, medium, subangular and some angular blocky structure that has evident vertical cleavage; firm; many soft accumulations and filaments of lime; common, fine, soft, dark oxides and stains, light brownish gray (2.5Y 6/2) in lower few inches of horizon; common small ½- to 1-inch pebbles; moderately alkaline, strongly effervescent.

In cultivated areas the A horizon is generally a dark grayish-brown (10YR 4/2) to brown (10YR 4/3) plow layer about 6 to 8 inches thick. In uncultivated areas the A1 horizon is generally very dark brown (10YR 2/2) to dark grayish brown (10YR 4/2) and is less than 6 inches thick. It is loam in places. The C horizon typically has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 or 4, but it is grayish brown (10YR or 2.5Y 5/2) or light brownish gray (10YR or 2.5Y 6/2) in places. Mottles range from few to many and typically from 7.5YR to 2.5Y in hue, from 4 to 6 in value, and from 2 to 8 chroma. The size and number of pebbles and stones and lime concretions vary from place to place. The texture is typically clay loam, but ranges to loam. Pockets or lenses of sand and gravel occur in places.

Steinauer soils formed in glacial till and have more sand and pebbles throughout than the associated Ida and Monona soils, both of which formed in loess.

Steinauer clay loam, 9 to 14 percent slopes, moderately eroded (33D2).—This soil is on the lower parts of upland side slopes. It is generally upslope from Napier soils and downslope from Ida and Monona soils. Individual areas are generally 5 to 20 acres in size.

This soil has a profile similar to that described as representative of the series, but in many places the plow layer is very dark grayish brown. About one-fourth of the acreage is severely eroded, and the plow layer is dark grayish brown to brown.

This soil is moderately well suited to row crops if further erosion is controlled. Most of the acreage is cultivated along with the associated soils. Some areas are in pasture. Capability unit IIIe-2.

Steinauer clay loam, 14 to 18 percent slopes, severely eroded (33E3).—This soil is on moderately steep side slopes in the uplands. It has the profile described as representative of the series. In many places the surface layer is very thin or is brown in color. About 30 percent of the acreage is moderately eroded, and here the plow layer is generally very dark grayish brown.

This soil is poorly suited to row crops. It is better suited to hay or pasture, for which most areas are now used. Some areas are cultivated, but these are generally in places where the surrounding soil is better suited to cropping. This soil is severely eroded and is subject to further erosion unless protected. Capability unit VIe-1.

Vore Series

The Vore series consists of nearly level, moderately well drained dark soils on slightly elevated bottom land near the Missouri River. These soils formed in moderately fine textured alluvium that overlies fine sand.

In a representative profile the surface layer is very dark gray silty clay loam about 7 inches thick. The substratum to a depth of about 24 inches is a stratified dark grayish-brown friable silty clay loam mottled with grayish brown, dark gray, and dark yellowish brown. To a depth of 60 inches it is stratified grayish-brown, loose fine sand that has a few dark-gray mottles.

These soils are low in organic-matter content. They are mildly alkaline or moderately alkaline and calcareous throughout. Permeability is moderately slow in the silty clay loam and is rapid in the underlying sand. Available water capacity is low or moderate. The supply of available phosphorus is very low. The supply of available potassium is high.

Most of the acreage is cultivated. These soils are droughty in most years. Before the construction of large dams and levees, these soils were subject to flooding. Now the hazard is slight in most areas. Only a few areas very near the river or on the river side of protective levees are subject to flooding.

Representative profile of Vore silty clay loam in a cultivated field 400 feet west and 300 feet south of the northeast corner of SE¼ sec. 16, T. 78 N., R. 45 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silty clay loam; grayish brown (10YR 5/2) dry; few dark grayish-brown (10YR 4/2) peds mixed in from horizon below; weak, fine, subangular blocky structure and weak, fine, granular; friable; few fine dark oxides; mildly alkaline, slightly effervescent; clear, smooth boundary.

C1—7 to 24 inches, stratified dark grayish-brown (2.5YR 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common, fine, distinct, grayish-brown (2.5Y 5/2), few, fine, distinct, dark-gray (10YR 4/1), and few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; very weak, fine, subangular blocky structure in some strata; friable; few dark oxides; firm heavy silty clay loam at a depth of 19 to 24 inches; few fine sand grains on peds; moderately alkaline, strongly effervescent; abrupt, smooth boundary.

IIC2—24 to 60 inches, stratified grayish-brown (2.5Y 5/2) fine sand; few, fine, distinct, dark-gray (10YR 4/1) mottles; weak, thick, platy structure to massive; loose; very friable fine sandy loam at a depth of 24 to 29 inches; few fine dark oxides; moderately alkaline, strongly effervescent; clear, smooth boundary.

The A horizon, in most places a plow layer, is less than 10 inches thick. It ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR or 2.5Y 4/2). The C1 and IIC2 horizons have color hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. Mottles are few to common and have hue of 10YR, 2.5Y, or 7.5YR, value of 3 to 7, and chroma of 1 to 8. The combined thickness of the A and C1 horizons is 15 to 30 inches. The IIC2 horizon is loamy fine sand in places. In places it contains 1- to 4-inch lenses of finer textured material. Vore soils are mildly alkaline or moderately alkaline throughout and are calcareous.

Vore soils contain more sand in the IIC horizon than Blake soils. They have less clay in the A and C1 horizons than Percival soils. They are more clayey in the A and C1 horizons than Grable soils. These soils all formed in alluvium are are associated on the landscape.

Vore silty clay loam (0 to 2 percent slopes) (516).—This soil is associated on the bottom land mainly with the Blake, Haynie, and Carr soils, which are at about the same elevation, and with the Albaton, Percival, and Onawa soils, which are generally a little lower on the landscape. Most areas are between 5 and 50 acres in size. Included in mapping are small areas of Blake and Grable soils.

This soil is well suited to row crops. Most of the acreage is cultivated. The rest is pastured or wooded. The soil tends to be droughty in most years and is well suited to irrigation. Capability unit IIs–1.

Woodbury Series

The Woodbury series consists of nearly level, poorly drained soils mainly in the central and eastern part of the Missouri River bottom land. These soils formed in clayey alluvium that is underlain by less clayey sediment at a depth of 2 to 3 feet.

In a representative profile the surface layer is silty clay about 19 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil to a depth of 35 inches is firm dark grayish-brown silty clay that has common to many yellowish-brown, strong-brown, and reddish-brown mottles. Below this to a depth of 41 inches it is friable, olive-gray and light olive-brown silty clay loam that has common strong-brown and a few reddish-brown mottles. The substratum to a depth of 60 inches is friable, olive-gray and light olive-brown silty clay loam that has many strong-brown and dark reddish-brown mottles.

These soils are high in organic-matter content. They are typically slightly acid in the surface layer and the upper part of the subsoil. Available water capacity is high. Permeability is slow or very slow. The supply of available phosphorus is low. The supply of available potassium is high.

Drained acreages are cultivated. Flooding from man-made ditches is a hazard. The water table is generally high in spring, and soils are often wet. Root growth is restricted in some wet seasons.

Representative profile of Woodbury silty clay in a nearly level cultivated field 840 feet east and 100 feet north of the southwest corner of SE¼ sec. 16, T. 78 N., R. 44 W.:

Ap—0 to 7 inches, black (10YR 2/1) silty clay; cloddy that parts to moderate, fine, angular blocky structure; firm, slightly compacted; slightly acid; clear, smooth boundary.

A1—7 to 12 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) crushed; few, fine, faint, dark grayish-brown (2.5Y 4/2) and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, fine, subangular blocky structure; firm; very few very fine inped tubular pores; sheen on peds; slightly acid; gradual, smooth boundary.

A3—12 to 19 inches, very dark gray (10YR 3/1) silty clay, very dark gray (10YR 3/1) crushed; few, fine, distinct, strong-brown (7.5YR 5/4) mottles; moderate, fine subangular blocky structure; firm; very few very fine inped tubular pores; some dark grayish-brown (2.5Y 4/2) peds, sheen on peds; slightly acid; gradual, smooth boundary.

B21—19 to 24 inches, dark grayish-brown (2.5Y 4/2) silty clay; few, fine, distinct, strong-brown (7.5YR 5/6) and common, fine, faint, light olive-brown (2.5Y 5/4) mottles; moderate, fine, subangular blocky structure; firm; very few very fine inped tubular pores; very dark gray (10YR 3/1) organic coatings on faces of peds, distinct sheen on peds; slightly acid; gradual, smooth boundary.

B22g—24 to 35 inches, dark grayish-brown (2.5Y 4/2) silty clay to heavy silty clay loam; faces of peds dark grayish brown (2.5Y 4/2) and dark gray (5Y 4/1); many, fine, distinct, yellowish-brown (10YR 5/4) and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, fine and medium, subangular blocky structure; firm; many very fine and few fine inped tubular pores; distinct sheen on peds; very dark gray (10YR 3/1) channel fillings; slightly acid; clear, smooth boundary.

B3g—35 to 41 inches, mottled olive-gray (5Y 5/2) and light olive-brown (2.5Y 5/4) silty clay loam, dark grayish brown (2.5Y 4/2) crushed; common, fine, distinct, strong-brown (7.5YR 5/6) and few, fine, distinct, dark reddish-brown (5YR 3/3) mottles; weak, medium, subangular blocky structure tending toward massive; friable; very few very fine inped tubular pores; neutral; gradual, smooth boundary.

Cg—41 to 60 inches, mottled olive-gray (5Y 5/2) and light olive-brown (2.5Y 5/4) light silty clay loam, olive brown (2.5Y 4/4) crushed; many, medium, distinct, strong-brown (7.5YR 5/6) and dark reddish-brown (5YR 3/3) mottles; massive; friable; few fine soft accumulations of an oxide; neutral, grading to moderately alkaline, strongly effervescent silt loam at a depth of 48 inches.

The A horizon is 16 to 24 inches thick. It is black (10YR 2/1) or very dark gray (10YR 3/1 to N 3/0). The B21 and B21g horizons have ped interiors that are dark grayish brown (2.5Y 4/2) to olive gray (5Y 4/2). The faces of peds are very dark gray (10YR 3/1), dark gray (5Y 4/1), very dark grayish brown (2.5Y 3/2), and dark grayish brown (2.5Y 4/2). Mottles are common to many and range from 5YR to 5Y in hue, from 4 to 6 in value, and from 3 to 8 in chroma. Woodbury soils are silty clay or clay to a depth of 24 to 36 inches. Below this they are light to medium silty clay loam. The B3 and C horizons range from dark grayish brown (2.5Y 4/2) to olive gray (5Y 5/2) and light olive brown (2.5Y 5/4). Mottles are similar to those in the B2 horizon. Woodbury soils are typically slightly acid to neutral but are mildly alkaline or moderately alkaline and in places are calcareous below a depth of 36 inches.

Woodbury soils are silty clay loam below a depth of 24 to 36 inches, whereas Blencoe soils are silt loam. They are not so clayey below this depth as Luton soils. All are associated on the landscape.

Woodbury silty clay (0 to 2 percent slopes) (67).—This soil is on bottom land. It is typically a little higher on the landscape than the associated Luton or Blend soils and slightly lower than the associated Blencoe or Salix soils. Included in mapping are small areas of Blencoe and Luton soils.

This soil is moderately well suited to row crops if adequate drainage is provided. Most of the acreage is cultivated and is used for row crops. Wetness often delays fieldwork. Power requirements for tillage are high on this soil. If tilled when wet, the surface layer tends to dry out cloddy and hard and tilth is poor. Capability unit IIIw-1.

Use and Management of the Soils

This section explains the capability classification used by the Soil Conservation Service, describes the soils in each capability unit, and suggests management suited to the soils in each unit. It gives predicted yields of the major crops for the soils of the county. It also contains information on the use of the soils for woodland, wildlife, and recreation.

Crops and Pasture

In 1969, about 220,000 acres in Harrison County was used for crops (*8*). About 81,000 acres, including most wooded areas, was used for pasture.

Corn, soybeans, and legume and grass-legume hay are the main crops. Smaller acreages are in oats, wheat, popcorn, and sorghum. There are a few commercial apple orchards in the county and a few vineyards (fig. 17).

Some pastures in the county are permanent bluegrass, but bromegrass or orchardgrass or legume-grass mixtures are also pastured. Big bluestem, little bluestem, side-oats grama, and other native grasses grow on some of the steep or very steep Hamburg and Ida soils.

Many soils in the county, especially Monona, Ida, Hamburg, and Steinauer soils, are subject to erosion and gullying. Parallel terraces and parallel grassy backslope terraces are commonly used for erosion control. Tilling on the contour is also a common erosion control practice.

Gully control structures, farm ponds, and grassed waterways are used to control gullying in watercourses. Farm ponds also furnish water for livestock and recreation.

Levees are used to protect bottom land from flooding, especially the Missouri River bottom land. These levees mainly have been constructed by the U.S. Army Engineers or government agencies. The construction of large dams upstream on the Missouri River has greatly lessened the hazard of flooding. A large acreage that was mostly idle has been cleared of brush and trees and is now farmed.

In some soils, a high water table or water that tends to pond on the surface is a concern in management. Drain tile is used to some extent in the county to reduce wetness, in Colo soils, for example. Drainage ditches are commonly used to lower the water table and reduce wetness in such soils as those of Luton, Solomon, Blend, and Blencoe series. Shallow field drainage ditches and land grading help in removing water that tends to stand on the surface.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does

Figure 17.—**Grape arbor and orchard on Monona-Ida-Napier soil association northwest of Magnolia.**

not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

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

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

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrow choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

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

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

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife.

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.

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

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (No Class VIII soils in Harrison 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 only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

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

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

The capability units in Harrison County are described on the pages that follow.

CAPABILITY UNIT I–1

This unit consists of nearly level, well-drained to somewhat poorly drained soils of the Keg, Kennebec, Lakeport, Burcham, and Salix series. These soils are at slightly elevated positions on bottom land. They have a friable loam, silt loam, or silty clay loam surface layer. They have similar textures in the subsoil and substratum except for Burcham soils, which are underlain by silty clay.

Permeability is slow or very slow in the underlying silty clay of the Burcham soils, but is moderate or moderately slow in the rest of the soils. In all, available water capacity is high or very high. The content of organic matter is moderate or high. Reaction is typically neutral to slightly acid in the surface layer and the upper part of the subsoil. The supply of available phosphorus is low or very low. The supply of available potassium is medium in Kennebec soils, but high in the rest.

These soils warm up quickly in spring and can be worked soon after rains. They readily absorb most of the rain that falls, and they hold much of this moisture available for plants. They have good to only slightly restricted internal drainage and are seldom wet. Aeration is generally good. Tilth is generally good. Erosion is not a hazard. Some areas on the Missouri River bottom land have been flooded, but are now protected by levees and dams. Kennebec soils are flooded occasionally, but crops are seldom damaged.

These soils are well suited to row crops. Corn is the major crop, but large acreages of soybeans are also grown. Most areas are cultivated. Little or no lime is needed. Irrigation is possible where water is available. The Salix and Keg soils particularly are well suited to irrigation.

CAPABILITY UNIT I–2

This unit consists of nearly level, stratified, silty, well-drained to somewhat poorly drained soils of the Blake, Haynie, McPaul, Modale, and Nodaway series. These soils are mainly at slightly elevated positions on the Missouri River bottom land. Some are in tributary stream valleys. These soils have a friable silt loam or silty clay loam surface layer.

Permeability in most of these soils is moderate, but Modale soils have a clayey substratum that is slowly or very slowly permeable. Available water capacity is high. Organic-matter content is moderately low or low. Reaction is moderately alkaline to neutral in the surface layer and upper part of the subsoil or substratum. The supply of available phosphorus is very low or low. The supply of available potassium is low to high.

Nodaway and McPaul soils are subject to flooding in many places. Water generally recedes rapidly, or flooding occurs in spring before crops are planted. Some areas of McPaul soils receive runoff and deposition from adjacent uplands. Before construction of large dams and levees, Blake, Haynie, and Modale soils were subject to flooding. Now the hazard is slight in most areas.

These soils are well suited to cultivated crops, such as corn and soybeans. They are well suited to irrigation, and in most areas water is available. Tilth is generally good. No lime is needed.

CAPABILITY UNIT I–3

This unit consists of nearly level, well-drained soils of the Monona series. These soils are on loess-mantled benches and upland ridgetops. They have a friable silt loam surface layer and subsoil.

Permeability is moderate, and available water capacity is high. The content of organic matter is moderate. Tilth is generally good. The surface layer and upper part of the subsoil are slightly acid or neutral. The supply of available phosphorus is very low. The supply of available potassium is low or very low. After heavy rain or during spring thaw, runoff collects on the nearly level benches, but generally does not stand on the surface for long periods because it is readily absorbed.

These soils are well suited to row crops. Corn is the main crop, but large acreages of soybeans are also grown. Most areas are cultivated. The hazard of erosion is slight. The major management requirements are maintaining tilth, fertility, and the organic-matter content. Lime is needed in places.

CAPABILITY UNIT IIe–1

This unit consists of gently sloping soils of the Napier series and the Napier-Nodaway-Colo complex. The Colo soil is poorly drained. The rest are well drained to moderately well drained. All are on low foot slopes and alluvial fans and in narrow upland drainageways or along streams. Napier and Nodaway soils are silt loam throughout. Colo soils are silty clay loam.

Napier and Nodaway soils are moderately permeable. Colo soils are moderately slowly permeable. Organic-matter content is high in the Napier and Colo soils and moderately low or low in Nodaway soils. All are typically neutral or slightly acid in the upper part. The supply of available phosphorus is very low to medium. The supply of available potassium is low or medium.

Wetness is a limitation on Colo soils, and all soils of the unit are subject to runoff and erosion. In periods of heavy rainfall, water from upslope forms rills and gullies. Short-duration flooding is a hazard in places, particularly in areas of the Napier-Nodaway-Colo complex.

These soils are subject to erosion and gullying. They are well suited to growing row crops if erosion is controlled. Most of the acreage is cultivated. A few acres that are inaccessible or are associated with soils not suited to cultivation, are in permanent pasture. The cultivated areas are used for corn, soybeans, small grain, and meadow.

These soils are generally in narrow strips and are managed along with adjacent soils. In wide valleys they can be farmed along with the adjacent bottom land. In narrow valleys they are managed with steeper soils on the hillsides.

