SOIL SURVEY OF

Black Hawk 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. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1968–72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1973. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station and Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, woodlands, and wildlife areas; 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 Black Hawk 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 "Index to Mapping Units" on page ii lists all the soils in the county by map symbol and shows the page where each soil is described. The capability unit to which each soil has been assigned is specified at the end of the soil description.

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

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

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

Wildlife managers and others can find information about soils and wildlife in the section "Wildlife Habitat."

Community planners and others can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the section "Soil Properties."

Engineers and builders can find, under "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 the soils in the section "Formation of Soils."

Newcomers in the area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Information About the County."

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Issued December 1978

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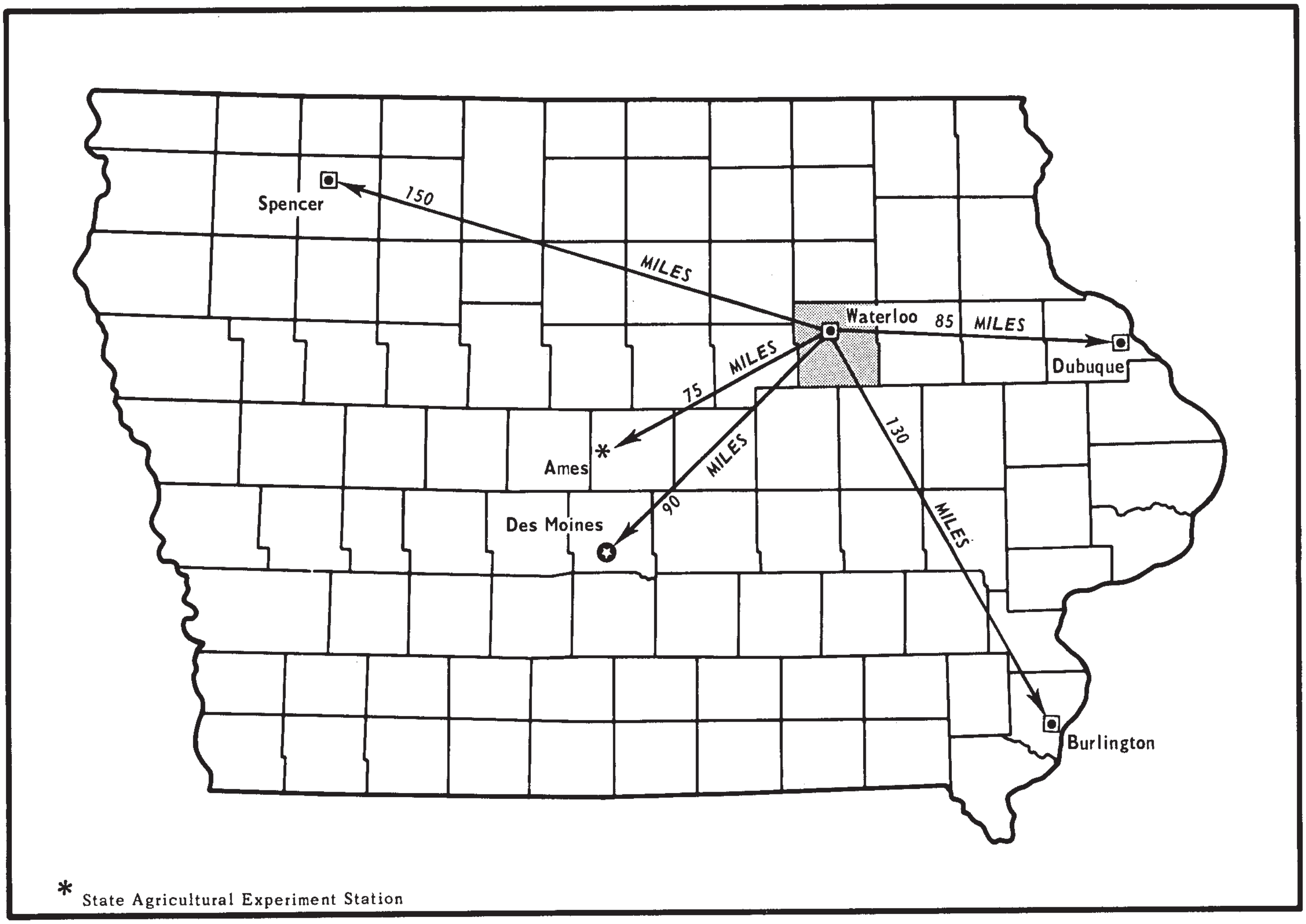

Location of Black Hawk County in Iowa.

SOIL SURVEY OF BLACK HAWK COUNTY, IOWA

By William L. Fouts and John D. Highland, Soil Conservation Service [1]

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

BLACK HAWK COUNTY is in the east-central part of Iowa (see facing page). Waterloo, the county seat and largest city, is about 90 miles northeast of Des Moines, the State capital. The county has an area of 363,520 acres. It is bounded on the north by Bremer County, on the east by Buchanan County, on the south by Benton and Tama counties, and on the west by Grundy and Butler counties.

Black Hawk County is agricultural. The principal crops are corn, soybeans, oats, hay, and pasture. Most of the crops, except soybeans, are fed to livestock. Beef cattle, hogs, and dairying are the principal sources of income. Industry and urbanization are increasing rapidly in the Waterloo and Cedar Falls vicinity.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; 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, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

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

The areas shown on a soil map are called soil mapping units. Some mapping units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Mapping units are discussed in the section "General Soil Map For Broad Land Use Planning."

General Soil Map For Broad Land Use Planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Each map unit is rated for cultivated farm crops, specialty crops, woodland, urban uses, and recreation areas. Cultivated farm crops are those grown extensively by farmers in the survey area. Specialty crops include vegetables, fruits, and nursery crops grown on limited acreage and generally requiring intensive management. Woodland refers to land that is producing either trees native to the area or introduced species. Urban uses include residential, commercial, and industrial developments. Intensive recreation areas include campsites, picnic areas, ballfields, and other areas that are subject to heavy foot traffic. Extensive recreation areas include those used for nature study and as wilderness.

[1] The soils were surveyed and the survey manuscript prepared under the general direction of Lacy I. Harmon, Soil Conservation Service, and F. F. Riecken and T. E. Fenton, Iowa Agriculture Experiment Station. Those participating in the field were L. L. Davis, W. L. Fouts, R. J. Kuehl, and M. J. Minger, Soil Conservation Service.

1. *Tama-Muscatine-Garwin*

Nearly level and gently sloping, well drained to poorly drained silty soils formed in loess; on uplands

This unit (fig. 1) is in the southwestern part of the county. It is characterized by nearly level to gently sloping ridges and side slopes and wide, nearly level to level, indistinct drainageways. Almost all of the unit is under cultivation. Fields are rectangular. Roads extend along section lines. The soils formed in loess more than 40 inches thick. They range from well drained to poorly drained.

This unit makes up about 4 percent of the county. It is about 22 percent Tama soils, 20 percent Muscatine soils, 15 percent Garwin soils, and 43 percent chiefly Dinsdale, Sawmill, Colo, and Ely soils.

Dinsdale soils are in the uplands. Colo and Ely soils are in narrow upland drainageways. Sawmill soils are on small stream bottom lands.

The well drained, gently sloping Tama soils are on ridgetops and side slopes. They have a thick, black and very dark brown silty clay loam surface layer. The subsoil is dark brown to yellowish brown silty clay loam.

The somewhat poorly drained, nearly level and gently sloping Muscatine soils have a thick, black to very dark grayish brown silty clay loam surface layer. The subsoil is dark grayish brown to grayish brown silty clay loam with yellowish brown mottles. The nearly level Muscatine soils are on upland divides, and the gently sloping soils on slightly concave foot slopes.

The poorly drained Garwin soils are in the depressional heads of upland drainageways. They have a thick, black silty clay loam surface layer. The subsoil is dark gray to olive gray silty clay loam with brown to light olive brown mottles.

Almost all of this unit is used for cultivated crops. It is well suited to corn and soybeans. Improving drainage and controlling erosion are the principal management needs. Maintaining tilth and fertility is also important.

2. *Dinsdale-Klinger-Maxfield*

Nearly level to moderately sloping, well drained to poorly drained silty soils formed in loess and the underlying glacial till; on uplands

This unit (fig. 2) is in the southwestern and northeastern parts of the county. It is characterized by nearly level areas and rounded, gently sloping convex ridges and side slopes. The soils are well drained to poorly drained. They formed in loess and the underlying glacial till. This loess is generally 24 to 40 inches thick.

This unit makes up about 15 percent of the county. It is about 37 percent Dinsdale soils, 22 percent Klinger soils, 11 percent Maxfield soils, and 30 percent chiefly

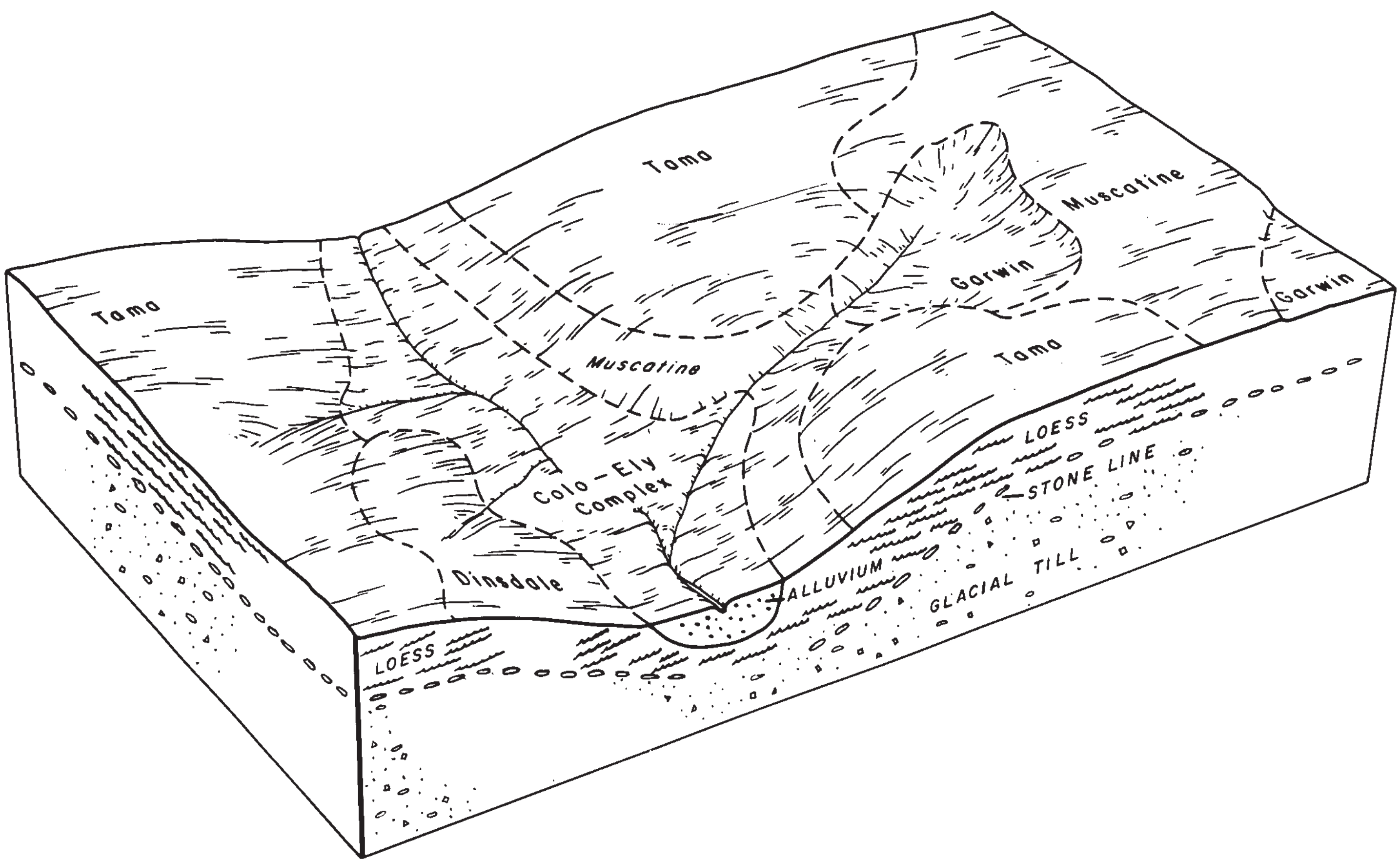

Figure 1.—Tama-Muscatine-Garwin. Pattern of soils and parent material.

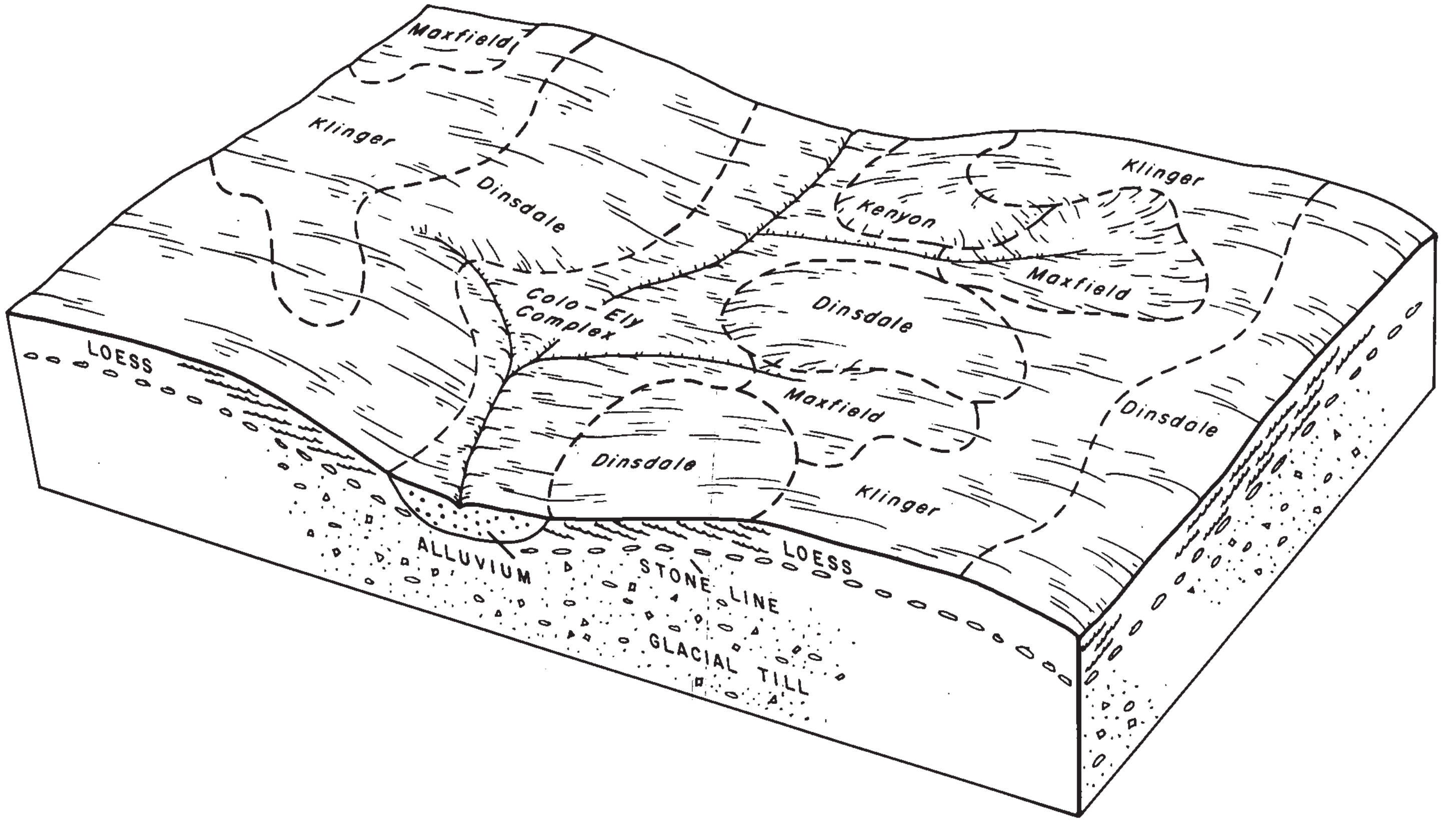

Figure 2.—**Dinsdale-Klinger-Maxfield. Pattern of soils and parent material.**

Kenyon, Colo, Ely, Franklin, Muscatine, Aredale, Donnan, Waubeek, and Sawmill soils.

The sloping Kenyon, Aredale, Donnan, and Waubeek soils and the nearly level Franklin and Muscatine soils are on uplands. Sawmill soils are on small stream bottom lands.

The dominantly gently sloping Dinsdale soils occur on convex ridgetops and side slopes. The moderately sloping Dinsdale soils occupy small areas on short, convex side slopes. All are well drained. They have a thick, black silty clay loam surface layer. The subsoil is dark brown or brown silty clay loam and yellowish brown and brown loam glacial till with gray mottles. A stone line or pebble band generally separates the loess from the glacial till.

The nearly level, somewhat poorly drained Klinger soils are on broad upland divides or on slightly concave foot slopes. They have a thick, black and very dark grayish brown silty clay loam surface layer. The subsoil is mottled grayish brown silty clay loam over grayish brown and yellowish brown loam glacial till that contains some stones and pebbles.

The poorly drained Maxfield soils are in slightly depressed areas of the uplands or at the heads of broad, shallow drainageways. They have a thick, black silty clay loam surface layer. The subsoil is mottled very dark gray and dark grayish brown silty clay loam over mottled yellowish brown and gray loam glacial till.

Almost all of this unit is used for cultivated crops. It is well suited to corn and soybeans. Tilth is generally good. The main concerns of management are controlling erosion, improving drainage, and maintaining tilth and fertility.

3. *Kenyon-Clyde-Floyd*

Nearly level to strongly sloping, moderately well drained to poorly drained loamy soils formed in loamy material and the underlying glacial till; on uplands

This unit (fig. 3) is the largest in the county. It is characterized by long, gentle slopes; slightly rounded ridges; and broad, nearly level valleys with low gradient drainageways, which form a well developed regional drainage system. Glacial stones and boulders are common landscape features. The soils formed in loamy materials and glacial till. Areas of this unit occur in most parts of the county.

This unit makes up about 35 percent of the county. It is about 38 percent Kenyon soils, 25 percent Clyde soils, 11 percent Floyd soils, 7 percent Aredale soils, and 19 percent chiefly Olin, Readlyn, Donnan, Bassett, Sparta, Dinsdale, Dickinson, Klinger, and Marshan soils.

The nearly level Readlyn and Klinger soils and the sloping Olin, Donnan, Bassett, Sparta, Dinsdale, and Dickinson soils are on uplands. The Marshan soils are on stream channels.

The dominantly gently sloping Kenyon soils are on ridgetops and long, smooth, convex side slopes. They have a thick, black and very dark brown loamy surface layer and a yellowish brown loamy subsoil that contains

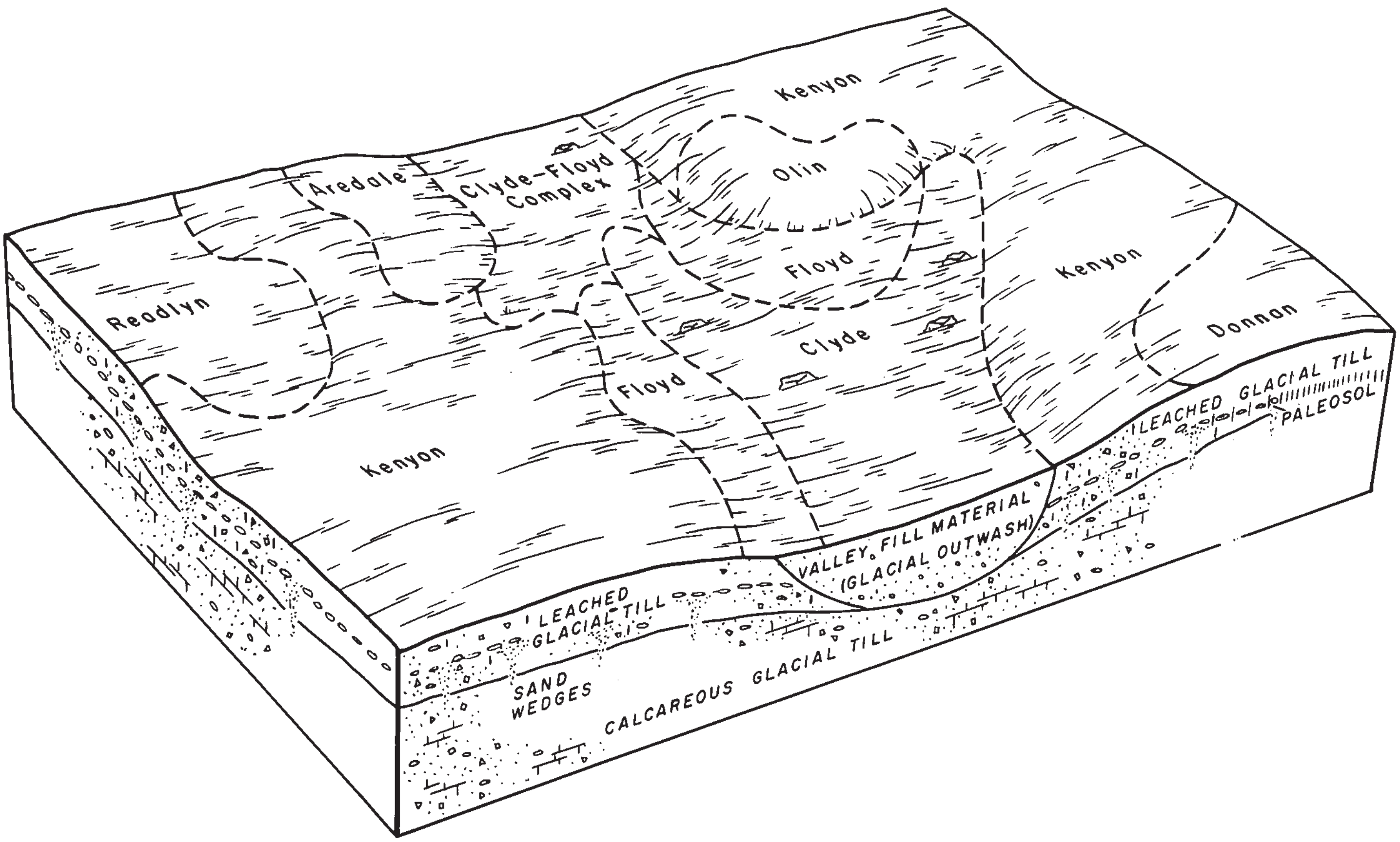

Figure 3.—**Kenyon-Clyde-Floyd. Pattern of soils and parent material.**

stones and pebbles. The moderately sloping Kenyon soils occur on short, convex side slopes. All are moderately well drained.

The nearly level to gently sloping, poorly drained Clyde soils are in drainageways and lower concave foot slopes. They have a thick, black and very dark gray clay loam surface layer and a mottled gray to yellowish brown, stratified loamy subsoil. Many of these areas contain stones and boulders.

The well drained Aredale soils are on convex slopes. They have a dark colored surface layer. They developed in thick loamy material and the underlying loam glacial till.

The nearly level to gently sloping, somewhat poorly drained Floyd soils are on concave foot slopes. They have a thick black, very dark gray, and very dark grayish brown loam surface layer and a yellowish brown mottled loam subsoil that contains stones and pebbles.

Almost all of this unit is under cultivation. It is well suited to corn and soybeans. The principal concerns of management are improving drainage, controlling erosion, and maintaining tilth and fertility.

Most uncultivated areas are wet, contain boulders, are sandy, or include short, steep slopes. These areas occur along drainageways. Some wet areas remain undrained because they lack suitable outlets. The wetness in Clyde and Floyd soils is partly the result of hillside seepage. Interceptor tile laid upslope from the wet spots is needed for adequate drainage.

4. *Readlyn-Tripoli*

Nearly level and very gently sloping, somewhat poorly drained and poorly drained loamy soils formed in loamy material and the underlying glacial till; on uplands

This unit (fig. 4) is mainly north and east of the Cedar River. It is characterized by broad, nearly level, upland divides that have few distinct drainageways. The roads in this unit generally follow the section lines, and the fields form a rectangular pattern. The soils formed in loamy materials and glacial till. Drainage is somewhat poor or poor.

This unit makes up about 9 percent of the county. It is about 55 percent Readlyn soils, 26 percent Tripoli soils, and 19 percent Kenyon, Clyde, Protivin, Oran, Olin, Sparta, Floyd, and Donnan soils.

The nearly level Oran soils and the sloping Kenyon, Olin, and Sparta soils are on uplands. The sloping Floyd and Protivin soils are at the base of uplands. The Clyde soils are in drainageways.

The somewhat poorly drained Readlyn soils are on the broad, nearly level or slightly convex slopes of the uplands. They have a thick, black and very dark brown loam surface layer. The subsoil is mottled dark grayish brown and yellowish brown loam glacial till.

The poorly drained Tripoli soils are in nearly level or slightly concave areas along the heads of drainageways. They have a thick, black clay loam surface layer. The

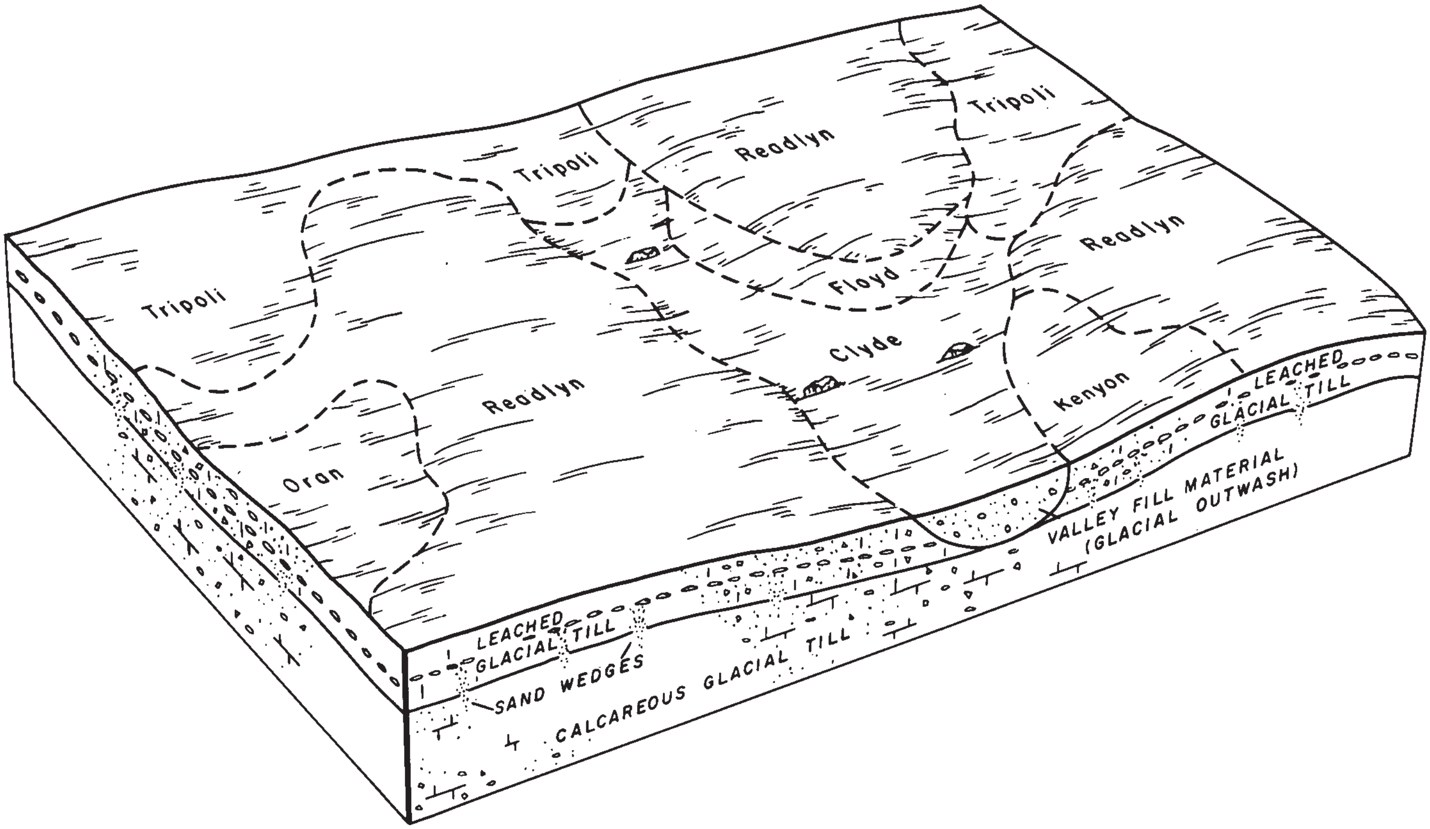

Figure 4.—**Readlyn-Tripoli. Pattern of soils and parent material.**

subsoil is dark grayish brown, brown, and yellowish brown mottled loamy glacial till.

Almost all of this unit is used for cultivated crops. The soils are well suited to corn and soybeans. Although much of this area has been drained, improving drainage is still the most important management need. Maintaining tilth and fertility are also important. Rocks and boulders interfere with cultivation and the installation of drainage tile in some locations.

5. *Sparta-Olin-Dickinson*

Nearly level to moderately steep, excessively drained to well drained sandy and loamy soils formed in eolian sands or eolian sands and the underlying glacial till; on uplands and terraces

This unit occurs as fairly small areas in irregular patterns on uplands and alluvial terraces, generally east and south of major stream valleys.

This unit makes up about 10 percent of the county. It is about 40 percent Sparta soils (fig. 5), 15 percent Olin soils, 12 percent Dickinson soils, and 33 percent Chelsea, Lamont, Kenyon, Clyde, Lawler, and Marshan soils.

The sloping Chelsea, Lamont, and Kenyon soils are on uplands. The Clyde soils are in upland drainageways. The Lawler and Marshall soils are on stream terraces.

The excessively drained Sparta soils are nearly level to moderately steep. In some places they occur as dune-like ridges oriented northwest to southeast. The surface

Figure 5.—**Profile of Sparta loamy fine sand showing weak stratification. Exposed in a weathered sandpit cut.**

layer typically is thick, very dark grayish brown and dark brown loamy fine sand. The subsoil is dark yellowish brown loamy fine sand, which grades to yellowish brown fine sand in the substratum at a depth of about 38 inches.

The well drained Olin soils are gently sloping to moderately sloping. They developed in 20 to 36 inches of fine sandy loam and the underlying glacial till. The surface layer typically is very dark brown to very dark grayish brown fine sandy loam about 20 inches thick. The subsoil is brown sandy loam to yellowish brown loamy sand to a depth of about 33 inches. Below this, it is strong brown loam. The substratum, at a depth of about 40 inches, is strong brown medium loam.

The somewhat excessively drained Dickinson soils are nearly level or gently sloping. They are dark grayish brown and dark brown. They developed in 24 to 36 inches of fine sandy loam over loamy fine sand and sand.

The light colored sandy upland areas are occupied by the Chelsea and Lamont soils. The low concave areas, which are poorly drained, are occupied by the Marshan and Clyde soils. The rims of the wet areas and some foot slopes are occupied by the somewhat poorly drained Lawler and Floyd soils. The sloping areas that are not covered by sandy materials are generally occupied by the Kenyon soils.

This unit can be used for row crops, but in places careful management is needed. Suitability is only fair for corn and soybeans. Soil blowing and water erosion are hazards if the vegetation is sparse.

A large part of the nearly level and gently sloping area is used for crop production. A large part of the moderately sloping to moderately steep area and the wet, seepy areas are used for permanent pasture, woodland, and wildlife.

6. Loamy alluvial land, channeled-Saude-Flagler

Nearly level and gently sloping, excessively drained to poorly drained loamy soils formed in loamy alluvial sediments; on bottom lands and terraces

This unit (fig. 6) is characterized by nearly level stream valleys, some moderately sloping areas, and a few strongly sloping to steep terrace escarpments. The bottom lands are subject to flooding. The alluvial terraces are usually free from flooding except in low areas, but they sometimes receive runoff from adjacent hillsides. The soils formed chiefly in loamy material and the underlying coarse sandy alluvium. They range from excessively drained to poorly drained.

The roads and fields in this unit commonly form irregular patterns. In many places the shape of the field is determined by streams, old stream channels, and terrace escarpments. Some roads parallel the streams,

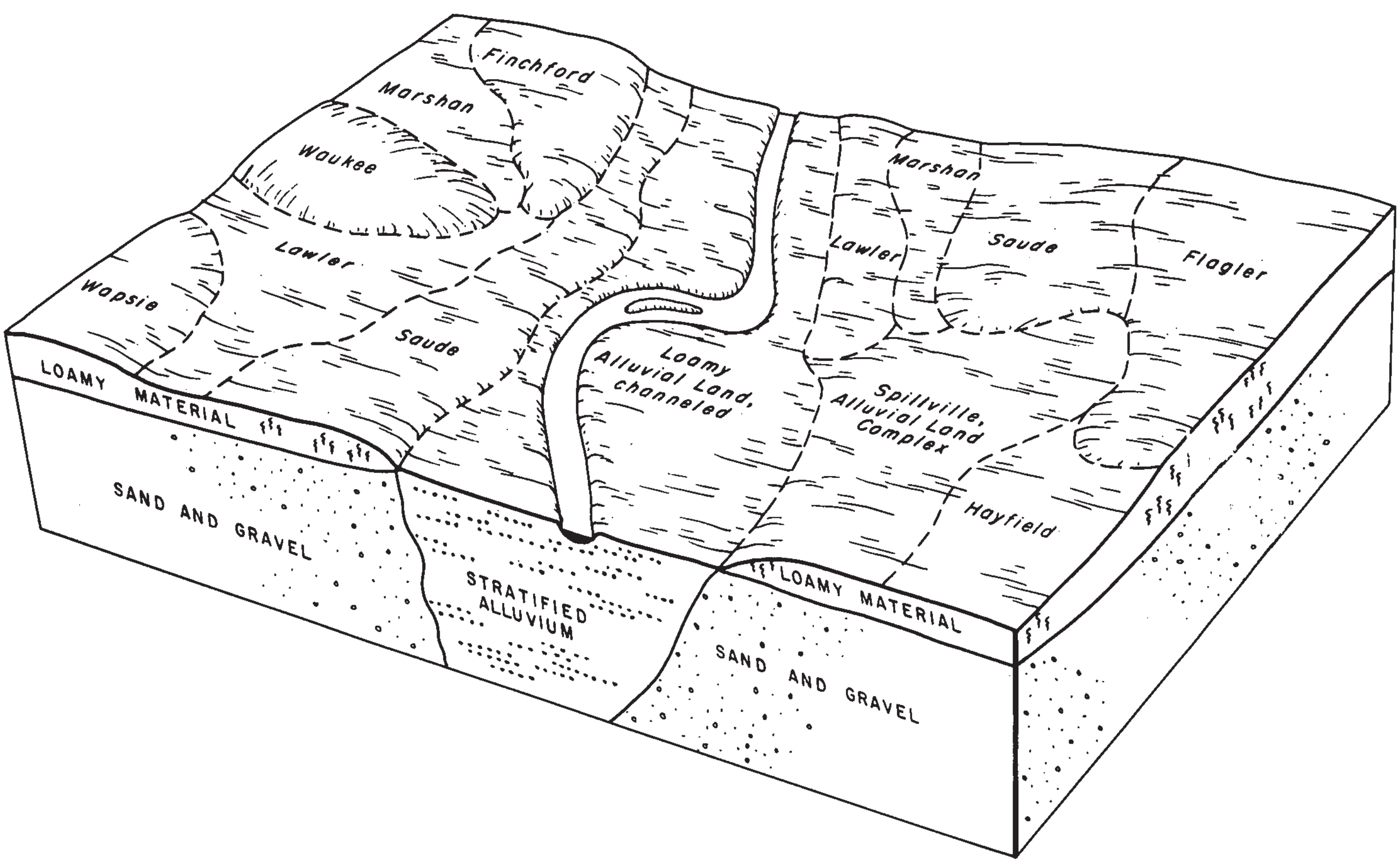

Figure 6.—**Loamy alluvial land, channeled-Saude-Flagler. Pattern of soils and parent material.**

but the network of roads is sketchy and only a few cross the rivers.

This unit makes up about 20 percent of the county. It is about 20 percent Loamy Alluvial land, channeled, 16 percent Saude soils, 7 percent Flagler soils, 7 percent Finchford soils, 5 percent Lawler soils, and 45 percent chiefly Spillville, Waukee, Marshan, Hayfield, Wapsie, Sparta, and Dickinson soils.

The Finchford, Lawler, Waukee, Marshan, and Wapsie soils are on stream terraces, and Spillville soils are on bottom lands. Sparta and Dickinson soils are dominantly on adjoining uplands.

Loamy alluvial land, channeled, is recently deposited, stratified loamy and sandy alluvial sediment (fig. 7). It is highly subject to flooding. It ranges from excessively drained to poorly drained. It is characterized by old stream channels and oxbows, often ponded, undulating areas, natural levees, and terrace escarpments. In places no soil development is evident.

The well drained, nearly level to moderately sloping Saude soils (fig. 8) are on alluvial terraces. They formed in 24 to 32 inches of loamy material and the underlying sand and gravel. They have a thick, very dark brown and dark brown loam surface layer. The subsoil is brown, friable loam grading to loamy sand in the lower part.

The somewhat excessively drained, nearly level to gently sloping Flagler soils are on alluvial terraces. They have a thick, dark colored sandy loam surface layer. The upper part of the subsoil is brown sandy loam that grades to yellowish brown loamy sand in the lower part.

The excessively drained Finchford soils are nearly level and gently sloping to moderately sloping. The nearly level soils are on terraces. The rest are on terrace escarpments. The surface layer is thick, very dark brown and very dark grayish brown loamy sand. The subsoil is very dark grayish brown coarse sand and some fine gravel.

The somewhat poorly drained Lawler soils have a thick, black loam surface layer. The subsoil is mottled very dark grayish brown to brown loam that grades to loamy sand. Sand and some fine gravel is generally below 24 to 40 inches.

The suitability for corn and soybeans varies. Potential yields range from very low to high, depending on the frequency of flooding. Loamy alluvial land, channeled, is generally used for pasture. The other soils are generally used for crops. The chief management needs are controlling flooding, improving drainage, stabilizing streambanks and channels, conserving soil and moisture, and maintaining fertility.

Figure 7.—**Sand, flood debris, and ponded areas on frequently flooded Loamy alluvial land, channeled.**

Figure 8.—**Saude soils on high alluvial terraces. These soils are underlain by sand and gravel. Permeability is moderate to very rapid. The limitation for septic tank absorption fields is only slight, but contamination of ground water is a hazard.**

7. *Marshan-Sawmill-Bremer*

Nearly level, poorly drained silty and loamy soils formed in silty and loamy alluvial sediments; on bottom lands and terraces

This unit is generally in the valleys of intermediate size streams. It is characterized by nearly level bottom lands and terraces. The soils formed in silty and loamy alluvial sediments. Typically the sandy substratum is at a depth of more than 4 feet. The network of section line roads is nearly complete, and most roads cross creeks.

This unit makes up about 7 percent of the county. It is about 28 percent Marshan soils, 28 percent Sawmill soils, 18 percent Bremer soils, 10 percent Colo soils, 10 percent Nevin soils, 6 percent Coland soil, and 10 percent chiefly Zook, Koszta, and Lawler soils.

The Nevin, Koszta, and Lawler soils are on stream terraces. The Colo and Coland soils are on bottom lands.

The nearly level, poorly drained Marshan soils are on bottoms and terraces. They developed in 24 to 40 inches of loamy materials and the underlying sand and gravel. They have a thick, black surface layer that ranges from clay loam to loam. The subsoil is dark gray loam mottled with olive in the upper part and gray sandy loam or loamy sand mottled with dark gray and light olive brown to strong brown in the lower part.

The nearly level, poorly drained Sawmill soils are on flood plains and on the lower part of upland drainageways. They have a very thick, black and very dark gray silty clay loam surface layer. The subsoil is olive gray silty clay loam that grades to mottled strong brown and gray.

The nearly level, poorly drained Bremer soils are on broad alluvial terraces. They have a thick, black silty clay loam surface layer. The subsoil is dark grayish brown silty clay loam, with dark gray ped coatings, that grades to olive gray mottled with yellowish brown. Some small areas are subject to flooding for short periods.

The nearly level, poorly drained Colo soils are on flood plains and in drainageways that are subject to frequent flooding. They have a very thick, very dark gray to black silty clay loam surface layer. The substratum is olive gray mottled silty clay loam.

The nearly level, somewhat poorly drained Nevin soils are on terraces along the major tributaries to the Cedar River. They have a thick, black and very dark gray silty clay loam surface layer. The subsoil is dark grayish brown silty clay loam that grades to grayish brown mottled with light olive brown to yellowish brown.

The nearly level, poorly drained Coland soils occur on flood plains. They have a very thick surface layer that grades from black clay loam to very dark gray loam. The subsoil is dark gray loam with yellowish red oxic mottles.

Most of this unit is used for cultivated crops. It is generally well suited to corn and soybeans. Improving drainage and controlling flooding are major management needs. Maintaining tilth and fertility is also important.

Soil Maps For Detailed Planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and Management of the Soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a profile that is almost alike make up a *soil series.* Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a soil phase commonly indicates a feature that affects use or management (*13*).[2] For example, Waukee loam, 2 to 5 percent slopes, is one of several phases within the Waukee series.

Some map units are made up of two or more dominant kinds of soil. One such kind of map unit is shown on the soil map of this survey area, the soil complex.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Clyde-Floyd complex, 1 to 4 percent slopes, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas;* they are delineated on the soil map and given descriptive names. Marsh is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 1, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Aredale Series

The Aredale series consists of gently and moderately sloping, well drained soils formed in loamy surficial sediments and loam glacial till. These soils are on uplands. Slopes are convex. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown, friable loam 13 inches thick. The subsoil is brown, friable loam to 22 inches and dark yellowish brown sandy loam and yellowish brown loamy sand to 45 inches. Below this is a brown loam with brown and yellowish brown mottles.

Aredale soils have variable permeability, which is moderate over moderately rapid over moderately slow. They have a high available water capacity. They have a high organic-matter content in uneroded areas and a moderate content in eroded areas. The subsoil is very low in available potassium and phosphorus.

These soils are used primarily for cultivated crops.

Representative profile of Aredale loam, 2 to 5 percent slopes, 1,110 feet west and 510 feet south of northeast corner NW1/4 sec. 31, T. 89 N., R. 13 W., in a meadow:

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam; moderate medium granular structure; friable; neutral; abrupt boundary.

A3—7 to 13 inches; very dark grayish brown (10YR 3/2) loam; moderate medium granular structure; friable; neutral; clear boundary.

B1—13 to 16 inches; brown (10YR 4/3) loam with dark brown (10YR 3/3) coatings on peds; weak fine subangular blocky structure; friable; slightly acid; clear boundary.

B21—16 to 22 inches; brown (10YR 4/3) loam; weak medium and fine subangular blocky structure; friable; medium acid; gradual boundary.

B22—22 to 31 inches; dark yellowish brown (10YR 4/4) sandy loam; weak coarse prismatic structure parting to weak medium subangular blocky; friable; medium acid; clear boundary.

IIB31—31 to 45 inches; yellowish brown (10YR 5/6) loamy sand; weak coarse prismatic structure parting to weak medium sub-

[2] Italic numbers in parentheses refer to literature cited, p. 143.

TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil name	Acres	Percent
7	Wiota silt loam, 0 to 2 percent slopes	4,010	1.1
11B	Colo-Ely complex, 2 to 5 percent slopes	3,625	1.0
41	Sparta loamy fine sand, 0 to 2 percent slopes	4,055	1.1
41B	Sparta loamy fine sand, 2 to 5 percent slopes	14,345	4.0
41C	Sparta loamy fine sand, 5 to 9 percent slopes	2,090	0.6
41D	Sparta loamy fine sand, 9 to 18 percent slopes	300	0.1
U41C	Sparta-Dickinson-Urban land complex, 0 to 9 percent slopes	1,050	0.3
43	Bremer silty clay loam, 0 to 2 percent slopes	5,015	1.4
U43	Bremer-Marshan-Urban land complex, 0 to 2 percent slopes	270	0.1
54	Zook silty clay loam, 0 to 2 percent slopes	680	0.2
63B	Chelsea loamy fine sand, 2 to 5 percent slopes	1,310	0.4
63C	Chelsea loamy fine sand, 5 to 9 percent slopes	505	0.1
63D	Chelsea loamy fine sand, 9 to 18 percent slopes	240	0.1
83B	Kenyon loam, 2 to 5 percent slopes	46,570	12.8
83C	Kenyon loam, 5 to 9 percent slopes	4,610	1.3
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded	4,705	1.3
83D2	Kenyon loam, 9 to 14 percent slopes, moderately eroded	245	0.1
U83C	Kenyon-Clyde-Urban land complex, 2 to 9 percent slopes	6,080	1.7
84	Clyde clay loam, 0 to 3 percent slopes	17,180	4.7
88	Nevin silty clay loam, 0 to 2 percent slopes	3,430	0.9
110B	Lamont fine sandy loam, 2 to 7 percent slopes	650	0.2
118	Garwin silty clay loam, 0 to 2 percent slopes	2,280	0.6
119	Muscatine silty clay loam, 0 to 2 percent slopes	1,225	0.3
119B	Muscatine silty clay loam, 2 to 5 percent slopes	2,210	0.6
120B	Tama silty clay loam, 2 to 5 percent slopes	3,170	0.9
T120	Tama silty clay loam, benches, 0 to 2 percent slopes	325	0.1
133	Colo silty clay loam, 0 to 2 percent slopes	2,930	0.8
C133	Colo silty clay loam, channeled, 0 to 2 percent slopes	250	0.1
135	Coland clay loam, 0 to 2 percent slopes	1,730	0.5
151	Marshan clay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	2,305	0.6
152	Marshan clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	6,745	1.9
154F	Loamy escarpments, 14 to 40 percent slopes	250	0.1
159	Finchford loamy sand, 0 to 2 percent slopes	4,465	1.2
159C	Finchford loamy sand, 2 to 9 percent slopes	820	0.2
U159	Finchford-Flagler-Urban land complex, 0 to 2 percent slopes	3,890	1.1
166	Bremer silty clay loam, clay subsoil variant, 0 to 2 percent slopes	180	(1)
171B	Bassett loam, 2 to 5 percent slopes	1,025	0.3
171C2	Bassett loam, 5 to 9 percent slopes, moderately eroded	215	0.1
U171D	Bassett-Chelsea-Urban land complex, 5 to 18 percent slopes	460	0.1
175	Dickinson fine sandy loam, 0 to 2 percent slopes	1,870	0.5
175B	Dickinson fine sandy loam, 2 to 5 percent slopes	3,600	1.0
177	Saude loam, 0 to 2 percent slopes	8,545	2.4
177B	Saude loam, 2 to 5 percent slopes	4,775	1.3
U177	Saude-Lawler-Urban land complex, 0 to 3 percent slopes	1,020	0.3
178	Waukee loam, 0 to 2 percent slopes	3,910	1.1
178B	Waukee loam, 2 to 5 percent slopes	2,285	0.6
184	Klinger silty clay loam, 1 to 3 percent slopes	13,605	3.7
198B	Floyd loam, 1 to 4 percent slopes	5,400	1.5
213B	Rockton loam, 30 to 40 inches to limestone, 2 to 5 percent slopes	610	0.2
221	Palms muck, 1 to 4 percent slopes	185	0.1
225	Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	1,870	0.5
226	Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	2,230	0.6
284	Flagler sandy loam, 0 to 2 percent slopes	4,510	1.2
284B	Flagler sandy loam, 2 to 5 percent slopes	1,490	0.4
290	Dells silt loam, 0 to 2 percent slopes	560	0.2
C315	Loamy alluvial land, channeled	17,665	4.9
354	Marsh	175	(1)
377B	Dinsdale silty clay loam, 2 to 5 percent slopes	22,800	6.3
377C	Dinsdale silty clay loam, 5 to 9 percent slopes	1,055	0.3
377C2	Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded	595	0.2
382	Maxfield silty clay loam, 0 to 2 percent slopes	7,080	1.9
391B	Clyde-Floyd complex, 1 to 4 percent slopes	31,025	8.5
398	Tripoli clay loam, 0 to 2 percent slopes	9,695	2.7
399	Readlyn loam, 1 to 3 percent slopes	20,805	5.7
408B	Olin fine sandy loam, 2 to 5 percent slopes	7,225	2.0
408C	Olin fine sandy loam, 5 to 9 percent slopes	540	0.1
412C	Sogn loam, 2 to 9 percent slopes	200	0.1
426B	Aredale loam, 2 to 5 percent slopes	5,520	1.5
426C	Aredale loam, 5 to 9 percent slopes	2,545	0.7
426C2	Aredale loam, 5 to 9 percent slopes, moderately eroded	1,460	0.4

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

Map symbol	Soil name	Acres	Percent	Map symbol	Soil name	Acres	Percent
471	Oran loam, 1 to 3 percent slopes	950	0.3	777	Wapsie loam, 1 to 3 percent slopes	890	0.2
485	Spillville loam, 0 to 2 percent slopes	1,920	0.5	782B	Donnan loam, 2 to 5 percent slopes	985	0.3
585	Spillville-Alluvial land complex, 0 to 2 percent slopes	3,550	1.0	782C	Donnan loam, 5 to 9 percent slopes	180	(1)
688	Koszta silt loam, 0 to 2 percent slopes	470	0.1	798	Protivin loam, 1 to 3 percent slopes	845	0.2
725	Hayfield loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	1,945	0.5	809B	Bertram fine sandy loam, 2 to 7 percent slopes	385	0.1
726	Hayfield loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	500	0.1	933	Sawmill silty clay loam, 0 to 2 percent slopes	6,145	1.7
761	Franklin silt loam, 1 to 3 percent slopes	830	0.2		Borrow area	495	0.1
771B	Waubeek silt loam, 2 to 5 percent slopes	440	0.1		Limestone quarries	225	0.1
776C	Lilah sandy loam, 2 to 9 percent slopes	395	0.1		Made land	1,970	0.5
					Sand and gravel pits	110	(1)
					Total	363,520	100.0

[1] Less than 0.1 percent.

angular blocky; very friable; stone line at 31 inches with stones up to 2 inches in diameter; some rounded small stones throughout horizon; medium acid; abrupt boundary.

IIIB32—45 to 60 inches; brown (10YR 4/3) loam; few fine distinct yellowish brown (10YR 5/6) and brown (10YR 5/3) mottles; moderate medium prismatic structure parting to moderate medium angular blocky; firm; medium acid.

The solum, commonly 4 feet or more thick, formed in loamy sediment and the underlying firm loam glacial till. Depth to the loam glacial till ranges from about 42 to 60 inches. A coarser textured layer up to 24 inches thick is between the loamy surficial sediments and the glacial till in many places.

The Al or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A horizon is loam or silt loam high in sand.

The B2 horizon has hue of 10YR, value of 3 to 5, and chroma of 3 through 6. It is free of low chroma mottles to about 3 feet. The texture ranges from loam and sandy loam to light clay loam or light sandy clay loam.

The IIB3 horizon varies greatly in thickness within short distances. It ranges from loamy sand to sandy loam with some stones and pebbles.

The IIIB3 horizon is typically loam, but in some areas is heavy clay loam. In places it has grayish mottles.

Aredale soils are associated with Dinsdale, Dickinson, and Kenyon soils. They have more sand in the upper part of the solum than Dinsdale soils, but less sand than Dickinson soils. In contrast with Kenyon soils, their overlying material is deeper over the till and they have a thicker coarse textured layer between the loamy overburden and the firm glacial till.

426B—Aredale loam, 2 to 5 percent slopes. This soil is on the convex slightly lowered ridges on uplands. It has the profile described as typical of the series.

Included with this soil in mapping are areas where the depth to glacial till is more than 5 feet and small moderately sloping areas. Also included and identified on the soil map by spot symbols are a few sandy and gravelly areas where the soil is droughty and less productive; small, severely eroded areas where little or no topsoil is left and the organic-matter content and fertility are lower than in this Aredale soil; and a few small areas where the soil is only 20 to 40 inches deep over fine textured weathered glacial till, or gumbotil, and is seepy in wet seasons.

If well managed, this soil is well suited to row crops year after year. It is subject to only slight erosion. Cuts for terraces should be kept to a minimum to avoid exposing the less productive subsoil. Capability unit IIe–2.

426C—Aredale loam, 5 to 9 percent slopes. This soil is on short, convex side slopes on uplands. It has a profile similar to the one described as typical of the series, but the dark surface layer is not so thick.

Included with this soil in mapping are areas of gently sloping soils. Also included and identified on the soil map by spot symbols are small severely eroded areas where the soil has a thinner, lighter colored plow layer and is lower in organic-matter content than this Aredale soil; a few sandy areas and gravelly areas where the soil is droughty and less productive; and a few small areas where the soil is only 20 to 40 inches deep over fine textured weathered glacial till, or gumbotil, and is seepy in wet seasons.

If well managed, this soil is well suited to row crops. It is subject to erosion in cultivated areas. Cuts for terraces should be kept to a minimum to avoid exposing the less productive subsoil. Capability unit IIIe–1.

426C2—Aredale loam, 5 to 9 percent slopes, mod-

erately eroded. This soil is on short, convex side slopes on uplands. It has a profile similar to the one described as typical of the series, but the surface layer is thinner and is mixed with subsoil material. The organic-matter content is moderate.

Included with this soil in mapping are a few small areas of gently sloping soils; small areas where the depth to glacial till is more than 5 feet; and small, severely eroded areas where the organic-matter content and fertility are lower than in this Aredale soil. Also included and identified on the soil map by spot symbols are a few sandy areas and gravelly areas where the soil is droughty and less productive.

If well managed, this soil is well suited to row crops. It is subject to erosion in cultivated areas. Cuts for terraces should be kept to a minimum to avoid exposing the less productive subsoil. Capability unit IIIe-1.

Bassett Series

The Bassett series consists of gently and moderately sloping, moderately well drained soils on uplands. These soils formed in 14 to 26 inches of loomy surficial sediment and the underlying glacial till. They occur on ridgetops or side slopes. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam 8 inches thick. The subsurface layer is brown loam 4 inches thick. The subsoil extends to 60 inches. The upper part is dark yellowish brown and yellowish brown loam to a depth of 23 inches. The lower part is yellowish brown clay loam and loam with grayish brown mottles. The substratum below 60 inches is light olive brown loam with grayish brown mottles.

Bassett soils are moderately permeable in the upper part and moderately slowly permeable in the lower part. There is an appreciable difference in the rate at which water moves through the friable loamy sediment as compared to the rate in the firm glacial till. Water moves more rapidly in the loamy sediment and accumulates at the till contact, resulting in wet, seepy areas in some years. Available water capacity is high. The organic-matter content is moderate in uneroded areas and low in eroded areas. The subsoil is very low in available phosphorus and potassium.

Bassett soils are used for row crops. In some areas stones or boulders interfere with cultivation.

Representative profile of Bassett loam, 2 to 5 percent slopes, 970 feet north and 870 feet east of southwest corner NW1/4 sec. 16, T. 90 N., R. 14 W., in bluegrass pasture and scattered trees:

A1—0 to 8 inches; very dark brown (10YR 2/2) loam; dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; clear boundary.

A2—8 to 12 inches; brown (10YR 4/3) loam; grayish brown (10YR 5/2) dry; very dark grayish brown (10YR 3/2) coatings on faces of plates; weak fine platy structure parting to weak fine subangular blocky; friable; medium acid; clear boundary.

B1—12 to 16 inches; dark yellowish brown (10YR 4/4) loam; brown (10YR 4/3) coatings on faces of peds; weak fine subangular blocky structure; friable; few discontinuous gray sand coatings on faces of peds when dry; strongly acid; clear boundary.

B21—16 to 23 inches; yellowish brown (10YR 5/4) light clay loam; dark yellowish brown (10YR 4/4) coatings on faces of peds; few fine faint strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; firm; discontinuous gray sand coatings on faces of peds when dry; few fine dark oxides; strongly acid; clear boundary.

IIB22—23 to 30 inches; yellowish brown (10YR 5/6) light clay loam; few fine distinct grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to moderate medium and fine subangular blocky; firm; continuous gray sand coatings on faces of prisms when dry and discontinuous on faces of peds; common fine dark oxides with some staining on faces of peds; discontinuous stone line at 23 inches with stones up to 2 inches in diameter; strongly acid; gradual boundary.

IIB23t—30 to 37 inches; yellowish brown (10YR 5/6) light clay loam; few fine distinct grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to moderate medium and fine subangular blocky; firm; discontinuous gray sand coatings on faces of peds when dry; thin discontinuous clay films on faces of peds; strongly acid; gradual boundary.

IIB31t—37 to 46 inches; mottled yellowish brown (10YR 5/4) and light brownish gray (2.5YR 6/2) light clay loam; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous very dark grayish brown (10YR 3/3) clay films on prism faces and some small clay-filled root channels; few dark oxides; strongly acid; gradual boundary.

IIB32—46 to 60 inches; mottled yellowish brown (10YR 5/4) and grayish brown (10YR 5/2) heavy loam; weak coarse prismatic structure parting to moderate medium angular and subangular blocky; firm; few small organic-filled root channels; common very fine dark oxides; slightly acid; gradual boundary.

IIC—60 to 70 inches; light olive brown (2.5YR 5/4) loam; common grayish brown (10YR 5/2) mottles; massive; firm; common white (10YR 8/1) lime concretions and filaments; calcareous; strong effervescence.

The solum ranges from 40 to 60 inches in thickness. In undisturbed areas the A1 horizon is very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) and is 6 to 9 inches thick.

The A2 horizon is brown (10YR 4/3 to 10YR 5/3) and ranges from 4 to 6 inches in thickness. In places all of the A2 horizon is incorporated in the Ap horizon. Depth to the II material ranges from about 14 to 26 inches, unless the soil is eroded.

The B horizon is typically heavy loam or light clay loam but ranges to sandy clay loam. The upper part has hue of 10YR, value of 4 to 5, and chroma of 3 or higher. It does not have distinct lower chroma mottles. Depth to low chroma mottles ranges from 24 to 34 inches. Typically a stone line separates the I material from the II material, but may be absent or incipient in some pedons.

The IIB horizon has hue of 10YR and 7.5YR, value of 4 to 5, and chroma of 3 and higher with lower chroma mottles.

The Bassett soils are associated with the Clyde, Floyd, and Kenyon soils. They formed in material similar to that of the Kenyon and Oran soils. They have a thinner, lighter colored A horizon and a more acid B horizon than the Kenyon, Clyde, and Floyd soils. They have a browner subsoil than the Clyde, Floyd, and Oran soils and are better drained.

171B—Bassett loam, 2 to 5 percent slopes. This soil is on long, convex ridges and side slopes. It has the profile described as typical of the series. In uncultivated areas the surface layer is very dark gray to very dark grayish brown, friable loam. The undisturbed subsurface layer is distinctly lighter colored and has platy structure.

Included with this soil in mapping and identified on the soil map by spot symbols are small sand and gravel areas where the soil is droughty and less productive.

If well managed, this soil is well suited to row crops year after year. It is subject to slight erosion in cultivated areas.

Providing adequate erosion control and drainage is difficult. A combination of terracing and tile drainage is sometimes needed. Fieldwork is sometimes delayed during wet periods. Capability unit IIe–2.

171C2—Bassett loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex side slopes on uplands. It has a profile similar to the one described as typical of the series, but the surface layer is very dark grayish brown to brown, friable loam. Part of it has been removed by erosion. The subsoil material has been mixed with the plow layer. The organic-matter content is low.

Included with this soil in mapping are small areas of soils that have been protected. They are less eroded than this soil and are somewhat higher in fertility and organic-matter content. Also included are small, strongly sloping areas that are potentially more erosive and a few severely eroded areas where little or no topsoil is left and the organic-matter content is very low. The severely eroded areas are identified on the soil map by spot symbols.

This soil is suited to row crops if it is well managed and erosion is controlled. Fertility is low. Additional fertilizer is needed for favorable crop production. Also, wet spots sometimes develop for short periods after terrace construction. A combination of terracing and tiling is beneficial. Capability unit IIIe–1.

U171D—Bassett-Chelsea-Urban land complex, 5 to 18 percent slopes. This moderately sloping to moderately steep mapping unit is on uplands. It is about 25 percent Bassett soil, 10 percent Chelsea soil, and 60 percent Urban land. The Urban land part is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible.

The Bassett soil formed in glacial till. The Chelsea soil formed in eolian sand commonly underlain by glacial till.

The original drainage patterns have been altered considerably by cutting and filling. Included in mapping are areas of poorly drained soils. Houses built on these poorly drained soils, or modified drainageways, are likely to have wet basements.

Onsite investigation is needed to determine present physical and chemical properties for any specific location.

The entire acreage is used for homesites or commercial development.

Bertram Series

The Bertram series consists of gently and moderately sloping, somewhat excessively drained soils. These soils formed in 20 to 40 inches of sandy loam with a thin discontinuous layer of limestone residuum over limestone bedrock. They are on convex ridges and side slopes on uplands. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown fine sandy loam 23 inches thick. The subsoil extends to 34 inches. It is brown sandy loam and grades to light sandy clay loam in the lower part. The substratum is fractured hard limestone bedrock.

The available water is low. Permeability is moderately rapid in the upper part and moderately slow in the lower part. The organic-matter content is moderate. The subsoil is very low in available phosphorus and potassium.

If well managed, these soils can be used for row crops. They are droughty and subject to soil blowing and water erosion if vegetation is sparse.

Representative profile of Bertram fine sandy loam, 2 to 7 percent slopes, 542 feet south and 20 feet east of northwest corner of sec. 1, T. 88 N., R. 11 W., in a meadow:

A1—0 to 15 inches; very dark brown (10YR 2/2) fine sandy loam; weak fine granular structure; very friable; neutral; clear boundary.

A3—15 to 23 inches; very dark grayish brown (10YR 3/2) fine sandy loam; common fine distinct brown (10YR 4/3) mottles; weak medium and fine subangular blocky structure; very friable; medium acid; gradual boundary.

B21t—23 to 27 inches; brown (10YR 4/3) fine sandy loam; weak medium and subangular blocky structure; very friable; very dark grayish brown (10YR 3/2) clay bridging between sand grains and clay deposits along root channels; neutral; gradual boundary.

B22t—27 to 31 inches; brown (10YR 4/3) light sandy clay loam; moderate medium and fine subangular blocky structure; very friable; some clay bridging between sand grains; mildly alkaline; abrupt boundary.

IIB3—31 to 34 inches; brown (10YR 4/3) sandy clay loam mixed with hard limestone fragments; moderate fine subangular blocky structure; friable; mildly alkaline; abrupt boundary.

IIR—34 to 40 inches; fractured hard limestone bedrock with tongues of brown clay loam between flags of limestone.

The solum ranges from 20 to 40 inches in thickness and is typically about 30 inches. Thickness of the solum and depth to limestone bedrock generally decrease as gradient increases.

The Ap or A1 horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A horizon ranges from 14 to 24 inches in thickness.

The B2 horizon has 10YR hue, dominantly 3 to 5 value, and 3 or 4 chroma. Texture is typically sandy loam but ranges to light sandy clay loam.

The IIB horizon or residuum ranges from 2 to 6 inches in thickness. Texture ranges from sandy clay loam or clay loam to clay.

Bertram soils are associated with Rockton, Sparta, Olin, Dickinson, and Kenyon soils. In contrast with Sparta, Olin, Dickinson, and Kenyon soils, which do not have a limestone substratum, they are underlain by limestone within 40 inches. They have more sand in the B horizon than Rockton soils.

809B—Bertram fine sandy loam, 2 to 7 percent slopes. This soil occurs on convex ridges and short side slopes on uplands.

Included with this soil in mapping are a few small areas, which have a thinner and lighter colored surface layer and a light colored subsurface layer; some small areas of loamy sand where the soil is more droughty and lower in organic-matter content than in this Bertram soil; and some areas where the depth to bedrock is more than 40 inches. Also included and identified on the soil map by spot symbols are a few areas with limestone outcrops.

This soil is not well suited to row crops because of the low available water capacity, even if it is well managed and rainfall is timely. It is subject to soil blowing if the surface is left unprotected. Capability unit IVs–1.