Upslope terracing and tilling on the contour are needed to intercept runoff water and sediment that would otherwise be deposited. In places where runoff has caused gullying, shaping and seeding of the waterway are needed. Some lime is needed in places, but amounts generally are not large.

CAPABILITY UNIT IIe-2

This unit consists of gently sloping, well-drained soils of the Monona series. These soils are on loess-mantled benches and upland ridgetops. They have a friable silt loam surface layer and subsoil.

Permeability is moderate. Available water capacity is high. Organic-matter content is about moderate. The soils are slightly acid or neutral in the surface layer and upper part of the subsoil. The supply of available phosphorus is very low. The supply of available potassium is very low or low.

These soils are well suited to row crops if erosion is controlled. Most of the acreage is cultivated. Corn, soybeans, oats, and meadow are the main crops. The soils are subject to runoff and erosion, particularly in periods of heavy rain. Tilth is generally good.

Control of erosion is a major concern of management. Terraces and contour tillage are generally used. Maintaining organic matter, soil tilth, and fertility is also important. Some areas need lime.

CAPABLITY UNIT IIw-1

This unit consists of nearly level, somewhat poorly drained or poorly drained soils of the Blencoe, Colo, and Cooper series. The Cooper and Blencoe series are on the Missouri River bottom land, and the Colo soils are on bottom land along other streams in the county. These soils have a friable or firm silty clay loam to silty clay surface layer. The subsoil is firm or very firm silty clay loam or silty clay. About 6 to 15 inches of friable silt loam has been recently deposited on the surface of one of the Colo soils.

Permeability in the Colo soils is moderately slow. It is slow or very slow in the silty clay layer of the Blencoe and Cooper soils. Available water capacity is high. Organic-matter content is high. Reaction is slightly acid or neutral in the surface layer or upper part of the subsoil. The supply of available phosphorus is very low to medium. The supply of available potassium is medium or high.

Some of these soils are subject to flooding. Some have a high water table. After floods recede, water remains ponded for several days in some small, slightly depressed areas. Flooding results from stream overflow and runoff from the uplands or adjacent soils.

If adequately drained, these soils are suited to row crops. Corn and soybeans are the major crops, but some oats and meadow are also grown. Most of the acreage is cultivated. Only small acreages are in permanent pasture. Wetness is a limitation, and artificial drainage generally is needed. Tile, drainage ditches, and in places, land grading are used for drainage.

These soils dry out somewhat slowly in spring and need to be worked later after rains than the better drained soils. They mostly tend to puddle and dry out cloddy and hard if worked wet. Fall plowing allows timely fieldwork in spring, and freezing and thawing improve tilth. Power requirements are high for those soils that have a silty clay surface layer. Lime is seldom needed, but if needed the amount is small.

CAPABILITY UNIT IIw-2

This unit consists of nearly level, stratified, well-drained to poorly drained soils of the Blake, Haynie, Onawa, Percival, and Moville series. These soils are on the Missouri River bottom lands, not far from the present river channel. These soils have a firm silty clay or friable silty clay loam or silt loam surface layer. They range from silt loam to silty clay in layers below the surface layer, except for Percival soils, which are loamy sand or sand below a depth of about 2 feet.

Permeability is moderate in the silt loam layers, but it is slow or very slow in the clayey layers. Percival soils are rapidly permeable in the sandy substratum. Available water capacity is low to high. Organic-matter content is low. The soils are mildly or moderately alkaline and calcareous throughout. The supply of available phosphorus is very low. The supply of available potassium is medium or high.

These soils are mostly in areas that are protected by the large dams upstream on the Missouri River, and they are seldom flooded. Flooding and the deposition of fresh sediment are hazards in some areas of Moville soils. Some of the other soils are flooded when the river stage is high.

If drained and protected from flooding, these soils are well suited to row crops. Corn and soybeans are the major crops. Some oats and meadow grasses are also grown. Most areas are cultivated. A few are still grassy and wooded.

Wetness is a hazard in most years, but many areas are managed without using artificial drainage. Ditches are generally used to improve drainage. Lack of suitable outlets limits the use of tile drains. In places, land grading is also used.

Maintaining fertility and good tilth is essential. If worked when too wet, the soils that have a clayey surface layer tend to dry out cloddy and hard. Fall plowing allows timely fieldwork in spring, and freezing and thawing improve tilth. No lime is needed.

CAPABILITY UNIT IIs-1

This unit consists of nearly level, stratified, somewhat excessively drained to somewhat poorly drained soils of the Grable, Modale, and Vore series. These soils are generally slightly more elevated than the associated soils on the Missouri River bottom lands. The Modale soil has a very friable surface layer of very fine sandy loam that grades to silty clay at a depth of about 2 feet. The Grable and Vore soils are silt loam or silty clay loam in the surface layer and upper part of the substratum, and they overlie sand.

Permeability in Modale soil is moderately rapid in the surface layer and slow or very slow in the substratum. Permeability in Grable and Vore soils is moderately rapid to moderately slow in the upper part and rapid in the lower part. All of these soils are low in organic-matter content. They are mildly alkaline or moderately alkaline throughout. Available water capacity is low or moderate. The supply of available phosphorus is low. The supply of available potassium is high.

These soils are well suited to row crops. Most of the acreage is cultivated. Corn is the main crop. Some oats and meadow are also grown. Droughtiness is the main limitation. In dry periods crops lack available moisture. The soils can be tilled fairly soon after rain, and soil tilth is generally good. The Modale soil is subject to blowing, and the blowing sand damages young plants.

Since construction of large dams and levees most areas are no longer subject to flooding. Only a few areas not protected by levees are still subject to flooding. No lime is needed. Needed practices are those that improve soil tilth, increase the organic-matter content, and conserve soil moisture.

CAPABILITY UNIT IIIe-1

This unit consists of moderately sloping and strongly sloping, well drained and moderately well drained soils of the Castana, Monona, and Napier series. Monona soils formed in loess and are on upland ridges and the sides of ridges. Napier soils are in narrow upland drainageways and on foot slopes and alluvial fans. Castana soils are on foot slopes, generally at elevations below Hamburg soils on bluffs. They formed in local alluvium. Some of the Monona soils are moderately eroded, and others are only slightly eroded. All have a friable silt loam surface layer. The subsoil is similar in texture.

Permeability is moderate. Available water capacity is high. Organic-matter content ranges from high to moderate. The surface layer and upper part of the subsoil are slightly acid to mildly alkaline or moderately alkaline. The supply of available phosphorus is very low. The supply of available potassium is low or very low. These soils typically are in good tilth.

The soils in the capability unit are subject to sheet and gully erosion. The Castana and Napier soils are subject to rilling and gullying by water that runs off the adjacent uplands, and in some places silty sediments are deposited on the surface.

Terraces, contour tillage, and grassed waterways are needed to control erosion. In places diversions are used to control water that runs across the Napier soils.

If erosion is controlled, the soils of this capability unit are moderately well suited to row crops. Most areas are cultivated, but a few areas, particularly of Napier and Castana soils, are in pasture. Corn, oats, and meadow grasses are the main crops. Soybeans are grown, although they generally are not grown on the strongly sloping soils. Close-growing crops are needed on the strongly sloping soils. In some areas lime is needed for satisfactory crop production. Needed practices are those that maintain or improve soil tilth and the organic-matter content of the moderately eroded soils.

CAPABILITY UNIT IIIe-2

This unit consists of moderately sloping and strongly sloping, well-drained soils of the Ida and Steinauer series and one mapping unit of Dow-Monona silt loams. All Steinauer soils formed in glacial till. The rest formed in loess. All are on side slopes in the uplands. All but the Steinauer soil have a friable silt loam surface layer. The more severely eroded soils have a very thin surface layer. The subsoil is also friable silt loam. Steinauer soils are clay loam throughout.

Permeability is moderate or moderately slow. Available water capacity is high. Organic-matter content is very low or low. Ida, Dow, and Steinauer soils are typically moderately alkaline. Monona soils are generally neutral. The supply of available phosphorus is generally very low. The supply of available potassium is very low or low.

These soils are subject to erosion. In places rills and gullies have formed. Although organic-matter content is very low, soil tilth is typically fair or good.

If erosion is controlled, these soils are moderately well suited to row crops. Most areas are cultivated, but small areas of steeper soils generally are pastured. Corn, oats, and meadow are the major crops. Soybeans generally are not grown on these strongly sloping soils. In places gullies need to be shaped and seeded. Terracing and tilling on the contour are needed for erosion control. The addition of phosphorus is important on meadow. No lime is needed. Additions of organic matter in the form of crop residue or barnyard manure are particularly beneficial to these soils.

CAPABILITY UNIT IIIw-1

This unit consists of nearly level, dark-colored, poorly drained to very poorly drained soils of the Albaton, Blend, Forney, Luton, Solomon, and Woodbury series. These soils have a firm or very firm silty clay surface layer. Some are covered by about 6 to

15 inches of friable silt loam that has recently been deposited. The subsoil in most areas is firm or very firm silty clay, but the Blend soil has a friable stratum at a depth of about 14 inches, and the Woodbury soil is silty clay loam below a depth of 2 to 3 feet.

Permeability is very slow or slow. Available water capacity is moderate or high. Organic-matter content is low to high. Reaction is moderately alkaline to medium acid in the surface layer. The supply of available phosphorus is very low. The supply of available potassium is high.

These soils absorb water slowly. They are poorly aerated. They warm up slowly in spring, and wetness delays fieldwork. The water table is seasonally high. In some years, on some soils, crops drown and have to be replanted. Runoff is slow. Most of these soils are difficult to work and puddle very easily if worked when wet. The surface layer generally becomes cloddy and hard when dry; however, the soils that have a silt loam surface layer generally have good tilth. Cracks are common in dry seasons. Some areas are subject to flooding.

If drainage is adequate, these soils are moderately suited to row crops. Most areas are cultivated, but some areas that are not drained are in pasture. Corn and soybeans are major crops. Sorghum, wheat, oats, and hay are also grown.

Many of these soils, particularly those on the Missouri River bottom land, are drained by land grading and drainage ditches (fig. 18). In places levees are used to prevent flooding. Fall plowing allows timely fieldwork in spring, and freezing and thawing improve tilth. Plowing is generally easier in fall, but power requirements are high for tilling those soils that have a silty clay surface layer.

In many years crop yields are reduced by limited moisture. Excess water in spring restricts root growth; consequently not enough moisture is available during the summer. Irrigation is practiced by some farmers. No lime is needed on Albaton and Solomon soils. The other soils seldom need lime.

CAPABILITY UNIT IIIs-1

This unit consists of nearly level, sandy, moderately well drained to somewhat excessively drained soils of the Carr and Kenmoor series. These soils are on slight rises on the Missouri River bottom lands. The Carr soils have a very friable very fine sandy loam surface layer and are similar in texture to a depth of about 2½ feet. Below this is loamy fine sand to sand. The Kenmoor soils have a surface layer of fine sand, and they are similar in texture to a depth of about 2 feet. Below this is silty clay.

In Carr soils permeability is rapid, and available water capacity is low or moderate. In Kenmoor soils permeability is rapid in the upper layers and slow or very slow in the underlying silty clay. Available water capacity is low or moderate. Organic-matter content is low or very low. Kenmoor soils are typically mildly alkaline throughout. The supply of available phosphorus in both soils is very low. The supply of available potassium is high.

The soils in this unit absorb water readily, but because they hold only moderate to low amounts for plant use they are droughty. They warm up early in spring and can be worked soon after rains. Droughtiness is the main limitation. Water erosion is not a serious hazard, but blowing sand damages young crops in places. Some areas near the Missouri River are subject to flooding.

These soils are moderately well suited to row crops, but drought often limits crop growth. Most areas are cultivated. Some are wooded or pastured. Corn, sorghum, small grain, and alfalfa are grown. Maintaining organic-matter content and fertility and preventing soil blowing are major management needs. Good management of crop residue is needed to control soil blowing and the resulting crop damage. No lime is needed. These soils are well suited to irrigation and are situated where water is available. Frequent applications are needed.

CAPABILITY UNIT IVe-1

This unit consists of moderately steep, silty and loamy, well drained and moderately well drained soils of the Castana, Ida, and Monona series and one mapping unit of Dow-Monona silt loams. These moderately steep soils are mainly on side slopes. Castana soils are on high foot slopes. They formed in silty material slumped or washed from adjacent slopes. The rest formed in loess. All have a friable silt loam surface layer and similar texture below.

Permeability is moderate. Available water capacity is high. Organic-matter content is moderate to very low. Monona soils are slightly acid or neutral in the surface layer and subsoil. The rest are mildly or moderately alkaline. The supply of available phosphorus is very low. The supply of available potassium is low or very low.

These soils are subject to erosion and gullying. Runoff is rapid; therefore the supply of soil moisture is seldom at capacity. In places gullies are uncrossable.

If erosion is controlled these soils are moderately well suited to row crops. Many areas are, or have been, cultivated. Some areas are in permanent pasture. A few are wooded, but are generally managed as pasture.

Terracing and tilling on the contour are needed for erosion control. A common practice is to use this soil for hay or pasture much of the time and to grow a row crop just before the meadow is to be reseeded. Corn is the major row crop. Soybeans are seldom planted. In places gullies have to be shaped and seeded for waterways. The addition of phosphorus is important for meadow. Need for potassium is generally small. No lime is needed except for small amounts on the Monona soils.

CAPABILITY UNIT IVs-1

This unit consists of excessively drained, stratified sandy soils of the Sarpy series. These soils have a loose fine sand or fine sandy loam surface layer and are typically fine sand below.

Permeability is rapid or very rapid, and the available water capacity is very low or low. Organic-matter content is very low. Sarpy soils are typically moderately alkaline throughout. The supply of available phosphorus is very low. The supply of available potassium is high.

Figure 18.—**Shallow drainage ditch in Luton silty clay soil. The crop is soybeans.**

Droughtiness and soil blowing are major hazards. Blowing sand sometimes damages young seedlings on these soils as well as young plants on adjacent soils. These soils can be cultivated soon after rains, and they warm up quickly in spring. Some areas that are not protected by levees are subject to flooding when the river stage is high.

These soils are best suited to pasture. Yields of row crops are seldom satisfactory. They depend largely on the amount of rainfall during the growing season. Alfalfa is well suited because it has a deep root system. Most areas of these soils are in native vegetation of trees and grass and are used as pasture. In the small areas farmed to cultivated crops, good management of crop residues decreases the amount of soil blowing. Maintaining fertility is difficult because permeability is rapid or very rapid. If well managed, some areas of these soils are suitable for timber. Use of the soils for wildlife and recreation is also possible.

CAPABILITY UNIT Vw–1

This unit consists of nearly level Albaton and Sarpy soils and Borrow pits. Albaton and Sarpy soils are near the Missouri River channel, and the Borrow pits are along Interstate Highway 29. Albaton and Sarpy soils vary in texture from sandy to clayey. Borrow pits are excavations where material has been removed for highway construction.

Drainage ranges from excessive to poor. Permeability is very rapid to very slow. Available water capacity is moderate to very low. Organic-matter content is low or very low.

Albaton and Sarpy soils are mainly on the river side of protective levees and are subject to flooding. Recent deposition of varying texture accumulates each year.

Flooding, droughtiness, and wetness make most areas of these soils of limited value in farming. Some areas are in pasture. Most areas are wooded with willows and other brush. Recreational uses and wildlife habitat are possible uses for many areas. A few borrow pits are cultivated, but some are ponded so much of the time that cultivation is not practical. Others have been planted to trees.

CAPABILITY UNIT VIe–1

This unit consists of moderately steep to steep, well drained or moderately well drained soils of the Ida, Monona, and Steinauer series. These soils are on uplands.

Ida and Monona soils have a friable silt loam surface layer and similar texture below. Steinauer soils are clay loam throughout. Permeability in all is moderate or moderately slow. Available water capacity is high. Organic-matter content is low or very low. Ida and Steinauer soils are typically moderately alkaline throughout. Monona soils are slightly acid or neutral in the surface layer and subsoil. The supply of available phosphorus in all is very low. The supply of available potassium is low or very low.

These soils are severely limited by steep slope, severe hazard of erosion, and gullies. Their capacity to hold water available for plants is high, but because runoff is rapid they are seldom at capacity.

These soils are poorly suited to cultivated crops. They are better suited to hay or pasture. Most areas are in pasture. Some areas can be worked with farm machinery and planted to grasses and legumes for more productive pasture. Many areas are too steep, too irregular, or too gullied for tillage.

Good grazing management is needed to maintain or increase forage yields. In places gullies should be shaped and seeded. Fertilizing pasture, if feasible, can be considered. Ida and Steinauer soils are calcareous and do not need lime, but Monona soils need small amounts in places.

CAPABILITY UNIT VIIe-1

This unit consists of steep or very steep, well-drained and somewhat excessively drained soils of the Monona, Hamburg, and Ida series and Napier-Gullied land complex. The Napier-Gullied land complex is along drainageways and small streams. The rest are on uplands. Monona, Ida, Napier, and Hamburg soils have a friable or very friable silt loam surface layer and similar texture below.

Permeability is moderate or moderately rapid. Available water capacity is high, but runoff is so rapid on Ida, Hamburg, and Monona soils that they are seldom at capacity. Organic-matter content is generally low, but in Napier soils it is high. Ida and Hamburg soils are moderately alkaline throughout. Monona and Napier soils are typically neutral in the surface layer and subsoil. The supply of available phosphorus in all these soils is very low. The supply of available potassium is low or very low.

These soils are severely limited by steep slopes, rapid runoff, and deep gullies. They are not suited to cultivation, and they are poorly suited to pasture. Many areas are in permanent pasture or trees. Some areas are in native grasses. Recreation and wildlife are possible uses for many areas. These soils are extremely erodible, and many areas are dry in midsummer.

A protective plant cover is needed to control erosion on the steep slopes. Trees, uncrossable gullies, and steep slopes generally prevent renovating pasture. Controlling grazing is important in maintaining pasture productivity. Controlling gullies in the Napier-Gullied land complex is difficult and generally involves expensive earthmoving. Some gullies can be shaped. Other methods used are diverting water around them, terracing the soils upslope, and placing special retention structures in major channels to trap sediments and raise the level of stream bottoms.

Soils of this unit are not suited to commercial woodland, but the timber stands reduce soil and water loss and are valuable for recreation and wildlife.

CAPABILITY UNIT VIIs-1

This unit consists of Riverwash, principally sandbars, most of which are near the main channel of the Missouri River. Riverwash is sandy throughout. Available water capacity and fertility are very low.