Bremer Series

The Bremer series consists of nearly level, poorly drained soils on alluvial terraces. These soils formed in moderately fine textured alluvium. The native vegetation was tall prairie grass.

In a representative profile the surface layer is black heavy silty clay loam 20 inches thick. The subsoil extends to 51 inches. The upper part is mottled dark grayish brown and grayish brown heavy silty clay loam with yellowish brown mottles. The lower part is mottled olive gray and dark grayish brown silty clay loam grading to olive gray light silty clay loam with yellowish brown mottles. The substratum is dark grayish brown loam with yellowish brown mottles and some fine gravel.

Bremer soils are slowly permeable and have a high available water capacity. They are high in organic-matter content. They are neutral or slightly acid and generally do not require lime. The subsoil is low in available phosphorus and potassium.

Bremer soils are used for row crops. Artificial drainage is needed for maximum yields. Wetness caused by occasional flooding and by a high water table is the major limitation to crop production. Tile drains function satisfactorily if properly installed.

Representative profile of Bremer silty clay loam, 0 to 2 percent slopes, 25 feet east and 1,295 feet north of southwest corner NW1/4 sec. 5, T. 87 N., R. 12 W., in meadow:

Ap—0 to 7 inches; black (N 2/0) heavy silty clay loam; cloddy; friable; fine gravel; neutral; abrupt boundary.

A12—7 to 20 inches; black (N 2/0) heavy silty clay loam; moderate fine subangular blocky structure; friable; some fine gravel; neutral; clear boundary.

B1tg—20 to 26 inches; mottled dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) heavy silty clay loam; dark gray (5Y 4/1) coatings on faces of peds; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; few thin clay films; common dark oxides; few very fine and fine pebbles; neutral; clear boundary.

B2tg—26 to 36 inches; mottled olive gray (5Y 5/2) and dark grayish brown (10YR 4/2) silty clay loam; common fine distinct yellowish brown mottles; strong medium and fine subangular blocky structure; firm; few thin discontinuous clay films; few very fine and fine pebbles; neutral; gradual boundary.

B3g—36 to 51 inches; olive gray (5Y 5/2) light silty clay loam; few medium distinct yellowish brown (10YR 5/6) and common medium distinct gray (10YR 5/2) mottles; weak coarse prismatic structure; friable; common dark oxides; few fine and very fine pebbles; neutral; gradual boundary.

IIC—51 to 60 inches; dark grayish brown (2.5Y 4/2) loam; many fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; common fine gravel; neutral.

The solum ranges from 40 to 60 inches in thickness and is typically more than 40 inches thick. It is less than 15 percent sand. The A horizon is 16 to 24 inches thick. It ranges from light to heavy silty clay loam. It is black, but the hue ranges from neutral to 10YR.

The B horizon is 20 to 40 inches thick. It ranges from heavy silty clay loam to light silty clay. It has hue of 2.5Y or 5Y, chroma of 1 or 2, and value of 3 or 4. The value increases to 5 with depth. The B horizon has few or common mottles, particularly in the middle part. It has few thin discontinuous to continuous clay films.

The C horizon to a depth of 60 inches ranges from sandy loam to light silty clay loam.

Bremer soils in Black Hawk County are outside the range for the Bremer series because they lack sufficient clay increase within a vertical distance of 12 inches. This difference, however, does not alter use or management.

Bremer soils are closely associated with Colo, Nevin, and Zook soils. They have a thinner A horizon than Colo and Zook soils and a grayer B horizon than Nevin soils. All formed in similar material.

43—Bremer silty clay loam, 0 to 2 percent slopes. This soil occurs as slightly concave areas on alluvial terraces.

Included with this soil in mapping are some areas where the soil has a loamy substratum at a depth of 40 to 48 inches and some areas where the soil is mildly alkaline in the substratum. Also included are a few small areas where the soils are better drained than this Bremer soil.

If drained, this soil is well suited to corn and soybeans. Some areas are subject to occasional flooding. Plowing is difficult and is commonly delayed because of excess moisture. The soil puddles readily if tilled when wet and becomes cloddy when dry. Capability unit IIw-2.

U43—Bremer-Marshan-Urban land complex, 0 to 2 percent slopes. This nearly level map unit is on low alluvial benches that have been altered by city and urban development. It is about 25 percent Bremer soil, 25 percent Marshall soil, and 35 percent Urban land. The Urban land part is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that soil identification is not feasible. The soils formed in alluvium underlain by sand at a depth of 3 to 5 feet. The native vegetation was grass.

Most of this unit is poorly drained and has a high water table. The organic-matter content is high.

Included in mapping are small areas of poorly drained soils that have a dark surface layer about 3 feet thick and a higher organic-matter content. These areas receive runoff from slopes or higher elevations and impound water for short durations. Also included are small areas, at slightly higher elevation, of loamy and silty soils that are better drained.

The entire acreage is used for homesites and commercial development. Onsite investigation is needed to determine physical and chemical properties.

Bremer Variant

The Bremer variant consists of nearly level to slightly depressed, poorly drained soils formed in moderately fine and fine textured alluvium. These soils are on alluvial terraces. The native vegetation was prairie grasses and sedges.

In a representative profile the surface layer is black and very dark gray silty clay loam and silty clay 20 inches thick. The subsoil extends to a depth of 49 inches. The upper part is gray clay and light olive gray silty clay. The lower part is light olive gray silty clay loam with light olive brown mottles. The substratum to a depth of 60 inches is light gray loam with yellowish brown mottles. Below this to a depth of 70 inches is olive gray loamy fine sand.

The Bremer variant has very slow permeability and a high available water capacity. It is high in organic-matter content. The subsoil is very low in available phosphorus and potassium.

These soils are used for cultivated crops and meadow. The major limitations are wetness, poor tilth, and slow permeability. Tile drains do not function well because of the slow permeability. Wetness sometimes delays planting in spring. Surface drainage is beneficial in some areas.

Representative profile of Bremer silty clay loam, clay subsoil variant, 0 to 2 percent slopes, 650 feet north and 250 feet east of southwest corner NW¼ sec. 29, T. 90 N., R. 14 W., in bluegrass pasture:

Ap—0 to 8 inches; black (N 2/0) silty clay loam; cloddy; firm; medium acid; abrupt boundary.

A12—8 to 15 inches; black (N 2/0) silty clay; fine granular structure; firm; medium acid; clear boundary.

A3—15 to 20 inches; very dark gray (10YR 3/1) silty clay; black (10YR 2/1) coatings on peds; moderate fine subangular blocky structure; firm; medium acid; clear boundary.

B21tg—20 to 28 inches; gray (5Y 5/1) clay; dark gray (10YR 4/1) coatings on peds; very fine subangular and angular blocky structure; very firm; common dark oxides; some olive brown oxides; medium acid; gradual boundary.

B22tg—28 to 36 inches; light olive gray (5Y 6/2) silty clay; few fine yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; very firm; few discontinuous dark gray clay films; few coarse yellowish red oxides; few fine dark oxides; medium acid; gradual boundary.

B3tg—36 to 49 inches; light olive gray (5Y 6/2) silty clay loam; common light olive brown (2.5Y 5/4) mottles; moderate medium prismatic structure; firm; few discontinuous dark gray clay films; few dark gray clay filled root channels; few fine strong brown oxides; slightly acid; gradual boundary.

C1—49 to 60 inches; light gray (5Y 6/1) loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; few fine dark gray clay filled root channels; many strong brown oxides; neutral; gradual boundary.

IIC2—60 to 70 inches; olive gray (5Y 5/2) loamy fine sand; few light olive brown (2.5Y 5/4) mottles; massive; very friable; few strong brown soft oxides; some dark strata of concentrated iron and manganese ⅛ inch thick; neutral.

The solum ranges from 36 to 52 inches in thickness. The solum and upper part of the C horizon typically have no coarse fragments, but in a few pedons the lower part of the solum, below a depth of 30 inches, and the C horizon to a depth of 60 inches are as much as 6 percent coarse fragments of mixed lithology. The solum typically is medium acid to neutral but ranges to strongly acid. The mollic epipedon ranges from 12 to 24 inches in thickness.

The A1 or Ap horizon is black and is typically heavy silty clay loam but ranges to light silty clay.

The Bt horizon has hue of 5Y, value of 5 or 6, and chroma of 1 or 2. The B2t horizon ranges from light silty clay to clay. The B3t horizon typically is silty clay loam but ranges to silty clay.

The C horizon has hue of 5Y, value of 5 or 6, and chroma of 1 or 2. The texture ranges from silt loam, loam, or clay loam in the upper part of the C horizon to loamy fine sand in the lower part.

The Bremer variant, Bremer soils, and Zook soils all formed in similar material and have the same drainage. The variant has a considerably higher percent of clay in the B horizon than Bremer and Zook soils.

In Bremer silty clay loam, clay subsoil variant, the content of clay in some part of the B horizon is generally more than 50 percent. These clay subsoil variants, as well as Bremer soils, have an A horizon less than 24 inches thick, whereas Zook soils have a dark colored A horizon thicker than 36 inches.

166—Bremer silty clay loam, clay subsoil variant, 0 to 2 percent slopes. This soil is on concave alluvial terraces.

Included with this soil in mapping is an area (NW¼ sec. 6, T. 90 N., R. 14 W.) where the soil has a dark grayish brown and brown subsoil and is better drained than this Bremer variant.

This soil is suited to row crops and meadow. Wetness and poor tilth are the major limitations. Tile drains may not function satisfactorily because of very slow permeability. Surface drains may be needed. The soil is subject to puddling if worked when wet. Capability unit IIw-4.

Chelsea Series

The Chelsea series consists of gently sloping to moderately steep, excessively drained soils. These soils are dominantly on upland ridges and side slopes and in a few areas on alluvial terraces. They formed mainly from wind-deposited sand. The native vegetation was trees. On the alluvial terraces, the sand grains are coarser and there is likely to be some gravel below 4 feet.

In a representative profile the surface layer is black and very dark grayish brown loamy fine sand 4 inches thick. It is underlain to a depth of 19 inches by brown loamy fine sand. Below this is dark yellowish brown, yellowish brown, and brown fine sand with very thin bands of brown loamy fine sand below 48 inches.

Chelsea soils have rapid permeability. Available water capacity is low. The organic-matter content is very low. The subsoil is very low in available phosphorus and potassium.

Chelsea soils are generally used for permanent pasture, woodland, or wildlife habitat. The gently sloping and moderately sloping Chelsea soils can be used for row crops. Yields are low, even under good management and timely rainfall, because of low fertility and low available water capacity.

These soils are subject to soil blowing and water erosion if vegetation is sparse.

Representative profile of Chelsea loamy fine sand, 2 to 5 percent slopes, 1,050 feet north and 350 feet east of southwest corner sec. 5, T. 88 N., R. 12 W., in timber vegetation:

A11—0 to 1 inch; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; much decomposed leaf litter; many fine roots; neutral; abrupt boundary.

A12—1 to 4 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure parting to single grained; very friable; slightly acid; abrupt boundary.

A21—4 to 19 inches; brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak coarse subangular blocky structure parting to single grained; very friable; strongly acid; gradual boundary.

A22—19 to 32 inches; dark yellowish brown (10YR 4/4) fine sand, brown (10YR 5/3) dry; single grained; loose; strongly acid; diffuse boundary.

A23—32 to 48 inches; yellowish brown (10YR 5/3) fine sand; single grained; loose; strongly acid; gradual boundary.

A&B—48 to 60 inches; brown (10YR 5/3) fine sand; single grained; loose; ¼- to 2-inch thick brown (7.5YR 4/4) loamy fine sand bands at 48, 51, 54, and 57 inches; massive; very friable; strongly acid.

The solum ranges from 4 to many feet in thickness. Undisturbed areas of the A1 horizon range from black (10YR 2/1) to very dark grayish brown (10YR 3/2) and are 3 to 5 inches thick. The Ap horizon is dark grayish brown (10YR 4/2), dark brown (10YR 3/3), and brown (10YR 4/3). The A horizon ranges from loamy fine sand to fine sand.

There is a B horizon of lamellae ¼ to 2 inches thick that have 7.5YR or 10YR hue and value and chroma of 3 to 4. Depth to the upper part of the lamellae is between 3 and 4 feet.

Chelsea soils developed in material similar to that of Sparta, Lamont, and Dickinson soils. They have a higher sand content in the upper 3 feet than Lamont soils. They have a lighter colored, thinner A horizon than Sparta soils. They have more sand in the upper part of the solum and a lighter colored A horizon than Dickinson soils.

63B—Chelsea loamy fine sand, 2 to 5 percent slopes. This soil is typically on ridges and side slopes on uplands, but a few areas are on alluvial terraces. This soil has a profile similar to the one described as typical of the series, but in cultivated areas, the plow layer is typically dark grayish brown.

Included with this soil in mapping are small areas where the surface layer is sandy loam, darker colored, and greater than 10 inches thick. Also included and identified on the soil map by spot symbols are sand blowouts. These blowouts are very erosive and need additional plant cover to prevent further erosion. Mottled, firm glacial till occurs at a depth greater than 40 inches in a few areas. This causes a perched water table during heavy rainfall.

This soil can be used for row crops, but it is not well suited. It is droughty and low in fertility. Capability unit IVs-1.

63C—Chelsea loamy fine sand, 5 to 9 percent slopes. This soil is typically on moundlike ridges and side slopes on uplands. It has a profile similar to the one described as typical of the series, but in cultivated areas, the plow layer is dark grayish brown or brown.

Included with this soil in mapping are small areas where the surface layer is sandy loam, darker colored, and greater than 10 inches thick. Also included and identified on the soil map by spot symbols are sand blowouts.

This soil is not well suited to row crops. It is low in fertility and very droughty. Capability unit IVs-1.

63D—Chelsea loamy fine sand, 9 to 18 percent slopes. This excessively drained soil is on side slopes on uplands. It has a profile similar to the one described as typical of the series, but in undisturbed areas it has a thin, very dark gray to very dark grayish brown surface layer. Wooded areas have up to 1½ inches of leaf litter on the surface. In cultivated areas the plow layer is dark grayish brown or brown. Included in mapping and identified on the soil map by spot symbols are sand blowouts, which are highly erodible and need additional plant cover to prevent further erosion.

This soil is droughty and is not suited to row crops. If the surface is unprotected, it is subject to soil blowing and water erosion. It is best used for permanent pasture, hay, timber, and wildlife habitat. Capability unit VIs-1.

Clyde Series

The Clyde series consists of nearly level to gently sloping, poorly drained soils in drainageways and lower concave positions on uplands. These soils formed in 30 to 50 inches of moderately fine textured surficial sediment and the underlying glacial till. A pebble band generally separates the glacial till and the overlying material. The native vegetation was prairie grasses and sedges.

In a representative profile the surface layer is black and very dark gray clay loam 24 inches thick. The upper part of the subsoil to a depth of 37 inches is olive brown and mottled grayish brown and yellowish brown, friable clay loam that grades to loam and strata of sandy loam at 37 inches. The lower part and the substratum to a depth of 60 inches are mottled gray and yellowish brown loam. Rocks and boulders occur at the surface and throughout the subsoil. Most have been removed from cultivated areas, but they are common in unimproved areas. Generally, the rock has to be removed before the soil is cultivated.

The soils have high available water capacity. They are moderately permeable in the upper part and moderately slowly permeable in the lower part. Wetness is partly caused by hillside seepage from Floyd and Kenyon soils, which commonly occur upslope.

These soils are high in organic-matter content. The subsoil is very low in available phosphorus and potassium. In most places, the soils are neutral and do not require lime.

If properly drained, these soils are well suited to intensive row crops. Undrained areas are in permanent pasture or are idle.

Representative profile of Clyde clay loam, 0 to 3 percent slopes, 380 feet south and 1,270 feet west of northeast corner NW¼ sec. 2, T. 90 N., R. 11 W., in a cultivated field:

Ap—0 to 7 inches; black (N 2/0) clay loam; cloddy; friable; neutral; abrupt boundary.

A12—7 to 16 inches; black (N 2/0) clay loam; few fine distinct brown (7.5YR 4/4) mottles; fine granular structure; friable; neutral; clear boundary.

A3—16 to 24 inches; very dark gray (10YR 3/1) clay loam; common fine weak dark grayish brown (2.5Y 4/2) mottles; weak medium subangular blocky structure; friable; neutral; clear boundary.

B21g—24 to 29 inches; grayish brown (2.5Y 5/2) clay loam; common fine distinct olive brown (2.5Y 4/4) mottles; weak medium and fine subangular blocky structure; friable; few patchy very dark gray (10YR 3/1) coatings on faces of peds; few fine dark oxides; neutral; clear boundary.

B22—29 to 37 inches; mottled yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) loam; few fine distinct brown (7.5YR 5/4) mottles; moderate medium and fine subangular blocky structure; friable; very thin lens of yellowish brown (10YR 5/8) sandy loam at 37 inches; neutral; abrupt boundary.

IIB3—37 to 52 inches; mottled yellowish brown (10YR 5/6) and gray (5YR 5/1) loam; weak coarse prismatic structure parting to weak medium subangular blocky; firm; neutral; gradual boundary.

IIC—52 to 60 inches; mottled yellowish brown (10YR 5/6) and gray (5Y 5/1) loam; massive; some vertical cleavage; firm; neutral.

The solum ranges from 2½ to 5 feet in thickness and is typically greater than 3½ feet. Depth of erosional sediment over glacial till is typically 3 to 3½ feet but ranges from 2½ to 5 feet. Thickness of the A horizon ranges from about 20 to 24 inches. Texture ranges from silty clay loam that is high in sand to clay loam or loam.

The B horizon is clay loam or loam but has some strata of silty clay loam and layers of sandy loam typically less than 6 inches thick, which are within the range of the series.

Clyde soils are associated with Floyd soils and have the same drainage as Tripoli, Marshan, and Maxfield soils. They are more poorly drained and have a grayer B horizon than Floyd soils. They are more stratified and deeper over till than Tripoli soils. Unlike Marshan soils, they are not underlain by sand and gravel. Clyde soils contain more sand in the upper part of the B horizon than Maxfield soils.

84—Clyde clay loam, 0 to 3 percent slopes. This soil is in drainageways and lower concave positions on uplands.

Included with this soil in mapping are a few small areas where the slope is greater than 3 percent. Also included and identified on the soil map by spot symbols are some small sandy areas.

In some areas, particularly in the vicinity of the watershed divide between the Cedar and Wapsipinicon Rivers, firm glacial till occurs at a depth of less than 24 inches.

This soil is well suited to intensive row crops if well drained. Wetness is partly caused by seepage and runoff from the soils upslope. Tilth is generally good. The soil puddles if worked when wet. Stones and boulders, which are common in many unimproved, undrained areas, have to be removed before the soil is cultivated. They may also interfere with tile installation. Because wetness is partly caused by hillside seepage, drainage that intercepts laterally moving water is needed. Capability unit IIw–1.

391B—Clyde-Floyd complex, 1 to 4 percent slopes. This poorly drained and somewhat poorly drained map unit is in small drainageways on uplands. It is 60 percent Clyde soils and 40 percent Floyd soils. For a more complete description of these soils, refer to the individual map units. In most places the Clyde soil is in the lowest part of the drainageway, with a band of Floyd soils bordering it.

Included with this unit in mapping are soils that are typically more acid and have a dark colored surface layer less than 10 inches thick, which is lower in organic matter. These areas are at the heads of drainageways. Also included and identified on the soil map by spot symbols are some small areas of sandy soils and organic soils.

These soils receive seepage and runoff from the more sloping soils. Tile drains work well if a suitable outlet is obtained. The soils are well suited to row crops year after year if well drained, but many areas need to be left in waterways to prevent gullies. In unimproved areas large boulders are common. These need to be removed before cultivation. Most soils in this unit are farmed with the surrounding soils. Individual areas may extend over several fields but are generally too narrow to be cropped separately. Capability unit IIw–1.

Coland Series

The Coland series consists of nearly level, poorly drained soils on flood plains principally on Crane Creek above Dunkerton. These soils formed in moderately fine textured alluvial material 48 to 60 inches thick over coarse textured alluvial material. The native vegetation was prairie grasses, sedges, and other water-tolerant plants.

In a representative profile the surface layer is black clay loam with yellowish red mottles to a depth of 24 inches. It grades to very dark gray heavy loam with yellowish red mottles to a depth of 33 inches. The subsoil is dark gray loam with yellowish red mottles to a depth of 46 inches. The substratum is gray loam with some thin coarse textured lenses. It grades to light olive gray coarse sand and some gravel.

Coland soils have a high available water capacity. Permeability is moderately slow. The organic-matter content is high. The subsoil is low in available phosphorus and very low in available potassium. In most places the soils are neutral and do not require lime. They have a seasonal high water table.

These soils are used for row crops if properly drained and protected from untimely flooding. In some areas fieldwork is delayed because of wetness caused by impounded surface water.

Representative profile of Coland clay loam, 0 to 2 percent slopes, 272 feet south and 1,195 feet west of northeast corner NW¼ sec. 15, T. 90 N., R. 12 W., in a cultivated field:

A11—0 to 6 inches; black (10YR 2/1) light clay loam; moderate fine granular structure; friable; some coarse sand and 2 percent very fine gravel; neutral; clear boundary.

A12—6 to 16 inches; black (10YR 2/1) light clay loam; moderate fine granular structure; friable; some coarse sand and 2 percent very fine gravel; medium acid; clear boundary.

A13—16 to 24 inches; black (10YR 2/1) light clay loam; few fine yellowish red (5YR 5/8) mottles; weak fine subangular blocky structure; friable; few fine dark oxides; some coarse sand and 2 percent very fine gravel; medium acid; gradual boundary.

A3—24 to 33 inches; very dark gray (10YR 3/1) heavy loam; black (10YR 2/1) coatings on peds; many fine yellowish red (5YR 5/8) mottles; weak fine prismatic structure parting to moderate medium angular blocky and subangular blocky; firm; few fine dark oxides; 5 percent fine gravel; medium acid; clear boundary.

B2g—33 to 46 inches; dark gray (5Y 4/1) loam; many fine dominant yellowish red (5YR 5/8) mottles; weak fine prismatic structure parting to weak fine angular blocky and subangular blocky; firm; 2 percent very fine gravel; many roots; slightly acid; abrupt boundary.

C1—46 to 56 inches; gray (N 5/0) loam; massive; firm; a 1-inch zone of coarse textured material from 52 to 53 inches; many roots; neutral; abrupt boundary.

IIC2—56 to 60 inches; light olive gray (5Y 6/2) coarse sand; 5 percent fine gravel; loose; single grained; many roots; neutral.

The solum ranges from 36 to 48 inches in thickness. Free carbonates are absent in the sola, commonly to a depth of 60 inches or more. Coarse fragments are lacking to a depth of more than 4 feet.

The A horizon is 24 to 36 inches thick. It is black or very dark gray with neutral or 10YR hue, value of 2 or 3, and chroma of 1 or less. It is typically clay loam but ranges to loam in the upper 10 inches. The lower part of this horizon and the B horizon to a depth of 40 inches average between 27 and 35 percent clay and 15 to 30 percent fine sand or coarser.

The C horizon is dominantly loam to a depth of 48 inches but includes thin strata that range from light silty clay to loamy sand. Between 48 to 60 inches, coarse textured materials generally occur.

Coland soils are associated with Marshan and Lawler soils. They are more poorly drained than Lawler soils and have a thicker, dark colored A horizon than Lawler and Marshan soils.

135—Coland clay loam, 0 to 2 percent slopes. This soil occurs on bottom lands.

Included with this soil in mapping are small areas which have 6 to 8 inches of lighter colored loamy overwash. Sand and gravel generally do not occur within 48 inches, but small areas with these coarser materials at a shallower depth are included. A few small areas in depressions are temporarily ponded unless they are drained.

This soil is well suited to row crops year after year if properly drained and protected from flooding. It generally has good tilth but will puddle if worked when wet. Surface runoff is slow. In most areas this soil is subject to flooding for short periods. Artificial drainage is needed in most areas for good crop production. Capability unit IIw–1.

Colo Series

The Colo series consists of nearly level, poorly drained soils in drainageways on flood plains and uplands. These soils formed in moderately fine textured alluvial sediment. The native vegetation was water-tolerant prairie grasses and sedges.

In a representative profile the surface layer is 48 inches thick. It is very dark gray in the upper 8 inches and grades to black silty clay loam in the upper part and very dark gray silty clay loam in the lower part. The substratum below 48 inches is dark gray silty clay loam with olive brown and strong brown mottles.

These soils are moderately slow in permeability and have high available water capacity. They are high in organic-matter content. The subsoil is medium in available phosphorus and very low in available potassium. Generally, these soils are neutral or slightly acid and do not need lime.

Unless flooded frequently or cut by old stream channels, these soils can be used for row crops year after year. Areas that are flooded frequently or cut by old stream channels are generally in pasture.

Representative profile of Colo silty clay loam, 0 to 2 percent slopes, 50 feet north and 25 feet west of northeast corner NW¼ sec. 6, T. 87 N., R. 14 W., in a cultivated field:

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam; cloddy; friable; neutral; abrupt boundary.

A12—8 to 40 inches; black (10YR 2/1) silty clay loam; few fine distinct brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; friable; neutral; clear boundary.

A12—40 to 48 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; neutral; gradual boundary.

C1g—48 to 54 inches; dark gray (5Y 4/1) light silty clay loam; common medium distinct strong brown (7.5YR 5/6) mottles; weak fine prismatic structure; friable; noticeable fine sand grains; neutral; gradual boundary.

C2g—54 to 60 inches; dark gray (10YR 4/1) silty clay loam; few fine faint olive brown (2.5Y 4/4) and brown (7.5YR 4/4) mottles; massive; firm; neutral.

The solum ranges from 36 to about 50 inches in thickness. These soils typically have a black or very dark gray silty clay loam A horizon.

The A horizon has hue of 2.5YR or 10YR, value of 2 or 3, and chroma of 0 to 1. The upper 10 inches ranges to heavy silt loam. Below 10 inches, the clay content ranges from 30 to 35 percent. Thin layers are as much as 38 percent clay. Value of 2 or 3 extends to a depth of 36 inches or more.

The C horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2, with few to common high chroma mottles in some places. Soils with sandy or gravelly horizons below 4 feet are within the range of the series.

Colo soils are associated with Ely, Sawmill, and Nevin soils and have the same drainage as Clyde and Marshan soils. They have a thicker, dark colored A horizon than Ely, Sawmill, Clyde, and Marshan soils. They are lower in sand than Clyde and Marshan soils.

133—Colo silty clay loam, 0 to 2 percent slopes. This soil is on flood plains or in narrow drainageways on uplands.

Included with this soil in mapping are small areas which have more clay in the subsoil, tend to be a little wetter, and have a more severe drainage problem than this Colo soil. Areas that do not drain as well as this Colo soil and are generally in depressions or "potholes" are also included. Open ditches are needed to remove surface water. Tiles may not function properly because of the finer textured subsoil. Also included are areas with a thinner, dark colored surface layer and a few, small sandy areas, which are identified on the soil map by spot symbols.

This soil is well suited to row crops year after year if well drained and protected from flooding. Areas that are frequently flooded are used mainly for pasture. The soil is wet because of flooding, slow runoff, or the high water table. Plowing is difficult and is delayed because of excessive moisture. The soil puddles readily if tilled when wet and becomes cloddy and hard when dry. Capability unit IIw–1.

C133—Colo silty clay loam, channeled, 0 to 2 percent slopes. This soil is on flood plains in Black Hawk Creek Valley at the western edge of the county. It is associated with Colo and Nevin soils.

This soil is free of sand and gravel bars and coarse textured overwash. It is subject to frequent overflow and is dissected by channels that vary in size. It contains many low natural levees and old oxbow lakes. It is often wet because of flooding or ponding.

This soil is better suited to woodland, wildlife habitat, or pasture than to crops, unless extensive improvements are made. If used for pasture, this soil needs to be cleared of the thick growth of young trees and brush. Capability unit Vw–1.

11B—Colo-Ely complex, 2 to 5 percent slopes. This poorly drained to somewhat poorly drained unit is along the narrow long drainageways on uplands. It is 50 percent Colo soils and 30 percent Ely soils. For a more complete description of each soil, refer to the individual map units.

These areas are generally less than 500 feet wide but in places are more than 1 mile long. The Colo soils occur nearer to the stream channels or waterways, with a band of Ely soils bordering and adjacent to the more sloping soils on uplands.

Included with this unit in mapping are areas of Sawmill soils, which may be as much as 20 percent of the delineations. A very few, small sandy areas are also included and are identified on the soil map by spot symbols. Firm glacial till occurs between 4 and 5 feet in some places, especially in the somewhat poorly drained areas.

This unit is generally wet because of overflow and the seepage from the more sloping soils. Drainageways that have a high concentration of water need to be maintained in grass to help prevent gullies. Tile is needed on each side of some drainageways to remove excess water.

Most soils of this unit are cropped with the surrounding soils. Individual areas are generally cropped separately because they are narrow and irregular in shape. Capability unit IIw–1.

Dells Series

The Dells series consists of nearly level, somewhat poorly drained soils on stream terraces. These soils formed in silty material 30 to 40 inches thick and underlying loamy and sandy material. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown silt loam 9 inches thick. The subsurface layer is dark grayish brown silt loam 4 inches thick. The upper 6 inches of the subsoil is dark grayish brown heavy silt loam. The next 8 inches is brown silty clay loam with yellowish brown and grayish brown mottles. The lower 9 inches is brown heavy silt loam with brown and light brownish gray mottles and grades to mottled yellowish brown and light brownish gray sandy loam from 36 to 40 inches. The substratum is yellowish brown gravelly loamy sand with a few strong brown mottles.

Dells soils are moderately permeable in the surface layer and upper part of the subsoil, moderately rapid in the lower part of the subsoil, and rapid in the substratum. They have moderate available water capacity and are moderate in organic-matter content. The subsoil is low in available phosphorus and very low in available potassium.

Dells soils are chiefly used for corn and soybeans. They may need protection from runoff of the more sloping soils. In most years they tend to have a seasonal high water table. Because they receive seepage, additional interceptor drainage is sometimes needed during seasons of high precipitation.

Representative profile of Dells silt loam, 0 to 2 percent slopes, 381 feet east and 204 feet north of southwest corner NE¼ sec. 12, T. 87 N., R. 13 W., in meadow:

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

A12—7 to 9 inches; very dark brown (10YR 2/2) silt loam; moderate fine granular structure; friable; neutral; abrupt boundary.

A2—9 to 13 inches; dark grayish brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) coatings on faces of peds, grayish brown (10YR 5/2) dry; weak medium platy structure parting to weak fine granular; friable, medium acid; clear boundary.

B1—13 to 19 inches; dark grayish brown (10YR 4/2) heavy silt loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; medium acid; clear boundary.

B2t—19 to 27 inches; brown (10YR 5/3) light silty clay loam; common fine distinct yellowish brown (10YR 5/6) and few fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; friable; few discontinuous clay films on some faces of peds; few discontinuous gray (10YR 6/1) dry, silt coatings on faces of peds; medium acid; clear boundary.

B3—27 to 36 inches; brown (10YR 5/3) heavy silt loam high in sand; common fine distinct brown (7.5YR 4/4) and few fine distinct light brownish gray (10YR 6/2) mottles; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; friable; common fine dark oxides; nearly continuous gray (10YR 6/1) dry, sand and silt coatings; medium acid; abrupt boundary.

IIB3—36 to 40 inches; mottled light brownish gray (10YR 6/2) and yellowish brown (10YR 5/4) sandy loam; few fine pebbles; common medium distinct brown (7.5YR 4/4) mottles; weak coarse prismatic structure parting to single grained; very friable; medium acid.

IIC—40 to 60 inches; yellowish brown (10YR 5/4) gravelly loamy sand; few fine distinct strong brown (7.5YR 5/6) mottles; single grained; loose; medium acid.

The Ap or Al horizon has 10YR hue, value of 2 or 3, and chroma generally of 1 or 2. The texture is silt loam. The A2 horizon has value higher than that of the Ap or Al horizons.

The B1 horizon has 10YR hue and value of 4 or 5. Texture is silt loam or heavy silt loam. The B2t horizon has 10YR hue, value of 4 or 5, and chroma of 3 through 5. The texture is heavy silt loam or light silty clay loam. The part of the solum that formed in the I material is less than 15 percent sand coarser than very fine. The IIB3 horizon is sandy loam or loam.

The IIC horizon has 10YR or 7.5YR hue and value and chroma of 4 through 8. Texture is loamy sand or sand. Depth to contrasting textures is generally from 30 to 40 inches. Dells soils have lower chroma in the upper part of the B horizon than is defined as the range for the Dells series, but this difference does not alter the use or management.

Dells soils developed in material similar to that of Waukee soils. They have a developed A2 horizon, which Waukee soils do not have. They have a thinner, dark colored A horizon and contain less sand in the upper horizons than Waukee soils.

290—Dells silt loam, 0 to 2 percent slopes. This soil is on stream terraces.

The plow layer is very dark brown silt loam underlain by a lighter colored subsurface layer. Plowing has mixed part of the platy subsurface layer with the surface layer. The present plow layer puddles during intense rainfall and forms a crust, which may retard plant growth.

Included with this soil in mapping are areas where the surface layer is slightly higher in sand content than is typical of the series. Also included and identified on the soil map by spot symbols are some small, poorly drained and very poorly drained areas where the surface layer is darker colored, the subsurface layer is thicker, and the subsoil is heavier textured.

This soil has moderate available water capacity. It is droughty in some years unless rainfall is timely. Tile drainage improves timeliness of fieldwork in some years. Because wetness is partly caused by seepage, drainage that intercepts laterally moving water is needed. Capability unit IIs–2.

Dickinson Series

The Dickinson series consists of nearly level to gently sloping, somewhat excessively drained soils on uplands and stream terraces. These soils formed in 24 to 36 inches of eolian sandy loam over loamy fine sand and sand. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark grayish brown and dark brown fine sandy loam 21 inches thick. The subsoil extends to a depth of 44 inches and is brown fine sandy loam and dark yellowish brown loamy fine sand. The substratum is yellowish brown fine sand.

These soils have moderately rapid permeability. Available water capacity is low. The organic-matter content is moderate. The subsoil is very low in available phosphorus and potassium.

Dickinson soils are suited to row crops if well managed, but yields depend on the amount and timeliness of rainfall. They are subject to soil blowing and water erosion if vegetation is sparse.

Representative profile of Dickinson fine sandy loam, 2 to 5 percent slopes, 1,188 feet west and 120 feet south of northeast corner NW¼ sec. 3, T. 89 N., R. 13 W., in meadow:

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

A12—6 to 15 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak coarse subangular blocky structure parting to weak fine granular; very friable; slightly acid; gradual boundary.

A3—15 to 21 inches; dark brown (10YR 3/3) fine sandy loam; very dark grayish brown (10YR 3/2) coatings on peds; weak coarse subangular blocky structure; very friable; strongly acid; gradual boundary.

B2—21 to 32 inches; brown (10YR 4/3) fine sandy loam; dark grayish brown (10YR 4/2) coatings on peds; weak medium subangular blocky structure; very friable; strongly acid; gradual boundary.

B3—32 to 44 inches; dark yellowish brown (10YR 4/4) loamy fine sand; some patchy brown (10YR 4/3) coatings on peds; weak medium subangular blocky structure; very friable; strongly acid; gradual boundary.

C1—44 to 60 inches; yellowish brown (10YR 5/6) fine sand; single grained; loose; medium acid.

The solum ranges from 24 to 50 inches in thickness. Depth to loamy sand and sand is commonly 24 to 42 inches, and sand particles are dominantly fine and medium in size. Color of the A horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). Thickness is commonly 10 to 24 inches.

Color of the B2 horizon ranges from dark brown (10YR 3/3) to brown (10YR 4/3) in the upper part to dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4 and 5/6) in the lower part.

Texture of the C horizon ranges from loamy sand to fine sand. The solum and the C horizon to a depth of 60 inches typically are free of gravel.

Dickinson soils developed in material similar to that of Lamont and Sparta soils. In the uplands they are associated with Lamont, Sparta, Kenyon, Olin, and Bertram soils. They have less sand in the A and B horizons than Sparta soils and typically have a thicker, dark colored A horizon than Lamont soils. In contrast with Kenyon and Olin soils, Dickinson soils have a higher sand content in the lower horizons and do not have glacial till in the lower solum. They do not have limestone bedrock, which is typical of Bertram soils. They are higher in sand content throughout than Kenyon soils.

175—Dickinson fine sandy loam, 0 to 2 percent slopes. This soil is on uplands and alluvial terraces. It has a profile similar to the one described as typical of the series, but the surface layer is very dark brown to very dark grayish brown, very friable fine sandy loam about 20 inches thick.

Included with this soil in mapping are small areas, especially on steam benches, where gravelly sand occurs below 40 inches.

This soil is moderately well suited to row crops. Good yields can be obtained if rainfall is normal and timely. The soil is somewhat excessively drained and is droughty in some years. It is subject to soil blowing in cultivated, unprotected areas. Capability unit IIIs–1.

175B—Dickinson fine sandy loam, 2 to 5 percent slopes. This soil is on convex slopes on uplands and on alluvial terraces. It has the profile described as typical of the series.

Included with this soil in mapping are small areas where gravel occurs below 40 inches and small areas with glacial till near 40 inches. Also included are small areas that are moderately sloping, some of which are moderately eroded and lower in organic-matter content than this Dickinson soil. A few seepy areas are included and identified on the soil map by spot symbols.

This soil is suited to row crops. Good yields can be obtained if rainfall is normal and timely. The soil is droughty and somewhat excessively drained. It is subject to soil blowing and water erosion in cultivated areas. Capability unit IIIe-3.

Dinsdale Series

The Dinsdale series consists of gently sloping to moderately sloping, well drained soils on convex slopes on uplands. These soils formed in 24 to 40 inches of loess and underlying glacial till. The native vegetation was prairie grasses.

In a representative profile the surface layer is 15 inches thick. It is black in the upper 7 inches and grades to very dark brown and very dark grayish brown silty clay loam. The subsoil is dark brown and brown silty clay loam that extends to a depth of 36 inches. Below this, it is yellowish brown and brown loam with gray mottles. The substratum is mottled yellowish brown heavy loam.

Dinsdale soils have a high available water capacity. They are moderately permeable in the upper part and moderately slowly permeable in the lower part. In uneroded areas, they are high in organic-matter content. The subsoil is moderately low in available phosphorus and very low in available potassium.

These soils are chiefly used for row crops.

Representative profile of Dinsdale silty clay loam, 2 to 5 percent slopes, 1,110 feet east and 780 feet south of center sec. 25, T. 87 N., R. 13 W., in a cultivated field:

Ap—0 to 7 inches; black (10YR 2/1) light silty clay loam; weak fine granular structure; friable; medium acid; clear boundary.

A12—7 to 11 inches; very dark brown (10YR 2/2) light silty clay loam; weak very fine subangular blocky structure and moderate fine granular; friable; strongly acid; gradual boundary.

A3—11 to 15 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate very fine subangular blocky structure; friable; strongly acid; gradual boundary.

B1—15 to 21 inches; dark brown (10YR 3/3) silty clay loam; moderate fine and very fine subangular blocky structure; friable; strongly acid; gradual boundary.

B2t—21 to 29 inches; brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; friable; few thin discontinuous clay films; few dark oxides; strongly acid; clear boundary.

B31t—29 to 36 inches; brown (10YR 4/3) light silty clay loam; few fine grayish brown (10YR 5/2) mottles in the lower part; weak medium prismatic structure parting to weak medium subangular blocky; friable; few thin discontinuous clay films; very few fine dark oxides; few medium sand grains in the lower part; strongly acid; clear boundary.

IIB32t—36 to 50 inches; brown (10YR 5/3) and yellowish brown (10YR 5/6) heavy loam; common fine distinct light gray (10YR 6/1) mottles; weak medium prismatic structure; friable; few clay coats in pores and on prism faces; common pebbles; many ½- to 3-inch diameter stones in upper part; medium acid; gradual boundary.

IIC1—50 to 56 inches; yellowish brown (10YR 5/4 and 5/8) heavy loam; common fine distinct light gray (10YR 6/1) very thin streaks; few fine faint brown (7.5YR 4/4) mottles; weak medium prismatic structure; firm; common pebbles; neutral; clear boundary.

IIC2—56 to 73 inches; yellowish brown (10YR 5/6) heavy loam; few distinct light gray (10YR 6/1) tongues and mottles; massive; distinct horizontal cleavage; firm; few soft white lime nodules and few soft reddish oxides; common pebbles; moderately alkaline; strong effervescence.

The solum is typically about 50 inches thick but ranges from about 40 to 60 inches. Dinsdale soils formed in loess and glacial till. The loess is typically 24 to 40 inches thick and ranges from about 20 to 42 inches. The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), and very dark grayish brown (10YR 3/2). Total thickness ranges from 10 to 20 inches unless it is eroded.

The upper part of the B horizon that formed in loess is dark brown (10YR 3/3), brown (10YR 4/3), and dark yellowish brown (10YR 4/4). Clay content ranges from about 29 to 34 percent. The lower part of this horizon and the C horizon formed in glacial till. These horizons have matrix colors in hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 8. They contain few to common mottles with value of 4 to 6 and chroma of 1 to 2. They are typically loam but include sandy clay loam and light clay loam. In places, a stone line or a layer of sandy loam or loamy sand as much as 10 inches thick is between the loess and the glacial till. Carbonates are at a depth of about 45 to 65 inches.

Dinsdale soils formed in material similar to that of Klinger, Franklin, Maxfield, and Waubeek soils, and they are associated with Tama and Kenyon soils. They have a thicker, dark colored A horizon than Waubeek soils. They formed in loess and glacial till, but the sola of Tama soils formed entirely in loess. They have a browner B horizon than Klinger, Franklin, and Maxfield soils and are better drained. They are lower in sand in the upper part and are deeper over glacial till than Kenyon soils.

377B—Dinsdale silty clay loam, 2 to 5 percent slopes. This soil occurs on convex slopes on uplands. It has the profile described as typical of the series.

Included with this soil in mapping are small sand spots and glacial till outcrops. The sandy areas are droughty and less productive. The glacial till is less productive and has poorer tilth than this Dinsdale soil. Also included are small areas where the soil is 20 to 40 inches deep over dense, weathered, fine textured glacial till, or gumbotil. These areas are seepy and more susceptible to erosion. Small, severely eroded areas are also included. They have little or no topsoil left and are lower in organic-matter content and fertility. All areas are identified on the soil map by spot symbols.

If well managed, this soil is well suited to row crops year after year. It is subject to only slight erosion. Terrace cuts should be kept to a minimum to avoid exposing the glacial till subsoil, which is lower in fertility and higher in bulk density. Capability unit IIe-2.

377C—Dinsdale silty clay loam, 5 to 9 percent slopes. This soil occurs on convex slopes on uplands. It has a profile similar to the one described as typical of the series, but the dark surface layer is not so thick and glacial till is at a shallower depth.

Included with this soil in mapping are some areas in which glacial till occurs below a depth of 42 inches and small sand spots and till outcrops, which are identified on the soil map by spot symbols. The sandy areas are droughty and less productive, and the till outcrops are lower in fertility than this Dinsdale soil.

If well managed, this soil is well suited to row crops. It is subject to erosion in cultivated areas.

Many of the slopes are long and smooth and are suitable for terrace construction. Terrace cuts should be kept to a minimum to avoid exposing the glacial till subsoil, which is lower in fertility and higher in bulk density. Capability unit IIIe-1.

377C2—Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex slopes on uplands. It has a profile similar to the one described as typical of the series, but part of the surface layer has been removed by erosion. The surface layer is a mixture of the original material and material from the subsoil.

Included with this soil in mapping are sand spots and till outcrops. The sand spots are droughty and less productive than this Dinsdale soil. The glacial till areas are less productive and lower in fertility. Also included and identified on the soil map by spot symbols are small areas of soils that are severely eroded, have little or no topsoil left, and are lower in organic-matter content and fertility; and small areas of soils that have dense, weathered, fine textured glacial till, or gumbotil, at a depth of 20 to 40 inches and tend to be seepy in wet seasons and lower in fertility. In some areas glacial till occurs below 42 inches.

This soil is well suited to row crops if well managed. It is subject to erosion in cultivated areas. More fertilizer is needed than on the uneroded Dinsdale soils if the same yields are to be obtained. Terrace cuts should be kept to a minimum to avoid exposing the glacial till subsoil, which is lower in fertility and higher in bulk density. Capability unit IIIe-1.

Donnan Series

The Donnan series consists of gently sloping to moderately sloping, moderately well drained to somewhat poorly drained soils on convex side slopes and ridge crests on uplands. These soils formed in 20 to 40 inches of loamy surficial sediment and the underlying, extremely firm and firm fine textured weathered glacial till.

In a representative profile the surface layer is very dark gray loam 8 inches thick. The subsurface layer is dark grayish brown loam 7 inches thick. The upper part of the subsoil to a depth of 20 inches is brown heavy loam with strong brown mottles. Below this, the subsoil is a gray clay that grades to mottled grayish brown clay loam to a depth of 40 inches. The substratum is massive gray clay loam with common strong brown mottles.

Donnan soils are moderately permeable in the upper part but very slowly permeable in the lower part. They have a high available water capacity. They are very low in organic-matter content. The subsoil is very low in available phosphorus and potassium.

In most years these soils are used for row crops. They are seasonally seepy and wet because of the varying permeability in the upper and lower materials. These soils dry out slowly in spring and are more difficult to cultivate after rainfall than the surrounding soils.

Representative profile of Donnan loam, 2 to 5 percent slopes, 1,288 feet south and 600 feet east of northwest corner sec. 35, T. 89 N., R. 11 W., in meadow:

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; cloddy; friable; neutral; abrupt boundary.

A2—8 to 15 inches; dark grayish brown (10YR 4/2) loam; discontinuous dark gray (10YR 4/1) coatings on peds in upper part of horizon; brown (10YR 5/3) dry; weak coarse platy structure parting to moderate fine subangular blocky; friable; medium acid; clear boundary.

B1—15 to 20 inches; brown (10YR 4/3) loam; dark grayish brown (10YR 4/2) coatings on faces of peds; few fine faint dark grayish brown (10YR 4/2) mottles; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; light gray (10YR 7/2) dry, silt and sand coatings on faces of peds; very strongly acid; abrupt boundary.

IIB2—20 to 29 inches; gray (5Y 5/1) clay; common fine distinct red (2.5YR 4/6) mottles; moderate coarse prismatic structure parting to strong medium subangular blocky; extremely firm; discontinuous clay films on faces of peds; stone line at 20 inches with stones up to 4 inches in diameter; strongly acid; gradual boundary.

IIB3—29 to 40 inches; grayish brown (10YR 5/2) heavy clay loam; few fine distinct red (2.5YR 4/6) and brown (7.5YR 4/4) mottles; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; very firm; thick continuous light gray (10YR 6/1) dry, sand coatings on faces of prisms; strongly acid; gradual boundary.

IIC1—40 to 45 inches; gray (10YR 5/1) heavy clay loam; common medium yellowish red (5YR 5/6) mottles; massive; very firm; common dark oxides; medium acid; gradual boundary.

IIC2—45 to 60 inches; gray (10YR 5/1) clay loam; many light brownish gray (10YR 6/2) thin sand lenses 1/8 to 1/2 inch thick; common fine distinct strong brown (7.5YR 5/6) mottles; massive; firm; medium acid.

The solum ranges from 40 to more than 80 inches in thickness. It formed in the loamy material and a buried paleosol, and thus the entire thickness varies.

Thickness of the loamy surficial sediment over the buried soil ranges from 20 to 40 inches.

The Al or Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 6 to 8 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) and is 2 to 5 inches thick. In places all of it is incorporated into the Ap horizon. The A horizon ranges from loam or silt loam that is high in content of sand to light clay loam or silty clay loam also high in sand.

The upper part of the B horizon has colors in 10YR or 2.5Y hue, value of 4 and 5, and chroma of 3 and 4. In some areas there are mottles with chroma of 1 or 2. The upper part of the B horizon is clay loam, loam, or silt loam that is high in sand.

The IIB horizon ranges from heavy clay loam to silty clay or clay and has colors in 5Y or 2.5Y hue, value of 5 and 6, and chroma of 1 or 2. Higher chroma mottles are common in places.

Donnan soils are associated with Bassett, Dinsdale, Kenyon, and Oran soils. They are underlain by a clayey paleosol, which Bassett, Dinsdale, Kenyon, and Oran soils do not have.

782B—Donnan loam, 2 to 5 percent slopes. This soil is on convex ridge crests on uplands. It has the profile described as typical of the series.

Included with this soil in mapping are areas where the depth to the gray clayey material, or gumbotil, is less than 20 inches or slightly more than 40 inches. Also included and identified on the soil map by spot symbols are a few areas where the surface layer is sandy.

This soil is not well suited to row crops. It is subject to slight erosion in cultivated areas. Most areas are cultivated. Land use is commonly determined by the use of the surrounding soils.

Providing adequate drainage and controlling erosion are difficult. Erosion control slows down movement of surface water and allows more water to soak into the soil. The extra water entering the soil, however, complicates the drainage problem, especially during wet periods. A combination of terracing and tile drainage helps to overcome these problems. Careful placement of tile is very important because of the very slowly permeable subsoil. Tile drainage may not drain all areas satisfactorily. If the clayey subsoil is deep enough, tile can be placed above this layer. Capability unit IIe–5.

782C—Donnan loam, 5 to 9 percent slopes. This soil is on ridge crests and convex side slopes on uplands. It has a profile similar to the one described as typical of the series, but erosion has removed part of the dark colored surface layer, and it is lower in organic-matter content than the representative soil.

Included with this soil in mapping and identified on the soil map by spot symbols are moderately eroded and severely eroded areas where the clayey subsoil is exposed at the surface. They are lower in fertility and organic-matter content. Also included are areas of soils that have a sandy surface layer and a high infiltration rate. During wet periods these areas are very seepy, and at other times they are droughty.

This soil is not well suited to row crops. The varying permeability in the overburden and the clayey subsoil result in water accumulation above the clay subsoil, causing a perched water table and seepy areas on the side slopes. Tile that intercepts water is needed.

Providing adequate drainage and controlling erosion are difficult. Erosion control slows down movement of surface water and allows more water to soak into the soil. The extra water, however, complicates the drainage problem. A combination of proper drainage and erosion control helps to overcome these problems. Careful placement of tile is important because of the very slowly permeable subsoil. Capability unit IIIe–5.

Ely Series

The Ely series consists of gently sloping, somewhat poorly drained soils on slightly concave foot slopes and fans at the base of loess-covered uplands. These soils formed in 40 to 60 inches of local alluvium.

In a representative profile the surface layer is black and very dark gray silt loam and silty clay loam to a depth of 23 inches. The subsoil is very dark gray and dark grayish brown mottled silty clay loam to a depth of 34 inches. Below the subsoil is brown and grayish brown, mottled silty clay loam. The substratum is yellowish brown and grayish brown silt loam.

Ely soils have a high available water capacity and moderate permeability. They are high in organic-matter content. The subsoil is medium in available phosphorus and potassium.

These soils are used for row crops year after year. Some areas receive runoff from soils upslope and may need protection by a diversion terrace. Tile drains are beneficial during wet periods.

Representative profile of Ely silt loam, in an area of Colo-Ely complex, 2 to 5 percent slopes, 100 feet north and 30 feet west of southeast corner sec. 18, T. 87 N., R. 13 W., in meadow:

Ap—0 to 9 inches; black (10YR 2/1) silt loam; cloddy; friable; neutral; abrupt boundary.

A12—9 to 16 inches; black (10YR 2/1) light silty clay loam; weak fine granular structure; friable; neutral; gradual boundary.

A3—16 to 23 inches; very dark gray (10YR 3/1) light silty clay loam; weak fine granular structure; friable; neutral; gradual boundary.

B1—23 to 29 inches; very dark gray (10YR 3/1) light silty clay loam; few fine faint dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; friable; gray (10YR 6/1) dry, silt coatings on faces of peds; neutral; gradual boundary.

B21—29 to 34 inches; dark grayish brown (10YR 4/2) light silty clay loam; nearly continuous very dark gray (10YR 3/1) coatings on faces of peds; few fine faint brown (10YR 5/3) mottles; weak fine subangular blocky structure; friable; gray (10YR 6/1) dry, silt coatings on faces of peds; neutral; gradual boundary.

B22—34 to 43 inches; brown (10YR 4/3) light silty clay loam; discontinuous dark grayish brown (10YR 4/2) and dark gray (10YR 4/1) coatings on faces of peds; few fine distinct yellowish brown (10YR

5/4) and few fine faint grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; friable; gray (10YR 6/1) dry, silt coatings on faces of peds; neutral; gradual boundary.

B3—43 to 51 inches; grayish brown (10YR 5/2) light silty clay loam; discontinuous dark grayish brown (10YR 4/2) coatings on faces of peds; common fine distinct yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; friable; gray (10YR 6/1) dry, silt coatings on faces of peds; neutral; gradual boundary.

C—51 to 60 inches; yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) heavy silt loam; massive; friable; few fine dark oxides; neutral.

The solum is generally more than 48 inches thick and ranges from about 40 to 60 inches. The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2) silt loam or light silty clay loam.

The matrix of the B horizon is typically dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2), but the lower part is brown (10YR 4/3 or 5/3) and contains some mottles of low chroma. This horizon ranges from light to medium silty clay loam and contains 30 to 35 percent clay. The soil contains 5 to 20 percent sand, most of which is very fine and fine. Stratification is evident in the upper horizons, where the soil has received recent overwash. The soil is typically noncalcareous to a depth of 5 feet or more.

Ely soils are associated with Colo and Sawmill soils. In contrast, they are better drained and have a browner subsoil that does not have a gleyed horizon.

Finchford Series

The Finchford series consists of nearly level to moderately sloping, excessively drained soils on high alluvial terraces and adjacent escarpments. These soils formed in coarse textured water-deposited material under the influence of drought-tolerant grass vegetation.

In a representative profile the surface layer is very dark brown and very dark grayish brown loamy sand 18 inches thick. The subsoil, which extends to a depth of 30 inches, is dark brown coarse sand and some fine gravel. The substratum is brown medium and coarse sand and some fine gravel.

These soils have very low available water capacity and very rapid permeability. They are low in organic-matter content. The subsoil is very low in available phosphorus and potassium.

These soils can be used for row crops if well managed. They are very droughty and subject to soil blowing when the surface is bare and unprotected. Yields of all crops are below average, even under good management, unless rainfall is above average and very timely.

Representative profile of Finchford loamy sand, 0 to 2 percent slopes, 1,320 feet east and 1,170 feet north of center sec. 13, T. 87 N., R. 12 W., in a cultivated field:

Ap—0 to 8 inches; very dark brown (10YR 2/2) loamy sand; single grained; loose; 3 to 5 percent fine gravel; neutral; clear boundary.

A3—8 to 18 inches; very dark grayish brown (10YR 3/2) loamy sand; weak coarse subangular blocky structure; loose; 5 to 10 percent fine gravel; slightly acid; clear boundary.

B2—18 to 30 inches; dark brown (7.5YR 3/2) coarse sand and fine gravel; very weak coarse subangular blocky structure parting to single grained; loose; 10 to 15 percent fine gravel; strongly acid; gradual boundary.

C—30 to 60 inches; brown (7.5YR 4/4) medium and coarse sand and fine gravel; very weak prismatic structure parting to single grained; loose; 15 to 20 percent fine gravel; medium acid.

The solum ranges from 24 to 40 inches in thickness. The A horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) and is 10 to 30 inches thick. The texture of the solum and upper part of the C horizon ranges from loamy sand to coarse sand. In some areas fine gravel is less than 5 percent, but sand is 70 percent or more medium and coarse.

The B horizon typically is weakly developed but has some vertical cleavage. Matrix color is hue of 10YR or 7.5YR, value of 3 or more, and chroma of 2 or more.

Colors of the C horizon are hue of 7.5YR or 10YR, and value and chroma are 4 or more if value is less than 5. If value is 5 or more, the chroma is as low as 3. Finchford soils are strongly acid in the most acid part.

Finchford soils formed in material similar to that of Flagler and Lilah soils. They have more sand in the A horizon than Lilah and Flagler soils, and they are shallower over coarse sand and gravel than Flagler soils.

159—Finchford loamy sand, 0 to 2 percent slopes. This soil is on alluvial terraces. It has the profile described as typical of the series.

Included with this soil in mapping are a few areas that are affected by a seasonal water table and that have a few gray mottles or graying on ped faces in the lower part of the subsoil.

This soil is not well suited to row crops. It is droughty and subject to soil blowing unless it is protected. Yields are below average, even under good management and timely precipitation. Capability unit IVs–1.

159C—Finchford loamy sand, 2 to 9 percent slopes. This soil is on escarpments of alluvial terraces. It has a profile similar to the one described as typical of the series, but the surface layer is 10 to 16 inches thick. Slopes are short and irregular in shape.

Included with this soil in mapping and identified on the soil map by spot symbols are some areas of severely eroded soils that have a thinner, lighter colored surface layer and some areas where gravel is concentrated on the surface.

This soil is not well suited to row crops, but some small areas often are used for meadow and row crops with the surrounding soils. Yields are below average, even under good management and timely precipitation.

Because of the short, irregular slopes, this soil is not well suited to mechanical practices. Capability unit IVs-1.

U159—Finchford-Flagler-Urban land complex, 0 to 2 percent slopes. This nearly level mapping unit is on high alluvial benches that have been altered by man for city and urban development. It is about 25 percent Finchford soil, 10 percent Flagler soil, and 60 percent Urban land. These areas formed in moderately coarse and coarse textured alluvium under the influence of grass vegetation. The Urban land part is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible. Most areas in this unit are excessively drained or somewhat excessively drained.

Residential dwellings on standard-sized lots cover most areas of this unit. The downtown business complex in Waterloo and Cedar Falls developed on these high terraces. Some areas have been used as a source of sand and gravel but are now being reshaped or filled with debris. Typically, these areas are not flooded, but heavy rainfall for extended periods may cause rapid runoff and local inundation.

The entire acreage is used for homesites and commercial development. Onsite investigation is needed to determine physical and chemical properties. Interpretations based on these properties may differ from those given for individual soils throughout this survey.

Flagler Series

The Flagler series consists of nearly level to gently sloping, somewhat excessively drained soils on alluvial terraces. These soils formed in 24 to 36 inches of stratified, moderately coarse textured alluvium and loamy sand and sand and some gravel. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown, very friable sandy loam 21 inches thick. The upper part of the subsoil, extending to a depth of 35 inches, is brown sandy loam and grades to yellowish brown loamy sand in the lower part. The substratum below 42 inches is yellowish brown sand and some gravel.

Flagler soils have low available water capacity. Permeability is moderately rapid in the upper part and very rapid in the coarse textured substratum. These soils are moderate in organic-matter content. The subsoil is very low in available phosphorus and potassium.

Flagler soils are used for row crops. The major management problems are droughtiness and soil blowing and water erosion on slopes.

Representative profile of Flagler sandy loam, 0 to 2 percent slopes, 96 feet east and 870 feet south of center sec. 7, T. 88 N., R. 12 W., in meadow:

A1—0 to 13 inches; very dark brown (10YR 2/2) sandy loam; fine granular structure; very friable; medium acid; abrupt boundary.

A3—13 to 21 inches; very dark brown (10YR 2/2) sandy loam; weak coarse subangular blocky structure; very friable; medium acid; gradual boundary.

B2—21 to 35 inches; brown (10YR 4/3) sandy loam; dark brown coatings on faces of peds; weak coarse subangular blocky structure; very friable; medium acid; gradual boundary.

B3—35 to 42 inches; yellowish brown (10YR 5/6) loamy sand; weak coarse subangular blocky structure parting to single grained; very friable; some fine gravel commencing at 35 inches; strongly acid; gradual boundary.

IIC—42 to 60 inches; yellowish brown (10YR 5/4) gravelly sand; single grained; loose; medium acid.

The solum typically ranges from 30 to 50 inches in thickness. Depth to loamy sand, gravelly sand, or sand ranges from 24 to 36 inches. The A1 or Ap horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). Total thickness of the A horizon ranges from about 12 to 24 inches.

The B2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. Clay content of the B2 horizon ranges from 10 to 18 percent, and sand content is typically 60 to 70 percent.

The IIC horizon has hue of 10YR or 7.5Y, value of 4 or 5, and chroma of 4 to 8. Texture is typically gravelly sand, gravelly loamy sand, or coarse sand. The content of gravel is about 5 to 15 percent.

Flagler soils are associated with Saude, Waukee, Dickinson, and Finchford soils. They have more sand and are coarser textured in the upper horizons than Saude and Waukee soils. Flagler soils contain coarser sand and gravel in the subsoil than Dickinson soils. They contain less sand in the upper horizons than Finchford soils.

284—Flagler sandy loam, 0 to 2 percent slopes. This soil is on alluvial terraces. It has the profile described as typical of the series. Depth to coarse sand and gravel is about 3 feet.

Included with this soil in mapping are some small areas that have more than 3 feet of sandy loam over the coarse sand and gravel. These areas are less droughty. Also included are a few small areas, which are more droughty and have sola of loamy sand, and small areas that are in depressions and that impound water for short periods. This may interfere with fieldwork. All these areas are identified on the soil map by spot symbols.

This soil is moderately well suited to row crops. It is droughty, however, and in most years crop yields are below average because of lack of moisture. It is subject to soil blowing in cultivated areas and when left unprotected. Capability unit IIIs-1.

284B—Flagler sandy loam, 2 to 5 percent slopes. This soil is on convex alluvial terraces. It has a profile similar to the one described as typical of the series, but coarse sand and gravel generally occur at a depth of about 2 feet and the surface layer is slightly thinner and lighter colored with a tendency to be slightly lower in fertility and organic-matter content.

Included with this soil in mapping are a few small areas that are sandy loam to a depth of more than 3 feet and small areas that have a loam surface layer. These areas tend to be higher in organic-matter content and less droughty.

This soil is suited to row crops, but it is droughty and yields are low unless rainfall is timely and above average. It is subject to soil blowing and water erosion in cultivated areas. Capability unit IIIe–3.

Floyd Series

The Floyd series consists of gently sloping, somewhat poorly drained soils on the concave head slopes of upland waterways or on the side slopes along drainageways. These soils formed in 30 to 45 inches of loamy surficial sediment and coarse loamy or sandy sediment, as a stratified combination of both, and the underlying firm glacial till. The native vegetation was prairie grasses.

In a representative profile the surface layer is black, very dark gray, and very dark grayish brown loam 24 inches thick. The upper part of the subsoil, to a depth of 45 inches, is dark grayish brown and grayish brown, mottled sandy loam. The lower part, below 45 inches, is yellowish brown and gray loam with brown mottles. The substratum is mottled yellowish brown and light brownish gray loam.

These soils are moderately permeable in the upper part and moderately slowly permeable in the underlying glacial till and have high available water capacity. They are high in organic-matter content. The subsoil is very low in available phosphorus and potassium. These soils are slightly acid or neutral and generally do not require lime.

If well drained, these soils are commonly used for row crops; if not, they are in pasture. These soils are wet, partly because of hillside seepage from soils upslope.

Representative profile of Floyd loam, 1 to 4 percent slopes, 726 feet east and 1,220 feet north of southwest corner SE¼ sec. 8, T. 88 N., R. 11 W., in a cultivated field:

Ap—0 to 7 inches; black (10YR 2/1) loam; weak fine granular structure; friable; neutral; abrupt boundary.

A12—7 to 19 inches; very dark gray (10YR 3/1) loam; fine granular structure; friable; slightly acid; gradual boundary.

A3—19 to 24 inches; very dark grayish brown (10YR 3/2) loam; weak fine subangular blocky structure; slightly acid; gradual boundary.

B1—24 to 32 inches; dark grayish brown (10YR 4/2) loam; few fine faint olive brown (2.5Y 4/4) mottles; weak medium and fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds and in root channels; slightly acid; gradual boundary.

B2—32 to 39 inches; dark grayish brown (10YR 4/2) loam; common fine distinct olive brown (2.5Y 4/4) and few fine distinct light brownish gray (2.5Y 6/2) mottles; weak medium and fine subangular blocky structure; friable; slightly acid; gradual boundary.

B31—39 to 45 inches; grayish brown (2.5Y 5/2) sandy loam; common medium distinct brown (7.5YR 4/4) and few fine faint light brownish gray (2.5Y 6/2) mottles; weak medium and fine subangular blocky structure; very friable; slightly acid; gradual boundary.