Areas of Riverwash are not protected by levees and are subject to frequent deposition of sand and frequent flooding. They are largely barren of vegetation, and blowing sand causes dunelike topography in places. Willows and cottonwoods grow rapidly where thin layers of silt have been deposited. The principal use of these areas is wildlife habitat. Some areas have potential for recreational development.

Predicted yields

Table 2 shows the predicted average yields per acre of the principal crops grown in the county under a high level of management. Under this level of management, seedbed preparation, planting, and tillage provide for adequate stands of adapted varieties; erosion is controlled; the organic-matter content and soil tilth are maintained; the level of fertility for each crop is maintained, as indicated by soil tests and field trials; the water level in wet soil is controlled; excellent weed and pest control are provided; and all fieldwork is timely.

Estimates are based on many available sources of information, including data from the Federal census, the Iowa farm census, data from experimental farms and cooperative experiments with farmers, and from on-farm experience by soil scientists, extension workers, and others.

The yield predictions are meant to serve as guides. They are approximate values only. Of more value than actual yield figures to many users will be the comparative yields between soils. These relationships are likely to remain consistent over a period of years. On the other hand, actual yields have been increasing in recent years. If they continue to increase as expected, predicted yields in this table will soon be too low.

Woodland

Much of the natural forest in the county is in an area a few miles wide adjacent to the Missouri River bottom land. In this area are mainly the steep and very steep Monona, Ida, and Hamburg soils. Apparently the soils have not been forested long enough to markedly influence their characteristics. Other areas of forest are mainly on the bottom land, on steep slopes adjacent to other bottom land, and in upland drainageways. Trees commonly on the uplands are red oak, bur oak, hackberry, black walnut, and butternut. Trees commonly on the bottom land are soft maple, boxelder, green ash, cottonwood, and willow.

Many farms have windbreaks, and some have small woodlots. Planting trees and shrubs for windbreaks and landscaping has been a common practice in the county since it was settled. As the size of individual farms increases, many farmstead sites are cleared and converted to crops or pasture.

Most of the existing woodland in the county is subject to grazing. Little is managed only as woodland. Very steep areas produce little feed and provide little more than shade for livestock and wildlife. Good woodland management would increase the value of such acreages.

The wooded acreage has not changed significantly in recent years. Some parts have been cleared and converted to crops, for example, the small woodlots of former farmsteads and wooded areas mainly on bottom land and on tops and sides of ridges. The soils ordinarily cleared for crops are the Monona, Ida, or Napier soils on uplands and the Napier, Kennebec, Napier-Nodaway, and Nodaway soils on bottom land. A few areas of Haynie soils, Albaton and Sarpy soils, Blake and Haynie soils, and Onawa soils, all on the Missouri bottom land, are also cleared.

The small demand for timber of the quality and volume produced in the county accounts largely for the lack of interest in woodland. The chief concern of farmers is in planting trees and shrubs for windbreaks or beautification. Several agencies in Iowa have programs to assist woodland owners in improving the quality of their product and to inform them on basic marketing practices. Personnel of the Soil Conservation Service assist landowners and operators in determining the best land use. Local district foresters, employed by the Iowa State Conservation Commission, assist in planning the management of woodlands.

Wildlife

Harrison County supports many kinds of wildlife that contribute to the economy of the county and also have recreational value. The kind and number of wildlife produced and maintained in the county are largely determined by the kind, amount, and distribution of vegetation.

Wildlife is influenced by topography and soil fertility. Fertile soils are capable of greater wildlife production than less fertile soils. Topography affects wildlife through its influence on land use. Extremely rough, irregular areas can be hazardous to livestock and unsuitable for wildlife. If suitable vegetation is lacking in such areas, it can often be developed to improve conditions for desirable kinds of wildlife. Nearly level or gently sloping soils that are cropped intensively in large fields often support only limited numbers of wildlife because few shelter and nesting areas are available. Natural wetness and the water-holding capacity of soils are important in selecting soils for constructing ponds for fish and in developing and maintaining habitat for waterfowl. In some places naturally marshy areas can be developed to provide aquatic or semiaquatic habitat for waterfowl and for some furbearers.

Albaton, Onawa, Haynie, Blake, Sarpy, and other soils along the Missouri River, especially those near the river, provide food and cover for large numbers of migrating ducks and geese in the fall and spring. A number of oxbow lakes and marshy areas along the bottoms provide resting places for waterfowl on their migration along the Missouri flyway. The De Soto Bend National Wildlife Refuge, for example, west of Missouri Valley along U.S. Highway 30, provides excellent resting and feeding areas for migratory waterfowl.

Pheasant, wild ducks and geese, cottontail rabbits, squirrel, and deer provide much of the hunting in the county. Pheasants and rabbits find habitat in all parts of the county, but the distribution is probably greater in the uplands. Deer find the most favorable food supply and cover on the stream bottom land and on adjacent uplands.

The Kennebec-McPaul-Nodaway, Hamburg-Ida-Monona, and Sarpy-Albaton-Carr soil associations provide the most favorable habitat for deer.

Squirrels are most numerous on the Hamburg-Ida-Monona and Monona-Ida-Napier soil associations. Opossum, raccoon, weasel, woodchuck, badger, fox, coyote, and skunk are in varying numbers throughout the county.

Furbearers, including muskrat, mink, and beaver, are along streams and in marshy areas. The Sarpy-Albaton-Carr, Albaton-Haynie-Onawa, Luton-Keg, and Kennebec-McPaul-Nodaway soil associations are most favorable.

Fish, mainly catfish, bullheads, and carp, are fairly numerous in the Missouri and Boyer Rivers. A number of private ponds and watershed structures provide fishing for bass, bluegills, crappies, and catfish.

Many areas that cannot be used for crops are well suited to wildlife habitat, and on most farms, areas of little economic value for other uses can be developed as habitat. Such areas are the Hamburg, Ida, Napier-Gullied land, Napier silt loam, Sarpy, and Steinauer soils. Also suitable as wildlife habitat are the small, steep or eroded parts of cropped fields, the railroad right-of-ways, or the tracts cut off from the rest of a field by a stream or drainage ditch. Even on soils that are suitable for crops, wildlife can be produced as a primary or secondary crop for income or recreational purposes.

Recreation

The soils and topography of Harrison County make it suitable for a variety of recreational facilities. The rolling uplands, especially the Hamburg-Ida-Monona soil association, are well suited to part development. Some of the marshy areas in the Sarpy-Albaton-Carr and Luton-Keg soil associations are well suited to development as wetland wildlife habitat. The Missouri River is available for those who are interested in boating and fishing. The Boyer River and the private ponds and watershed structures also provide good fishing.

The largest and best known recreational facility developed in the county is the De Soto Bend National Wildlife Refuge west of Missouri Valley on U.S. Highway 30, on the Sarpy-Albaton-Carr and Albaton-Haynie-Onawa soil associations. This refuge provides facilities for fishing, swimming, boating, water-skiing, and

TABLE 2.—*Predicted average yields per acre of principal crops under high level management*

[Only arable soils are listed. Dashes indicate that the crop is not suited to the soil or is not generally grown on it. Pasture is alfalfa-bromegrass unless otherwise indicated]

Soil	Corn	Soybeans	Oats	Hay	Pasture
	Bu	*Bu*	*Bu*	*Tons*	*Animal-unit-days* [1]
Albaton silt loam	90	34	63	3.4	170
Albaton silty clay	80	30	56	3.0	150
Albaton and Sarpy soils	----	----	----	----	[2]30
Blake silt loam	98	37	69	3.7	185
Blake silty clay loam	98	37	69	3.7	185
Blake and Haynie soils	72	27	50	2.7	135
Blencoe silty clay	96	36	67	3.6	180
Blend silty clay	80	30	56	3.0	150
Burcham silt loam	106	40	74	4.0	200
Carr very fine sandy loam	70	27	49	2.7	135
Castana silt loam, 5 to 14 percent slopes	79	30	55	3.0	150
Castana silt loam, 14 to 20 percent slopes	64	24	45	2.4	120
Colo silt loam, overwash	107	41	75	4.1	205
Colo silty clay loam	104	40	73	4.0	200
Cooper silty clay loam	98	37	69	3.7	185
Dow-Monona silt loams, 9 to 14 percent slopes, severely eroded	69	26	48	2.6	130
Dow-Monona silt loams, 14 to 20 percent slopes, severely eroded	54	21	38	2.1	105
Forney silty clay	80	30	56	3.0	150
Grable silt loam	75	28	52	2.8	140
Hamburg silt loam, 40 to 75 percent slopes	----	----	----	----	[2]30
Haynie silt loam	96	36	67	3.6	180
Ida silt loam, 5 to 9 percent slopes	83	32	58	3.2	160
Ida silt loam, 5 to 9 percent slopes, severely eroded	77	29	54	2.9	145
Ida silt loam, 9 to 14 percent slopes	74	28	52	2.8	140
Ida silt loam, 9 to 14 percent slopes, severely eroded	68	26	48	2.6	130
Ida silt loam, 14 to 20 percent slopes	59	22	41	2.2	110
Ida silt loam, 14 to 20 percent slopes, severely eroded	53	20	37	2.0	100
Ida silt loam, 20 to 30 percent slopes	----	----	----	1.7	85
Ida silt loam, 20 to 30 percent slopes, severely eroded	----	----	----	1.5	75
Ida silt loam, 30 to 40 percent slopes	----	----	----	----	[2]35
Keg silt loam	118	45	83	4.5	225
Kenmoor fine sand	65	25	46	2.5	125
Kennebec silt loam	118	45	83	4.5	225
Kennebec silt loam, overwash	118	45	83	4.5	225
Lakeport silty clay loam	105	40	74	4.0	200
Luton silt loam, overwash	80	31	56	3.1	155
Luton silty clay	65	25	45	2.5	125
Luton silty clay, thin surface	70	27	49	2.7	135
McPaul silt loam	98	37	69	3.7	185
Modale very fine sandy loam	85	32	60	3.2	160
Modale silt loam	92	35	64	3.5	175
Monona silt loam, 0 to 2 percent slopes	100	38	70	3.8	190
Monona silt loam, benches, 0 to 2 percent slopes	100	38	70	3.8	190
Monona silt loam, 2 to 5 percent slopes	98	37	69	3.7	185
Monona silt loam, benches, 2 to 5 percent slopes	98	37	69	3.7	185
Monona silt loam, 5 to 9 percent slopes	93	35	65	3.5	175
Monona silt loam, 5 to 9 percent slopes, moderately eroded	90	34	63	3.4	170
Monona silt loam, 9 to 14 percent slopes	84	32	59	3.2	160
Monona silt loam, 9 to 14 percent slopes, moderately eroded	81	31	57	3.1	155
Monona silt loam, 9 to 14 percent slopes, severely eroded	75	28	53	2.8	140
Monona silt loam, 14 to 20 percent slopes	69	26	48	2.6	130
Monona silt loam, 14 to 20 percent slopes, moderately eroded	66	25	46	2.5	125
Monona silt loam, 14 to 20 percent slopes, severely eroded	60	23	42	2.3	115
Monona silt loam, 20 to 30 percent slopes	----	----	----	2.0	100
Monona silt loam, 20 to 30 percent slopes, moderately eroded	----	----	----	2.0	100
Monona silt loam, 30 to 40 percent slopes	----	----	----	----	[2]40
Moville silt loam	98	37	69	3.7	185
Napier silt loam, 2 to 5 percent slopes	105	40	74	4.0	200
Napier silt loam, 2 to 5 percent slopes, overwash	105	40	74	4.0	200
Napier silt loam, 5 to 9 percent slopes	100	38	70	3.8	190
Napier silt loam, 9 to 14 percent slopes	91	35	64	3.5	175
Napier-Gullied land complex, 2 to 10 percent slopes	----	----	----	----	[2]15
Napier-Nodaway-Colo complex, 2 to 5 percent slopes	102	39	71	3.9	195
Nodaway silt loam	108	41	75	4.1	205
Onawa silt loam	100	38	70	3.8	190
Onawa silty clay	90	34	63	3.4	170
Percival silty clay	65	25	45	2.5	125
Salix silty clay loam	114	43	80	4.3	215
Sarpy fine sand, 0 to 3 percent slopes	----	----	25	1.0	50
Sarpy fine sand, 3 to 7 percent slopes	----	----	24	0.9	45
Sarpy fine sandy loam, 0 to 3 percent slopes	----	----	26	1.0	50

TABLE 2.—*Predicted average yields per acre of principal crops under high level management*—Continued

Soil	Corn	Soybeans	Oats	Hay	Pasture
	Bu	*Bu*	*Bu*	*Tons*	*Animal-unit-days* [1]
Solomon silty clay	60	23	42	2.3	115
Steinauer clay loam, 9 to 14 percent slopes, moderately eroded	76	29	43	2.9	145
Steinauer clay loam, 14 to 18 percent slopes, severely eroded			30	2.0	100
Vore silty clay loam	75	28	53	2.8	140
Woodbury silty clay	80	30	56	3.0	150

[1] Animal-unit-days is 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.
[2] Bluegrass or native grasses.

picnicking. This refuge and other areas along the Missouri River also provide feeding and resting areas for thousands of blue, snow, and Canada geese each spring and fall (fig. 19).

Most towns have parks available for picnicking, softball, and other light recreation. A number have swimming pools. The park at Dunlap is adjacent to a watershed structure and 7-acre pond in the Mill-Picayune watershed.

Soils and Engineering

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, facilities for storing water, erosion control structures, irrigation systems, drainage systems, building foundations, and sewage disposal systems. Among the properties most important to engineers are permeability, shear strength, compaction characteristics, soil drainage, shrink-swell potential, grain size, plasticity, and pH. Depth to the water table, depth to bedrock, and topography are also important.

The information in this publication can be used to—

1. Make soil and land use studies that will aid in selecting and developing industrial, commercial, residential and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in the planning of farm drainage systems, farm ponds, irrigation systems, terraces, waterways, and diversions.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting highway and airport locations and in planning detailed investigations at the selected locations.
4. Locate probable sources of gravel, sand, or other construction materials.
5. Correlate performance of engineering structures with soil mapping units to develop information for planning that will be useful in designing and maintaining specified engineering practices and structures.
6. Determine the suitability of soil mapping units for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photographs to make maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

With the soil map for identification of soil areas, the data and interpretations reported here can be useful for many purposes. It should be emphasized, however, that these interpretations may not eliminate the need for sampling and testing at the site of specific engineering works that involve heavy loads, or where the excavations are deeper than the depth of the layers reported.

Information regarding the behavior and properties of the soils in Harrison County can be obtained from the detailed soil map at the back of the survey and from tables 3, 4, and 5 in this section. The information in the tables was obtained and evaluated from field experience, field performance, and the result of tests, such as those shown in table 5. The data in table 5, and other assistance as well, were furnished by the Iowa State Highway Commission.

Some terms used by soil scientists have special meaning in soil science that may not be familiar to engineers. These terms are defined in the Glossary.

Engineering classification

Most highway engineers classify soil material according to the system approved by the American Association of State Highway Officials (AASHO) (*1*). In this system soil materials are placed in seven principal groups based on field performance. The groups range from A–1, which consists of soils that have the highest bearing strength, to A–7, which consists of soils that have the lowest strength when wet.

Some engineers prefer to use the Unified Soil Classification System developed by the Bureau of Reclamation and the U.S. Army Corps of Engineers (*29*). This system is based on the texture and plasticity of soils and the performance of soils as material for engineering works. In this system, soil materials are classified as coarse grained (four classes), fine grained (four

Figure 19.—**Lake at De Soto Bend National Wildlife Refuge and adjoining soils provide resting places for thousands of wildfowl during migration. The light-colored area in the left background is Riverwash.**

classes), mixed and fine grained (four classes), or organic (three classes). An approximate classification can be made in the field. The soil series and land types in Harrison County have been classified by the AASHO and Unified systems in table 3.

Soil scientists use the USDA textural classification (*26*). In this, the texture of the soil is determined according to the properties of soil particles smaller than 2 millimeters in diameter, that is, the proportion of sand, silt, and clay.

Table 5 shows the AASHO and Unified classification of specified soils in the county, as determined by laboratory tests. Table 3 shows the estimated classification of all the soils in the county according to all three systems of classification.

Engineering properties

Estimates of soil properties significant in engineering are shown in table 3. Some estimates are based on the test data shown in table 5, and some on the test data for similar soils in other counties in Iowa.

Depth to bedrock is not shown in table 3 because the soils in Harrison County are so deep that bedrock does not generally affect their use.

Permeability is estimated for each soil as it occurs in place. The estimates were based on soil structure and porosity and were compared with undisturbed cores of similar soil material.

Available water capacity is expressed in this table in inches per inch of soil depth. It is the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point.

Reaction, the degree of acidity or alkalinity, is expressed in pH value. The pH of a neutral soil is 7.0. An acid soil is less than 7.0, and an alkaline soil is more than 7.0.

The shrink-swell potential indicates the change in volume that occurs with a change in moisture content. It is estimated primarily on the basis of the kind and amount of clay present.