IIB32—45 to 60 inches; mottled yellowish brown (10YR 5/6) and gray (5Y 6/1) loam; few fine distinct brown (7.5YR 4/4) mottles; moderate medium and fine subangular blocky structure; firm; few dark oxides; neutral; abrupt boundary.

IIC—60 to 65 inches; mottled yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) loam; common fine distinct brown (7.5YR 4/4) mottles; massive; firm; few fine dark oxides; mildly alkaline.

The solum ranges from about 40 to 60 inches in thickness. Depth of the loamy surficial sediments over the loam glacial till, which may be separated by a stone line, ranges from 30 to 45 inches. The A1 horizon is typically black (10YR 2/1) but ranges from black (N 2/0) to very dark gray (10YR 3/1). The A3 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (2.5Y 3/2). Texture of the A horizon is typically loam but ranges to silt loam that is high in sand, light clay loam, and light silty clay loam that is high in sand.

The B horizon has value of 4 to 5 and chroma of 2 to 6 in hue of 2.5Y and 10YR. Texture ranges to loam, silty clay loam that is high in sand, light clay loam, and thin horizons of sandy loam with a weighted clay content of more than 18 percent. Depth to carbonates ranges from 50 to 80 inches.

Floyd soils are closely associated with Aredale, Readlyn, Kenyon, Oran, and Clyde soils. They have a thicker, dark colored A horizon and a less acid solum than Oran soils. They are more stratified and deeper over glacial till and less acid than Readlyn soils. Floyd soils are not so gray in the B horizon as the poorly drained Clyde soils. They are more poorly drained and grayer in the upper part of the B horizon than Aredale and Kenyon soils.

198B—Floyd loam, 1 to 4 percent slopes. This soil occurs on concave head slopes of upland waterways or on side slopes along drainageways.

Included with this soil in mapping are a few areas that have more coarse textured materials in the substratum. In uncultivated areas, stones or boulders are generally on the surface.

If properly drained, this soil is well suited to corn and soybeans year after year. Wetness is the major hazard, but in a few areas, some soil is lost because of erosion. Because wetness is partly caused by hillside seepage, drainage that intercepts lateral movement of water is needed. Capability unit IIw–1.

Franklin Series

The Franklin series consists of very gently sloping, somewhat poorly drained soils on upland divides, concave head slopes of waterways, and along lower portions of valley side slopes. These soils formed in 24 to

40 inches of loess and the underlying loam glacial till. The native vegetation was trees and prairie grasses.

In a representative profile the surface layer is very dark gray silt loam 8 inches thick. The subsurface layer is dark grayish brown silt loam 4 inches thick. The upper part of the subsoil is dark grayish brown silty clay loam with light olive brown mottles and grades to grayish brown silty clay loam with light olive brown and strong brown mottles to a depth of 26 inches. Below this is light olive brown loam with strong brown and grayish brown mottles to a depth of 32 inches. At 32 inches and extending to a depth of 57 inches is firm, yellowish brown loam with grayish brown mottles. The substratum is yellowish brown loam with grayish brown mottles.

Franklin soils are moderately permeable in the upper part and moderately slowly permeable in the lower part, and they have high available water capacity. They are moderate in organic-matter content. The subsoil is low in available phosphorus and very low in available potassium.

Franklin soils are used for row crops, but they tend to have a seasonal high water table. Some areas may need tile drainage.

Representative profile of Franklin silt loam, 1 to 3 percent slopes, 330 feet west and 500 feet south of northeast corner sec. 24, T. 90 N., R. 11 W., in meadow:

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

A2—8 to 12 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; weak thin platy structure; friable; some very dark grayish brown organic staining on faces of peds; strongly acid; clear boundary.

B1—12 to 18 inches; dark grayish brown (10YR 4/2) light silty clay loam; common fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; few very fine dark oxides; discontinuous gray silt coatings on faces of peds when dry; strongly acid; gradual boundary.

B2t—18 to 26 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct light olive brown (2.5Y 5/4) and few fine distinct strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; friable; few thin discontinuous clay films; discontinuous gray silt coatings on faces of peds when dry; few fine dark oxides; strongly acid; clear boundary.

IIB31—26 to 32 inches; light olive brown (2.5Y 5/4) loam; common fine distinct grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to moderate medium and fine subangular blocky; firm; discontinuous stone line at 26 inches with stones less than 1 inch in diameter; few thin discontinuous gray silt and sand coatings on faces of peds when dry; slightly acid; gradual boundary.

IIB32—32 to 57 inches; yellowish brown (10YR 5/6) loam; common fine distinct grayish brown (10YR 5/2) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; common clay filled root channels; neutral; gradual boundary.

IIC—57 to 60 inches; yellowish brown (10YR 5/6) loam; few fine distinct grayish brown (2.5Y 5/2) mottles; massive; firm; common fine light gray (10YR 7/2) calcium veining and small nodules; moderately alkaline; strong effervescence.

The solum is typically more than 48 inches thick and ranges from 40 to about 70 inches. It formed partly in loess and partly in glacial till. The loess is typically 24 to 40 inches and ranges from 20 to 42 inches in thickness. The A horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2) and is 6 to 10 inches thick. The A2 horizon is typically 10YR or 2.5Y 4/2 or 5/2 and about 4 to 8 inches thick.

The upper part of the B horizon ranges from dark grayish brown (10YR 4/2) or (2.5Y 4/2) to grayish brown (10YR 5/2) or olive brown (2.5Y 5/4) with higher chroma mottles. It ranges from light to medium silty clay loam with a clay content of 28 to 34 percent. The lower part is typically loam, but in some areas it is light clay loam or sandy clay loam. In most places a stone line or a thin lens of sandy material is at a depth of 24 to 40 inches and separates the silty upper part of the B horizon from the loamy lower part.

The IIB horizon has 10YR or 7.5YR hue, value of 4 to 5, and chroma of 4 to 8 with lower chroma mottles.

Franklin soils formed in material similar to that of Waubeek, Klinger, Maxfield, and Dinsdale soils. They have the same drainage as Oran, Klinger, and Dells soils. Franklin soils have a thinner, dark A horizon than Klinger, Dinsdale, and Maxfield soils. They are better drained than Maxfield soils but are more poorly drained than Waubeek and Dinsdale soils. Franklin soils have less sand and more silt in the upper part of the solum than Oran soils.

761—Franklin silt loam, 1 to 3 percent slopes. This soil is on the upland divides and head slopes of drainageways. Those areas at the heads of drainageways tend to be slightly wetter than those on divides because of lateral seepage.

Included with this soil in mapping are areas that are moderately sloping and slightly more erodible.

If properly managed, this soil is well suited to row crops year after year. It may have a moderately high water table during wet periods, so that it benefits from tile drainage. Capability unit I–2.

Garwin Series

The Garwin series consists of nearly level, poorly drained soils on slightly concave heads of drainageways on uplands. These soils formed in loess that is more than 40 inches thick. The native vegetation was prairie grasses and sedges.

In a representative profile the surface layer is black silty clay loam 23 inches thick. The upper 4 inches of the subsoil is dark gray silty clay loam mottled with olive brown. The next 5 inches is olive gray mottled with light olive brown. It grades to olive gray mottled with light olive brown and brown in the lower 17 inches. The substratum is olive gray silt loam mottled with yellowish brown.

Garwin soils are moderately slowly permeable in the upper part and moderately permeable in the lower part. They have high available water capacity. They are high in organic-matter content. The subsoil is very low in available phosphorus and potassium. These soils are slightly acid or neutral and generally do not need lime for optimum growth of crops.

If properly drained, these soils are well suited to corn and soybeans.

Representative profile of Garwin silty clay loam, 0 to 2 percent slopes, 900 feet east and 120 feet south of northwest corner sec. 31, T. 87 N., R. 14 W., in a cultivated field:

Ap—0 to 8 inches; black (N 2/0) silty clay loam; fine granular structure; friable; slightly acid; abrupt boundary.

A12—8 to 19 inches; black (N 2/0) silty clay loam; fine granular structure; slightly acid; clear boundary.

A13—19 to 23 inches; black (10YR 2/1) silty clay loam; few fine distinct olive gray (5Y 4/2) mottles; moderate medium and fine subangular blocky structure; friable; slightly acid; clear boundary.

B1g—23 to 27 inches; dark gray (10YR 4/1) silty clay loam; very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct olive brown (2.5Y 4/4) mottles; moderate medium and fine subangular blocky structure; friable; slightly acid; clear boundary.

B21g—27 to 32 inches; olive gray (5Y 5/2) silty clay loam; dark gray (5Y 4/1) coatings on faces of peds; few fine distinct light olive brown (2.5Y 5/6) mottles; weak medium prismatic structure parting to medium and fine subangular blocky; friable; thin discontinuous very dark gray (10YR 3/1) organic stains on faces of prisms; neutral; gradual boundary.

B22g—32 to 37 inches; olive gray (5Y 5/2) silty clay loam; few fine distinct light gray (5Y 6/1) and brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to moderate medium and fine subangular blocky; friable; some dark gray (5Y 4/1) and very dark gray (5Y 3/1) organic stains on faces of prisms; few fine dark oxides; neutral; gradual boundary.

B31g—37 to 41 inches; olive gray (5Y 5/2) light silty clay loam; few fine distinct brown (7.5YR 4/4) mottles; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; friable; neutral; gradual boundary.

B32g—41 to 49 inches; olive gray (5Y 5/2) light silty clay loam; few fine distinct light olive brown (2.5Y 5/6) and brown (7.5YR 4/4) mottles; weak medium prismatic structure; friable; neutral; gradual boundary.

C1g—49 to 54 inches; olive gray (5Y 5/2) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; very weak medium prismatic structure; friable; neutral; few fine dark oxides; gradual boundary.

C2g—54 to 60 inches; same as above but massive.

The solum ranges from 36 to 50 inches in thickness. The A1 or Ap horizon ranges from black (N 2/0) to very dark gray (10YR 3/1). Thickness of the A horizon ranges from 14 to 23 inches.

The B2 horizon has hue of 5Y and 2.5Y, value of 3 to 5, and chroma of 1 to 2. Texture ranges from 30 to 36 percent clay in the B1 and B2 horizons. Depth to carbonates ranges from 48 to 70 inches or more.

Garwin soils formed in material similar to that of Muscatine and Tama soils, and they have the same drainage as Maxfield soils. These soils formed in loess deeper than 40 inches, but Maxfield soils formed in loess and the underlying glacial till at a depth of about 2 to 3 feet. Garwin soils have a grayer B horizon than Tama and Muscatine soils and are more poorly drained.

118—Garwin silty clay loam, 0 to 2 percent slopes. This soil is at the slightly concave heads of drainageways on uplands.

When this soil is tiled, it is well suited to corn and soybeans year after year. Almost all the acreage has been tile drained. Tilth is generally good, but this soil will puddle if worked when wet. Capability unit IIw-1.

Hayfield Series

The Hayfield series consists of nearly level, somewhat poorly drained soils on stream benches and in drainageways on low uplands that lack well defined outlets. These soils formed in 24 to 40 inches of loamy textured alluvial deposits and loamy sand and some gravel. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown friable loam 9 inches thick. The subsurface layer is dark grayish brown friable loam 7 inches thick. The subsoil extends to a depth of 34 inches and is brown friable loam with grayish brown and dark yellowish brown mottles. Below this, it is pale brown, mottled loamy fine sand. The substratum below 41 inches is pale brown fine sand mottled with dark yellowish brown and yellowish brown.

Hayfield soils, 32 to 40 inches to sand and gravel, have moderate available water capacity. Hayfield soils, 24 to 32 inches to sand and gravel, have low to moderate available water capacity. Permeability of the sand and gravel is rapid, but it is moderate above the sand. The soils are moderate in organic-matter content. The subsoil is low in available phosphorus and very low in available potassium.

These soils are chiefly used for row crops, but in some seasons fieldwork is delayed because of wetness. Later in the growing season the soils may be droughty, especially Hayfield soils, 24 to 32 inches to sand and gravel.

Representative profile of Hayfield loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, 528 feet north and 1,188 feet west of southeast corner

NE¼ sec. 29, T. 87 N., R. 11 W., in native grass and timber:

A1—0 to 9 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; medium acid; clear boundary.

A21—9 to 12 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; thin discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak coarse subangular blocky structure with horizontal cleavage; friable; medium acid; clear boundary.

A22—12 to 16 inches; dark grayish brown (10YR 4/2) loam, very pale brown (10YR 7/3) dry; weak medium platy structure; friable; medium acid; clear boundary.

B21—16 to 25 inches; brown (10YR 4/3) loam; grayish brown (10YR 4/2) coatings on faces of peds; moderate medium subangular blocky structure; friable; few dark oxides; strongly acid; gradual boundary.

B22t—25 to 34 inches; brown (10YR 4/3) loam; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) coatings on faces of peds; few fine distinct grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4) mottles; moderate medium and fine subangular blocky structure; friable; few thin discontinuous dark grayish brown (10YR 4/2) clay films; few dark oxides; strongly acid; abrupt boundary.

IIB3t—34 to 41 inches; pale brown (10YR 6/3) loamy fine sand; few fine faint dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; very friable; few fine dark oxides; some clay bridging on sand grains; strongly acid; gradual boundary.

IIC—41 to 60 inches; pale brown (10YR 6/3) fine sand; few fine faint dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; single grained; loose; medium acid.

The solum ranges from about 24 to 50 inches in thickness, and depth to the II material, or contrasting textures, ranges from about 24 to 40 inches. The A1 or Ap horizon is 6 to 10 inches thick in hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A2 horizon has a matrix with value of 4 or 5 and chroma of 2 or 3 and is from 3 to 7 inches thick.

The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 or 3. With 3 chroma there are lower chroma mottles. This horizon in the I material is typically loam or silt loam that is high in sand, light clay loam, or sandy clay. In some places the lower part is sandy loam.

The IIB3 horizon, or the upper part of the C horizon, typically ranges from loamy sand to loamy gravel. The II material, or the C horizon, has a matrix with value of 4 to 6 and chroma of 2 to 6 in hue of 10YR or 2.5Y. Texture ranges from loamy sand and coarse sand to sand and some gravel. Content of gravel ranges from nearly 0 to 20 percent.

Hayfield soils formed in material similar to that of Waukee, Saude, Wapsie, Lawler, and Marshan soils. They have a grayer B horizon and are more poorly drained than Waukee, Saude, or Wapsie soils. They have a thinner dark A horizon than Lawler and Marshan soils and are better drained than Marshan soils.

726—Hayfield loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This soil is on alluvial terraces. It has the profile described as typical of the series. Depth to coarse textures of sand and gravel is between 32 and 40 inches.

Included with this soil in mapping are a few areas with coarse material as shallow as 30 inches, or as deep as 45 inches, and small areas which have more silt in the surface layer and subsoil than this Hayfield soil.

If properly managed, this soil is well suited to row crops year after year. It is somewhat poorly drained, so that it benefits from tile drainage during wet periods. Tile placement is difficult in some places because of the loose, water-bearing sand and gravel. Capability unit I–2.

725—Hayfield loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This soil is on alluvial terraces or in areas of erosional sediment on uplands. It has a profile similar to the one described as typical of the series, but the sand and gravel occur at a shallower depth. Depth to coarse textures ranges from 24 to 32 inches, with a few areas as shallow as 20 inches.

Included with this soil in mapping are areas on uplands that have a sandy loam profile and that are underlain by glacial material below 5 feet. These areas are primarily in section 24 of Lester Township.

If properly managed, this soil is moderately well suited to row crops. Because the water table fluctuates rapidly, this soil can be wet and droughty during the growing season, depending on rainfall. During some years when there is a seasonal high water table, this soil benefits from tile drainage; however, tile placement is difficult in places because of the loose, water-bearing sand and gravel. Capability unit IIs–2.

Kenyon Series

The Kenyon series consists of gently sloping to strongly sloping, moderately well drained soils on uplands. These soils formed in 14 to 24 inches of loamy surficial sediment and the underlying firm glacial till. They are on ridgetops and side slopes. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown loam 13 inches thick. The subsoil, which extends to a depth of 48 inches, is yellowish brown loam and light clay loam that has grayish brown mottles below a depth of 28 inches. The substratum is mottled yellowish brown and olive gray loam.

There is an appreciable difference in the rate at which water moves through the friable loamy sediment, compared with the rate in the firm glacial till. Water moves more rapidly in the loamy material and accumulates at the till contact, resulting in wet, seepy areas in some years.

Kenyon soils have high available water capacity. They are moderately permeable in the upper part and moderately slowly permeable in the lower part. They are high in organic-matter content in uneroded areas and moderate in eroded areas. The subsoil is very low in available potassium.

Providing adequate drainage and controlling erosion on these soils are difficult. The long, uniform upland slopes are suitable for contour cultivation and terracing, both of which slow down movement of surface water and let more of it soak into the soil. The extra water entering the soil, however, complicates drainage, especially in wet years. A combination of tile drainage and terracing helps to overcome these problems.

These soils are chiefly used for corn and soybeans.

Representative profile of Kenyon loam, 2 to 5 percent slopes, 276 feet south and 645 feet east of northwest corner NE¼ sec. 18, T. 89 N., R. 12 W., in meadow:

Ap—0 to 7 inches; black (10YR 2/1) loam; moderate fine granular structure; friable; medium acid; abrupt boundary.

A12—7 to 13 inches; very dark brown (10YR 2/2) loam; moderate fine granular structure; friable; medium acid; clear boundary.

B1—13 to 19 inches; dark yellowish brown (10YR 4/4) loam; brown (10YR 4/3) coatings on faces of peds; moderate fine subangular blocky structure; friable; strongly acid; clear boundary.

IIB21—19 to 28 inches; yellowish brown (10YR 5/6) light clay loam; brown (10YR 4/3) coatings on faces of peds; few fine distinct brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; firm; stone line at a depth of 19 to 21 inches consisting of small stones and pebbles; few dark oxides; medium acid; gradual boundary.

IIB22—28 to 38 inches; yellowish brown (10YR 5/6) heavy loam; yellowish brown (10YR 5/4) coatings on faces of peds; few fine distinct grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; few dark oxides; medium acid; gradual boundary.

IIB3—38 to 48 inches; yellowish brown (10YR 5/6) heavy loam; discontinuous grayish brown (2.5Y 5/2) coatings on faces of prisms; common medium distinct grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure; firm; common strong brown oxides; slightly acid; gradual boundary.

IIC1—48 to 56 inches; mottled yellowish brown (10YR 5/6) and olive gray (5Y 5/2) heavy loam; massive; firm; common strong brown oxides; neutral; gradual boundary.

IIC2—56 to 60 inches; same as IIC1 horizon, but is mildly alkaline; strong effervescence.

The solum is 45 to 60 inches thick. This soil formed in about 14 to 24 inches of loamy surficial sediment and the underlying firm loam glacial till.

The Al horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It is typically loam but ranges to silt loam high in sand. Unless eroded, it is 10 to 20 inches thick. Thickness generally decreases as the gradient increases.

The B2 horizon has hue of 10YR, value of 3 to 5, and chroma of 3 to 6. The IIB horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 8, and mottles with chroma 2 or lower. The IIB horizon is typically heavy loam but ranges to light clay loam and sandy clay loam.

The IIC horizon is similar in color and texture to the IIB horizon, but grayish mottles are more common.

Kenyon soils formed in material similar to that of Bassett, Readlyn, Oran, and Tripoli soils. They have a thicker, dark A horizon than Bassett and Oran soils. They are browner in the upper part of the B horizon than Readlyn and Tripoli soils.

83B—Kenyon loam, 2 to 5 percent slopes. This soil is on long, convex ridges and side slopes. It has the profile described as typical of the series.

Included with this soil in mapping are small areas of friable loamy sediment that is more than 24 inches thick over firm glacial till and is better drained than this Kenyon soil and where the surface layer is silt loam and is slightly higher in fertility. Also included and identified by spot symbols on the soil map are small sandy and gravelly areas that are more droughty than the Kenyon soil; small areas of soils that have dense, weathered clayey material at a depth of 20 to 40 inches, are seepy during wet periods, and are less productive; and a few small severely eroded areas that are lower in fertility and organic-matter content.

If well managed, this soil is well suited to row crops. It is subject to slight erosion, however, in cultivated areas. Because of the varying permeability in the loamy surficial sediment and the underlying glacial till at a depth of about 1½ to 2 feet, water tends to accumulate at this contact and produces a seasonal high water table, particularly early in spring. Providing adequate erosion control and drainage is difficult. A combination of terracing and tile drainage is sometimes needed. Capability unit IIe–2.

83C—Kenyon loam, 5 to 9 percent slopes. This soil is on short, convex side slopes. It has a profile similar to the one described as typical of the series, but the dark surface layer is not so thick.

Included with this soil in mapping are a few areas of sandy and gravelly soils that are droughty and less productive than the Kenyon soil; a few small areas of soils that have dense weathered clayey material, or gumbotil, at a depth of 18 to 48 inches, are seepy during wet periods, and are less productive; and a few spots of severely eroded soils that are lower in fertility and organic-matter content. All are identified by spot symbols on the soil map.

If well drained, this soil is well suited to row crops. It is subject to moderate to severe erosion, however, in cultivated areas. Contouring and terracing help in erosion control. Fieldwork is sometimes delayed during wet periods. Providing adequate erosion control and drainage is difficult. A combination of terracing and tile drainage is sometimes needed. Capability unit IIIe–1.

83C2—Kenyon loam, 5 to 9 percent slopes, moderately eroded. This soil is on short, convex side slopes. It has a profile similar to the one described, but the surface layer is thinner and some of the subsoil material has been mixed with the plow layer. Stones and pebbles on the surface interfere with tillage. The organic-matter content is moderate. Fertility is lower than in the uneroded Kenyon soil.

Included with this soil in mapping are severely eroded areas where little or no topsoil is left and the organic-matter content and fertility are lower than in the less eroded Kenyon soil. Also included are areas of a droughty, less productive sandy soil that has dense, weathered clayey material at a depth of 18 to 48 inches and is seepy during wet periods. All included areas are identified by spot symbols on the soil map.

If well managed, this soil is suited to row crops. It is subject to severe erosion, however, in cultivated areas. Fieldwork is delayed during wet periods. Providing adequate erosion control and drainage is difficult. A combination of terracing and tile drainage is sometimes needed. Capability unit IIIe–1.

83D2—Kenyon loam, 9 to 14 percent slopes, moderately eroded. This soil is on short, convex side slopes. It has a profile similar to the one described as typical of the series, but the surface layer is very dark grayish brown, friable loam mixed with brown subsoil material. The organic-matter content is moderate.

Included with this soil in mapping and identified by spot symbols on the soil map are small, severely eroded areas where little or no topsoil is left and the organic-matter content and fertility are lower than in this Kenyon soil; small areas where the surface layer is sandy loam; small areas of sand and gravel; and small areas where limestone near the surface or limestone outcrops interfere with tillage.

This soil is suited to row crops if it is well managed and erosion is controlled. Capability unit IIIe–4.

U83C—Kenyon-Clyde-Urban land complex, 2 to 9 percent slopes. This gently sloping to moderately sloping mapping unit is on uplands. It is about 30 percent Kenyon soils, 20 percent Clyde soils, and 45 percent Urban land. The Kenyon soil is mainly on the ridges and side slopes and Clyde soil in the lower lying drainageways. Both formed in glacial till under prairie vegetation. The Urban land part of this unit is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible.

The original drainage patterns have been changed considerably by cutting and filling. Some areas have not been disturbed. Some have been excavated and cut to a depth in excess of 50 feet. Others have been filled with 20 feet or more of fill. Houses built in the lower lying drainageways are likely to have wet basements.

Included in mapping are areas of Olin and Dickinson soils that contain more sand than is typical. Also included are areas of Klinger and Dinsdale soils that have 2 to 3 feet of loess over the glacial till and contain less sand in the upper part than is typical.

The entire acreage is used for homesites and commercial development. Onsite investigation is needed to determine physical and chemical properties in any specific location.

Klinger Series

The Klinger series consists of nearly level to gently sloping, somewhat poorly drained soils on broad ridges and side slopes on uplands. These soils formed in loess and the underlying firm glacial till. The loess ranges from about 24 to 40 inches in thickness. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark grayish brown silty clay loam about 18 inches thick. The subsoil extends to 42 inches. The upper part is dark grayish brown silty clay loam, and the lower part is light olive brown loam that grades to mottled yellowish brown and dark grayish brown to a depth of 42 inches. The substratum is yellowish brown loam.

Klinger soils are moderately permeable in the upper part, which developed in the loess, and moderately slowly permeable in the part that developed in glacial till. They have high available water capacity. These soils are high in organic-matter content. The subsoil is very low in available phosphorus and potassium.

Klinger soils are chiefly used for corn and soybeans. They have a seasonal high water table, and some areas benefit from tile drainage.

Representative profile of Klinger silty clay loam, 1 to 3 percent slopes, 1,200 feet south and 294 feet east of center sec. 5, T. 89 N., R. 14 W., in meadow:

Ap—0 to 8 inches; black (10YR 2/1) light silty clay loam; cloddy; friable; neutral; abrupt boundary.

A12—8 to 13 inches; black (10YR 2/1) silty clay loam; moderate fine granular structure; friable; slightly acid; clear boundary.

A3—13 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam; very dark brown (10YR 2/2) coatings on faces of peds; moderate medium and fine subangular blocky structure; friable; few fine soft dark oxides; few discontinuous gray (10YR 5/1) dry, silt coatings on faces of peds; medium acid; clear boundary.

B21t—18 to 26 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark gray (10YR 3/1) coatings on faces of peds; moderate medium and fine subangular blocky structure; friable; few thin discontinuous clay films; few fine dark oxides; few discontinuous gray (10YR 5/1) dry, silt coatings on faces of peds; medium acid; gradual boundary.

B22t—26 to 32 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; friable; few fine distinct brown (7.5YR 4/4) and black (10YR 2/1) oxides; nearly continuous dark gray (10YR 4/1) clay films on faces of peds; slightly acid; abrupt boundary.

IIB23t—32 to 35 inches; light olive brown (2.5YR 5/6) loam; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; few fine black (10YR 2/1) and strong brown (7.5YR 5/6) oxides; few thin discontinuous dark brown (10YR 4/2) clay films on faces of peds; some very dark grayish brown (10YR 3/2) organic staining on faces of peds; neutral; gradual boundary.

IIB3—35 to 42 inches; mottled yellowish brown

(10YR 5/6) and dark grayish brown (10YR 4/2) loam; weak medium prismatic structure parting to moderate medium subangular blocky; firm; some dark gray (10YR 4/1) organic staining on faces of prisms; neutral; gradual boundary.

IIC—42 to 60 inches; yellowish brown (10YR 5/6) loam; massive; common light gray (10YR 7/2) calcium veining and nodules; few fine black (10YR 2/1) oxides; moderately alkaline; strong effervescence.

The solum ranges from about 40 to 60 inches in thickness. The loess is typically 24 to 40 inches thick. The A horizon is typically black (10YR 2/1) or very dark brown (10YR 2/2) and grades to a value of 3 and chroma of 1 or 2 in the lower part. It ranges from 18 to 22 inches in thickness.

The B2t horizon formed from the I material is dominantly dark grayish brown (2.5Y 4/2) but includes value of 5 and chroma of 3 or 4 in a minor part of the matrix. Clay content ranges from 28 to 35 percent. In most places a stone line or a lens of sandy material is at a depth of 24 to 40 inches and separates the silty upper part of the B horizon from the loamy lower part.

The IIBt horizon has value of 4 and 5 and chroma of 2 with higher chroma mottles. Texture is loam, light clay loam, or sandy clay loam.

Klinger soils are associated with Franklin, Dinsdale, Muscatine, Floyd, Readlyn, Maxfield, and Clyde soils. They have a thicker, dark colored A horizon than Franklin soils. They have a grayer B horizon and are more poorly drained than Dinsdale soils. Klinger soils have a higher sand content in the lower part of the B horizon than Muscatine soils. They contain less sand in the A horizon and upper part of the B horizon than Floyd and Readlyn soils. They are not as poorly drained as Clyde and Maxfield soils.

184—Klinger silty clay loam, 1 to 3 percent slopes. This soil is at the heads of drainageways and the base of side slopes on uplands.

Included with this soil in mapping are small areas that have a surface layer that is higher in sand, some small areas which are well drained, and some sandy areas and wet spots. The wet areas delay farming operations, especially after heavy rain. Also included are a few small areas where the glacial material is exposed at the surface. A few other small areas that have dense weathered clayey material, or gumbotil, at a depth of 20 to 40 inches are included. These areas are seepy during wet periods. All included areas are identified on the soil map by spot symbols.

This soil is well suited to corn and soybeans year after year. Surface runoff is slow. Some areas can be farmed without tile, but tile drainage is beneficial and improves the timeliness of fieldwork. Capability unit I–2.

Koszta Series

The Koszta series consists of nearly level, somewhat poorly drained soils. These soils formed in silty alluvium on stream benches. The native vegetation was trees and prairie grasses.

In a representative profile the surface layer is black silt loam 9 inches thick. The subsurface layer is dark grayish brown silt loam 4 inches thick. The subsoil extends to a depth of 53 inches. It is dark grayish brown light silty clay loam with a few brown mottles in the upper part. The middle part, at 22 inches and extending to a depth of 37 inches, is grayish brown silty clay loam with a few brown mottles. The lower part is grayish brown light silty clay loam with common fine brown and light olive brown mottles to a depth of 43 inches and grades to light olive brown silt loam to a depth of 53 inches. The substratum is stratified dark yellowish brown sandy loam and loamy sand.

Koszta soils have high available water capacity and moderate permeability. They are moderate in organic-matter content. The subsoil is low in available phosphorus and very low in available potassium.

These soils are chiefly used for corn and soybeans. Tile drains are beneficial during wet periods. Farm operations may be slightly delayed unless the soils are tile drained.

Representative profile of Koszta silt loam, 0 to 2 percent slopes, 50 feet north and 150 feet east of southwest corner sec. 31, T. 88 N., R. 14 W., in a cultivated field:

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; neutral; abrupt boundary.

A2—9 to 13 inches; dark grayish brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; grayish brown (10YR 5/2) dry; few fine faint brown (7.5YR 4/4) mottles; weak medium and fine platy structure parting to weak fine subangular blocky; friable; common very fine dark oxides; slightly acid; clear boundary.

B1—13 to 22 inches; dark grayish brown (10YR 4/2) light silty clay loam; few fine distinct brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; friable; few fine dark oxides; slightly acid; gradual boundary.

B2t—22 to 37 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; friable; thin discontinuous clay films on faces of peds and in root channels; medium acid; gradual boundary.

B31t—37 to 43 inches; grayish brown (2.5Y 5/2) light silty clay loam; common fine distinct brown (7.5YR 4/4) and light olive brown (2.5Y 5/6) mottles; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; friable; few fine dark oxides; discontinuous gray (10YR 6/1) dry, silt and sand coatings on faces of prisms and peds; thin dark grayish brown (10YR 4/2) clay films in root channels; medium acid; gradual boundary.

B32t—43 to 53 inches; light olive brown (2.5Y 5/4) silt loam; few fine faint brown (7.5YR 4/4) and grayish brown (2.5Y 5/2) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; friable; common fine dark oxides; few dark grayish brown (10YR 4/2) clay films in root channels; medium acid; abrupt boundary.

C—53 to 60 inches; stratified dark yellowish brown (10YR 4/4) sandy loam and loamy sand; common fine distinct light brownish gray (2.5Y 6/2) mottles; very weak medium subangular blocky structure; very friable; slightly acid.

The solum is typically more than 48 inches thick and ranges from 40 to 60 inches. The A1 horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark gray (10YR 3/1) and from 6 to 10 inches in thickness. The A2 horizon ranges from 4 to 10 inches in thickness and commonly is grayish brown (10YR 4/2).

The B horizon is light or medium silty clay loam. It has hue of 10YR to 2.5Y when moist, value of 4 or 5, and chroma of 2.

Texture of the C horizon ranges from loamy sand to sandy loam with some fine gravel. Depth to loamy and sandy material is generally below 48 inches.

Koszta soils formed in material similar to that of Nevin, Wiota, and Bremer soils. They have a thinner, dark A horizon and have an A2 horizon, which Nevin, Wiota, and Bremer soils do not have.

688—Koszta silt loam, 0 to 2 percent slopes. This soil is on alluvial terraces along the major streams.

Included with this soil in mapping are small areas that have loamy material at a depth of less than 48 inches. Also included and identified on the soil map by spot symbols are small areas that have a somewhat thinner surface layer, a thicker gray subsurface layer, and a heavier textured subsoil and that are poorly drained.

If properly managed, this soil is well suited to row crops year after year. Unless tile drainage is provided, a reduction in yield can be expected during above average rainfall. Capability unit I–2.

Lamont Series

The Lamont series consists of gently sloping to moderately sloping, somewhat excessively drained soils on uplands and high terraces. These soils formed in wind-deposited sandy material. The native vegetation was trees.

In a representative profile the surface layer is very dark grayish brown fine sandy loam 3 inches thick. The subsurface layer is dark brown and brown fine sandy loam 9 inches thick. The subsoil extends to a depth of 50 inches. It is dark yellowish brown sandy loam and strong brown loam in the upper part and strong brown mottled sandy loam in the lower part. The substratum is light yellowish brown loamy sand.

Lamont soils have moderately rapid permeability and low available water capacity. They are low to very low in organic-matter content. The subsoil is medium in available phosphorus and very low in available potassium. These soils are acid unless they have been limed within the past 4 years. They are subject to soil blowing and water erosion in cultivated areas. These soils can be used for row crops, but moisture is a limiting factor during most years.

Representative profile of Lamont fine sandy loam, 2 to 7 percent slopes, 425 feet south of center sec. 28, T. 87 N., R. 11 W., in bluegrass pasture:

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

A21—3 to 8 inches; dark brown (10YR 3/3) fine sandy loam, pale brown (10YR 6/3) dry; moderate medium platy structure parting to moderate fine platy; very friable; neutral; clear boundary.

A22—8 to 12 inches; brown (10YR 4/3) fine sandy loam; dark brown (10YR 3/3) coatings on faces of peds; weak medium platy structure; very friable; neutral; clear boundary.

B1—12 to 17 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak fine subangular blocky structure; friable; few thin discontinuous gray (10YR 6/1) dry, sand coatings on faces of peds; neutral; clear boundary.

B21t—17 to 25 inches; strong brown (7.5YR 5/6) loam; brown (7.5YR 4/4) coatings on faces of peds; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; few thin patchy brown (7.5YR 4/4) clay films on faces of peds; nearly continuous gray (10YR 6/1) dry, sand coatings on faces of peds; strongly acid; gradual boundary.

B22t—25 to 33 inches; strong brown (7.5YR 5/6) heavy sandy loam; brown (7.5YR 4/4) coatings on faces of peds; weak coarse subangular blocky structure; friable; few thin patchy brown (7.5YR 4/4) clay films on faces of peds; nearly continuous gray (10YR 6/1) dry, sand coatings on faces of peds; strongly acid; gradual boundary.

B3t—33 to 50 inches; strong brown (7.5YR 5/6) sandy loam; few coarse grayish brown (2.5Y 5/2) and few medium distinct strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure parting to weak coarse subangular blocky; very friable; few thin patchy brown (7.5YR 4/4) clay films on faces of peds; discontinuous gray (10YR 6/1) dry, sand coatings on faces of prisms; strongly acid; gradual boundary.

C—50 to 60 inches; light yellowish brown (10YR 6/4) loamy sand; single grained; loose; brown (7.5YR 4/4) zone of iron accumulation at 55 to 56 inches; medium acid.

The solum ranges from 24 to 50 inches in thickness. The A1 horizon is dark grayish brown (10YR 4/2), dark gray (10YR 4/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/3). In uneroded areas the A2 horizon ranges from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) and brown (10YR 5/3). In some places all of the A2 horizon is incorporated into the Ap horizon.

The B2 horizon ranges from sandy loam to light loam and light sandy clay loam. The B horizon ranges in hue from 10YR to 7.5YR, in value from 4 to 5, and in chroma from 3 to 6.

Lamont soils formed in material similar to that of Chelsea and Dickinson soils. They have a thinner, lighter colored A horizon than Dickinson soils and are not so coarse textured in the upper part of the solum as Chelsea soils.

110B—Lamont fine sandy loam, 2 to 7 percent slopes. This soil is on convex uplands and a few high terraces.

Included with this soil in mapping are small areas that have a surface layer of more silt and less fine sand. Also included and identified on the soil map by spot symbols are areas that have better available water capacity than is typical of this soil, areas where glacial till outcrops on the surface, and a few small areas that are in depressions and are more poorly drained.

This soil is suited to row crops, but it is droughty unless rainfall is very timely. It is subject to soil blowing and water erosion in cultivated areas. Capability unit IIIe-3.

Lawler Series

The Lawler series consists of nearly level, somewhat poorly drained soils on stream benches. These soils formed in loamy alluvial material 24 to 40 inches thick over coarse textured material. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black loam 17 inches thick. The subsoil extends to a depth of 30 inches. It is very dark grayish brown loam with some mottles in the upper part, dark grayish brown with brown mottles in the middle part, and grayish brown and brown loamy sand with brown mottles in the lower part. The substratum is stratified yellowish brown sand and fine gravel.

Lawler soils, 32 to 40 inches to sand and gravel, have moderate available water capacity. Lawler soils, 24 to 32 inches to sand and gravel, have low to moderate available water capacity. Permeability is moderate in the medium textured material and rapid in the coarse textured substratum. These soils are high in organic-matter content. The subsoil is very low in available phosphorus and potassium.

These soils are chiefly used for row crops. In some seasons fieldwork is delayed because of wetness. Later in the growing season these soils may be droughty, especially the Lawler soils, 24 to 32 inches to sand and gravel.

Representative profile of Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes, 1,220 feet east and 1,050 feet south of northwest corner sec. 7, T. 87 N., R. 11 W., in a cultivated field:

Ap—0 to 7 inches; black (10YR 2/1) loam; weak fine granular structure; friable; neutral; abrupt boundary.

A12—7 to 11 inches; black (10YR 2/1) loam; moderate fine granular structure; friable; neutral; clear boundary.

A3—11 to 17 inches; black (10YR 2/1) loam; weak fine subangular blocky structure; friable; neutral; clear boundary.

B1—17 to 21 inches; very dark grayish brown (10YR 3/2) loam; common fine faint dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; friable; medium acid; clear boundary.

B2—21 to 26 inches; dark grayish brown (10YR 4/2) loam; few fine distinct brown (7.5YR 4/4) and few fine faint olive brown (2.5Y 4/4) mottles; weak medium and fine subangular blocky structure; friable; few fine dark oxides; medium acid; gradual boundary.

IIB3—26 to 30 inches; mottled grayish brown (10YR 5/2) and brown (10YR 4/3) loamy sand; few fine pebbles and coarse sand; common fine faint brown (7.5YR 4/4) mottles; weak medium and fine subangular blocky structure; very friable; medium acid; gradual boundary.

IIC—30 to 60 inches; stratified yellowish brown (10YR 5/4) sand and fine gravel; common fine brown (7.5YR 4/4) and grayish brown (10YR 5/2) mottles; single grained; loose; medium acid.

Depth to coarse textures ranges from 24 to 40 inches, and generally the solum thickness is the same. The A horizon is loam or silt loam that is high in sand. The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1), and the A3 horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). Total thickness of the A horizon typically ranges from 12 to 18 inches, but some areas having value of 3 extend to a depth of 24 inches.

The B2 horizon is typically dark grayish brown (2.5Y or 10YR 4/2) with high chroma mottles. It is mostly heavy loam but ranges from loam to light sandy clay loam.

Where depth to sand and gravel is near the minimum for the series, the soil has a IIB3 horizon that formed in coarse material. The IIB3 horizon or the upper part of the C horizon typically ranges from loamy sand to loamy gravel. These soils have dark gray coatings in the B22 horizon, which is grayer than is typical for the series.

Lawler soils are associated with Hayfield, Marshan, Saude, and Waukee soils. They have a thicker dark colored A horizon than Hayfield soils. They are not so well drained as Saude and Waukee soils and have a grayer B horizon. They do not have so gray a B horizon as the poorly drained Marshan soils.

226—Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This soil is on alluvial terraces. It has a profile similar to the one described as typical of the series, but sand and gravel are at a depth of 32 to 40 inches.

Included with this soil in mapping are a few small areas that have more silt in the surface layer and subsoil. Also included and identified on the soil map by spot symbols are a few sandy areas, which are droughty and less productive.

This soil is well suited to corn and soybeans year after year. It is somewhat poorly drained and benefits from tile drainage during wet seasons. Tile placement is difficult in places because of the loose, water-bearing sand and gravel at a depth of about 3 feet. Capability unit I-2.

225—Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This soil is on alluvial terraces. It has the profile described as typical of the series.

Included with this soil in mapping are a few small areas that have more silt in the surface layer and subsoil. Also included and identified on the soil map by spot symbols are a few sandy areas, which are droughty and less productive, and some wet areas, which may hinder farming operations.

This soil is moderately well suited to row crops. Good yields can be expected if rainfall is timely. Wetness or droughtiness during the growing season depends on rainfall. This soil is somewhat poorly drained and benefits from tile drainage during wet seasons. Tile placement may be difficult because of the loose, water-bearing sand and gravel. Capability unit IIs–2.

Lilah Series

The Lilah series consists of gently sloping to moderately sloping, excessively drained soils on convex high knolls and side slopes on uplands. These soils formed in 6 to 18 inches of sandy loam and the underlying gravelly loamy sand and sand. The native vegetation was scattered trees and grass.

In a representative profile the surface layer is very dark grayish brown sandy loam about 9 inches thick. The subsoil extends to a depth of 30 inches. It is brown gravelly loamy sand in the upper part and brown loamy sand in the lower part. The substratum is strong brown coarse sand.

These soils have very low available water capacity and rapid permeability. They are low in organic-matter content. The subsoil is very low in available phosphorus and potassium.

Lilah soils can be used for row crops if they are properly managed. They are droughty even in years with average rainfall.

Representative profile of Lilah sandy loam, 2 to 9 percent slopes, 275 feet south and 250 feet west of northeast corner SW¼ sec. 2, T. 89 N., R. 11 W., in bluegrass pasture:

A1—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam; dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; some coarse gravel; slightly acid; clear boundary.

IIB1t—9 to 15 inches; brown (10YR 4/3) gravelly loamy sand, brown (10YR 5/3) dry; weak coarse subangular blocky structure; very friable; some clay bridging between sand grains; estimated 30 to 50 percent fine gravel; some stones 3 inches or greater in diameter; strongly acid; gradual boundary.

IIB2t—15 to 30 inches; brown (7.5YR 4/4) loamy sand; very weak coarse subangular blocky structure; very friable; some clay bridging between sand grains; estimated 10 to 15 percent fine gravel; strongly acid; gradual boundary.

IIC—30 to 60 inches; strong brown (7.5YR 5/6) coarse sand; single grained; loose; estimated 5 to 10 percent fine gravel; strongly acid.

The solum ranges from about 30 to 42 inches in thickness. The A1 or Ap horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and from 6 to 9 inches in thickness. Texture of the A horizon is typically sandy loam but ranges to light loam and gravelly sandy loam. An A2 horizon occurs in some pedons; in others it has been mixed with the Ap horizon.

The B2 horizon ranges from light sandy loam to gravelly loamy sand or sand. Reaction is strongly acid or very strongly acid in the most acid part.

Lilah soils are associated with Sparta, Dinsdale, Aredale, Dickinson, and Kenyon soils. They contain more coarse sand and gravel throughout the solum than Sparta and Dickinson soils. They have a coarser textured A horizon than Dinsdale, Arendale, and Kenyon soils.

776C—Lilah sandy loam, 2 to 9 percent slopes. This soil is on convex ridges and side slopes on uplands. West of the Cedar River it generally is on isolated, moderately sloping knolls surrounded by the gently sloping Dinsdale and Aredale soils. East of the Cedar River the convex knolls are less distinct and the associated soils are Kenyon, Sparta, and Dickinson.

Included with this soil in mapping are some eroded areas that have a thinner, lighter colored surface layer and that are lower in organic-matter content; some areas that are slightly darker colored and are a little higher in organic-matter content; and a few small strongly sloping areas. Also included and identified on the soil map by spot symbols are small areas of gravel that outcrop on the surface, are more droughty, and are less productive than this Lilah soil.

This soil is not well suited to row crops. It is excessively drained and droughty and is subject to soil blowing and water erosion in cultivated areas. Crop yields depend on the amount and timeliness of rainfall. Capability unit IVs–1.

Loamy Alluvial Land, Channeled

C315—Loamy alluvial land, channeled, consists of highly stratified, recently deposited alluvial sediments that have not been in place long enough for soil to develop. The sediments were deposited on flood plains along the larger streams in the county and small areas of their tributaries. This area is nearly level but generally is cut by many stream channels, which often produce escarpments on the higher alluvial terraces. The native vegetation was mainly mixed grass, brush, and generally low quality timber.

The available water capacity varies, but in most places it is low. Permeability and drainage also vary. In the old channels, permeability is slow and drainage is poor. On the natural levees permeability is rapid and drainage is excessive.

This area is not suitable for cultivation because of the flood hazard, unless it is protected by levees. Land leveling may be necessary so that oxbows and sloughs can be crossed with farm equipment. In many places this area is kept wet by flooding or by water impounded or fed by a high water table after flooding.

Some areas have been cleared and provide permanent pasture; other areas are in bushes and scrub trees. Many commercial dredging operations have been successfully established in these areas to supply sand and gravel. Timber is used for crating purposes by industry in and around Waterloo and Cedar Falls. The principal use is permanent pasture. Capability unit Vw–1.

Loamy Escarpments

154F—Loamy escarpments, 14 to 40 percent slopes, occurs as moderately steep to very steep areas between the uplands or alluvial terraces and the bottom lands. The soil material varies but is dominantly loam and sandy loam. In some areas, about 12 inches of silty or loamy material is underlain by fractured bedrock. In other areas, firm glacial till is at a depth of about 24 inches; the most prominent of these areas is in the Cedar River Valley in section 15 of Union Township. On a west-facing slope extending from north to south is an island of firm glacial till that is about 1 mile long. The color of the surface material ranges from dark to light. Gravel or limestone outcrops are identified by spot symbols on the soil map.

Loamy escarpments is generally used for trees or wildlife habitat. In some areas it provides permanent pasture. It is subject to severe gully erosion. Because it is underlain by sand or gravel, it is droughty. Fertility varies but is generally very low. Capability unit VIIs–1.

Marsh

354—Marsh is a depression or a flat, often intermingled with ponds and small lakes, where the water table is at or near the surface the year round. It is mainly at the northwest corner of the county, in Union Township. It occurs in land-locked depressions of the uplands and in old meanders of the Cedar River. In the uplands it is surrounded by Sparta, Chelsea, and Palms soils. On alluvial terraces along the Cedar River, it is associated with Marshan and Lawler soils. The natural vegetation is cattails, rushes, sedges, and other water-tolerant grasses.

Marsh is not suitable for cultivation and provides poor yields for pasture. It is best suited to wildlife habitat. Areas are interspersed with ponds. When the water recedes from the surface, a layer of old plant residue is evident on the surface. Capability unit VIIw–1.

Marshan Series

The Marshan series consists of nearly level, poorly drained soils on stream terraces. These soils formed in loamy alluvial sediment about 24 to 40 inches thick over coarse textured alluvial sediment. The native vegetation was prairie grasses, sedges, and other water-tolerant plants.

In a representative profile the surface layer is black clay loam 20 inches thick. The subsoil extends to a depth of 37 inches. It is dark gray and gray heavy loam with olive mottles in the upper part and gray sandy loam with light olive brown, dark gray, and olive gray mottles in the lower part. The substratum is light brownish gray loamy fine sand that contains some fine gravel with olive brown and brown mottles.

Marshan soils, 32 to 40 inches to sand and gravel, have moderate available water capacity. Marshan soils, 24 to 32 inches to sand and gravel, have low to moderate available water capacity. Permeability is moderate in the upper part and rapid in the sand and gravel. These soils are high in organic-matter content. The subsoil is very low in available phosphorus and potassium. In most places these soils are neutral in reaction and do not need lime. They have a seasonal high water table.

These soils are used for row crops if properly drained, but fieldwork is sometimes delayed because of wetness.

Representative profile of Marshan clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, 1,020 feet north and 70 feet east of center sec. 1, T. 89 N., R. 11 W., in bluegrass pasture:

A11—0 to 10 inches; black (N 2/0) light clay loam; weak fine granular structure; friable; medium acid; clear boundary.

A12—10 to 20 inches; black (10YR 2/1) light clay loam; weak fine subangular blocky structure; friable; medium acid; clear boundary.

B21g—20 to 28 inches; dark gray (5Y 4/1) heavy loam; few fine distinct olive (5Y 5/3) mottles; weak fine subangular blocky structure; friable; medium acid; gradual boundary.

B22g—28 to 33 inches; gray (5Y 5/1) heavy loam; common fine distinct olive (5Y 5/3) mottles; weak fine subangular blocky structure; friable; some fine gravel; medium acid; clear boundary.

B3g—33 to 37 inches; gray (5Y 5/1) gravelly sandy loam; common fine distinct light olive brown (2.5Y 5/6) and few fine distinct dark gray (5Y 4/1) and olive gray (5Y 5/2) mottles; weak fine subangular blocky structure; friable; slightly acid; abrupt boundary.

IIC—37 to 60 inches; light brownish gray (2.5Y 6/2) loamy fine sand; common fine distinct olive brown (2.5Y 4/4) and brown (7.5YR 4/4) mottles; single grained; loose; some fine gravel; slightly acid.

Thickness of the solum and depth to the I material range from 24 to 40 inches. The A horizon ranges from black (N 2/0) to very dark gray (10YR 3/1) and from 14 to 24 inches in thickness. Texture is typically clay loam but ranges to silty clay loam that is high in sand and loam.

The B horizon in the I material has hue of 5Y, 2.5Y, or 10YR, value of 4 to 5, and chroma of 1 or 2. The texture is silty clay loam, clay loam, or loam.

The IIC horizon is loam or sandy loam in the upper part, but gravelly sand, loamy sand, or sand occurs between 24 and 40 inches.

Marshan soils are closely associated with Lawler and Waukee soils and have the same drainage as Clyde and Tripoli. They have a grayer B horizon than Lawler and Waukee soils and are more poorly drained. Unlike Clyde and Tripoli soils, which are underlain by glacial till, Marshan soils are underlain by sand and gravel.

152—Marshan clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This soil is on alluvial terraces. It has the profile described as typical of the series. Sand and gravel generally occur between 34 and 40 inches. In a few places they are within 2 feet, and in some other areas they are as deep as 48 inches, but generally they are at a depth of about 36 inches.

Included with this soil in mapping are small areas, which have a silty clay loam texture in the surface layer and upper part of the subsoil, and small areas that are in depressions and that pond water during wet periods unless they are drained. Also included and identified on the soil map by spot symbols are a few small sandy areas that are less fertile.

If properly drained, this soil is well suited to row crops year after year. It generally has good tilth but will puddle if worked when wet. Surface runoff is slow. In some areas this soil is subject to flooding for short periods. Artificial drainage is needed for good crop production. Capability unit IIw–1.

151—Marshan clay loam,, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This soil is on alluvial terraces. It has a profile similar to the one described as typical of the series, but sand and gravel are at a depth of 24 to 32 inches.

Included with this soil in mapping are a few small areas, which have more sand in the surface layer and subsoil than is typical of the series. Also included are small areas that are in depressions and that pond water part of the year unless they are drained.

If well drained, this soil is well suited to row crops year after year. It generally has good tilth but will puddle if worked when wet. Surface runoff is slow. In some areas this soil is subject to flooding for short periods. The water table is high, especially in spring, so plowing and planting may be delayed. Artificial drainage is needed for row crops. Tile placement may be difficult because of the loose, water-bearing sand and gravel. Capability unit IIw–1.

Maxfield Series

The Maxfield series consists of nearly level, poorly drained soils on upland divides or at the heads of broad, shallow drainageways on uplands. These soils formed in 24 to 40 inches of loess and the underlying glacial till. The native vegetation was prairie grasses and sedges.

In a representative profile the surface layer is black silty clay loam about 17 inches thick. The subsoil extends to a depth of 42 inches. The upper part is very dark gray and dark grayish brown, mottled silty clay. Below 34 inches is mottled yellowish brown and gray loam. There is a thin layer about 4 inches thick of olive brown loamy sand between the loess and the glacial till. The substratum at a depth of 42 inches is mottled yellowish brown and gray loam.

These soils are moderately permeable in the upper part and moderately slowly permeable in the lower part. They have high available water capacity. They are high in organic-matter content. The subsoil is very low in available phosphorus and potassium. These soils are generally slightly acid or neutral and generally do not need lime.

Maxfield soils are used for cultivated crops if drained, and most areas are drained.

Representative profile of Maxfield silty clay loam, 0 to 2 percent slopes, 924 feet east and 1,300 feet south of center sec. 5, T. 89 N., R. 14 W., in a cultivated field:

Ap—0 to 8 inches; black (N 2/0) silty clay loam; cloddy; friable; neutral; abrupt boundary.

A12—8 to 13 inches; black (N 2/0) silty clay loam; fine granular structure; friable; few fine distinct dark yellowish brown (10YR 4/4) oxides; neutral; clear boundary.

A13—13 to 17 inches; black (N 2/0) silty clay loam; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; friable; neutral; clear boundary.

B1—17 to 21 inches; very dark gray (10YR 3/1) silty clay loam; common fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; friable; few fine dark brown to brown (7.5YR 4/4) oxides; neutral; clear boundary.

B21—21 to 25 inches; dark grayish brown (2.5Y 4/2) silty clay loam; very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; common fine dark brown to brown (7.5YR 4/4) oxides; neutral; clear boundary.

B22—25 to 30 inches; dark grayish brown (2.5Y 4/2) silty clay loam; thin discontinuous dark gray (10YR 4/1) coatings on faces of prisms; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium and fine subangular blocky; friable; few fine dark brown to brown (7.5YR 4/4) oxides; neutral; abrupt boundary.

IIB31—30 to 34 inches; olive brown (2.5Y 4/4) loamy sand; weak coarse subangular blocky structure parting to single grained; loose; few small pebbles and stones up to 2 inches in diameter; neutral; abrupt boundary.

IIB32—34 to 42 inches; mottled yellowish brown (10YR 5/6) and gray (10YR 6/1) loam; weak medium prismatic structure; firm; neutral; gradual boundary.

IIC—42 to 60 inches; mottled yellowish brown (10YR 5/6) and gray (10YR 6/1) loam; massive; firm; mildly alkaline; strong effervescence.

The solum is typically about 48 inches thick but ranges from about 40 to 55 inches. The soil formed in loess and glacial till. The loess is typically 24 to 40 inches thick but ranges from 20 to 42 inches. The A horizon is black (N 2/0 or 10YR 2/1) and very dark gray (10YR or 5Y 3/1).

The upper part of the B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. Texture ranges from heavy silt loam to medium silty clay loam.

The IIB3 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 8 with lower chroma mottles. Texture is typically loam and ranges to light clay loam and sandy clay loam. A thin layer of loamy sand or sand typically less than 10 inches thick, or a stone line, commonly separates the I and II materials.

The IIC horizon has the same colors and textures as the IIB3 horizon. Carbonates are at a depth of about 40 to 60 inches.

Maxfield soils formed in material similar to that of Dinsdale, Klinger, Franklin, and Waubeek soils. They are associated with Dinsdale, Klinger, Garwin, Sawmill, and Colo soils. Maxfield soils have a grayer B horizon and are more poorly drained than Dinsdale, Klinger, Franklin, and Waubeek soils. They have more sand in the lower part of the solum than Garwin soils. Maxfield soils formed in glacial till in the lower part, whereas Garwin soils formed entirely in loess that is low in sand. They have a thinner, dark A horizon than Colo and Sawmill soils.

382—Maxfield silty clay loam, 0 to 2 percent slopes. This nearly level soil is on upland divides or at heads of broad, shallow drainageways on uplands.

Included with this soil in mapping and identified on the soil map by spot symbols are small areas that have a moderately alkaline surface layer, which may be lower in available phosphate than this Maxfield soil.

If drained, this soil is well suited to corn and soybeans year after year. Capability unit IIw–1.

Muscatine Series

The Muscatine series consists of nearly level to gently sloping, somewhat poorly drained soils on upland divides and slightly convex side slopes. These soils formed in more than 40 inches of loess. The native vegetation was prairie grasses.

In a representative profile the surface layer is silty clay loam 16 inches thick. It is black and very dark brown and grades to very dark grayish brown. The subsoil extends to a depth of 50 inches. It is dark grayish brown silty clay loam with mottles in the upper part and brown and grayish brown silty clay loam with mottles in the lower part. The substratum is mottled brown and gray sandy loam in the upper part and mottled yellowish brown loam in the lower part.

Muscatine soils are moderately permeable and have high available water capacity. They are high in organic-matter content. The subsoil is low in available phosphorus and very low in available potassium.

Muscatine soils are generally used for row crops year after year. Some of these soils have a seasonal high water table. Timeliness of fieldwork can be improved by tile drainage in years with above normal rainfall.

Representative profile of Muscatine silty clay loam, 0 to 2 percent slopes, 69 feet west and 756 feet north of southeast corner sec. 19, T. 87 N., R. 14 W., in a cultivated field:

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam; cloddy; friable; neutral; abrupt boundary.

A12—7 to 12 inches; very dark brown (10YR 2/2) light silty clay loam; weak fine granular structure; friable; neutral; clear boundary.

A3—12 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam; fine subangular blocky structure; friable; strongly acid; clear boundary.

B21—16 to 20 inches; dark grayish brown (10YR 4/2) light silty clay loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/6) and common fine distinct brown (10YR 5/3) mottles; moderate fine subangular blocky structure; friable; few fine dark brown oxides; strongly acid; clear boundary.

B22t—20 to 25 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) and common fine distinct brown (10YR 5/3) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; friable; thin discontinuous dark gray (10YR 4/1) clay films; few fine dark oxides; strongly acid; clear boundary.

B23t—25 to 36 inches; brown (10YR 5/3) silty clay loam; dark grayish brown (10YR 4/2) coatings on faces of peds; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; friable; thin discontinuous dark gray (10YR 4/1) clay films; few fine dark oxides; very strongly acid; gradual boundary.

B3—36 to 50 inches; grayish brown (10YR 5/2) light silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine dark oxides; strongly acid; gradual boundary.

IIC1—50 to 60 inches; mottled brown (7.5YR 4/4) and gray (10YR 5/1) sandy loam; weak coarse prismatic structure; friable; weakly defined stone line at 50 inches; slightly acid; gradual boundary.

IIIC2—60 to 65 inches; yellowish brown (10YR 5/6) loam; few medium distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; massive; firm; neutral.

The solum ranges from 45 to 70 inches in thickness. The A horizon ranges from black (10YR 2/1) and very dark gray (10YR 3/1) to very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2). It is 14 to 24 inches thick.

The B horizon has 10YR and 2.5Y hue, value of 4 to 5, and chroma of 2 and higher chroma mottles. The B2 horizon is about 27 to 35 percent clay.

Muscatine soils formed in material similar to that of Garwin and Tama soils and have the same drainage as Franklin and Klinger soils. They have a thicker, dark A horizon than Franklin soils and, in contrast, do not have an A2 horizon. They have a browner subsoil than the poorly drained Garwin soils and have a grayer B horizon than the well drained Tama soils. Muscatine soils formed in thicker loess deposits than Franklin and Klinger soils, which have glacial till within 3 feet.

119—Muscatine silty clay loam, 0 to 2 percent slopes. This soil is on uplands divides. It has the profile described as typical of the series.

Included with this soil in mapping are small areas of poorly drained, dark colored Garwin soils and small areas where glacial material is less than 40 inches deep.

This soil has a seasonal high water table. In places tile is used to improve timeliness of fieldwork during wet periods.

This soil is well suited to corn and soybeans year after year. Capability unit I–2.

119B—Muscatine silty clay loam, 2 to 5 percent slopes. This soil is on lower side slopes of uplands along the drainageways. It has a profile similar to the one described as typical of the series, but it has a thicker A horizon and a slightly less acid solum.

Included with this soil in mapping are small areas of poorly drained soils, which delay fieldwork.

Because of its position, this soil receives surface runoff and lateral subsoil movement of seepage water. It is slightly wetter than the nearly level Muscatine soil, which also may delay fieldwork unless it is drained.

If properly managed, this soil is well suited to row crops year after year. It benefits from practices that include protection from soil erosion, runoff from soils upslope, and additional drainage. Capability unit IIe–1.

Nevin Series

The Nevin series consists of nearly level, somewhat poorly drained soils on terraces along the major tributaries of the Cedar River. These soils formed in silty clay loam alluvium. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark gray silty clay loam 18 inches thick. The subsoil extends to a depth of 53 inches. It is dark grayish brown silty clay loam in the upper part and grayish brown silty clay loam in the lower part. The substratum is olive gray, mottled silty clay loam.

Nevin soils have high available water capacity and are moderately to moderately slowly permeable. They are high in organic-matter content. The subsoil is medium in available phosphorus and potassium.

These soils are used for row crops year after year. Some areas receive runoff from soils upslope. Tile drains are beneficial during wet periods. Farm operations may be slightly delayed unless the soils are tile drained.

Representative profile of Nevin silty clay loam, 0 to 2 percent slopes, 1,023 feet south and 1,303 feet east of northwest corner sec. 6, T. 87 N., R. 14 W., in a cultivated field:

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam; cloddy; friable; neutral; abrupt boundary.

A12—7 to 11 inches; black (10YR 2/1) silty clay loam; moderate fine granular structure; friable; neutral; clear boundary.

A3—11 to 18 inches; very dark gray (10YR 3/1) silty clay loam; very dark brown (10YR 2/2) coatings on faces of peds; moderate fine granular structure; friable; neutral; clear boundary.

B1—18 to 24 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark gray (10YR 3/1) coatings on faces of peds; moderate fine subangular blocky structure; friable; few fine dark oxides; neutral; clear boundary.

B21t—24 to 30 inches; dark grayish brown (2.5Y 4/2) silty clay loam; dark gray (10YR 4/1) coatings on faces of peds; common fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; few thin discontinuous clay films; few fine dark oxides; neutral; gradual boundary.

B22t—30 to 34 inches; grayish brown (2.5Y 5/2) silty clay loam; dark grayish brown (2.5Y 4/2) coatings on faces of peds; common fine distinct light olive brown (2.5Y 5/4) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; few thin discontinuous clay films; few fine dark oxides; neutral; gradual boundary.

B23t—34 to 40 inches; grayish brown (2.5Y 5/2) silty clay loam; dark grayish brown (2.5Y 4/2) coatings on faces of peds; common fine distinct light olive brown (2.5Y 5/4) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; few thin discontinuous clay films; neutral; gradual boundary.

B31t—40 to 49 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; moderate medium angular blocky and subangular blocky structure; friable; nearly continuous clay coatings in root channels; neutral; gradual boundary.

B32t—49 to 53 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) silty clay loam; moderate medium subangular blocky structure; friable; common clay coated root channels; neutral; gradual boundary.

C—53 to 60 inches; olive gray (5Y 5/2) silty clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; few clay coated root channels; neutral.

The solum is typically more than 40 inches thick but ranges from 36 to 60 inches or more. The A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) to very dark brown (10YR 2/2). It ranges from 18 to 24 inches in thickness and in a few places may range to 30 inches. Texture is typically silty clay loam but ranges to silt loam.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3 with high chroma mottles. The texture of the B2 horizon ranges from light to medium silty clay loam. These soils range from neutral to medium acid.

Nevin soils are closely associated with Bremer, Colo, Koszta, and Wiota soils and have the same drainage as Koszta soils. They have a thicker, dark A horizon than Koszta soils. Nevin soils have a grayer subsoil than Wiota soils and are more poorly drained. They have a thinner, dark A horizon than the poorly drained Colo soils. They have a browner subsoil than the poorly drained Bremer soils.

88—Nevin silty clay loam, 0 to 2 percent slopes. This soil is on alluvial terraces dominantly along major tributaries of the Cedar River. In some areas loamy or sandy materials are at a depth of 40 to 48 inches.