TABLE 3.—*Estimates of soil*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more necessary to follow carefully the instructions for referring to other series that appear in the

Soil and map symbols	Depth to seasonal high water table	Depth from surface	Classification: USDA texture
	Feet	*Inches*	
*Albaton:			
157	1–3	0–10	Silt loam
		10–60	Silty clay
156, 315	1–3	0–60	Silty clay
For Sarpy part of unit 315, see units 237 and 238 under Sarpy series.			
*Blake:			
844	2–4	0–10	Silt loam
		10–24	Silty clay loam
		24–60	Silt loam
144, 38	2–4	0–24	Silty clay loam
For Haynie part of unit 38, see unit 137 under Haynie series.		24–60	Silt loam
Blencoe: 44	1–3	0–24	Silty clay
		24–30	Silty clay loam
		30–60	Silt loam
Blend: 244	1–3	0–22	Silty clay and silty clay loam
		22–32	Light silty clay loam
		32–60	Silty clay
Borrow pits: 550. No estimates made. Material too variable.			
Burcham: 446	2–5	0–26	Silt loam
		26–60	Silty clay
Carr: 538	3–6	0–29	Very fine sandy loam
		29–60	Loamy fine sand and fine sand
Castana: 3D, 3E	>5	0–13	Silt loam
		13–60	Silt loam
Colo:			
133+	[1]1–3	0–10	Silt loam
		10–34	Silty clay loam
		34–60	Silty clay loam
133	[1]1–3	0–35	Silty clay loam
		35–60	Silty clay loam
Cooper: 255	2–4	0–19	Silty clay loam
		19–26	Light silty clay loam
		26–50	Silty clay
*Dow: 22D3, 22E3	>5	0–60	Silt loam
For Monona part of these units, see Monona series.			
Forney: 553	1–3	0–60	Silty clay or clay
Grable: 514	>4	0–23	Silt loam
Gullied land. Too variable to be rated.		23–60	Fine sand
Hamburg: 2G	>5	0–65	Silt loam
Haynie: 137	3–5	0–60	Silt loam
Ida: 1C, 1C3, 1D, 1D3, 1E, 1E3, 1F, 1F3, 1G	>5	0–60	Silt loam
Keg: 46	>5	0–18	Silt loam
		18–60	Silt loam

See footnote at end of table.

properties significant in engineering

kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is first column of this table. The symbol > means more than; the symbol < means less than]

Classification—Continued		Percentage passing sieve—		Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 10	No. 200				
				Inches per hour	*Inches per inch of soil*	*pH*	
ML or ML-CL	A-4 (4-8) or A-6 (6-12)	100	85-100	0.63-2.0	0.19	7.4-8.4	Moderate.
CH	A-7-6 (20)	100	95-100	<0.06-0.2	.14	7.4-8.4	High.
CH	A-7-6 (20)	100	95-100	<0.06-0.2	.14	7.4-8.4	High.
ML or ML-CL	A-6 (8-12)	100	90-100	0.63-2.0	.19	7.4-8.4	Moderate.
ML-CL or CL	A-7-6 (14-19)	100	95-100	0.2-2.0	.19	7.4-7.8	Moderate to high.
ML or CL	A-4 (6-8) or A-6 (8-12)	100	90-100	0.63-2.0	.18	7.4-8.4	Moderate.
ML-CL or CL	A-7-6 (14-19)	100	95-100	0.2-2.0	.19	7.4-7.8	Moderate to high.
ML or CL	A-4 (6-8) or A-6 (8-12)	100	95-100	0.63-2.0	.18	7.4-8.4	Moderate.
OH or CH	A-7-5 (20) or A-7-6 (20)	100	95-100	<0.06	.17	6.1-7.3	High.
CL or CH	A-7-6 (14-18)	100	90-100	0.2-2.0	.19	6.6-7.8	Moderate to high.
ML or CL	A-4 (6-8) or A-6 (8-12)	100	95-100	0.63-2.0	.20	6.6-8.4	Moderate.
OH or CH	A-7-6 (16-20)	100	95-100	<0.06	.17	5.6-7.8	High.
CL or ML-CL	A-4 (6-8) or A-6 (8-12)	100	90-100	0.63-2.0	.20	6.1-7.8	Moderate.
CH	A-7-6 (20)	100	95-100	<0.06	.14	6.1-8.4	High.
ML-CL or CL	A-6 (8-12) or A-7-6 (10-14)	100	95-100	0.63-2.0	.21	6.6-8.4	Moderate.
CH	A-7-6 (20)	100	95-100	<0.06	.14	7.4-8.4	High.
SM or SC	A-2-4 (0-4) or A-4 (0-4)	100	25-50	2.0-6.3	.15	7.4-8.4	Low.
SM	A-2-4 (0)	100	12-30	6.3-20	.06	7.4-8.4	Low.
ML or CL	A-4 (6-8) or A-6 (8-12)	100	95-100	0.63-2.0	.21	7.4-8.4	Low to moderate.
ML or CL	A-4 (6-8) or A-6 (8-12)	100	95-100	0.63-2.0	.18	7.4-8.4	Low to moderate.
ML or CL	A-4 (6-8) or A-6 (8-12)	100	85-100	0.63-2.0	.19	6.1-7.3	Low to moderate.
CH or OH or CL	A-7-5 or A-7-6 (14-20)	100	85-100	0.2-0.63	.21	6.1-7.3	High.
CH or CL	A-7-6 (14-20)	100	85-100	0.2-0.63	.18	6.1-7.3	High.
CH or OH or CL	A-7-5 or A-7-6 (14-20)	100	90-100	0.2-0.63	.21	6.1-7.3	High.
CH or CL	A-7-6 (14-20)	100	85-100	0.2-0.63	.18	6.1-7.3	High.
OL, ML or CL	A-7-5 or A-7-6 (10-14)	100	95-100	0.63-2.0	.21	6.1-7.3	Moderate to high.
CL or ML-CL	A-6 (8-12)	100	85-100	0.63-2.0	.19	6.6-7.8	Moderate.
CH	A-7-6 (20)	100	95-100	<0.06-0.2	.14	7.4-8.4	High.
ML-CL or CL	A-4 (6-8) or A-6 (8-10)	100	95-100	0.63-2.0	.18	7.4-8.4	Low.
CH	A-7-6 (20)	100	95-100	<0.06	.14	6.1-7.8	High.
ML or ML-CL	A-4 (4-8) or A-6 (6-12)	100	80-95	0.63-2.0	.18	7.4-7.8	Low.
SM or SP-SM	A-2-4 (0)	100	10-30	6.3-20	.06	7.4-8.4	Low.
ML or ML-CL	A-4 (4-8) or A-6 (6-10)	100	95-100	2.0-6.3	.17	7.4-8.4	Low.
ML or ML-CL	A-4 (4-8) or A-6 (6-12)	100	70-100	0.63-2.0	.18	7.4-8.4	Low.
ML or CL	A-4 (4-8) or A-6 (6-10)	100	95-100	0.63-2.0	.18	7.8-8.4	Low.
ML-CL or CL	A-6 (8-12) or A-7-6 (10-14)	100	90-100	0.63-2.0	.21	6.1-7.3	Moderate.
ML or CL	A-6 (8-12)	100	90-100	0.63-2.0	.18	6.1-8.4	Moderate.

TABLE 3.—*Estimates of soil*

Soil and map symbols	Depth to seasonal high water table	Depth from surface	Classification: USDA texture
	Feet	*Inches*	
Kenmore: 849	2–4	0–25	Fine sand
		25–60	Silty clay
Kennebec: 212, 212+	[1]3–5	0–60	Silt loam
Lakeport: 436	2–4	0–21	Silty clay loam
		21–42	Silty clay loam and light silty clay
		42–60	Silt loam
Luton:			
66+	1–3	0–10	Silt loam
		10–28	Silty clay
		28–60	Silty clay or clay
66, 866	0–3	0–21	Silty clay
		21–60	Silty clay or clay
McPaul: 70	[1]3–5	0–60	Silt loam
Modale:			
149	1–3	0–22	Silt loam
		22–60	Silty clay
549	1–3	0–24	Very fine sandy loam
		24–60	Silty clay
Monona: 10, T10, 10B, T10B, 10C, 10C2, 10D, 10D2, 10D3, 10E, 10E2, 10E3, 10F, 10F2, 10G.	>5	0–15	Silt loam
		15–30	Silt loam
		30–60	Silt loam
Moville: 275	[1]1–3	0–27	Silt loam
		27–60	Silty clay or clay
*Napier: 12B, 12B+, 12C, 12D, 17B, 717C	>5	0–30	Silt loam
No valid estimates for Gullied land part of unit 717C. For Nodaway part of unit 17B, see Nodaway series, for Colo part of unit 17B, see Colo series.		30–60	Silt loam
Nodaway: 220	[1]3–5	0–60	Silt loam
Onawa:			
145	1–3	0–10	Silt loam
		10–29	Silty clay
		29–60	Silt loam
146	1–3	0–26	Silty clay or clay
		26–60	Silt loam
Percival: 515	1–3	0–24	Silty clay
		24–60	Loamy fine sand and fine sand
Riverwash: 53	[1]0–3	0–60	Variable, generally loamy sand or sand
Salix: 36	3–5	0–24	Silty clay loam
		24–60	Silt loam
Sarpy:			
237, 237B	>5	0–60	Fine sand
238	>5	0–10	Fine sandy loam
		10–60	Fine sand
Solomon: 466	0–3	0–17	Silty clay
		17–60	Silty clay and clay
Steinauer: 33D2, 33E3	>5	0–60	Clay loam
Vore: 516	1–3	0–24	Silty clay loam
		24–60	Fine sand
Woodbury: 67	1–3	0–24	Silty clay
		24–35	Silty clay to heavy silty clay loam
		35–60	Silty clay loam

[1] Subject to flooding.
[2] 95 to 100 percent passes No. 4 sieve.

properties significant in engineering classification—Continued

Classification—Continued		Percentage passing sieve—		Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 10	No. 200				
				Inches per hour	*Inches per inch of soil*	*pH*	
SM or SP-SM	A–2–4 (0) or A–3 (0)	100	5–30	6.3–20	0.05	7.4–8.4	Low.
CH	A–7–6 (20)	100	95–100	<0.06–0.2	.14	7.4–8.4	High.
OL or CL	A–6 (8–12) or A–7–6 (10–14)	100	90–100	0.63–2.0	.21	6.6–7.8	Moderate.
OH or CH or CL	A–7–5 or A–7–6 (14–19)	100	995–100	0.2–0.63	.21	6.1–7.3	High.
CH or CL	A–7–6 (14–20)	100	5–100	0.2–0.63	.19	6.6–7.8	High.
ML-CL or CL	A–6 (8–12) or A–7–6 (12–14)	100	90–100	0.63–2.0	.19	7.4–7.8	Moderate.
ML or ML-CL	A–6 (8–12)	100	90–100	0.63–2.0	.18	7.4–7.8	Moderate.
CH or OH	A–7–5 or A–7–6 (20)	100	95–100	<0.06	.14	6.6–7.3	High.
CH	A–7–6 (20)	100	95–100	<0.06	.14	6.6–7.3	High.
CH or OH	A–7–5 or A–7–6 (20)	100	95–100	<0.06	.16	6.6–7.8	High.
CH	A–7–6 (20)	100	95–100	<0.06	.14	6.6–8.4	High.
ML or CL	A–4 (6–8) or A–6 (8–12)	100	95–100	0.63–2.0	.19	7.4–8.4	Moderate.
ML-CL or CL	A–4 (4–8) or A–6 (6–12)	100	70–90	0.63–2.0	.21	7.4–8.4	Low to moderate.
CH	A–7–6 (20)	100	95–100	<0.06–0.2	.14	7.4–8.4	High.
SM or SC	A–2–4 (0–4) or A–4 (0–4)	100	25–50	2.0–6.3	.15	7.4–8.4	Low.
CH	A–7–6 (20)	100	95–100	<0.06–0.2	.14	7.4–8.4	High.
ML or CL	A–7–6 (10–15)	100	95–100	0.63–2.0	.22	6.1–6.5	Moderate.
ML or CL	A–7–6 (10–15)	100	95–100	0.63–2.0	.19	6.6–7.3	Moderate.
ML or CL	A–6 (8–12) or A–7–6 (10–14)	100	95–100	0.63–2.0	.19	6.6–8.4	Moderate.
ML or CL	A–4 (6–8) or A–6 (8–12)	100	90–100	0.63–2.0	.21	7.4–8.4	Moderate.
CH or OH	A–7–6 (20)	100	95–100	<0.06	.14	6.6–7.8	High.
OL or CL	A–6 (8–12) or A–7–6 (10–13)	100	95–100	0.63–2.0	.23	6.1–7.3	Moderate.
ML-CL or CL	A–6 (8–12) or A–7–6 (10–13)	100	95–100	0.63–2.0	.20	6.1–8.4	Moderate.
ML-CL or CL	A–4 (4–8) or A–6 (6–10)	100	90–100	0.63–2.0	.19	6.1–7.3	Moderate.
ML or ML-CL	A–4 (4–8) or A–6 (6–12)	100	90–100	0.63–2.0	.18	7.4–8.4	Moderate.
CH	A–7–6 (20)	100	95–100	0.06–0.2	.14	7.4–8.4	High.
CL or ML-CL	A–4 (6–8) or A–6 (8–12)	100	85–100	0.63–6.3	.18	7.4–8.4	Low to moderate.
CH	A–7–6 (20)	100	95–100	0.06–0.2	.14	7.4–8.4	High.
CL or ML-CL	A–4 (6–8) or A–6 (8–12)	100	85–100	0.63–2.0	.18	7.4–8.4	Low to moderate.
CH	A–7–6 (20)	100	95–100	<0.06	.14	7.4–8.4	High.
SM	A–2–4 (0)	100	12–30	>6.3	.04	7.4–8.4	Low.
SM or SP-SM	A–2–4 or A–3	90–100	5–25	6.3–>20	.04	7.4–7.8	Low.
OL, CL or CH	A–7–6 (12–18)	100	95–100	0.63–2.0	.21	6.1–7.3	Moderate to high.
ML-CL or CL	A–6 (8–12)	100	90–100	0.63–2.0	.19	6.6–8.4	Moderate.
SP-SM or SM	A–2–4 (0) or A–3 (0)	100	5–35	6.3–>20	.04	7.4–8.4	Low.
SM	A–2–4 or A–4 (0–4)	100	30–50	2.0–6.3	.12	7.4–8.4	Low.
SP-SM or SM	A–2–4 (0) or A–3 (0)	100	5–25	6.3–>20	.04	7.4–8.4	Low.
CH or OH	A–7–5 or A–7–6 (20)	100	95–100	<0.06	.17	7.4–8.4	High.
CH	A–7–6 (20)	100	95–100	<0.06	.14	7.4–8.4	High.
CL	A–6 (8–12) or A–7–6 (10–14)	[2]80–95	55–75	0.2–0.63	16	7.9–8.4	Moderate.
CL or CH	A–7–6 (15–20)	100	90–100	0.2–0.63	.19	7.4–8.4	Moderate to high.
SM or SP-SM	A–2–4 (0) or A–3–0	100	5–30	6.3–>20	.04	7.4–8.4	Low.
CH or OH	A–7–6 (20)	100	95–100	<0.06–0.2	.17	6.1–7.3	High.
CH	A–7–6 (16–20)	100	95–100	0.2–0.63	.15	6.1–7.3	High.
CH or CL	A–7–6 (14–19)	100	80–100	0.2–0.63	.19	6.1–8.4	High.

TABLE 4.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds to follow carefully the instructions for referring to

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill [1]	Highway location	Foundations for low buildings [1]	Farm ponds: Reservoir area
*Albaton: 156, 157, 315. For Sarpy part of 315, see Sarpy series.	Poor: high clay content; good if surface layer is silt loam.	Not suitable.	Not suitable.	Very poor: poor bearing capacity; high shrink-swell potential; very clayey.	Nearly level; seasonal high water table; very clayey soil material.	Poor bearing capacity; poor shear strength; high shrink-swell potential; seasonal high water table; some areas subject to flooding.	Very slow or slow perme-ability; seasonal high water table; nearly level.
*Blake: 38, 144, 844. For Haynie part of 38, see Haynie series.	Fair: moderately fine textured; good if surface layer is silt loam.	Not suitable.	Not suitable.	Fair to poor: fair to poor bearing capacity; fair to poor workability and compaction charac-teristics.	Nearly level; seasonal high water table; fair to poor source of borrow materials.	Fair to poor bearing capacity; medium to high com-pressibility; fair resistance to piping; occasional high water table; some areas subject to flooding.	Nearly level; moderate or moderately rapid permeability in lower part.
Blencoe: 44	Poor: high clay content.	Not suitable.	Not suitable.	Very poor: clayey; high organic–matter content to a depth of about 2 feet; high shrink-swell potential.	Nearly level; seasonal high water table; poor source of embankment material.	Seasonal high water table; poor shear strength and bearing capacity.	Nearly level; moderate permeability in substratum.
Blend: 244	Poor: high clay content.	Not suitable.	Not suitable.	Very poor: very clayey; fair to poor bearing capacity; high shrink-swell potential.	Nearly level; seasonal high water table; poor foundation for high fills.	Seasonal high water table; fair to poor bearing capacity; high shrink-swell potential.	Nearly level; very slow per-meability.
Borrow pits: 550.	Poor: low organic-matter content: variable material; often ponded.	Not suitable.	Not suitable.	Poor: variable material; often ponded.	Excavated area next to highway needs to be filled; often ponded.	Often ponded.	Often ponded.

See footnote at end of table.

interpretations

of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary other series that appear in the first column of this table]

Soil features affecting—Continued					Degree and kind of limitation for—	
Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank disposal fields	Sewage lagoons
Fair stability; poor compaction characteristics; not ordinarily used.	Very slow or slow permeability.	Moderate available water capacity; water intake rate varies with the amount of vertical cracking.	Nearly level bottom land.	Nearly level bottom land.	Severe: very slow or slow permeability; seasonal high water table.	Moderate or severe: some areas subject to flooding; seasonal high water table; very slow or slow permeability.
Fair stability; fair to poor workability; not ordinarily used.	No drainage needed; moderate or moderately rapid permeability below a depth of about 2 feet.	High available water capacity; medium intake rate.	Nearly level bottom land.	Nearly level bottom land.	Slight to moderate unless subject to flooding; occasional high water table; moderate or moderately rapid permeability below a depth of about 2 feet.	Slight or moderate unless subject to flooding; moderately slow or moderate permeability in upper part; occasional high water table.
Fair to poor stability; medium to high compacted compressibility; underlying silt loam has poor resistance to piping; not ordinarily used.	Very slow permeability in upper part, moderate permeability below; few outlets for tile drains.	High available water capacity; intake rate varies with amount of vertical cracking in clayey material.	Nearly level bottom land.	Nearly level bottom land.	Severe: seasonal high water table; moderate permeability in substratum.	Moderate or severe: high organic-matter content; very slow permeability to a depth of about 2 feet; seasonal high water table.
Fair to poor stability; poor compaction characteristics; not ordinarily used.	Very slow permeability.	Moderate or high available water capacity; intake rate varies with amount of vertical cracking.	Nearly level bottom land.	Nearly level bottom land.	Severe: very slow permeability; seasonal high water table.	Moderate or severe: high organic-matter content; seasonal high water table; very slow permeability except in silty clay loam layer between depths of 1 and 2 feet.
Variable material; often ponded.	Very low and wet; often ponded.	Low agricultural value because of excess water and ponding.	Low-lying excavations near highway; no contouring needed.	Low-lying excavations near highway; no contouring needed.	Severe: high water table; often ponded.	Severe: variable soil material; often ponded.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill [1]	Highway location	Foundations for low buildings [1]	Farm ponds: Reservoir area
Burcham: 446	Good: medium textured; high organic matter content in surface layer.	Not suitable	Not suitable	Very poor: seasonal high water table; material below a depth of about 2 feet is very clayey.	Nearly level; seasonal high water table; very clayey material below a depth of about 2 feet.	Seasonal high water table; poor bearing capacity.	Nearly level bottom land; slow or very slow permeability in substratum.
Carr: 538	Fair: low organic-matter content and droughty.	Fair to poor: poorly graded; considerable fines.	Not suitable	Good: good bearing capacity; low shrink-swell potential.	Good borrow material potential; nearly level topography; erodible in embankments.	Low compressibility; fair shear strength; good to fair bearing capacity; low shrink-swell potential; susceptible to piping; a few areas subject to flooding.	Nearly level; rapid permeability.
Castana: 3D, 3E.	Good: medium texture.	Not suitable	Not suitable	Fair to poor: low bearing capacity when wet; medium to high compressibility; narrow range of moisture content for good compaction.	Moderately sloping to moderately steep; very erodible in gutters and ditches; subject to gullying.	Poor bearing capacity; poor resistance to piping; receives local runoff.	Moderate permeability.
Colo: 133+, 133.	Fair to good: high in organic-matter content; moderately fine textures; overwash, where present, is medium textured but low in organic-matter content.	Not suitable	Not suitable	Very poor; poor bearing capacity and shear strength; seasonal high water table; highly compressible; high in organic-matter content to a depth of about 3 feet or more.	Nearly level; seasonal high water table; subject to flooding; poor foundation for high fills.	Seasonal high water table; subject to flooding; high compressibility with uneven consolidation; high shrink-swell potential.	Nearly level; high in organic-matter content; moderately slow permeability.