Included with this soil in mapping and identified on the soil map by spot symbols are a few small poorly drained areas and a few small sandy areas. The sandy areas are lower in fertility than this Nevin soil. The wet areas delay fieldwork unless they are drained. South and east of La Porte City, this soil has a grayer subsoil, which indicates a high water table for periods longer than average.

If properly managed, this soil is well suited to row crops year after year. It is slightly wet but generally does not require tile drainage except during wet periods. Diversion terraces placed on the adjacent upland slopes protect the soil from local overflow and silting. Capability unit I–2.

Olin Series

The Olin series consists of gently sloping and moderately sloping, well drained soils on uplands. These soils formed in 20 to 36 inches of sandy loam and the underlying glacial till. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown in the upper 13 inches and grades to very dark grayish brown fine sandy loam to a depth of 20 inches. The subsoil extends to a depth of 40 inches. The upper part is brown sandy loam, which grades to dark yellowish brown loamy sand to a depth of 33 inches. Below 33 inches, it is strong brown medium loam with light brownish gray and brown mottles. The substratum is strong brown medium loam and contains carbonates.

Permeability of these soils is moderately rapid in the upper part and moderately slow in the lower part, which formed in glacial till. The available water capacity is moderate. These soils are acid unless limed within the past 5 years. They are moderate in organic-matter content. The subsoil is very low in available phosphorus and potassium.

These soils are used chiefly for row crops, but they may be droughty during periods of below average rainfall. Soil blowing is a hazard if the soils are bare and unprotected. Because of the varying permeability in the upper part of the subsoil and the lower part, water tends to accumulate at this contact. During periods of high rainfall, seepy spots are formed.

Representative profile of Olin fine sandy loam, 2 to 5 percent slopes, 330 feet west and 198 feet north of southeast corner sec. 2, T. 89 N., R. 11 W., in a cultivated field:

Ap—0 to 7 inches; very dark brown (10YR 2/2) fine sandy loam; weak fine subangular blocky structure; very friable; neutral; clear boundary.

A12—7 to 13 inches; very dark brown (10YR 2/2) fine sandy loam; weak fine subangular blocky structure parting to weak fine granular; very friable; neutral; gradual boundary.

A3—13 to 20 inches; very dark grayish brown (10YR 3/2) fine sandy loam; some mixing of brown (10YR 4/3); weak fine granular structure; very friable; medium acid; gradual boundary.

B1—20 to 27 inches; brown (10YR 4/3) sandy loam; weak medium subangular blocky structure; very friable; few discontinuous dark brown (10YR 3/3) coatings on faces of peds; strongly acid; gradual boundary.

B21—27 to 33 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; strongly acid; gradual boundary.

IIB22—33 to 40 inches; strong brown (7.5YR 5/6) medium loam; common medium distinct light brownish gray (10YR 6/2) and few fine distinct brown (7.5YR 4/4) mottles; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; firm; stone line at a depth of 32 to 34 inches; common fine dark oxides; medium acid; gradual boundary.

IIC1—40 to 57 inches; strong brown (7.5YR 5/6) medium loam; common fine distinct grayish brown (10YR 5/2) and few fine distinct strong brown (7.5YR 5/8) mottles; massive; firm; few brown (10YR 5/2) clay filled root channels; few very fine dark oxides; medium acid; gradual boundary.

IIC2—57 to 60 inches; strong brown (7.5YR 5/6) medium loam; common fine distinct light brownish gray (10YR 6/2) mottles and streaks; massive; firm; few very fine dark oxides; medium acid.

IIC3—60 to 70 inches; same as IIC2 horizon but mildly alkaline; mild effervescence.

The solum ranges from 40 to 60 inches in thickness. The soil formed from parent material consisting of a very friable, loamy upper layer that ranges from 20 to 36 inches in thickness and a lower layer of firm loam glacial till.

The Ap horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2). Thickness of the A horizon ranges from 14 to 24 inches and generally decreases as gradient increases.

The B2 horizon has 10YR hue, is dominantly 3 to 5 in value, and has chroma of 3 or 4. In places a dark brown (10YR 3/3) or brown (10YR 4/3) B1 horizon is present. The texture of the B2 horizon in the I material is mostly sandy loam but includes layers of loamy sand 6 to 8 inches thick.

A pebble band is present in the lower part of the I material or upper part of the IIB2 horizon. The IIB horizon has 10YR hue, value of 3 to 5, and chroma of 3 to 6. In the lower part of the B horizon below 30 inches, there are mottles with chroma of 2 or lower, which increase in size and number as depth increases. The IIB2 horizon is commonly heavy loam but ranges to medium loam, light clay loam, or sandy clay loam.

The IIC horizon has 10YR or 7.5 YR hue, value of

4 to 6, and chroma of 4 to 8 with some grayish mottles. Depth to carbonates ranges from 50 to 80 inches and generally corresponds to the solum thickness.

Olin soils formed in material similar to that of Dickinson soils, and they are associated with Kenyon, Dickinson, and Sparta soils. They are shallower over glacial till than Dickinson or Sparta soils. Olin soils have more sand in the upper part of the solum than Kenyon soils, and they contain less sand than Sparta soils.

408B—Olin fine sandy loam, 2 to 5 percent slopes. This soil is on uplands. It has the profile described as typical of the series.

Included with this soil in mapping are areas of soil that have a sandy loam texture between 36 and 48 inches, and some areas of soils that are less than 20 inches thick. Also included and identified on the soil map by spot symbols are small areas of very sandy soils that have a loamy fine sand surface layer and that are more droughty and susceptible to soil blowing.

This soil is moderately well suited to row crows if well managed. The surface is easy to work and dries out quickly. It may be droughty in some years, however, because of the varying permeability in the upper and lower parts of the subsoil. Water tends to accumulate during periods of above average rainfall and then move laterally, resulting in seepy areas. Capability unit IIe–4.

408C—Olin fine sandy loam, 5 to 9 percent slopes. This soil is on the narrow ridges and side slopes of the uplands. It has a profile similar to the one described as typical of the series, but the dark surface layer is not as thick and it is typically shallower to the loam till.

Included with this soil in mapping are areas where the surface layer is sandy loam 36 to 48 inches thick, some areas that are less than 20 inches thick, and small areas that have a thinner surface layer and that are lower in organic-matter content. Also included and identified on the soil map by spot symbols are small areas that have a loamy fine sand surface layer and that are more droughty and susceptible to soil blowing.

This soil is suited to row crops if well managed. The surface is easy to work and dries out quickly. It may be droughty in some years. Because of the varying permeability in the upper and lower parts of the subsoil, water tends to accumulate during periods of above average rainfall and then move laterally, resulting in seepy, wet areas. This soil is subject to soil blowing and water erosion. Capability unit IIIe–2.

Oran Series

The Oran series consists of nearly level to gently sloping, somewhat poorly drained soils on long, slightly concave side slopes on uplands. These soils formed in 14 to 24 inches of loamy surficial sediment and the underlying glacial till. In most places a layer of pebbles and stones is at the contact of the loamy material and the glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is dark grayish brown loam 4 inches thick. The subsoil extends to a depth of 53 inches. The upper part, extending to a depth of 18 inches, is grayish brown clay loam with yellowish brown mottles. Below this is mottled grayish brown and yellowish brown loam to a depth of 24 inches. At 24 inches and extending to a depth of 42 inches is firm, mottled yellowish brown and grayish brown loam with strong brown mottles. The lower part is yellowish brown loam with strong brown and grayish brown mottles. The substratum is yellowish brown loam.

Oran soils have moderate permeability in the upper part and moderately slow permeability in the lower part. Water moves through the upper part of the soil and accumulates at the till contact, resulting in a seasonally perched water table. These soils have high available water capacity. They are moderate in organic-matter content. The subsoil is very low in available phosphorus and potassium.

These soils are chiefly used for row crops.

Representative profile of Oran loam, 1 to 3 percent slopes, 35 feet west and 920 feet south of northeast corner NW¼ sec. 2, T. 90 N., R. 11 W., in a cultivated field:

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; cloddy; friable; neutral; abrupt boundary.

A2—8 to 12 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; light brownish gray (10YR 6/2) dry; few fine faint yellowish brown (10YR 5/4) mottles; weak medium and fine platy structure parting to fine granular; friable; some tonguing into the B1 horizon; neutral; clear boundary.

B1—12 to 18 inches; grayish brown (10YR 4/2) clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; friable; few discontinuous gray (10YR 6/1) dry, silt and sand coatings on faces of peds; very strongly acid; clear boundary.

IIB21—18 to 24 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) loam; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; few discontinuous gray (10YR 6/1) dry, silt and sand coatings; nearly continuous pebble band at 18 to 20 inches; strongly acid; clear boundary.

IIB22t—24 to 32 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) loam; grayish brown (2.5Y 5/2) coatings on faces of peds; moderate coarse prismatic structure parting to moderate medium subangular blocky; firm; few thin discontinuous clay films; discontinuous gray (10YR 6/1) dry, silt and sand coatings on faces of peds; medium acid; clear boundary.

IIB23t—32 to 42 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) loam; grayish brown (2.5Y 5/2) coatings on faces of peds; few fine faint dark brown (7.5YR 3/2) and common fine faint strong brown (7.5YR 5/6) oxides; moderate coarse prismatic structure parting to moderate medium angular and subangular blocky; firm; few thin discontinuous clay films on faces of peds and in old root channels; thick nearly continuous light gray (10YR 7/2) dry, sand coatings on faces of prisms, slightly acid; gradual boundary.

IIB3—42 to 53 inches; yellowish brown (10YR 5/6) loam; few fine faint strong brown (7.5YR 5/6) and common medium distinct grayish brown (2.5Y 5/2) mottles; moderate coarse prismatic structure; firm; few fine dark oxides; neutral; gradual boundary.

IIC1—53 to 60 inches; yellowish brown (10YR 5/4) loam; light gray (10YR 7/1) vertical streaks; massive; firm; few fine dark oxides; neutral.

The solum is typically more than 48 inches thick. It ranges from about 40 to 60 inches in thickness. The Ap horizon is very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). The A2 horizon ranges from 3 to 6 inches in thickness. The A horizon is mostly loam or silt loam and contains a noticeable amount of sand.

Depth to the stone line, or IIB horizon, ranges from 14 to 24 inches. The B horizon ranges from 10YR to 2.5Y hue, value of 4 or 5, and chroma of 2 with higher chroma mottles in the upper part, to value of 4 or 6 and chroma of 2 to 6 in a mottled pattern in the lower part. It ranges from medium loam to light clay loam but includes sandy clay loam.

Oran soils formed in material similar to that of Readlyn, Kenyon, and Tripoli soils, and they have the same drainage as Franklin and Floyd soils. They have a grayer B horizon than Kenyon soils and are more poorly drained. Oran soils have a browner B horizon than Tripoli soils and are better drained. They also have a lighter colored A horizon than Tripoli and Floyd soils. Oran soils are shallower over glacial till than Franklin soils.

471—Oran loam, 1 to 3 percent slopes. This soil is on ridges or in weakly defined drainageways on uplands.

If well managed, this soil is well suited to row crops year after year. It has a seasonal high water table because of the moderately slowly permeable underlying glacial material. Tile drainage is needed during wet periods and improves the timeliness of fieldwork. Capability unit I–2.

Palms Muck

Palms muck consists of very poorly drained organic soils 18 to 52 inches deep over alluvial sediment or glacial till. These nearly level to gently sloping soils are on sidehill seeps or in upland drainageways. A few areas are on stream benches. The native vegetation was grass, sedges, and other water-tolerant plants.

In a representative profile the surface layer, about 45 inches thick, is black sapric material muck with a few greenish gray mottles in the lower part. The substratum is greenish gray heavy silt loam to a depth of 60 inches.

Palms soils have a very high available water capacity. Permeability varies from moderately rapid to moderately slow. The organic-matter content is very high. The subsoil is very low in available phosphorus and potassium.

These soils have a very high water table. The surface layer is hummocky, unless it has been leveled and drained. Drainage is difficult. Drainage and leveling are needed before row crops can be grown. Tile upslope from the muck can generally be expected to intercept seep water and increase the chance of successful drainage. Considerable settling takes place in drained areas. Undrained areas are poorly suited to row crops and are left idle or are in pasture.

Representative profile of Palms muck, 1 to 4 percent slopes, 924 feet east and 792 feet south of center sec. 15, T. 87 N., R. 13 W., in grass vegetation in a cultivated field:

Oa1—0 to 6 inches; black (N 2/0) sapric material; weak fine granular structure; very friable; many roots; slightly acid; clear boundary.

Oa2—6 to 20 inches; black (N 2/0) sapric material with few fibers that disintegrate when rubbed; weak fine granular structure; very friable; many fine roots; medium acid; clear boundary.

IIab1—20 to 29 inches; black (N 2/0) mucky silt loam with few fibers that disintegrate when rubbed; weak fine subangular blocky structure; very friable; neutral; clear boundary.

IIab2—29 to 38 inches; black (N 2/0) mucky silt loam with few vertical fibers that disintegrate when rubbed; weak prismatic structure parting to weak fine subangular blocky; very friable; mildly alkaline; clear boundary.

IIab3—38 to 45 inches; black (N 2/0) mucky silt loam with few vertical fibers that disintegrate when rubbed; few medium distinct greenish gray (5G 6/1) mottles; weak prismatic structure parting to weak fine subangular blocky; very friable; mildly alkaline; noneffervescent; abrupt boundary.

IIcg—45 to 60 inches; greenish gray (5G 6/1) heavy silt loam with few fibers that disintegrate when kneaded; massive; friable; mildly alkaline; noneffervescent.

The Palms series consists of organic material, which ranges from 18 to 52 inches thick. It is black to very dark brown. Reaction ranges from neutral to medium acid in places.

The underlying material typically is gray (5Y 5/1) or greenish gray (5G 6/1) but ranges from black (10YR 2/1) to olive gray (5Y 5/2) and light olive gray (5Y 6/2). It is typically silty clay loam, loam, or silt loam and contains sandy strata in places. Reaction is typically neutral but ranges from slightly acid to mildly alkaline.

Palms soils are associated with Aredale, Maxfield, Clyde, Colo, and Marshan soils. In contrast, they have a surface layer of decomposed organic material more than 18 inches thick. They are also more poorly drained than those soils.

221—Palms muck, 1 to 4 percent slopes. This soil generally is on lower hillsides that are seepy and wet and in broad upland drainageways. Some areas are also on alluvial terraces.

Included with this soil in mapping are areas of soils that have more than 7 feet of organic matter over mineral material.

This soil is too wet for crops unless it is drained. If drained, it is well suited to row crops; if not, it is generally in permanent pasture or left idle. In undrained areas, the water table is at or near the surface during most of the year. Outlets for drainage are difficult to obtain in some areas. Capability unit IIIw-1.

Protivin Series

The Protivin series consists of nearly level to gently sloping, somewhat poorly drained soils on uplands and on long, slightly convex side slopes. These soils formed in 14 to 24 inches of loamy artificial sediment and the underlying, very firm clay loam glacial till. The native vegetation was mixed prairie grasses. In most places a layer of pebbles and stones is at the contact of the loamy material and glacial till.

In a representative profile the surface layer is black and very dark gray loam and clay loam 22 inches thick. The subsoil extends to a depth of 43 inches. The upper part is dark grayish brown clay loam. Below this is mottled dark grayish brown and dark yellowish brown clay loam. The substratum is mottled dark grayish brown and olive brown clay loam and loam to a depth of 60 inches.

Protivin soils have high available water capacity. There is an appreciable difference in the rate at which water moves through the loamy surficial sediment, as compared with the rate in the glacial till. Water moves more rapidly in the sediment and accumulates at the till contact, resulting in a seasonal perched water table. The upper part is moderately permeable, and below this, it is slowly permeable. These soils are high in organic-matter content. The subsoil is very low in available phosphorus and potassium.

These soils are used for row crops. Placement and spacing of tile are very important because of the slowly permeable subsoil.

Representative profile of Protivin loam, 1 to 3 percent slopes, 828 feet north and 405 feet east of southwest corner sec. 5, T. 89 N., R. 12 W., in cultivated field:

Ap—0 to 7 inches; black (10YR 2/1) loam; cloddy; friable; slightly acid; abrupt boundary.

A12—7 to 13 inches; black (10YR 2/1) light clay loam; moderate medium and fine granular structure; friable; strongly acid; clear boundary.

A3—13 to 22 inches; very dark gray (10YR 3/1) clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; moderate medium and fine subangular blocky structure; friable; medium acid; clear boundary.

IIB1t—22 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam; very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct light olive brown (2.5Y 5/4) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; very firm; few thin discontinuous very dark gray (10YR 3/1) clay films; prominent stone line between 22 and 24 inches; very firm; slightly acid; clear boundary.

IIB2t—30 to 36 inches; mottled dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) clay loam; moderate medium prismatic structure parting to moderate medium angular and subangular blocky; very firm; few thin discontinuous very dark gray (10YR 3/1) clay films; thick nearly continuous grayish brown (2.5Y 5/2) dry, sand coatings on faces of peds and prisms; neutral; clear boundary.

IIB3—36 to 43 inches; mottled grayish brown (10YR 5/2) and light olive brown (2.5Y 5/4) clay loam; moderate medium prismatic structure parting to moderate medium angular blocky; very firm; very few thin discontinuous very dark gray (10YR 3/1) clay films; thick continuous grayish brown (2.5Y 5/2) dry, sand coatings on ped and prism faces; slightly acid; gradual boundary.

IIC1—43 to 50 inches; mottled dark grayish brown (10YR 4/2) and olive brown (2.5Y 4/4) clay loam; massive; some vertical cleavage; continuous grayish brown (10YR 5/2) dry, sand coatings on faces of prisms; firm; neutral; gradual boundary.

IIC2—50 to 60 inches; mottled dark grayish brown (10YR 4/2) and olive brown (2.5Y 4/4) heavy loam; massive; weak; firm; neutral.

The surface layer ranges in color from black to very dark gray and in thickness from 10 to 24 inches. Texture is typically loam but ranges to silt loam that is high in sand and light clay loam. A stone line typically separates the I material from the II material.

The subsoil ranges from dark grayish brown and olive brown with mottles in the upper part to mottled gray, strong brown, and yellowish brown in the lower part. The exteriors of the peds typically have nearly continuous gray coatings. Texture ranges from light to medium clay loam.

The substratum is mottled gray, strong brown, or yellowish brown. It ranges in texture from clay loam to heavy loam. Depth to carbonates ranges from 40 to more than 60 inches.

Protivin soils are associated with Donnan, Kenyon, Clyde, and Floyd soils. They are better drained and have a browner subsoil than Clyde soils. Protivin soils have more clay and are more compact in the subsoil than Clyde and Floyd soils. They do not have the degree of stratification found in Floyd and Clyde soils, which are stratified in the upper and middle parts of the profile. They are less clayey in the lower part of the subsoil than Donnan soils.

798—Protivin loam, 1 to 3 percent slopes. This nearly level soil is on uplands and lower side slopes.

Included with this soil in mapping are small areas or bands along the lower edge of the slopes that have a thinner surface layer, which is lower in organic-matter content than this Protivin soil. Also included and identified on the soil map by spot symbols are a few small areas of soils that have dense, weathered, clayey glacial material at a depth of 20 to 40 inches. These soils tend to be more seepy and delay fieldwork.

If well managed, this soil is moderately well suited to row crops year after year. Because of the slowly permeable subsoil, wetness and seepage are problems during wet periods. Tile drainage is beneficial. In some areas a drainage system that will intercept laterally moving water is needed.

The more sloping soils are subject to slight erosion in cultivated areas. Because of the difficulty in drainage and in erosion control, a combination of terraces and tile drainage is needed. Capability unit IIw-1.

Readlyn Series

The Readlyn series consists of nearly level to gently sloping, somewhat poorly drained soils on uplands. These soils are on nearly level upland divides or at slightly concave heads of upland drainageways. They formed in 14 to 24 inches of loamy surficial sediment and the underlying glacial till. In most places a layer of pebbles and stones is at the contact of the loamy material and the glacial till. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer, 17 inches thick, is black and very dark brown loam. The subsoil extends to a depth of 44 inches. It is dark grayish brown loam in the upper part and grades to mottled yellowish brown and dark grayish brown heavy loam in the middle and lower parts. The substratum, below 44 inches, is mottled yellowish brown and gray heavy loam.

These soils have high available water capacity. They are moderately permeable in the loamy material and moderately slowly permeable in the glacial till. They are high in organic-matter content. The subsoil is very low in available phosphorus and potassium.

Readlyn soils are chiefly used for row crops year after year. Artificial drainage is beneficial and improves timeliness of fieldwork.

Representative profile of Readlyn loam, 1 to 3 percent slopes, 807 feet south and 720 feet east of northwest corner NE¼ sec. 18, T. 88 N., R. 12 W., in meadow:

Ap—0 to 7 inches; black (10YR 2/1) loam; medium and fine granular structure; friable; neutral; abrupt boundary.

A12—7 to 12 inches; black (10YR 2/1) loam; weak medium and fine subangular blocky structure; friable; neutral; clear boundary.

A3—12 to 17 inches; very dark brown (10YR 2/2) loam; few fine distinct brown (7.5YR 4/4) mottles; some mixing of dark grayish brown (2.5Y 4/2); moderate medium and fine subangular blocky structure; friable; medium acid; clear boundary.

B1—17 to 22 inches; dark grayish brown (2.5Y 4/2) loam; very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure parting to fine subangular blocky; friable; medium acid; clear boundary.

IIB2—22 to 27 inches; mottled dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/6) loam; discontinuous dark gray (10YR 4/1) coatings on faces of peds; moderate medium subangular blocky structure parting to moderate fine subangular blocky; firm; stone line at 22 to 24 inches; medium acid; clear boundary.

IIB31—27 to 32 inches; mottled dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/6) loam; moderate medium subangular blocky structure; firm; medium acid; clear boundary.

IIB32—32 to 44 inches; mottled dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/6) heavy loam; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; firm; few soft lime nodules, slightly effervescent near nodules; neutral; gradual boundary.

IIC1—44 to 60 inches; mottled yellowish brown (10YR 5/6) and gray (10YR 6/1) heavy loam; very weak coarse prismatic structure; firm; common to many fine lime nodules; mildly alkaline; strong effervescence; gradual boundary.

IIC3—60 to 70 inches; same as IIC1 horizon, but it is massive.

The solum is typically 40 to 60 inches thick. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in the lower part. It ranges from about 15 to 20 inches in thickness. The texture is typically loam but ranges to light silty clay loam or heavy silt loam that is high in sand.

The B horizon has hue of 10YR or 2.5Y, value of 4 to 5, and chroma of 2 to 8 and is mottled. The matrix color of the upper part of this horizon is 2 chroma.

Typically a stone line separates the I material from the II material. The IIB and IIC horizons are heavy loam, light clay loam, or sandy clay loam. Depth to carbonates commonly coincides with solum thickness. The reaction of the most acid part of the solum ranges from medium acid to strongly acid.

Readlyn soils formed in material similar to that of Oran, Kenyon, and Tripoli soils. They are associated with Kenyon, Tripoli, Clyde, and Floyd soils. Readlyn soils have a thicker dark colored A horizon than Oran soils. They have a grayer subsoil and are more poorly drained than Kenyon soils. They are less gray and are better drained than Tripoli and Clyde soils. They are shallower over firm loam till than Floyd and Clyde soils.

399—Readlyn loam, 1 to 3 percent slopes. This soil is on upland divides or in slightly concave heads of drainageways.

Included with this soil in mapping are a few areas of soils which are deeper than 2 feet to glacial till, and a few small areas of soils that have dense, weathered, clayey glacial material, or gumbotil, at a depth of 20 to 40 inches. The gumbotil areas, identified on the soil map by spot symbols, are less fertile and are seepy during wet periods.

This soil is well suited to corn and soybeans year after year. It has a seasonal high water table and benefits from tile drainage. Capability unit I–2.

Rockton Series

The Rockton series consists of gently sloping, well drained soils on uplands. These soils formed in 30 to 40 inches of loamy material and an intermittent thin layer of limestone residuum over limestone bedrock. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and dark brown loam 15 inches thick. The subsoil extends to a depth of 34 inches. It is brown loam in the upper part and dark yellowish brown loam in the middle part and grades to yellowish brown sandy clay loam in the lower part. The substratum is partly weathered, shattered limestone and thin rinds of clay residuum between the rocks.

Rockton soils have low to moderate available water capacity and are moderately permeable. They are high in organic-matter content. The subsoil is very low in available phosphorus and potassium.

These soils are used for row crops, but they tend to be droughty unless rainfall is timely.

Representative profile of Rockton loam, 30 to 40 inches to limestone, 2 to 5 percent slopes, 1,200 feet east and 135 feet north of southwest corner sec. 23, T. 87 N., R. 12 W., in bluegrass pasture:

A1—0 to 11 inches; very dark brown (10YR 2/2) loam; moderate fine granular structure; friable; neutral; clear boundary.

A3—11 to 15 inches; dark brown (10YR 3/3) loam; nearly continuous very dark gray (10YR 2/2) coatings on faces of peds; moderate fine granular structure; friable; medium acid; clear boundary.

B21—15 to 21 inches; brown (10YR 4/3) loam; nearly continuous dark brown (10YR 3/3) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; clear boundary.

B22—21 to 28 inches; dark yellowish brown (10YR 4/4) loam; nearly continuous brown (10YR 4/3) coatings on faces of peds; weak medium subangular blocky structure; friable; slightly acid; clear boundary.

B3—28 to 34 inches; yellowish brown (10YR 5/4) sandy clay loam; weak medium subangular blocky structure; friable; slightly acid; abrupt boundary.

IIR—34 inches; fractured limestone bedrock with some residuum rinds on limestone particles in upper part.

The solum thickness and depth to limestone bedrock ranges from 30 to 40 inches. The A horizon has value of 2 or 3 and chroma of 1 or 2 in 10YR hue and is 10 to 18 inches thick. Texture is typically loam, but ranges to silt loam.

The B horizon has value of 4 or 5 and chroma of 3 to 6 in 10YR hue in the upper part and 7.5YR or 10YR hue in the lower part. The B3 horizon is about 25 to 35 percent clay. In some areas, residuum does not occur. In others, it is evident only by rinds around limestone flags or is up to 6 inches thick. Textures are heavy clay loam, clay, or silty clay.

Rockton soils formed in material similar to that of Aredale, Kenyon, and Sogn soils. They are more shallow over limestone bedrock than Aredale and Kenyon soils but are deeper to bedrock than Sogn soils.

213B—Rockton loam, 30 to 40 inches to limestone, 2 to 5 percent slopes. This soil is on convex side slopes or upland divides.

Included with this soil in mapping are a few areas of less sloping soils. Depth to bedrock is generally 30 to 40 inches, but there are some areas of soils that have limestone less than 30 inches deep. Also included and identified on the soil map by spot symbols are a few small areas where limestone outcrops on the surface. Some areas of more erodible, moderately sloping soils, where the subsoil material is mixed with the plow layer, and areas that are slightly more droughty because of increased runoff and loss of organic-matter content are also included.

This soil is well suited to row crops but may be droughty if rainfall is not timely. Terracing is difficult in some areas because of the shallowness to bedrock. Capability unit IIe–3.

Saude Series

The Saude series consists of nearly level and gently sloping, well drained soils on stream benches. These soils formed in 24 to 32 inches of loamy material over sand and gravel. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and dark brown loam 17 inches thick. The subsoil extends to a depth of 33 inches. It is brown loam in the upper part and grades to loamy sand in the lower part. The substratum is strong brown sand, with some gravel, that grades to yellowish brown sand.

Saude soils have a low to moderate available water capacity. Permeability is moderate and moderately rapid in the medium and moderately coarse textured material and very rapid in the coarse material. The organic-matter content is moderate. The subsoil is low in available phosphorus and very low in available potassium.

These soils are used for row crops but are droughty unless rainfall is above normal and timely.

Representative profile of Saude loam, 0 to 2 percent slopes, 560 feet west and 1,185 feet south of northeast corner SE$\frac{1}{4}$ sec. 24, T. 88 N., R. 12 W., in meadow:

Ap—0 to 6 inches; very dark brown (10YR 2/2) loam; cloddy; friable; medium acid; abrupt boundary.

A12—6 to 17 inches; dark brown (10YR 3/3) loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine granular structure; friable; medium acid; clear boundary.

B1—17 to 23 inches; brown (10YR 4/3) loam; nearly continuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; medium acid; clear boundary.

B2—23 to 27 inches; brown (10YR 4/4) loam; brown (10YR 4/3) coatings on faces of peds; weak coarse prismatic structure parting to weak medium and fine subangular blocky; friable; medium acid; gradual boundary.

B31—27 to 30 inches; brown (10YR 4/4) sandy loam; dark brown (7.5YR 3/2) coatings on faces of peds; weak medium subangular blocky structure parting to weak fine subangular blocky; very friable; few fine pebbles; medium acid; gradual boundary.

IIB32—30 to 33 inches; brown (7.5YR 4/4) loamy sand; dark brown (7.5YR 3/2) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure parting to weak fine subangular blocky; very friable; few fine pebbles; medium acid; gradual boundary.

IIC1—33 to 40 inches; strong brown (7.5YR 5/6) medium and fine sand; up to 15 percent gravel; single grained; loose; medium acid; gradual boundary.

IIC2—40 to 60 inches; yellowish brown (10YR 5/6) medium and coarse sand; single grained; loose; medium acid.

The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A horizon is typically 10 to 15 inches thick but ranges to as much as 20 inches. It is typically loam but ranges to sandy loam.

The B horizon typically has hue of 10YR, value of 4 or 5, and chroma of 3 to 6. It is typically medium acid but ranges from slightly acid to strongly acid. Clay content ranges from 10 to 20 percent.

The C horizon is medium and coarse loamy sand and sand with some gravel. Depth to loamy sand, gravelly sand, and sand is typically 24 to 32 inches but ranges from 18 to 36 inches. The coarse materials are acid. Carbonates are leached to a depth of 6 feet or more. Gravel content ranges from 5 to 15 percent by volume.

Saude soils formed in material similar to that of Waukee, Wapsie, Flagler, and Lawler soils. They are shallower over sand and gravel than Waukee soils and have a thicker, dark A horizon. They are better drained and have a browner B horizon than Lawler soils. They are finer textured in the upper part of the solum than Flagler soils.

177—Saude loam, 0 to 2 percent slopes. This soil is on alluvial terraces. It has the profile described as typical of the series.

Included with this soil in mapping are some areas of soils with a silty surface layer. Also included and identified by spot symbols on the soil map are small areas of sand and gravel outcrops. In these areas the soil is more droughty than this Saude soil. Additional plant residue is needed to conserve moisture.

This soil is moderately well suited to row crops. It is droughty when rainfall is average or below. Good yields can be obtained if rainfall is timely and above average. Capability unit IIs–1.

177B—Saude loam, 2 to 5 percent slopes. This soil is on alluvial terraces. It has a profile similar to the one described as typical of the series, but the surface layer is slightly thinner.

Included with this soil in mapping are small areas where the surface layer contains more silt and small areas of sand and gravel outcrops, which are identified by spot symbols on the soil map. Also included are some moderately sloping, eroded soils in which the subsoil material is mixed with the plow layer and the material is slightly more droughty because of increased runoff and loss of organic matter. All the included areas are droughty. Additional plant residue is needed to conserve moisture. Stripcropping, minimum tillage, and contouring are needed in erosion control.

This soil is moderately well suited to row crops. It is subject to erosion in cultivated areas. It is droughty when rainfall is normal or below. Good yields can be obtained when rainfall is timely and above normal. Capability unit IIe–4.

U177—Saude-Lawler-Urban land complex, 0 to 3 percent slopes. This nearly level to gently sloping map unit is on low alluvial benches. It is about 35 percent Saude soil, 15 percent Lawler soil, and 35 percent Urban land. The soils are well drained to somewhat poorly drained. They formed in alluvium under grass vegetation. The Urban land part is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible.

The surface layer is generally medium textured, but included in mapping are areas where it is moderately coarse and coarse textured. Also included are areas where the soil has a dark surface layer 36 inches or more thick, receives runoff from higher slopes, and impounds water for short periods. Intense rainfall causes flooding in some areas.

All the acreage is used for homesites and commercial development. Onsite investigation is needed to determine physical and chemical properties.