See footnote at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitation for—	
Farm ponds–Con.						
Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank disposal fields	Sewage lagoons
Material below a depth of about 2 feet is very clayey and has very high shrink-swell potential and poor workability; not ordinarily used because of position.	Drainage generally needed; very slow or slow permeability in substratum.	High available water capacity; medium intake rate in silt loam, slow below.	Nearly level bottom land.	Nearly level bottom land.	Severe: very slow or slow permeability in substratum.	Moderate: moderate permeability in upper part, very slow or slow permeability below a depth of about 2 feet; seasonal high water table.
Fair stability; pervious when compacted; susceptible to piping; not used because of position.	No drainage needed; excessively drained.	Low available water capacity; rapid intake rate.	Nearly level bottom land.	Nearly level bottom land.	Slight: rapid permeability; poor filtering material; danger of pollution.	Severe: rapid permeability.
Fair to poor stability; difficult to compact to high density; poor resistance to piping.	No drainage needed; well drained.	High available water capacity; medium intake rate; potential very limited because of slopes and position.	Soil features favorable; gullies hinder construction in places.	Erosion hazard severe in waterway channels; gullies hinder construction in places.	Moderate if slope is 5 to 9 percent; severe if more than 9 percent.	Severe: moderately sloping to moderately steep; receives local runoff; moderate permeability.
High in organic-matter content in top 3 feet or more; high shrink-swell potential; difficult to compact.	Moderately slow permeability; outlets not available in places; subject to overflow.	Medium intake rate; high available water capacity; subject to flooding.	Nearly level bottom land.	Nearly level bottom land.	Severe: seasonal high water table; subject to flooding; moderately slow permeability.	Severe: subject to flooding; high in organic-matter content; seasonal high water table.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as source of— Topsoil	Sand	Gravel	Road fill [1]	Soil features affecting— Highway location	Foundations for low buildings [1]	Farm ponds: Reservoir area
Cooper: 255	Fair: moderately fine textured.	Not suitable	Not suitable	Very poor: seasonal high water table; material below a depth of 2 or 2½ feet is very clayey.	Nearly level: high seasonal water table; high organic-matter content in surface layer; very poor source of borrow material.	Seasonal high water table; high shrink-swell potential; poor bearing capacity.	Nearly level; slow or very slow permeability in the substratum.
*Dow: 22D3, 22E3. For Monona part of 22D3 and 22E3, see Monona series.	Fair: low organic-matter content.	Not suitable	Not suitable	Fair: fair to poor bearing capacity and shear strength; medium compressibility; narrow range of moisture for satisfactory compaction.	Very erodible; rolling topography.	Fair to poor bearing capacity; medium compressibility; low shrink-swell potential.	Strongly sloping; moderate permeability.
Forney: 553	Poor: high clay content; low organic-matter content.	Not suitable	Not suitable	Very poor: fair to poor bearing capacity; high shrink-swell potential; very clayey.	Nearly level; seasonal high water table; very clayey soil materials; poor foundation for high fills.	Fair to poor bearing capacity; poor shear strength; high shrink-swell potential; seasonal high water table.	Very slow permeability; seasonal high water table; nearly level.
Grable: 514	Good: low organic-matter content.	Fair to poor in substratum; fine grained; poorly graded.	Not suitable	Fair to good: fair bearing capacity; narrow range of moisture for satisfactory compaction; slow shrink-swell potential; erodible when exposed on embankments.	Nearly level topography; fair to good borrow material potential.	Fair bearing capacity; low shrink-swell potential; susceptible to piping; a few areas subject to flooding.	Nearly level; substratum rapidly permeable.
Gullied land	Not suitable	Not suitable	Not suitable	Not suitable	Severe gullying.	Not suitable	Severe gullying.

See footnote at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitation for—	
Farm ponds–Con.						
Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank disposal fields	Sewage lagoons
Fair stability: impervious when compacted; high shrink-swell potential; not ordinarily used because of position.	Seasonal high water table: slow or very slow permeability in substratum.	High available water capacity: medium water intake rate in upper part, slow in substratum.	Nearly level bottom land.	Nearly level bottom land.	Severe: seasonal high water table; slow or very slow permeability in substratum.	Moderate or severe: high organic-matter content; slow or very slow permeability in substratum; seasonal high water table.
Fair to poor stability; difficult to compact to high density; generally poor resistance to piping; erodible.	No drainage needed: well drained.	Strongly sloping to moderately steep; high available water capacity; very erodible.	Soil features favorable for construction; low fertility.	Very erodible; low fertility.	Severe: slope is more than 9 percent.	Severe: slope is more than 9 percent; moderate permeability.
Fair stability; poor compaction characteristics; seldom used because of position.	Very slow permeability.	Moderate available water capacity: water intake rates vary with the amount of vertical cracking.	Nearly level bottom land.	Nearly level bottom land.	Severe: very slow permeability; seasonal high water table.	Moderate or severe: seasonal high water table; very slow permeability.
Poor stability; poor resistance to piping; erodible when exposed on embankments; not ordinarily used for embankments because of position.	No drainage needed; well drained or somewhat excessively drained.	Moderate or low available water capacity; medium water intake rate.	Nearly level bottom land.	Nearly level bottom land.	Slight: rapid permeability in underlying material; danger of pollution.	Severe: rapid permeability in underlying material.
Not suitable	Not suitable	Not suitable	Not suitable	Severe gullying.	Not suitable	Not suitable.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as source of— Topsoil	Sand	Gravel	Road fill [1]	Soil features affecting— Highway location	Foundations for low buildings [1]	Farm ponds: Reservoir area
Hamburg: 2G	Fair: low fertility; very low organic-matter content.	Not suitable	Not suitable	Fair: fair bearing capacity; narrow range of moisture content for satisfactory compaction; very erodible when exposed on embankments.	Very steep; large need for cut and fills; very erodible in cuts and on embankments; low shrink-swell potential.	Fair to poor bearing capacity; medium to high compressibility; poor resistance to piping.	Very steep; moderately rapid permeability.
Haynie: 137	Good: low in organic-matter content.	Not suitable	Not suitable	Fair to poor: fair to poor bearing capacity; narrow range of moisture for satisfactory compaction; low shrink-swell potential; very erodible.	Nearly level; exposed back slopes very erodible.	Fair bearing capacity; low shrink-swell potential; susceptible to piping; some areas subject to flooding.	Nearly level; moderate permeability.
Ida: 1C, 1C3, 1D, 1D3, 1E, 1E3, 1F, 1F3, 1G	Fair to good: low or very low organic-matter content; low fertility.	Not suitable	Not suitable	Fair: fair to poor bearing capacity; narrow range of moisture for satisfactory compaction; medium compressibility; low shrink-swell potential.	Moderately sloping to steep; very erodible on back slopes and in ditches.	Fair to poor bearing capacity and shear strength; medium compressibility; poor resistance to piping.	Moderately sloping to steep; moderate permeability.
Keg: 46	Good: medium textured; moderate in organic-matter content.	Not suitable	Not suitable	Fair to poor: fair to poor bearing capacity, narrow range of moisture for satisfactory compaction; moderate shrink-swell potential.	Exposed back slopes very erodible; nearly level topography.	Fair to poor bearing capacity; medium to high compressibility; poor resistance to piping.	Nearly level; moderate permeability.
Kenmoor: 849	Poor: coarse texture in upper part; clayey in lower part.	Not suitable	Not suitable	Good in upper part; very poor below; clayey material has poor bearing capacity and high shrink-swell potential.	Nearly level topography.	Poor bearing capacity; high shrink-swell potential in underlying material; seasonal high water table.	Nearly level; very slow or slow permeability in underlying material.

See footnote at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitation for—	
Farm ponds–Con.: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank disposal fields	Sewage lagoons
Poor stability; narrow range of moisture for satisfactory compaction; very erodible; poor resistance to piping.	No drainage needed; somewhat excessively drained.	Slopes too steep for ordinary farming.	Slopes too steep for ordinary terrace construction.	Slopes too steep for ordinary waterway construction.	Severe: very steep slopes.	Severe: very steep slopes.
Poor stability; narrow range of moisture for satisfactory compaction; poor resistance to piping; erodible when exposed on embankments; not ordinarily used for embankment because of position.	No drainage needed; well drained and moderately well drained.	High available water capacity; medium intake rate.	Nearly level bottom land.	Nearly level bottom land.	Slight unless subject to flooding: moderate permeability.	Moderate: moderate permeability; subject to piping; severe if subject to flooding.
Generally poor stability; narrow range of moisture for satisfactory compaction; poor resistance to piping.	No drainage needed; well drained.	High available water capacity; medium intake rate; subject to runoff and erosion; low fertility.	Features favorable for construction; low fertility hinders vegetation.	Very erodible; low fertility hinders vegetation.	Moderate limitations if slope is 5 to 9 percent, severe if more than 9 percent: moderate permeability.	Severe: moderately sloping to steep; moderate permeability.
Poor stability; erodible when exposed on embankments; not ordinarily used for embankments because of position.	No drainage needed; well drained and moderately well drained.	High available water capacity; medium intake rate.	Nearly level bottom land.	Nearly level bottom land.	Slight: moderate permeability.	Moderate; moderate permeability.
Material below a depth of about 2 feet is very clayey and has high shrink-swell potential; poor workability and compaction; not ordinarily used because of position.	No drainage needed; very slow or slow permeability below a depth of about 2 feet.	Low or moderate available water capacity; rapid intake rate in upper part, slow below.	Nearly level bottom land.	Nearly level bottom land.	Severe: very slow or slow permeability below a depth of about 2 feet; seasonal high water table.	Moderate or severe: seasonal high water table; very slow or slow permeability below a depth of about 2 feet; a few areas subject to flooding.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill [1]	Highway location	Foundations for low buildings [1]	Farm ponds: Reservoir area
Kennebec: 212, 212+.	Good: a thick layer high in organic-matter content.	Not suitable	Not suitable	Poor: high in organic-matter content in upper 2 to 3 feet; poor bearing capacity; high compressibility.	Nearly level; subject to flooding; high in organic-matter content; poor foundation for high fills.	Poor bearing capacity; high compressibility and possible uneven consolidation; subject to flooding.	Nearly level; high organic-matter content; moderate permeability.
Lakeport: 436	Fair: moderately fine textured; high in organic-matter content.	Not suitable	Not suitable	Very poor: poor bearing capacity and shear strength; seasonal high water table; high in organic-matter content to a depth of about 2 feet.	Nearly level; seasonal high water table; very poor source of borrow material.	Seasonal high water table; fair to poor bearing capacity.	Nearly level; moderate or moderately slow permeability.
Luton: 66+, 66, 866.	Poor: high clay content; good if overwash is present.	Not suitable	Not suitable	Very poor: high organic-matter content; high shrink-swell potential; very clayey.	Seasonal high water table; very poor for borrow material; poor foundation for high fills.	Poor bearing capacity; poor shear strength; very high shrink-swell potential; seasonal high water table.	Nearly level; very slow permeability.
McPaul: 70	Good: low organic-matter content.	Not suitable	Not suitable	Fair to poor: fair to poor bearing capacity; narrow range of moisture for satisfactory compaction.	Nearly level topography; many areas subject to flooding.	Fair to poor bearing capacity; medium to high compressibility; subject to flooding; occasional high water table.	Nearly level; moderate permeability.
Modale: 149, 549.	Good: low organic-matter content.	Not suitable	Not suitable	Upper 2 feet fair, silty clay below very poor: fair to poor bearing capacity; high shrink-swell potential in silty clay.	Level topography; very poor source of borrow material below a depth of 2 feet.	Fair to poor bearing capacity; poor shear strength; high shrink-swell potential; seasonal high water table; a few areas subject to flooding.	Nearly level; very slow or slow permeability in the underlying clay.

See footnote at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitation for—	
Farm ponds–Con. — Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank disposal fields	Sewage lagoons
High in organic-matter content; high compressibility; poor embankment foundation.	No drainage needed in most areas; moderately well drained.	Very high available water capacity; medium intake rate; subject to flooding.	Nearly level bottom land.	Nearly level bottom land.	Severe: subject to flooding; occasional high water table.	Severe: subject to flooding; moderate permeability.
High in organic-matter content to a depth of about 2 feet; seldom used because of position.	Moderately slow or moderate permeability.	Medium intake rate; high available water capacity.	Nearly level bottom land.	Nearly level bottom land.	Severe: seasonal high water table; moderately slow or moderate permeability.	Moderate or severe: moderately slow or moderate permeability; high organic-matter content; seasonal high water table.
Fair to poor stability; poor compaction characteristics; high compressibility; not ordinarily used because of position.	Very slow permeability.	Moderate available water capacity; intake rates vary with amount of vertical cracking.	Nearly level bottom land.	Nearly level bottom land.	Severe: very slow permeability; seasonal high water table.	Moderate or severe: some areas subject to flooding; seasonal high water table; high organic-matter content; very slow permeability.
Fair to poor stability; difficult to compact to high density.	No drainage needed; well drained and moderately well drained.	High available water capacity; medium intake rate; level topography.	Nearly level bottom land.	Soil features favorable; grassed waterways seldom needed.	Moderate to severe: subject to flooding; occasional high water table; moderate permeability.	Severe: subject to flooding; moderate permeability.
Material below a depth of about 2 feet is very clayey and has high shrink-swell potential; poor compaction and workability; seldom used because of position.	Drainage usually not needed; very slow or slow permeability in underlying silty clay.	Moderate or high available water capacity; medium intake rate in upper part, slow below.	Nearly level bottom land.	Nearly level bottom land.	Severe: very slow permeability in substratum.	Moderate or severe: moderate or moderately rapid permeability in upper part; seasonal high water table; a few areas subject to flooding.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill [1]	Highway location	Foundations for low buildings [1]	Farm ponds: Reservoir area
Monona: 10, T10, 10B, T10B, 10C, 10C2, 10D, 10D2, 10D3, 10E, 10E2, 10E3, 10F, 10F2, 10G.	Good: severely eroded soils are low in organic-matter content and the surface layer is thin.	Not suitable	Not suitable	Fair: fair to poor bearing capacity and shear strength; narrow range of moisture content for satisfactory compaction; moderate shrink-swell potential.	Nearly level to steep slopes; erodible in gutters and on exposed slopes.	Fair to poor bearing capacity and shear strength; fair to poor resistance to piping.	Nearly level to steep; moderate permeability.
Moville: 275	Good: low organic-matter content.	Not suitable	Not suitable	Fair to poor to a depth of about 2 feet, very poor below: underlying silty clay or clay has high shrink-swell potential.	Nearly level; poor source of borrow material.	Poor bearing capacity; poor shear strength; high shrink-swell potential below a depth of 2 feet; seasonal high water table; high compressibility; many areas subject to flooding.	Nearly level; very slow permeability in the underlying silty clay or clay.
*Napier: 12B, 12B+, 12C, 12D, 17B, 717C. For Colo part of 17B, see Colo series. For Nodaway part of 17B, see Nodoway series. For Gullied land part of 717C, see Gullied land.	Good: surface layer high in organic-matter content.	Not suitable	Not suitable	Poor: high in organic-matter content to a depth of 2 feet or more; poor bearing capacity; difficult to compact to high density.	Poor source of borrow material; poor embankment foundations for high fills.	Poor bearing capacity; high compressibility and uneven consolidation; subject to local runoff.	Moderate permeability.
Nodaway: 220	Good: low organic-matter content.	Not suitable	Not suitable	Poor: poor bearing capacity and shear strength; difficult to compact to high density.	Nearly level topography; subject to flooding; frequent change in support where old channels are present.	Poor bearing capacity; high compressibility; subject to overflow; seasonal high water table.	Nearly level; moderate permeability.

See footnote at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitation for—	
Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank disposal fields	Sewage lagoons
Embankment						
Fair stability; narrow moisture range for satisfactory compaction; fair to poor resistance to piping.	No drainage needed: well drained.	Sloping soils subject to runoff and erosion; high available water capacity; medium intake rate.	Soil features favorable.	Soil features favorable; erodible.	Slight if slope is less than 5 percent, moderate if 5 to 9 percent, severe if more than 9 percent: moderate permeability.	Moderate if slope is less than 9 percent, severe if more than 9 percent: moderate permeability.
Material below a depth of about 2 feet is very clayey with high shrink-swell potential; poor workability and compaction.	Very slow permeability in underlying material.	High available water capacity; medium intake rate in silt loam, slow below.	Nearly level bottom land.	Nearly level bottom land.	Severe: very slow permeability below depth of about 2 feet.	Moderate or severe: many areas subject to flooding; seasonal high water table; moderate permeability in upper part, very slow below.
High organic-matter content to a depth of 2 feet or more; difficult to compact to high density; high compressibility with uneven consolidation.	No drainage needed: well drained.	High available water capacity; medium intake rate; subject to local runoff concentration, erosion, and gullying.	Soil features are favorable.	Soil features are favorable.	Slight if slope is less than 5 percent, moderate if 5 to 9 percent, severe if more than 9 percent: subject to short duration runoff.	Moderate if slope is more than 9 percent, severe if more than 9 percent: moderate permeability; subject to short duration runoff; high organic-matter content.
Fair stability; poor resistance to piping; difficult to compact to high density.	No drainage needed: moderately well drained.	High available water capacity; medium intake rate; subject to flooding.	Nearly level bottom land.	Soil features favorable; grassed waterways generally not needed.	Severe: subject to flooding; seasonal high water table; moderate permeability.	Severe: subject to flooding; moderate permeability.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill [1]	Highway location	Foundations for low buildings [1]	Farm ponds: Reservoir area
Onawa: 145, 146.	Poor: high clay content; low organic-matter content; good if surface layer is silt loam.	Not suitable	Not suitable	Very poor to a depth of about 2 feet, very clayey; fair below.	Nearly level; seasonal high water table; very clayey soil material in upper part.	Fair to poor bearing capacity; seasonal high water table; few areas subject to flooding.	Nearly level; moderate or moderately rapid permeability below a depth of about 2 feet.
Percival: 515	Poor: high clay content; low organic-matter content.	Not suitable	Not suitable	Very poor in the clayey material; good in underlying sands.	Seasonal high water table; very clayey soil materials in upper part.	Fair bearing capacity; fair shear strength below a depth of 2 feet; seasonal high water table; underlying sands subject to liquefaction and piping; few areas subject to flooding.	Nearly level; rapidly permeable in the underlying sands.
Riverwash: 53	Poor: mostly sands.	Fair to good	Variable: generally poor.	Good: good bearing capacity; erodible in embankments.	Good source of borrow material; subject to flooding.	Subject to frequent flooding.	Frequently flooded; very porous.
Salix: 36	Good: moderately fine textured; moderate organic-matter content.	Not suitable	Not suitable	Fair to poor: fair to poor bearing capacity; fair to poor workability and compaction characteristics; moderate to high shrink-swell potential.	Nearly level; fair to poor source of borrow material.	Fair to poor bearing capacity; medium to high compressibility; fair to poor resistance to piping.	Nearly level; moderately permeable.
Sarpy: 237, 237B, 238.	Poor: low fertility; droughty.	Fair to good: fine grained and poorly graded.	Not suitable	Good: good bearing capacity; can be compacted to high density; very erodible when exposed on embankments.	Good source of borrow material; good foundation for fill.	Good bearing capacity; low shrink-swell potential; slight compressibility; poor resistance to liquefaction and piping; some areas are subject to flooding.	Undulating topography; rapid or very rapid permeability.

See footnote at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitation for—	
Farm ponds–Con.: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank disposal fields	Sewage lagoons
Fair to poor stability; generally poor compaction characteristics; not ordinarily used because of position.	Permeability slow in upper part, moderate or moderately rapid below.	High available water capacity; intake rates vary with amount of cracking in upper part; medium intake rate in silts beneath.	Nearly level bottom land.	Nearly level bottom land.	Severe: seasonal high water table; permeability slow in upper part, moderate or moderately rapid below.	Moderate or severe: a few areas subject to flooding; slow permeability to a depth of about 2 feet; seasonal high water table.
Fair to poor stability; generally poor compaction characteristics; underlying sandy material has poor resistance to liquefaction and piping; not ordinarily used because of position.	Permeability is slow in upper part, rapid below.	Moderate or low available water capacity; intake rates vary with amount of vertical cracking in upper part; permeable in substratum.	Nearly level bottom land.	Nearly level bottom land.	Moderate to severe: seasonal high water table; rapid permeability in substratum; danger of pollution.	Severe: rapid permeability in underlying sands; seasonal high water table.
Poor resistance to piping and liquefaction; erodible when exposed on embankments; not ordinarily used for pond embankment because of position.	No drainage needed: frequently flooded; not suitable for farming.	Land not suitable for farming.	Bottom land	Bottom land	Severe: subject to frequent flooding.	Severe: very rapid permeability; subject to frequent flooding.
Fair stability; fair to poor workability and compaction characteristics; not ordinarily used because of position.	No drainage needed: moderately well drained.	High available water capacity; medium intake rate.	Nearly level bottom land.	Nearly level bottom land.	Slight: moderate permeability; occasional high water table.	Moderate: moderate permeability; moderate organic-matter content.
Poor resistance to liquefaction and piping; erodible when exposed on embankments; not ordinarily used because of position.	No drainage needed; excessively drained.	Low or very low available water capacity; rapid intake rate.	Undulating bottom land; very droughty; very erodible.	Undulating bottom land; very droughty; very erodible.	Moderate: rapid or very rapid permeability; severe danger of pollution of streams or ground water.	Severe: rapid or very rapid permeability.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as source of— Topsoil	Sand	Gravel	Road fill [1]	Soil features affecting— Highway location	Foundations for low buildings [1]	Farm ponds: Reservoir area
Solomon: 466	Poor: high clay content.	Not suitable	Not suitable	Very poor: high shrink-swell potential; high organic-matter content; very clayey.	Seasonal high water table; very poor foundation for high fills; very poor for borrow material.	Poor bearing capacity; poor shear strength; high shrink-swell potential; seasonal high water table.	Nearly level; very slow permeability.
Steinauer: 33D2, 33E3.	Poor: low organic-matter content; gravelly in places.	Not suitable	Not suitable	Good: good bearing capacity; easily compacted to high density; slight compressibility.	Strongly sloping to moderately steep; good source of borrow material; seepy in some cuts.	Good bearing capacity and shear strength; slight compressibility; deep to seasonal high water table.	Moderately slow permeability; pockets of sand and gravel in places.
Vore: 516	Fair: moderately fine textured; low organic-matter content.	Not suitable	Not suitable	Poor above a depth of 2 feet; underlying sands are good and have low shrink-swell potential and fair bearing capacity.	Seasonal high water table.	Fair bearing capacity and fair shear strength below a depth of about 2 feet; underlying sands subject to liquefaction and piping; a few areas subject to flooding.	Nearly level; rapid permeability in underlying sands.
Woodbury: 67	Poor: high clay content.	Not suitable	Not suitable	Very poor: high shrink-swell potential; high organic-matter content; very clayey.	Seasonal high water table; very poor for borrow material; poor foundation for high fills.	Fair to poor bearing capacity; poor shear strength; high shrink-swell potential; seasonal high water table.	Nearly level; slow or very slow permeability to depth of about 2 to 3 feet, moderately slow below.

[1] Engineers and others should not apply specific values to the estimates given for bearing capacity of soils.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitation for—	
Farm ponds–Con.: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank disposal fields	Sewage lagoons
Fair to poor stability; poor compaction characteristics; high compressibility; not used because of position.	Very slow permeability; outlets for ditches inadequate in places.	Moderate available water capacity; water intake rates vary with amount of vertical cracking.	Nearly level bottom land.	Nearly level bottom land.	Severe: very low permeability; seasonal high water table.	Moderate or severe: some areas subject to flooding; high organic-matter content; seasonal high water table; very slow permeability.
Fair to good stability; good for impervious cores and blankets; a few stones or boulders; easily compacted to high density.	No drainage needed; well drained.	Strongly sloping to moderately steep.	Soil properties generally favorable; some stones; good management needed to establish vegetation.	Strongly sloping to moderately steep; some stones; good management needed to establish vegetation.	Severe: slope is more than 9 percent; moderately slow permeability.	Severe: strongly sloping to moderately steep.
Fair to poor stability; underlying sandy material has poor resistance to liquefaction and piping; not ordinarily used because of position.	No drainage needed; moderately well drained.	Low or moderate available water capacity; medium intake rate in surface layer, rapid below a depth of about 2 feet.	Nearly level bottom land.	Nearly level bottom land.	Moderate to severe: seasonal high water table; rapid permeability in substratum; danger of pollution.	Severe: rapid permeability in underlying sands: seasonal high water table.
Fair to poor stability; poor compaction characteristics; high compressibility; not ordinarily used because of position.	Slow or very slow permeability to a depth of about 2 to 3 feet; moderate or moderately slow below.	High available water capacity; water intake rates vary with amount of vertical cracking.	Nearly level bottom land.	Nearly level bottom land.	Severe: very slow or slow permeability; seasonal high water table.	Moderate or severe: seasonal high water table; high organic-matter content; slow or very slow permeability; some areas subject to flooding.

TABLE 5.—*Engineering*

[Tests performed by the Iowa State Highway Commission in accordance with standard

Soil name and location	Parent material	Iowa report number AAD6—	Depth from surface	Moisture-density data[1]	
				Maximum dry density	Optimum moisture
			In	*Lb per cu ft*	*Pct*
Blencoe silty clay:					
1,030 feet N. and 300 feet E. of SW. corner of SE¼SW¼ sec. 16, T. 78 N., R. 44 W. Modal.	Alluvium	1479	8–16	92	26
		1480	30–36	103	17
Keg silt loam:					
760 feet S. and 120 feet W. of NE. corner of NE¼ sec. 35, T. 78 N., R. 45 W. Modal.	Alluvium	1477	0–8	104	20
		1478	23–35	99	21
Lakeport silty clay loam:					
680 feet N. and 660 feet E. of SW. corner of SW¼ sec. 30, T. 78 N., R. 44 W. Modal.	Alluvium	1481	21–27	97	22
		1482	42–48	100	21
McPaul silt loam:					
1,080 feet S. and 860 feet W. of NE. corner of NE¼ sec. 27, T. 78 N., R. 44 W. Modal.	Alluvium	1476	16–31	98	18
Napier silt loam:					
325 feet S. and 191 feet E. of first telephone pole S. of highway along drainage ditch in SE¼SW¼ sec. 11, T. 78 N., R. 44 W. Modal.	Local alluvium derived from Wisconsin Loess.	1483	7–14	100	20
		1484	30–40	101	20

[1] Based on AASHO designation T 99-57, Method A (*1*).
[2] Mechanical analysis according to AASHO designation T 88-57 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that

Engineering interpretations

Table 4 shows the suitability of the soils for use as topsoil, sand, gravel, and road fill. The suitability of soil material for road fill depends largely on the density that can be obtained by compacting the material. Density affects the rigidity, flexibility, and load-bearing properties of the soil as subgrade fill for paved roads and as surfacing material for unpaved roads. Shrink-swell potential is also a factor in evaluating material for road fill.

Table 4 also shows soil features affecting the use of soils for highway location, farm ponds, agricultural drainage, irrigation, terraces and diversions, and waterways. Features that have an adverse effect on these practices generally are listed, but beneficial features are listed in some columns. Special features affecting highway construction are considered in this section.

Also rated in table 4 is the degree of limitation of each soil for foundations for low buildings and for septic tank disposal fields. For foundations for low buildings, the soils are rated for bearing capacity, compressibility, depth to the water table, and other important features. These features vary widely. Engineers and others should not apply specific values to the estimates given for bearing capacity. For septic tank disposal fields, the soils are rated on their capacity to absorb sewage effluent over a long period. Before a septic tank and field are installed, however, a percolation test should be made at the site. A sewage system close to a well or stream is likely to contaminate the water. Important properties considered in rating the limitation of a soil for sewage lagoons are permeability, slope, organic-matter content, and flooding hazard.

Engineering test data

Soil samples were taken, by horizons, from modal profiles representing five soil series and tested according to standard AASHO procedures to help evaluate the soils for engineering purposes. The tests were made by the Iowa State Highway Commission. The results are shown in table 5. The samples tested were obtained at a depth of 5 feet or less.

The relationship between the moisture content and the density of compacted soil material, as determined by the test explained in AASHO designation T99–57 (*1*), is shown in table 5 under the heading "Moisture–density." The density, or unit weight, of the compacted dry soil increases as the content of moisture increases until the optimum moisture content is reached for standard compactive effort. After that, the density decreases with each increase in moisture content. The highest density obtained in the test is at the optimum moisture content and is the maximum density. As a rule, optimum stability is obtained if the soil is compacted to about the maximum density when the soil is at or near the optimum moisture content.

The liquid limit and the plasticity index indicate the effect of moisture on the consistence of the soil material. As the moisture content of a dry clayey soil is increased, the material changes from a semisolid state to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the material passes from the plastic to the liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

test data

procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis[2]						Liquid limit	Plasticity index	Classification	
Percentage passing sieve—		Percentage smaller than—						AASHO[3]	Unified
No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
						Pct			
100	96	88	71	55	44	58	32	A-7-6(20)	CH.
100	86	70	41	27	22	36	15	A-6(10)	CL.
100	97	86	58	35	27	40	18	A-6(11)	CL.
100	95	83	54	27	19	40	17	A-6(11)	CL.
100	98	89	71	49	39	53	30	A-7-6(19)	CH.
100	99	88	55	31	25	43	21	A-7-6(13)	CL.
100	99	79	31	18	14	31	7	A-4(8)	ML.
----------	100	85	45	25	19	39	15	A-6(10)	CL.
----------	100	78	42	24	19	36	14	A-6(10)	CL.

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 analysis data used in this table are not suitable for naming textural classes for soils.

[3] Based on AASHO designation M 145-49 (*1*).

Special features affecting highway work [2]

Most of the upland soils in Harrison County formed in loess over glacial till. The loess ranges from about 100 feet thick in parts of the Hamburg-Ida-Monona soil association to about 40 feet thick in the Monona-Ida-Napier association, which is in the eastern part of the county. In some stream valleys loess soils are on benches and are underlain by alluvium. In places where streams have dissected the landscape, glacial till is exposed. The Sarpy-Albaton-Carr, Albaton-Haynie-Onawa, Luton-Keg, and Kennebec-McPaul-Nodaway soil associations, which make up about 34 percent of the county, consist of soils that formed in alluvium. The soils in many small stream valleys and drainageways in the uplands also formed in alluvium.

Monona, Ida, and Hamburg soils are the most extensive loess-derived soils in the county. They are nearly level to very steep. Monona soils are typically classified as A–6 or A–7–6 (ML–CL) and have group index numbers of 9 to 15. Ida soils are typically A–6 or A–4 (ML–CL), and Hamburg soils A–4 (ML or ML–CL). Group indexes are ordinarily 8 to 10. These soils erode easily where runoff is concentrated. In places sodding, paving, or check dams are needed in gutters and ditches to help prevent excessive erosion. Nearly vertical back slopes in the drier Hamburg soils are stable and have good ditch drainage.

In the soils formed in loess, the seasonal high water table in places is above the glacial till-loess contact. In some of these places, since the inplace density of the loess is relatively low, the soil has a high moisture content, and subdrains are needed in the back slope to intercept seepage.

The Steinauer soils formed in glacial till. They mainly form slopes adjacent to stream valleys. They are classified mainly as A–6 (CL), but the upper part of the profile is A–7–6 in places. Where this material is in or along grading projects, it generally is placed in the upper subgrade through unstable areas. Because inplace density is high, these glacial till soils generally do not have excessively high moisture content and are more stable and more easily compacted than loess-derived soils.

Pockets and lenses of sand and gravel are commonly interspersed throughout the till and are often water bearing. Where the road grade is only a few feet above such a deposit, and loess or silty till overlie it, frost heaves are likely to develop unless the deposit is drained or the soil above it is replaced with granular backfill or clay till.

Alluvium is the material in which soils of the Missouri River bottom lands formed, as well as those along smaller streams and drainageways. A number of soils on the Missouri River bottom lands are very clayey throughout, and are classified as A–7–6(20) (CH). Most of these soils are high in organic-matter content in the upper part of the profile. They include Albaton, Blend, Solomon, Luton, and Woodbury soils. The clayey material should not be placed within 5 feet of grade in embankments. In some places in visible old oxbows of the river, these soils are very soft and unable to support an embankment more than 5 feet high. They should be investigated for stability against sliding and

[2] Prepared by DONALD A. ANDERSON, soils engineer, Iowa State Highway Commission.

for consolidation. A number of soils have these clayey materials to a depth of about 2 feet and have coarser textures below 2 feet depth. These include Blencoe, Onawa, and Percival soils. Modale, Moville, and Kenmoor soils have clay beginning at a depth of about 2 feet and have coarser textures above 2 feet.

On bottom land and in upland drainageways throughout the county, Colo, Kennebec, and Napier soils have a thick surface layer that is high in organic-matter content. The soil material in this surface layer can consolidate erratically under the load of a heavy embankment. If the embankment is to be more than 15 feet high, these soils should be carefully investigated to be sure that they have sufficient strength. Road embankments through bottom lands should be constructed on a continuous embankment that extends above the level reached by frequent floods.

Many soils of the bottom land have a seasonal high water table. A number of the soils, especially those formed in recent alluvial sediment near the Missouri River, are stratified with fine sandy sediment and are dominantly sandy throughout. These include Grable, Percival, Sarpy, and Carr soils. If an embankment is constructed only a few feet above the water table in these soils, frost heaving can result unless proper drainage is established, or unless materials not susceptible to frost action are used in the subgrade. Some of these materials make up the better borrow sources available for road construction in the flood plain.

The bedrock in Harrison County is buried so deeply under other deposits that it is seldom a factor in road work.

Ratings are given in table 4 to show the suitability of the soils in Harrison County as sources of topsoil to promote the growth of vegetation on embankments, on cut slopes, and in ditches, and as sources of borrow for road construction. At many construction sites there are major variations in the soil within the depth of proposed excavation, and several soils occur within short distances.

The soil map and profile descriptions as well as the engineering data in this section can be used in planning detailed surveys of soils at construction sites. By using the information in soil survey publications, the engineer can concentrate on the most important soil units. Then he can obtain a minimum number of soil samples for laboratory testing, and an adequate soil investigation can be made at minimum cost.

Formation and Classification of the Soils

This section describes the major factors of soil formation, tells how those factors have affected the soils in Harrison County, and explains some of the processes in horizon development. It also defines the current system for classifying soils and classifies the soils of the county according to that system.

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 materials, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief or lay of the land, and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons.

The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that forms 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. Usually a long time is required for the formation of distinct horizons.

The factors of soil genesis 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 formation are unknown.

Parent material

The soils of Harrison County formed in loess, in alluvium, and in glacial till. In the vicinity of Logan, some limestone, Cretaceous in age, is exposed at the base of slopes along the Boyer River Valley. None of the soils mapped formed in this material. In addition, the material has had little or no effect on the surrounding soils.

Loess is the most extensive parent material in the county according to a number of studies made in the western part of Iowa. Hutton (*7*) and White, McClelland, Coultas, and Prill (*31*) characterized Monona and Ida soils as part of a regional or countywide study. Daniels and Jordan (*2*) reported on physical and chemical characteristics of Monona, Ida, and Dow soils and the loess in which they formed. This study took place in Harrison County. Davidson and associates (*3*) studied the physical and engineering properties of loess in western Iowa and elsewhere. Ulrich (*24, 25*) and Godfrey and Riecken (*5*) studied physical and chemical changes accompanying soil profile formation in soils formed in loess in southwest Iowa. Physical and chemical data for loess soils in the southwestern part of Iowa, including Ida and Hamburg, have been published (*28*).

Loess is yellowish-brown, wind-deposited material that consists largely of silt particles. It has smaller amounts of clay and sand. Most of the upland soils in Harrison County formed in Wisconsin Loess. Monona and Ida soils are the most extensive of these; others are the Hamburg and Dow soils. Hamburg soils are on bluffs adjacent to the Missouri River Valley.

The Wisconsin Loess is believed to have blown mainly from the flood plain of the Missouri River during the Wisconsin glacial period from about 25,000 to 14,000 years ago (*18*). The thickness of the loess and the differences between soils formed in loess are related to the distance from the source of the loess (*7, 18*). The loess is thickest in the bluffs in the western part of the county, almost 100 feet thick in places. In the eastern part of Harrison County, it is 40 feet thick or less. In places, mainly on steep hillsides adjacent to stream valleys, the Wisconsin Loess has been removed by geologic erosion. Here, glacial till, or in a few places another loess deposit, Loveland Loess, is exposed on the surface.

The Loveland Loess is exposed in a few small areas on side slopes. It underlies the Wisconsin Loess and was deposited during the Illinoian glacial episode (*14*). A reddish paleosol formed in this loess during the Sangamon interglacial period and was subsequently covered by Wisconsin Loess. In Harrison County, the outcrops of this paleosol were so small that no soil containing it could be mapped. Areas of this red clayey soil are identified by a spot symbol on the soil map.

The loess of southwest and southern Iowa thins and becomes finer textured as it is tested from west to east. The change in texture is marked in southwest Iowa. The Marshall soils, in Shelby County east of Harrison County, have a much higher clay content than the Hamburg soils in the western part of Harrison County. The Ida and Monona soils are intermediate between these two in clay content. Loess is mainly silt loam; consequently, soils formed in loess have a good, unrestricted root zone for plants, have high available water capacity, and generally are well aerated.

Alluvium is the second most extensive parent material in the county. It consists of sediment deposited along the major and minor streams and in the narrow upland drainageways. The texture of the alluvium, which ranges from sand to clay, depends on the kind of material from which it is derived and the way in which it was deposited. The largest area of soils formed in alluvium is along the Missouri River. Other areas are along the Boyer River and the small upland streams and drainageways.

Alluvial material that has been transported only short distances is local alluvium. This alluvium retains many of the characteristics of the soils from which it was washed. Napier soils, for example, formed in local alluvium. Castana soils formed partly in colluvium, or material moved downslope by gravity. Both are similar in texture to the soils at higher elevations.

Alluvium is the parent material of about 30 soil series in the county. Luton, Blencoe, Colo, Keg, Salix, Lakeport, and Cooper soils that formed in alluvium have been in place long enough that soil-forming factors have had an effect on the soils. They differ most noticeably from the Sarpy, Haynie, McPaul, Onawa, Blake, and Albaton soils, which formed in recent alluvium, in that they have a larger accumulation of organic matter and a darker, deeper surface layer.

The alluvium and the soils formed in it vary widely in texture. Luton, Solomon, and Albaton soils formed entirely in clayey alluvium. Sarpy soils are loamy sand or sand. Keg, Haynie, McPaul, and Kennebec soils are silt loam. Colo and Lakeport soils are silty clay loam. Blencoe, Blake, Blend, Onawa, Modale, and Percival soils formed in alluvium that has layers of different textures.

Glacial till is the parent material for only one soil in the county and is very minor in extent on the landscape. Fairly thick glacial till deposits occur throughout the uplands, but most are covered with loess. The main areas exposed are on upland hillsides near the Boyer River and Pigeon and Mosquito Creeks where the loess has been removed by erosion.

Most of the glacial till is considered to be from the Kansas Glaciation. There is some indication that a few exposures are from the earlier Nebraskan Glaciation. The unweathered till is firm, calcareous clay loam. It contains pebbles, boulders, and sand, as well as silt and clay. The till is a heterogeneous mixture and shows little evidence of sorting or stratification. The mineral composition of its components is also heterogeneous (*11*) and is similar to that of particles in unweathered loess.

Soils formed on the Kansan till plain during the Yarmouth and Sangamon interglacial periods before the loess was deposited. The soils that formed during this period are called Yarmouth-Sangamon paleosols. In nearly level areas, the soils are strongly weathered and have a gray, plastic subsoil called "gumbotil" (*9, 10, 15, 19*). This gumbotil is several feet thick and is very slowly permeable. A widespread erosion surface has cut below the Yarmouth-Sangamon paleosols into Kansan till and older deposits. The surface generally is characterized by a stone line or subjacent sediment and is surmounted by pedisediment (*15, 16, 17*). A paleosol formed in the pedisediment (stone line) and the usually subjacent till. This surface is referred to as Late Sangamon. These paleosols are less strongly weathered, reddish in color, and not so thick as those in nearly level areas.

The strongly weathered, gray, clay paleosol is not exposed in Harrison County. The reddish Late Sangamon paleosol outcrops in some small areas. It is identified by a spot symbol on the soil map.

In places, erosion has removed the loess and underlying paleosols, and only slightly weathered glacial till is exposed. Steinauer soils formed in this till.

Climate

Soils in Harrison County, according to recent evidence, have been forming under variable climatic conditions. Walker (*30*), in his studies, concluded that in the post-Cary glaciation period from about 13,000 to 10,500 years ago, the climate in central Iowa was cool and the vegetation was dominantly conifers. During the period from 10,500 to 8,000 years ago, a warming trend took place, and the vegetation changed from conifers to mixed forest dominated by hardwoods. Beginning about 8,000 years ago, the climate became even warmer and drier. Herbaceous prairie vegetation became dominant. McComb and Loomis (*13*) concluded from studies of the forest-prairie transition of central Iowa that a late change in postglacial climate from relatively dry prairie to more moist conditions took place.

Walker's evidence indicates that this change may have been about 3,000 years ago. The present climate is midcontinental subhumid.

Nearly uniform climate prevails throughout the county. The influence of the general climate, however, is modified by local conditions. For example, on the very steep bluffs occupied by Hamburg soils most of the water runs off or soaks rapidly into the soil. This results in a warmer, drier climate than that of nearby areas. On south-facing slopes the effect is similar. North– and east-facing slopes tend to be cooler and more moist than south-facing slopes, and in such a climate as that of Harrison County, natural stands of trees are more likely to grow. Low-lying or depressional, poorly or very poorly drained soils are wetter and colder than most areas around them.

The general climate has had an important overall influence on the characteristics of the soils but has not caused major differences among them. The local climate differences influence the characteristics of the soils and account for some of the differences in soils within the same climatic region.

Weathering of the parent material by water and air is activated by changes in temperature. As a result of weathering, changes caused by both physical and chemical actions take place. Rainfall has influenced the formation of the soils through its effect on the amount of leaching in soils and on the kinds of plants that grow.

Some variations in plant and animal life are caused by variation in temperature or by the action of other climatic forces on the soil material. To that extent, climate influences changes in soils that are brought about by differences in plant and animal populations.

Plant and animal life

A number of kinds of living organisms are important in soil formation. The activities of burrowing animals, worms, crayfish, and microorganisms, for example, are reflected in soil properties. But differences in the kind of vegetation commonly cause the most marked differences between soils.

At the time Harrison County was settled, tall grasses were the dominant vegetation. Trees grew mainly in steep areas within a few miles of the Missouri River Valley and in other areas, mainly near streams. The thickest stands of timber are on north- and east-facing slopes.

Grasses have roots and tops that decay in the soil. Therefore, soils that formed under prairie typically have a thicker, darker surface layer than do soils that formed under trees. Soils that formed under trees are generally more acid than those that formed under grass because the organic matter, principally leaves, is deposited mainly on the surface of the soil. Monona soils are typical of soils that formed under prairie. No soils considered to have been markedly influenced by trees were mapped in Harrison County.

Man has had marked influence on the soils. Changes caused by water erosion are often the most apparent. On many of the farmed soils in the county, part or all of the original surface layer has been lost through sheet erosion. In some places, gullies have formed. Tillage alters the structure of the surface layer of the soil. Less obvious are chemical changes brought about by additions of lime and fertilizer and changes in microbial activity and organic-matter content as a result of removing the native vegetation and planting crops.

The McPaul, Nodaway, and Moville soils on bottom land, for example, are evidence of man's activities. Those originally dark-colored soils have been covered with light-colored, calcareous material eroded from cultivated fields in the uplands.

Relief

Relief, or topography, refers to the lay of the land. It ranges from nearly level to very steep in Harrison County. Relief is an important factor in soil formation because it affects drainage, runoff, the height of the water table, and erosion. A difference in topography is the basic reason for the differing soil properties of some of the soils in the county.

Even in soils formed from the same parent material, the influence of relief is evident in the color, thickness of solum, and horizonation of the soils. Ida and Monona soils are examples of soils that formed in similar parent material but differ in characteristics mainly related to relief. Some water runs off the well-drained, sloping Monona soils, but more water runs off the more strongly sloping Ida soils. Water has eroded the Ida soils at such a rate that little soil formation has taken place. Monona soils have a thicker, darker surface layer than Ida soils and are leached of carbonates, whereas Ida soils are calcareous at or near the surface. Slope also affects the thickness of solum. The steeper and more convex the slope, the thinner the solum.

Relief affects the color of the B horizon through its effect on drainage and soil aeration. The subsoil of a soil that has good drainage generally is brown because iron compounds are well distributed throughout the horizon and are oxidized. Conversely, the subsoil of soils that have restricted drainage generally is grayish and mottled. The low-lying, poorly drained to very poorly drained clayey Luton soils on the Missouri River bottom land, for example, have a gray and olive-gray subsoil (*12*). In contrast, the Keg soils at slightly higher elevations are well drained and have a brownish subsoil.

Time

The passage of time enables the factors of relief, climate, and plant and animal life to bring about changes in the parent material. If other factors continue to operate over long periods, similar kinds of soils are produced from widely different kinds of parent material. Soil formation, however, generally is interrupted by geologic events that expose new parent material.

In Harrison County, the bedrock has been covered by glacial drift from two different glaciers, the Nebraskan and the Kansan. After a period of time, Loveland Loess was deposited. Later the present surface material, the Wisconsin Loess, was deposited. As a result, some soils have been buried.

The radiocarbon dating technique for determining the age of carbonaceous material found in loess and till has been useful in dating late Pleistocene events

(*20*). Loess deposition began about 25,000 years ago and continued to about 14,000 years ago (*4*). Based on these dates, the surface of nearly level, loess-mantled divides in Iowa is about 14,000 years old. In Harrison County, these stable areas are the nearly level ridgetops or divides, benches, and the gently sloping ridgetops occupied mainly by Monona soils.

In much of Iowa, including Harrison County, geologic erosion has beveled and in places removed material from slopes and deposited new sediment at lower elevations (*19*). The surfaces of nearly level upland divides are older than the slopes that bevel and ascend to the divides. The slopes therefore are less than 14,000 years old.

The sediment stripped from slopes accumulated to form local alluvium. The age of the slopes thus is determined by the alluvial fill at the base of the slopes. Daniels and Jordan (*2*) found the alluvium in some stream valleys in Harrison County to be less than 1,800 years old. Studies by Ruhe, Daniels, and Cady (*19*) in Adair County in southwest Iowa indicated that the base of the alluvial fill was about 6,800 years old. Because the sediment from the slopes accumulated to form the alluvium, the slope surface in these areas are as young or younger than those dates. Among the soils that formed in similar alluvium in Harrison County are Nodaway, Napier, and Kennebec soils. Some soils on the Missouri River bottom land formed in alluvium deposited since settlement by man.

Processes of Soil Formation

Horizon differentiation is the result of four basic kinds of changes. These are additions, removals, transfers, and transformations in the soil system (*22*). Each of these four kinds of changes affect the amount of organic matter, soluble salts, carbonates, sesquioxides, or silicate clay minerals in the soils.

In general, these processes tend to promote horizon differentiation, but some tend to offset or retard it. These processes and the changes brought about proceed simultaneously in soils, and the ultimate nature of the profile is governed by the balance of those changes within the profile.

The addition of organic matter is an early step in the process of horizon differentiation in most soils. In Harrison County the soils of the flood plains are divided into two broad groups based mainly on this feature. The soils that have relatively thick, dark-colored surface layers are separated from those that lack them. The dark color, or lack of it, is the most obvious difference between the Luton and Albaton soils, between the Keg and Haynie soils, and between the Blencoe and Onawa soils.

In some upland soils the darkened surface layer is the only soil feature that reflects to any extent these basic processes. The Ida and Steinauer soils are examples of these soils.

The process of removal of substances from parts of the soil profile causes some of the most obvious differences among soils in the county. The movement of calcium carbonate downward in the soil material as a result of leaching is an example. Ida and Steinauer soils are calcareous at or near the surface because little calcium carbonate has been leached out. In many places lime concretions are on the surface. No B horizon has formed in these soils. Soil scientists consider that calcium carbonate in Monona soils has been moved through leaching from the upper part of the profile. This removal, along with other processes, has resulted in the differentiation of a B horizon in these soils. The Monona and Ida soils formed in calcareous loess, and Steinauer soils formed in glacial till.

A number of kinds of transfers of substances from one horizon to another are evident in the soils of Harrison County.

Phosphorus is removed from the subsoil by plant roots and transferred to parts of the plant growing above the ground. Then it is added to the surface layer in plant residue.

The translocation of silicate clay minerals is another important process in horizon differentiation. The clay minerals are carried downward in suspension in percolating water from the A horizon. They accumulate in the B horizon in pores and root channels and as clay films on ped faces. In Harrison County soils the clay content of the A and B horizons is not markedly different, and other evidence of clay movement is minimal. Another kind of transfer that is minimal in most soils, but occurs to some extent in very clayey soils, is that brought about by shrinking and swelling. This causes cracks to form and the incorporation of some materials from the surface layer into lower parts of the profile. Luton and Albaton are examples of soils that have potential for this kind of physical transfer.

Transformations are physical and chemical. For example, particles are weathered to smaller sizes. The reduction of iron is another example of a transformation. This process is called "gleying" and involves the saturation of the soil with water for long periods of time in the presence of organic matter. It is characterized by the presence of gray colors. Gleying is associated with poorly drained and very poorly drained soils, such as Luton soils.

Still another kind of transformation is the weathering of the primary apatite mineral present in soil parent materials to secondary phosphorus compounds. According to theory, the soil pH must decline to about 7 before appreciable amounts of this weathering take place (*6, 21*). This fact helps explain the difference in available phosphorus levels between soils formed from similar calcareous parent materials. For example, Ida soils, which are calcareous, are very low in available phosphorus. In Monona soils, which have been leached and are about neutral, the available phosphorus, although low, is in better supply than in Ida soils.

Classification of the Soils

The purpose of soil classification is to help us remember the significant characteristics of soils, assemble our knowledge about the soils, see their relationships to one another and to the whole environment, and develop principles relating to their behavior and their response to manipulation. First through classification and then through the use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The current system of soil classification (*23, 27*) was adopted by the Cooperative Soil Survey in 1965. It is a comprehensive system, designed to accommodate all soils. In this system, classes of soils are defined in terms of observable or measurable properties. The properties chosen are primarily those that result in the grouping of soils of similar genesis, or mode of origin. Genesis does not, however, appear in the definitions of the classes.

The current system of classification has six categories. Beginning with the most inclusive, the categories are the order, the suborder, the great group, the subgroup, the family, and the series. Table 6 shows the classification of the soils of Harrison County according to this system. Brief descriptions of the six categories follow.

Order.—Ten soil orders are recognized: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate orders are those that tend to give broad climatic groupings of soils. Two exceptions to this generalization are the Entisols and the Histosols, both of which occur in many different climates. Two of the ten orders are represented in Harrison County: Entisols and Mollisols.

Suborder.—Each order is divided into suborders, mainly on the basis of soil characteristics that result in grouping soils according to genetic similarity. The climatic range is narrower than that of the order. The properties used are mainly those that reflect either the presence or absence of waterlogging or differences in climate or vegetation.

Great group.—Each suborder is divided into great groups on the basis of similarity in the kind and sequence of the major horizons and in major soil properties. The horizons considered are those in which clay, iron, or humus have accumulated and those in which pans that interfere with the growth of roots and the movement of water have formed. The properties are soil temperature, chemical composition (mainly content of calcium, magnesium, sodium, and potassium), and the like.

Subgroup.—Each great group is divided into subgroups, one that represents the central (typic) concept of the group, and others, called intergrades, that have one or more properties of another great group, suborder, or order.

Family.—Families are established within each subgroup, primarily on the basis of properties important to the growth of plants or properties significant in engineering. Texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence are among the properties considered.

Series.—A series is a group of soils that have horizons similar in all important characteristics, except for texture of the surface layer, and similar in arrangement in the profile. (See the section "How This Survey Was Made.")

General Nature of the County

Harrison County was originally the hunting and camping grounds of the Sioux, Sac, Fox, and other Indian tribes. Settlement of the county began with the Mormons, many of whom moved west at a later date. The boundaries of Harrison County were established by the 1851 Iowa Legislature. The first county seat was Magnolia. Logan, first known as Boyer Falls, became the county seat in 1875.

Since the settlement of Harrison County by pioneer farmers, farming has continued to be the principal industry. In general, the history of the area follows that of agricultural expansion and the growth of trade centers to provide goods and services to support the industry.

Climate [3]

Harrison County is in west-central Iowa and is bordered on the west by the Missouri River. Nearly 75 percent of the annual precipitation falls in the period from April through September. A substantial part falls as warm-season showers. Daily rainfall ranges from 2 inches or more once a year to 6 inches about once every 50 years. Normally, on about 8 days per year an inch or more of rain falls, on 19 days a half inch or more is measured, and on about 35 days a quarter inch or more. Heavy intensity showers, about 80 percent occurring during the crop season, are of concern to farmers on the flood plains, particularly those on the poorly drained soils, and to those in the rolling uplands where sheet and gully erosion are hazards.

Snow cover of an inch or more is reported on about 47 days per winter. The average depth is 6 inches. In recent years, the deepest snow was 28 inches reported in February and March 1960. The first 1-inch snowfall normally occurs late in November.

Ideally, during the crop growing season, the amount of moisture in the subsoil is abundant, and in the topsoil it is moderate. Variations from the optimum are frequent, tending to the subnormal. About 1 inch of available moisture per week is required for optimum corn growth. During May and June sufficient moisture usually is available, but higher July and August temperatures occasionally cause crop stress. The probability of receiving sufficient rainfall during each week of the growing season is about 30 percent during the early part of May and is about 40 percent from mid-May through June. During each week in July through the first week in August, the probability is 20 to 30 percent. It is about 40 percent during the second week in August.

Midday temperatures vary little over the county, as contrasted to the late nighttime temperatures, which can vary as much as 10 degrees on calm, clear nights when the denser cold air sinks into the valleys and lowlands. Spring and autumn freezes thus tend to shorten the growing season in areas that receive cold air drainage.

[3] By PAUL J. WAITE, State climatologist, National Weather Service.

TABLE 6.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Albaton	Fine, montmorillonitic, calcareous, mesic	Vertic Haplaquents	Entisols.
Blake	Fine-silty, mixed, calcareous, mesic	Aquic Udifluvents	Entisols.
Blencoe	Clayey over loamy, montmorillonitic, mesic	Aquic Hapludolls	Mollisols.
Blend	Fine, montmorillonitic, noncalcareous, mesic	Fluventic Haplaquolls	Mollisols.
Burcham	Fine-silty over clayey, mixed, mesic	Aquic Hapludolls	Mollisols.
Carr [1]	Coarse-loamy, mixed, calcareous, mesic	Typic Udifluvents	Entisols.
Castana	Fine-silty, mixed, mesic	Entic Hapludolls	Mollisols.
Colo	Fine-silty, mixed, noncalcareous, mesic	Cumulic Haplaquolls	Mollisols.
Cooper	Fine-silty over clayey, mixed, mesic	Aquic Hapludolls	Mollisols.
Dow	Fine-silty, mixed, calcareous, mesic	Typic Udorthents	Entisols.
Forney	Fine, montmorillonitic, noncalcareous, mesic	Vertic Haplaquolls	Mollisols.
Grable	Coarse-silty over sandy or sandy-skeletal, mixed, calcareous, mesic	Typic Udifluvents	Entisols.
Hamburg	Coarse-silty, mixed, calcareous, mesic	Typic Udorthents	Entisols.
Haynie	Coarse-silty, mixed, calcareous, mesic	Typic Udifluvents	Entisols.
Ida	Fine-silty, mixed, calcareous, mesic	Typic Udorthents	Entisols.
Keg	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Kenmoor	Sandy over clayey, mixed, calcareous, mesic	Aquic Udifluvents	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Lakeport	Fine, montmorillonitic, mesic	Aquic Hapludolls	Mollisols.
Luton	Fine, montmorillonitic, noncalcareous, mesic	Vertic Haplaquolls	Mollisols.
McPaul	Coarse-silty, mixed, calcareous, mesic	Typic Udifluvents	Entisols.
Modale	Coarse-silty over clayey, mixed, calcareous, mesic	Aquic Udifluvents	Entisols.
Monona [2]	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Moville	Coarse-silty over clayey, mixed, calcareous, mesic	Aquic Udifluvents	Entisols.
Napier	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Nodaway	Fine-silty, mixed, nonacid, mesic	Typic Udifluvents	Entisols.
Onawa	Clayey over loamy, montmorillonitic, calcareous, mesic	Mollic Haplaquents	Entisols.
Percival	Clayey over sandy or sandy-skeletal, montmorillonitic, calcareous, mesic	Aquic Udifluvents	Entisols.
Salix	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Sarpy	Mixed, mesic	Typic Udipsamments	Entisols.
Solomon	Fine, montmorillonitic, calcareous, mesic	Vertic Haplaquolls	Mollisols.
Steinauer	Fine-loamy, mixed, calcareous, mesic	Typic Udorthents	Entisols.
Vore	Fine-silty over sandy or sandy skeletal, mixed, calcareous, mesic	Aquic Udifluvents	Entisols.
Woodbury	Fine, montmorillonitic, noncalcareous, mesic	Vertic Haplaquolls	Mollisols.

[1] The Carr soils in Harrison County are taxadjuncts to the Carr series because their 10- to 40-inch control section is more than 15 percent fine sand and coarser sand.
[2] The Monona soils in units 10D3, 10E3, 22D3, and 22E3 are taxadjuncts to the Monona series because their surface layer is either too thin or too light colored to qualify as a mollic epipedon.

The last spring freeze usually occurs shortly after May 1, and the first autumn freeze is about October 6. Thus the growing season is about 156 to 161 days.

Optimum corn growth occurs in hot weather, but on very hot days that have temperatures of 90° F or more, stress generally impedes growth. On the average, 27 days have a maximum temperature of 90° or higher, and during the normal season the extreme maximum is about 99°. Table 7 shows year-round temperature and precipitation data for the county.

Topography

Three distinct topographic areas are recognized in the county. These are the rolling uplands, the steep bluffs along the Missouri River bottom land, and the broad, nearly level bottom land along the Missouri and Boyer Rivers. The more gently rolling upland areas are in the eastern part of the county in the Monona-Ida-Napier soil association. In these areas, ridgetops are well rounded, the side slopes are smooth and regular, and the valleys are wide.

A strip of very hilly land about ¼ mile to 2 miles wide is east of the bottom land of the Missouri River and parallels the river through the county. In this area, the west-facing bluffs rise about 150 to 250 feet above the bottom land. This area is occupied by the Hamburg-Ida-Monona soil association. The bluffs near the bottom land are occupied mainly by Hamburg soils and have characteristic "catsteps" formed by small earth slips on the very steep slopes. Narrow ridgetops, long, steep or very steep sides, and deep, raw gullies are characteristic features of this area.

The Missouri River bottom land ranges from about 12 miles wide north of the Missouri Valley to about 2½ miles at the narrowest point near River Sioux. Areas are mainly nearly level; a few areas bordering the river are undulating or hummocky. Numerous old sloughs or swales and channels are in the bottom land. Many have been drained by drainage ditches. In places near the Missouri River channel, there is a narrow band of sandy material, some of which is in hummocks and dunes, that ranges to about 10 feet in height. Many nearly level benches are along the Boyer River. The loess-covered soils on these benches are in the Monona series.

Drainage

The county is drained by the Missouri River and its tributaries, chiefly the Boyer River and the Soldier

River. Some of the other important streams in the county are Willow, Allen, Steer, Pigeon, Picayune, Mill, and Mud Creeks.

The need for artificial drainage generally is restricted to the bottom lands. The Missouri bottom land in the west and southwest parts of the county is crossed by the straightened and deepened channels of a number of streams that flow onto the bottom land from the uplands to the east and north. The nearly level topography, the fine-textured soils, and the lack of a natural drainage system account for the fact that many of the soils and large areas of the bottom land have poor natural drainage.

Transportation

Several major railroads serve Harrison County. A network of Federal, State, and county highways serves all parts of the county. Interstate Highway 29 provides north-south service in the western part of the county. U.S. Highway 30 enters the county at Dunlap and crosses the county diagonally. Routes 44, 127, 183, and 191 are major State highways.

There are a number of gravel and crushed stone surfaced farm-to-market roads. Few farms are far from all-weather roads.

Most communities have truck freight service. Bus service is provided to the communities along U.S. Highway 30 and adjacent to Interstate Highway 29.

Two community airfields are located in the county. One is south of Missouri Valley, and the other is east of Woodbine.

Industries

Industries within the county produce concrete block, furniture frames, trenchers for pipelines, and hydraulic endgates for trucks. The only industry in the county seat of Logan produces a variety of forms for schools.

Two large stone quarries of Logan provide crushed limestone for roads and ground limestone for agricultural purposes. Two large gravel pits, one south of Woodbine and the other near Pisgah, are in operation at the present time.

Markets

Beef cattle, hogs, and other livestock intended for slaughter are generally trucked to markets at Omaha, Nebraska, or to other markets in west-central Iowa. Community sale barns are located at Dunlap and Woodbine. Corn, soybeans, and wheat are bought and sold through local grain dealers. Large grain elevators are located at Missouri Valley, Logan, Woodbine, Modale, California Junction, Mondamin, River Sioux, Dunlap, and Persia. The milk, cream, and eggs produced on farms are hauled to creameries, dairies, and produce houses, most of which are outside the county.

Farming

The Iowa Annual Farm Census for 1969 (*8*) shows that the total land in farms in Harrison County as of January 1, 1970, amounted to 430,553 acres. Most of the land in farms was in crops, but 80,789 acres was in pasture. All other land in farms, including cropland not harvested, roads, buildings, lots, woods, wasteland, etc. amounted to 129,997 acres.

Beef cattle, hogs, dairy cattle, and poultry are the livestock most extensively raised in Harrison County. In 1969, grain-fed cattle sold numbered 32,884, and hogs marketed 108,346. Laying hens numbered 24,541, and commercial broilers 2,325. Beef cows numbered 12,456, and milk cows totaled 2,006. Lambs born in the county totaled 1,035. There has been a slight increase

TABLE 7.—*Temperature and precipitation data*

[Data from Logan, elevation 1,035 feet]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average highest	Average lowest	Average total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Number of days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
	°F	°F	°F	°F	Inches	Inches	Inches		Inches
January	31	11	50	—16	1.0	0.2	1.7	16	5
February	35	15	56	— 7	1.0	.2	1.9	12	5
March	48	26	72	4	1.6	.5	3.4	9	6
April	63	38	85	23	2.7	.6	6.6	(1)	1
May	74	49	90	33	3.9	1.1	7.6	(1)	1
June	83	59	95	45	5.0	2.4	8.7	0	
July	88	63	97	52	4.0	1.1	5.9	0	
August	86	61	97	48	3.8	1.7	7.7	0	
September	78	53	91	35	3.1	1.1	5.0	0	
October	66	41	84	23	2.1	.1	4.7	(1)	2
November	48	27	68	7	1.4	0.0	2.5	2	4
December	36	17	56	— 6	1.0	.1	2.0	8	4
Year	61	38	99	—17	30.6	21.5	37.5	47	

[1] Less than one-half day.

in beef cattle raised and fed and a decrease in cows milked in Harrison County in recent years. The number of hogs has fluctuated but remained fairly stable. The number of poultry and sheep, especially poultry, has decreased.

The largest acreage in crops in Harrison County is corn. The next largest acreage is soybeans. A total of 119,413 acres of corn was harvested for grain in 1969. The average yield was 106.3 bushels per acre. Soybeans were harvested from 61,438 acres, and the average yield was 35.1 bushels per acre. Other crops and the acreage grown were: hay 15,992 acres; wheat 3,144 acres; oats 11,807 acres; sorghums 550 acres; and popcorn 4,257 acres. Limited amounts of apples and other orchard crops are also grown.

A steady decrease in the number of farms and an increase in the size have been evident in recent years. The 1969 census showed 5,216 people on 1,446 farms. The farms averaged 298 acres. Land owned by farm operators amounted to 48.1 percent, which was slightly lower than the average of 53.5 percent for the State of Iowa. Tenants operated 51.9 percent of the land, compared to a State average of 47.5 percent.

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Glossary

Acidity. See Reaction, soil.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Bottom land. The normal flood plain of a stream and the old alluvial plain that is seldom flooded.

Bottom, first. The normal flood plain of a stream; land along the stream subject to overflow.

Bottom, second. An old alluvial plain, generally flat or smooth, that borders a stream but is seldom flooded.

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.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure. between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist,, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Glacial drift (geology). Rock material transported by glacial ice and then deposited; also includes the assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major 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 (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by 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.

Interfluve. The land between two adjacent streams flowing in the same general direction.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many*; size *fine, medium,* and *coarse*; and contrast— *faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Paleosol. A soil that was formed during the geologic past and was buried and preserved by more recent sedimentation. This kind of buried soil is often reexposed on the modern surface by subsequent erosion. It then occurs with soils on the modern surface and is called an exhumed paleosol.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Percolation. The downward movement of water through the soil.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is 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 degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

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 characteristic 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 either *single grain* (each grain by itself, as in dune sand) or *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 solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent is uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy cay, 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.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

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GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Other information is given in tables as follows:

Acreage and extent, table 1, page 13.
Predicted yields, table 2, page 55.

Engineering, tables 3, 4, and 5, pages 58 to 79.

Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page
1C	Ida silt loam, 5 to 9 percent slopes	23	IIIe-2	50
1C3	Ida silt loam, 5 to 9 percent slopes, severely eroded	23	IIIe-2	50
1D	Ida silt loam, 9 to 14 percent slopes	23	IIIe-2	50
1D3	Ida silt loam, 9 to 14 percent slopes, severely eroded	23	IIIe-2	50
1E	Ida silt loam, 14 to 20 percent slopes	24	IVe-1	51
1E3	Ida silt loam, 14 to 20 percent slopes, severely eroded	24	IVe-1	51
1F	Ida silt loam, 20 to 30 percent slopes	24	VIe-1	52
1F3	Ida silt loam, 20 to 30 percent slopes, severely eroded	24	VIe-1	52
1G	Ida silt loam, 30 to 40 percent slopes	25	VIIe-1	53
2G	Hamburg silt loam, 40 to 75 percent slopes	22	VIIe-1	53
3D	Castana silt loam, 5 to 14 percent slopes	17	IIIe-1	50
3E	Castana silt loam, 14 to 20 percent slopes	17	IVe-1	51
10	Monona silt loam, 0 to 2 percent slopes	32	I-3	48
10B	Monona silt loam, 2 to 5 percent slopes	33	IIe-2	49
10C	Monona silt loam, 5 to 9 percent slopes	33	IIIe-1	50
10C2	Monona silt loam, 5 to 9 percent slopes, moderately eroded	33	IIIe-1	50
10D	Monona silt loam, 9 to 14 percent slopes	33	IIIe-1	50
10D2	Monona silt loam, 9 to 14 percent slopes, moderately eroded	34	IIIe-1	50
10D3	Monona silt loam, 9 to 14 percent slopes, severely eroded	34	IIIe-1	50
10E	Monona silt loam, 14 to 20 percent slopes	34	IVe-1	51
10E2	Monona silt loam, 14 to 20 percent slopes, moderately eroded	34	IVe-1	51
10E3	Monona silt loam, 14 to 20 percent slopes, severely eroded	34	IVe-1	51
10F	Monona silt loam, 20 to 30 percent slopes	34	VIe-1	52
10F2	Monona silt loam, 20 to 30 percent slopes, moderately eroded	35	VIe-1	52
10G	Monona silt loam, 30 to 40 percent slopes	36	VIIe-1	53
T10	Monona silt loam, benches, 0 to 2 percent slopes	32	I-3	48
T10B	Monona silt loam, benches, 2 to 5 percent slopes	33	IIe-2	49
12B	Napier silt loam, 2 to 5 percent slopes	37	IIe-1	48
12B+	Napier silt loam, 2 to 5 percent slopes, overwash	37	IIe-1	48
12C	Napier silt loam, 5 to 9 percent slopes	37	IIIe-1	50
12D	Napier silt loam, 9 to 14 percent slopes	37	IIIe-1	50
17B	Napier-Nodaway-Colo complex, 2 to 5 percent slopes	38	IIe-1	48
22D3	Dow-Monona silt loams, 9 to 14 percent slopes, severely eroded	19	IIIe-2	50
22E3	Dow-Monona silt loams, 14 to 20 percent slopes, severely eroded	19	IVe-1	51
33D2	Steinauer clay loam, 9 to 14 percent slopes, moderately eroded	44	IIIe-2	50
33E3	Steinauer clay loam, 14 to 18 percent slopes, severely eroded	44	VIe-1	52
36	Salix silty clay loam	41	I-1	48
38	Blake and Haynie soils	12	IIw-2	49
44	Blencoe silty clay	14	IIw-1	49
46	Keg silt loam	26	I-1	48
53	Riverwash	41	VIIs-1	53
66	Luton silty clay	30	IIIw-1	50
66+	Luton silt loam, overwash	30	IIIw-1	50
67	Woodbury silty clay	46	IIIw-1	50
70	McPaul silt loam	31	I-2	48
133	Colo silty clay loam	18	IIw-1	49
133+	Colo silt loam, overwash	17	IIw-1	49
137	Haynie silt loam	22	I-2	48
144	Blake silty clay loam	12	I-2	48
145	Onawa silt loam	40	IIw-2	49
146	Onawa silty clay	40	IIw-2	49
149	Modale silt loam	32	I-2	48

Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page
156	Albaton silty clay	9	IIIw-1	50
157	Albaton silt loam	9	IIIw-1	50
212	Kennebec silt loam	28	I-1	48
212+	Kennebec silt loam, overwash	28	I-1	48
220	Nodaway silt loam	39	I-2	48
237	Sarpy fine sand, 0 to 3 percent slopes	42	IVs-1	51
237B	Sarpy fine sand, 3 to 7 percent slopes	42	IVs-1	51
238	Sarpy fine sandy loam, 0 to 3 percent slopes	42	IVs-1	51
244	Blend silty clay	15	IIIw-1	50
255	Cooper silty clay loam	18	IIw-1	49
275	Moville silt loam	36	IIw-2	49
315	Albaton and Sarpy soils	10	Vw-1	52
436	Lakeport silty clay loam	29	I-1	48
446	Burcham silt loam	15	I-1	48
466	Solomon silty clay	44	IIIw-1	50
514	Grable silt loam	21	IIs-1	50
515	Percival silty clay	41	IIw-2	49
516	Vore silty clay loam	45	IIs-1	50
538	Carr very fine sandy loam	16	IIIs-1	51
549	Modale very fine sandy loam	31	IIs-1	50
550	Borrow pits	15	Vw-1	52
553	Forney silty clay	20	IIIw-1	50
717C	Napier-Gullied land complex, 2 to 10 percent slopes	38	VIIe-1	53
844	Blake silt loam	11	I-2	48
849	Kenmoor fine sand	26	IIIs-1	51
866	Luton silty clay, thin surface	30	IIIw-1	50

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