Sawmill Series

The Sawmill series consists of nearly level, poorly drained soils on flood plains and in the lower part of upland drainageways. These soils formed in moderately fine textured alluvial deposits. The native vegetation was water-tolerant prairie grasses and sedges.

In a representative profile the surface layer is black and very dark gray silty clay loam 29 inches thick. The subsoil extends to a depth of 52 inches. It is olive gray silty clay loam to a depth of 40 inches and grades to mottled strong brown and gray to a depth of 46 inches. Between 46 and 52 inches it is strong brown light silty clay loam. The substratum is olive gray silty clay loam.

Sawmill soils are moderately slowly permeable and have high available water capacity. They are high in organic-matter content. The subsoil is medium in available phosphorus and very low in available potassium.

Areas of these soils that do not overflow too frequently and are not cut up by stream channels are used for row crops year after year. Areas that overflow frequently are generally in pasture.

Representative profile of Sawmill silty clay loam, 756 feet north and 54 feet west of southeast corner sec. 18, T. 87 N., R. 13 W., in bluegrass pasture:

A1—0 to 20 inches; black (10YR 2/1) silty clay loam; weak fine granular structure; friable; neutral; clear boundary.

A3—20 to 29 inches; very dark gray (10YR 3/1) silty clay loam; common fine distinct olive gray (5Y 5/2) mottles; few fine brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; friable; neutral; clear boundary.

B2g—29 to 40 inches; olive gray (5Y 5/2) silty clay loam; weak medium prismatic structure parting to moderate fine subangular blocky; friable; common fine black oxides; some root channels with very dark grayish brown (10YR 3/2) staining; neutral; gradual boundary.

B31—40 to 46 inches; mottled strong brown (7.5YR 5/6) and gray (10YR 6/1) silty clay loam; weak medium prismatic structure parting to medium and fine subangular blocky; friable; neutral; gradual boundary.

B32—46 to 52 inches; strong brown (7.5YR 5/6) light silty clay loam; common fine distinct grayish brown (10YR 5/2) mottles and streaks surrounding old small root channels; common fine distinct brown (7.5YR 4/4) and strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; friable; neutral; gradual boundary.

Cg—52 to 60 inches; olive gray (5Y 5/2) light silty clay loam; common very fine olive (5Y 5/3) mottles and common fine greenish gray (5BG 5/1) mottles and streaks surrounding old root channels; massive; firm; neutral.

The solum ranges from 36 to 60 inches in thickness. The Ap or A1 horizon ranges from black (N 2/0) to very dark brown (10YR 2/2) or very dark gray (10YR 3/1). The A horizon ranges in thickness from 25 to 30 inches and in texture from heavy silt loam to silty clay loam.

The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5, and chroma of 1 and 2 with mottles.

The C horizon is generally silty clay loam but may contain strata of silt loam, loam, sandy loam, or loamy sand.

Sawmill soils are associated with Colo and Garwin soils and have the same drainage as Bremer soils. They formed in material similar to that of Colo soils. Sawmill soils have a thicker, dark surface layer than Garwin and Bremer soils and have a thinner, dark surface layer than Colo soils. They are lower in clay content throughout the solum than Bremer soils.

933—Sawmill silty clay loam, 0 to 2 percent slopes. This soil is mainly in the lower part of the upland waterways that drain loess covered slopes. The areas are generally 500 to 1,000 feet wide and extend downstream for more than 1 mile. This Sawmill soil occurs in waterways between Garwin soils and areas mapped as Colo-Ely complex in the upper part of the waterways and the soils on nearly level flood plains that are below the point where the waterways change gradient. It also occurs on nearly level flood plains that are adjacent to some of the smaller creeks in the survey area. These areas are generally somewhat more than 1,000 feet wide and are about 1 mile long.

Included with this soil in mapping are small areas of soils that have a dark surface layer less than 25 inches thick, some small areas where the surface layer is slightly more than 30 inches thick, and small areas of soils that are underlain by loamy sediment at a depth slightly less than 48 inches. Also included and identified on the soil map by spot symbols are a few small sandy areas and a few small mucky areas.

If well drained and protected from flooding, this soil is well suited to row crops year after year. Tilth is generally good. This soil puddles readily if worked when wet. Capability unit IIw–1.

Sogn Series

The Sogn series consists of gently sloping to moderately sloping, somewhat excessively drained soils on convex ridges and short side slopes on uplands. These soils formed in 4 to 20 inches of loamy materials over limestone bedrock. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and grades to very dark grayish brown loam 17 inches thick. The substratum is fractured limestone over hard limestone bedrock.

These soils have very low available water capacity and are moderately permeable. They are low in organic-matter content. The subsoil is very low in available phosphorus and potassium. These soils are neutral, and limestone fragments are common on the surface and throughout the profile.

These soils are seldom used for row crops because of the shallowness over bedrock. Most areas are used for pasture.

Representative profile of Sogn loam, 2 to 9 percent slopes, 1,200 feet east and 265 feet north of southwest corner sec. 23, T. 87 N., R. 12 W., in bluegrass pasture:

A1—0 to 12 inches; very dark brown (10YR 2/2) loam; moderate fine granular structure; friable; slightly acid; clear boundary.

A3—12 to 17 inches; very dark grayish brown (10YR 3/2) loam; some limestone flags 10 to 20 percent by volume; moderate medium granular structure; friable; moderately alkaline; strong effervescence; abrupt boundary.

R1—17 inches; fractured limestock bedrock.

Thickness of the solum and depth to limestone range from 4 to 20 inches. The A1 horizon is very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2) and is 5 to 15 inches thick. An A3 horizon is present in some profiles and is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). The A horizon ranges from loam or silt loam that is high in sand to heavy sandy loam or light clay loam. In some places there is 1 to 4 inches of clay or silty material above the limestone. The average annual rainfall is higher than is defined as the range for the Sogn series.

Sogn soils are associated with Rockton and Bertram soils. They are shallower over bedrock than those soils.

412C—Sogn loam, 2 to 9 percent slopes. This soil is on convex slopes on uplands.

Included with this soil in mapping are areas where bedrock is near or is exposed at the surface as shattered slabs. Also included are small areas that have slightly more than 20 inches of soil over bedrock.

This soil is better suited to pasture or hay. It is not well suited to row crops because it has a very limited root zone and is droughty. Tillage is very difficult because of the exposure to bedrock and limestone slabs on the surface. This soil is subject to erosion in cultivated areas. Some areas have been cultivated, but most are now in pasture. Capability unit IVs–1.

Sparta Series

The Sparta series consists of nearly level to moderately steep, excessively drained soils on alluvial terraces and uplands. These soils formed in sand deposited mainly by wind, but in some places by water. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark grayish brown and dark brown loamy fine sand 17 inches thick. The subsoil extends to a depth of 26 inches. It is dark yellowish brown loamy fine sand. The substratum is dark yellowish brown and yellowish brown fine sand.

Sparta soils have rapid permeability. The available water capacity is low. These soils are low in organic-matter content. The subsoil is very low in available phosphorus and potassium. These soils are acid unless limed within the past 3 or 4 years.

Some of these soils can be used for row crops if they are properly managed. Yields of all crops are below average, even under good management, unless rainfall is above average and very timely. Sparta soils are very droughty. They are subject to soil blowing and water erosion. Land use of the less sloping soils is determined by the adjacent soils. Steeper soils are used mainly for pasture.

Representative profile of Sparta loamy fine sand, 2 to 5 percent slopes, 510 feet west and 480 feet north of southeast corner NW¼ sec. 4, T. 89 N., R. 13 W., in a cultivated field:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loamy fine sand; weak fine granular structure; very friable; slightly acid; abrupt boundary.

A3—7 to 17 inches; dark brown (10YR 3/3) loamy fine sand; weak coarse subangular blocky structure parting to single grained; very friable; slightly acid; clear boundary.

B2—17 to 26 inches; dark yellowish brown (10YR 4/4) loamy fine sand; weak coarse subangular blocky structure parting to single grained; very friable; medium acid; clear boundary.

C1—26 to 38 inches; dark yellowish brown (10YR 4/4) fine sand; single grained; loose; medium acid; clear boundary.

C2—38 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; slightly acid.

The thickness of the solum ranges from 24 to 40 inches. Thickness of dark colors ranges from 15 to 24 inches. Texture of the A horizon ranges from loamy fine sand to loamy sand or fine sand.

The B horizon has hue of 10YR and ranges in value and chroma from 3 to 6. Texture is fine sand, loamy sand, or loamy fine sand. Fine and medium sand are dominant throughout the control section.

Sparta soils formed in material similar to that of Dickinson, Chelsea, Flagler, Finchford, and Lamont soils. They are coarser textured in the upper part than Dickinson and Lamont soils. Sparta soils have a thicker, darker A horizon than Chelsea and Lamont soils. They contain more sand in the upper part of the solum and are deeper to gravel than Flagler soils.

Sparta soils have a solum that is medium and fine sand without gravel, whereas Finchford soils have medium and coarse sand with gravel throughout the entire solum and substratum.

41—Sparta loamy fine sand, 0 to 2 percent slopes. This excessively drained soil is on alluvial terraces and in places is underlain by coarser sand and gravel below 4 feet. It has a profile similar to the one described as typical of the series, but the very dark brown or very dark grayish brown surface layer is generally 18 to 24 inches thick.

Included with this soil in mapping are a few areas where the dark colored surface layer is considerably more than 24 inches thick and is slightly higher in organic-matter content. Also included are some small areas where the surface layer is coarser than loamy fine sand or in places is sandy loam.

This soil is not well suited to row crops. Yields are generally low but vary, depending on amount and timeliness of rainfall. This soil is droughty and is subject to soil blowing (fig. 9). Capability unit IVs–1.

41B—Sparta loamy fine sand, 2 to 5 percent slopes. This gently sloping soil is on convex slopes on uplands that typically blend with the landscape and are generally adjacent to some stream valleys. It also occurs as isolated areas in the glacial uplands and on alluvial terraces. In a few places it is on dunelike, low, elongated ridges oriented from northwest to southeast. This soil has the profile described as typical of the series.

Included with this soil in mapping are small areas where the surface layer is sandy loam. Some small areas have a coarser textured, lighter colored surface layer, which is lower in organic-matter content than this Sparta soil. These eroded areas are identified by spot symbols on the soil map. Also included are areas that are moderately sloping, some of which have a thinner, lighter colored surface layer and are lower in organic-matter content. In some upland areas glacial till occurs within 4 feet, and in a few small areas it outcrops on the surface. These outcrops are also identified on the soil map by spot symbols.

Figure 9.—**Tree planting on Sparta loamy fine sand.**

This soil is not well suited to row crops, but if rainfall is timely and above normal, yields are greatly increased. It is subject, however, to slight water erosion and soil blowing. Capability unit IVs–1.

41C—Sparta loamy fine sand, 5 to 9 percent slopes. This soil is in areas adjacent to drainageways and in isolated areas. Some areas are east of the Cedar River on elongated, nearly continuous ridges that are as much as 1 mile or more long and as much as 1/8 mile wide. These ridges are oriented northwest to southeast. Also, there are some areas with complex moderate slopes and small, enclosed depressions south and east of the Cedar River. The depressions have a stratified, loamy, dark colored surface layer 25 to 48 inches thick. Most dunelike areas with depressions are not cultivated regularly but are used for pasture. A few areas are on moderately sloping alluvial terraces.

This soil has a profile similar to the one described as typical of the series, but it commonly has a thinner, dark surface layer that is 12 to 16 inches thick. It is generally free of gravel, but a few areas, especially on the terraces, have some gravel below 40 inches.

Included with this soil in mapping and identified on the soil map by spot symbols are some areas of soils in the uplands that have glacial till, which outcrops at the surface. Also included are areas where the surface layer is lighter colored and thinner and areas of soils with a sandy loam surface layer.

This soil is not well suited to row crops. It is excessively drained and droughty. It is subject to soil blowing and water erosion in cultivated areas. Capability unit IVs–1.

41D—Sparta loamy fine sand, 9 to 18 percent slopes. This soil is on convex side slopes along the major streams or drainageways and in some places on narrow, convex ridges. It has a profile similar to the one described as typical of the series, but it has a very dark brown to very dark grayish brown surface layer about 12 inches thick.

Included with this soil in mapping and indicated by spot symbols on the soil map are areas where the surface layer is less than 7 inches thick and is lower in organic-matter content and fertility than the uneroded soil. Also included are areas of sandy loam soils more than 24 inches deep, which also have glacial till between depths of 36 and 60 inches.

This soil is excessively drained and droughty. It is subject to soil blowing and water erosion. Row crops are generally not grown. The soil is best suited to hay and pasture and is not suited to row crops. Capability unit VIs–1.

U41C—Sparta-Dickinson-Urban land complex, 0 to

9 percent slopes. This gently sloping and moderately sloping map unit is on alluvial benches and uplands that have been altered by man for city and urban development. Most areas of this unit are in the northeastern part of Waterloo. Generally, this unit is about 25 percent Sparta soils, 10 percent Dickinson soils, and 60 percent Urban land. The Urban land part of this unit is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible. These areas formed in medium to coarse textured eolian material under grass vegetation. Most areas are excessively drained or somewhat excessively drained.

Included with this soil in mapping are small areas with moderately slowly permeable glacial till within a depth of 3 feet, where hillside seeps may occur during periods of extended precipitation. Also included are small areas that are underlain by fractured bedrock at a depth less than 4 feet. In some areas there are upland waterways that are somewhat poorly drained and poorly drained, are cut into moderately slowly permeable glacial till, and contain between 2 and 5 feet of loamy or sandy sediment.

All the acreage is used for homesites and commercial development. Onsite investigations are needed to determine physical and chemical properties. Interpretations based on these properties may differ from those given for individual soils throughout this survey.

Spillville Series

The Spillville series consists of nearly level, moderately well drained to somewhat poorly drained soils on flood plains and along intermittent streams. These soils formed in medium textured loamy alluvium. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown and grades to very dark gray loam. It extends to a depth of about 52 inches. The substratum is very dark gray loam to a depth of 60 inches.

Spillville soils are moderately permeable and have high available water capacity. They are high in organic-matter content. The subsoil is low in available phosphorus and very low in available potassium. These soils are commonly neutral in reaction and generally do not need lime.

These soils are chiefly used for and are well suited to row crops year after year. They are subject, however, to occasional flooding. Some areas along narrow streams are in native grass pasture.

Representative profile of Spillville loam, 0 to 2 percent slopes, 1,056 feet west and 660 feet south of northeast corner SE¼ sec. 19, T. 87 N., R. 11 W., in an area of Spillville-Alluvial land complex, in a cultivated field:

Ap—0 to 8 inches; black (10YR 2/1) loam; weak structure; friable; neutral; clear boundary.

A12—8 to 21 inches; black (10YR 2/1) loam; weak medium subangular blocky structure parting to weak fine granular; friable; neutral; gradual boundary.

A13—21 to 39 inches; very dark brown (10YR 2/2) loam; weak medium and coarse subangular blocky structure; friable; few fine soft brown (7.5YR 4/4) oxides; neutral; gradual boundary.

A14—39 to 52 inches; very dark gray (10YR 3/1) loam; weak coarse subangular blocky structure; friable; few fine soft brown (7.5YR 4/4) oxides; neutral; gradual boundary.

C—52 to 60 inches; very dark gray (10YR 3/1) light loam; weak coarse subangular blocky structure; friable; common fine soft brown (7.5YR 4/4) oxides; neutral.

The solum ranges from 40 to 60 inches in thickness. The A horizon is typically black (10YR 2/1) or very dark brown (10YR 2/2). Some profiles are very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1) to a depth of 40 inches or more. The texture is typically loam, but there is some silt loam that is high in sand.

Below the A horizon is a B or C horizon commonly with hue of 10YR but in some areas with 2.5Y. Value is 3 or 4 and chroma is 1 or 2. Texture is commonly loam. In places it is sandy loam with strata of loamy sand below 40 inches. The solum is commonly neutral or slightly acid.

Spillville soils are associated with Colo, Waukee, and Lawler soils. They are better drained and contain less clay and more sand than Colo soils. Unlike Spillville soils, Waukee and Lawler soils have moderately coarse or coarse textured materials at a depth of 24 to 40 inches and have a dark colored surface layer that extends to a depth less than 24 inches.

485—Spillville loam, 0 to 2 percent slopes. This soil is on the bottom land of the major rivers and narrow, intermittent streams.

Included with this soil in mapping are small areas that are more sandy than is typical of the series and are less productive.

This soil is well suited to row crops year after year. It is subject to flooding, however, particularly along intermittent streams during periods of heavy rainfall. This causes a reduction in crop yields. Capability unit I–2.

585—Spillville-Alluvial land complex, 0 to 2 percent slopes. This map unit is on alluvial flood plains associated with the major streams and some of their tributaries in the survey area. Some areas are islands surrounded by the Cedar River. The topography is uniform, but in some places, areas are dissected to some degree by depressions or discontinuous stream channels. This unit is about 50 percent Spillville soils. The rest is well drained to poorly drained, sometimes highly stratified loamy and sandy soils that have a dark colored surface layer and are less than 24 inches thick. In some areas the stratified subsoil and substratum contain layers of coarse textured material 2 to 3 feet thick.

Some small intermittent ponds and areas that have sandy textures are identified on the soil map by spot symbols. Water may be impounded for periods long enough to damage crops and reduce yields. Areas of soils that have a coarse textured surface layer tend to be droughty. Unless protected, they are more susceptible to soil blowing than the surrounding area.

These soils are moderately well suited to row crops.

The productivity of cultivated crops varies because of the difficulty of drainage and the varying available water capacity, fertility, and management requirements. The soils are subject to flooding. In 1 or more years out of 10, flooding has prevented crop production in some areas. Levees reduced the frequency of flooding in some places. Unless drained and protected from flooding, many areas are in pasture or have reverted to grass.

Because of the frequency of damage by floodwater, permanent fencing is difficult to maintain. This creates problems for livestock grazing. Many of these areas could be developed for certain recreational activities without loss of crop production. Capability unit IIw–3.

Tama Series

The Tama series consists of nearly level to gently sloping, well drained soils in convex areas on uplands and on loess-covered terraces. These soils formed in loess more than 40 inches thick. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown silty clay loam about 22 inches thick. The subsoil extends to a depth of 52 inches. It is brown silty clay loam in the upper part and yellowish brown silty clay loam in the lower part. The substratum is yellowish brown silt loam with brown and grayish brown mottles.

Tama soils are moderately permeable and have high available water capacity. They are high in organic-matter content. The subsoil is medium in available phosphorus and very low in available potassium. These soils are acid unless lime has been applied within the past 5 years.

Tama soils are chiefly used for row crops. They have good tilth and are easy to work.

Representative profile of Tama silty clay loam, 2 to 5 percent slopes, 1,300 feet north and 495 feet west of center sec. 30, T. 87 N., R. 14 W., in meadow:

Ap—0 to 8 inches; black (10YR 2/1) light silty clay loam; cloddy; neutral; abrupt boundary.

A12—8 to 17 inches; very dark brown (10YR 2/2) light silty clay loam; moderate medium granular structure; friable; neutral; clear boundary.

A13—17 to 22 inches; very dark brown (10YR 2/2) light silty clay loam; moderate fine granular structure; friable; strongly acid; clear boundary.

B1t—22 to 29 inches; brown (10YR 4/3) silty clay loam; very dark brown (10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; very thin discontinuous clay films; strongly acid; gradual boundary.

B2t—29 to 35 inches; brown (10YR 4/3) silty clay loam; dark brown (10YR 3/3) coatings on faces of peds; moderate medium and fine subangular blocky structure; friable; thin nearly continuous clay films; strongly acid; gradual boundary.

B31t—35 to 41 inches; yellowish brown (10YR 5/4) light silty clay loam; few fine distinct grayish brown (10YR 5/2) and few fine faint brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; friable; very few very thin clay films; medium acid; gradual boundary.

B32t—41 to 52 inches; yellowish brown (10YR 5/4) light silty clay loam; few fine distinct grayish brown (10YR 5/2) and few fine faint brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to weak medium and coarse subangular blocky; friable; medium acid; abrupt boundary.

C—52 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine distinct grayish brown (10YR 5/2) and few fine faint brown (7.5YR 4/4) mottles; massive; friable; neutral.

The solum ranges from about 40 to 60 inches in thickness. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The thickness ranges from 13 to 20 inches unless it is eroded. Texture ranges from silt loam to silty clay loam.

The B horizon typically has 10YR hue, value of 3 to 5, and chroma of 3 to 6. The B2t horizon ranges in clay content from 27 to 35 percent. Depth to grayish mottles is about 30 to 50 inches. These soils are medium to strongly acid in the most acid part.

Tama soils formed in material similar to that of Garwin, Dinsdale, and Muscatine soils. They formed in loess more than 40 inches thick. They have less sand in the lower part of the solum than Dinsdale soils, which formed in loess and glacial till. Tama soils have a browner B horizon than Muscatine and Garwin soils and are better drained.

120B—Tama silty clay loam, 2 to 5 percent slopes. This soil is on upland ridges and side slopes. It has the profile described as typical of the series.

Included with this soil in mapping are small areas that have glacial till at a shallower depth, are lower in fertility, and are less permeable than this Tama soil. Also included and identified on the soil map by spot symbols are a few small areas where the glacial till outcrops on the surface; a few small areas with a thinner, lighter colored surface layer, which is lower in organic-matter content; and a few small areas of soils that have dense, weathered, clayey glacial material, or gumbotil, at a depth of 24 to 40 inches and are lower in fertility and seepy during wet periods.

If well managed, this soil is well suited to row crops year after year. Erosion is a problem, however, in cultivated areas. This soil is suited to minimum tillage, contouring, terracing, or stripcropping. Capability unit IIe–2.

T120—Tama silty clay loam, benches, 0 to 2 percent slopes. This soil is on loess-covered benches above the flood plains. It formed in 4 to 6 feet of loess over coarser textured material. It has a profile similar to the one described as typical of the series, but the surface layer is very dark brown and grades to very dark grayish brown, friable silty clay loam at a depth of about 12 inches to 18 inches. Loamy and sandy textured material is at a depth of about 4 to 6 feet.

This soil is well suited to corn and soybeans year after year. In places it receives runoff water and sediment from higher soils. If properly placed, diversions are beneficial. Capability unit I–1.

Tripoli Series

The Tripoli series consists of nearly level, poorly drained soils on uplands. These soils are on the slightly concave to nearly level upland divides or at the heads of drainageways. They formed in 18 to 28 inches of loamy surficial sediment and the underlying firm glacial till. In most places a layer of pebbles and stones is at the contact of the loamy material and the glacial till. The native vegetation was mixed prairie grasses and water-tolerant plants.

In a representative profile the surface layer is black light clay loam 19 inches thick. The subsoil extends to a depth of 52 inches. It is dark grayish brown loam in the upper part. Below this is light olive brown, brown, and mottled yellowish brown and gray firm loam. The substratum is yellowish brown loam with grayish brown and strong brown mottles.

Tripoli soils have high available water capacity. Permeability is moderate in the upper part and moderately slow in the lower part. The subsoil is low in available phosphorus and potassium. These soils are high in organic-matter content. They are neutral to mildly alkaline and generally do not need lime.

These soils are mainly suited to row crops year after year.

Representative profile of Tripoli clay loam, 0 to 2 percent slopes, 585 feet west and 66 feet north of southeast corner NE¼ sec. 10, T. 90 N., R. 12 W., in meadow:

Ap—0 to 6 inches; black (N 2/0) light clay loam; cloddy; friable; neutral; abrupt boundary.

A12—6 to 14 inches; black (N 2/0) light clay loam; moderate fine granular structure; friable; neutral; clear boundary.

A3—14 to 19 inches; black (10YR 2/1) light clay loam; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; friable; few dark oxides; neutral; gradual boundary.

B1g—19 to 26 inches; dark grayish brown (2.5Y 4/2) heavy loam; nearly continuous dark gray (10YR 4/1) coatings on faces of peds in the upper part, diminishing to discontinuous with depth; common fine distinct light olive brown (2.5Y 5/6) and few fine faint dark gray (10YR 4/1) mottles; weak fine subangular blocky structure; friable; thin discontinuous pebble band at 26 inches; few fine dark oxides; neutral; gradual boundary.

IIB2—26 to 33 inches; light olive brown (2.5Y 5/4) heavy loam; grayish brown (2.5Y 5/2) coatings on faces of peds; common fine distinct yellowish brown (10YR 5/6) and few fine faint light brownish gray (10YR 6/2) mottles; moderate medium prismatic structure parting to moderate medium angular blocky and subangular blocky; firm; neutral; gradual boundary.

IIB31—33 to 45 inches; brown (10YR 5/3) loam; common medium and fine distinct yellowish brown (10YR 5/6) and common fine distinct light brownish gray (10YR 6/2) mottles; moderate coarse prismatic structure parting to moderate medium and fine subangular blocky; firm; few fine dark oxides; neutral; abrupt boundary.

IIB32—45 to 52 inches; mottled yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) loam; moderate coarse prismatic structure parting to moderate medium subangular blocky; firm; mildly alkaline; gradual boundary.

IIC—52 to 60 inches; yellowish brown (10YR 5/4) loam; continuous gray (10YR 6/1) coatings on faces of prisms; few fine distinct strong brown (7.5YR 5/6) and common fine distinct grayish brown (10YR 5/2) mottles; massive; some vertical cleavage; firm; few roots along prism faces to 59 inches; common soft lime nodules; moderately alkaline.

The solum ranges from about 40 to 55 inches in thickness. The loamy material in the upper part ranges from 18 to 28 inches in thickness over the underlying firm glacial till. Typically a stone line separates the I material and the II material. The A horizon is black (N 2/0 or 10YR 2/1) in the upper part and very dark gray (10YR 3/1 or 5Y 3/1) in the lower part. It ranges from 15 to 22 inches in thickness and in texture from light or medium clay loam to silty clay loam that is high in sand.

The IIB2 horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2 with higher chroma mottles. Texture of the IIB and IIC horizons is generally heavy loam but ranges to light clay loam and sandy clay loam. Carbonates typically occur within 60 inches.

Tripoli soils formed in material similar to that of Kenyon, Readlyn, and Oran soils, and they are associated with Clyde, Oran, Kenyon, Readlyn, and Floyd soils. Tripoli soils are more poorly drained and have a grayer B horizon than Floyd, Kenyon, Oran, and Readlyn soils. They are shallower over firm glacial till and carbonates than Clyde soils.

398—Tripoli clay loam, 0 to 2 percent slopes. This soil is on the slightly concave upland flats and at the heads of upland drainageways.

Included with this soil in mapping are areas of soils that have a loam surface layer.

This soil is well suited to corn and soybeans year after year. It generally has good tilth but will puddle if worked when wet. Wetness is the major limitation. Yields are usually not very good unless the soil is tiled. Suitable tile outlets are generally available. Capability unit IIw–1.

Wapsie Series

The Wapsie series consists of nearly level to gently sloping, well drained soils on alluvial terraces. These soils formed in 24 to 32 inches of loamy material over coarse textured sand and gravel. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish brown loam 7 inches thick. The subsurface layer is brown loam 3 inches thick. The subsoil extends to a depth of 30 inches and is dark yellowish brown loam. The lower part to a depth of 30 inches is yellowish brown loam that grades to fine sandy loam. The substratum is yellowish brown gravelly loamy sand.

Permeability of these soils is moderate and moderately rapid in the upper part and very rapid in the coarse textured substratum. These soils have low to moderate available water capacity. The organic-matter content is low to moderate. The subsoil is low in available phosphorus and very low in available potassium.

Wapsie soils are mainly used for row crops, but they are droughty when rainfall is below average.

Representative profile of Wapsie loam, 1 to 3 percent slopes, 50 feet south and 594 feet east of center sec. 15, T. 90 N., R. 11 W., in cultivated field:

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

A2—7 to 10 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) coatings on peds; dry; weak fine platy structure parting to weak fine granular; friable; discontinuous pale brown (10YR 6/3) sand coatings on faces of peds when dry; neutral; clear boundary.

B21t—10 to 16 inches; dark yellowish brown (10YR 4/4) medium loam; dark yellowish brown (10YR 3/4) coatings on peds; weak fine subangular blocky structure; friable; continuous light brownish gray (10YR 6/2) sand coatings on faces of peds when dry; few discontinuous clay films on faces of peds; neutral; gradual boundary.

B22t—16 to 21 inches; dark yellowish brown (10 YR 4/4) heavy loam; dark yellowish brown (10YR 3/4) coatings on peds; weak fine subangular blocky structure; friable; few discontinuous light brownish gray (10YR 6/2) sand coatings on faces of peds when dry; few discontinuous clay films on faces of peds; some dark brown (7.5YR 3/2) stains on faces of peds; medium acid; gradual boundary.

B31—21 to 27 inches; yellowish brown (10YR 5/6) loam; brown (10YR 4/3) coatings on peds; weak coarse prismatic structure parting to weak medium subangular blocky; friable; some dark brown (7.5YR 3/2) stains on faces of peds; strongly acid; clear boundary.

IIB32—27 to 30 inches; yellowish brown (10YR 5/6) sandy loam; brown (10YR 4/3) coatings on peds; weak coarse prismatic structure parting to weak medium subangular blocky; friable; some patchy dark brown (10YR 3/3) staining on faces of prisms; strongly acid; clear boundary.

IIC—30 to 60 inches; yellowish brown (10YR 5/4) gravelly loamy sand; single grained; loose; at 40 inches a concentration of dark brown (7.5YR 3/2) mottles in ½-inch thick strata; strongly acid.

The solum typically ranges from 24 to 40 inches in thickness. It may or may not correspond with the depth to contrasting textures of loamy sand or sand. Depth to these materials ranges from 24 to 32 inches. The A1 or Ap horizon is very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2) and ranges from 6 to 10 inches in thickness. The A2 horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. All of the A2 horizon may be incorporated into the Ap horizon in some eroded and cultivated areas. The A horizon is loam or silt loam that is high in sand.

The B2 horizon has 10YR hue, value of 4 or 5, and chroma of 3 to 8. The B horizon is loam or light sandy clay loam that grades to sandy loam or loamy sand in the lower part. Clay content ranges from about 15 to 20 percent.

The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 4 to 8. Texture is loamy sand or sand, with some gravel in places.

Wapsie soils formed in material similar to that of Marshan, Waukee, and Hayfield soils. They have a thinner dark colored surface layer than Marshan and Waukee soils, and they are better drained than Hayfield or Marshan soils. The upper part of the B horizon is browner in Wapsie soils.

777—Wapsie loam, 1 to 3 percent slopes. This soil is on terraces.

Included with this soil in mapping are small areas of soils, which are coarse textured and are shallower than 24 inches, and a few areas of soils that have a sandy surface layer, are lower in organic-matter content, and are more droughty.

This soil is moderately well suited to row crops, but it is droughty unless rainfall is timely and above average. Capability unit IIs-1.

Waubeek Series

The Waubeek series consists of gently sloping, well drained soils on uplands. These soils formed in 24 to 40 inches of loess and the underlying glacial till. They are on convex slopes. The native vegetation was trees and prairie grasses.

In a representative profile the surface layer is very dark brown silt loam 8 inches thick. The subsoil extends to a depth of 47 inches. The upper part is brown silty clay loam to a depth of about 24 inches. Below this is yellowish brown and strong brown loam mottled with grayish brown. The substratum is strong brown loam mottled with grayish brown.

Waubeek soils have high available water capacity. They are moderately permeable in the upper part and moderately slowly permeable in the lower part. They are moderate in organic-matter content. The subsoil is medium in available phosphorus and very low in available potassium.

Waubeek soils are mainly used for row crops.

Representative profile of Waubeek silt loam, 2 to 5 percent slopes, 895 feet south and 50 feet west of northeast corner NE¼ sec. 24, T. 90 N., R. 11 W., in cultivated field:

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; neutral; abrupt boundary.

B1t—8 to 14 inches; brown (10YR 4/3) light silty clay loam; nearly continuous dark brown (10YR 3/3) coatings on peds; moderate fine subangular blocky structure; friable; few thin discontinuous clay films; discontinuous gray (10YR 6/1) silt coatings on surface of peds when dry; medium acid; gradual boundary.

B21t—14 to 24 inches; brown (10YR 4/3) silty clay loam; few fine strong brown mottles in lower part; moderate fine subangular and angular blocky structure; friable; few thin discontinuous clay films; discontinuous gray (10YR 6/1) silt coatings on faces of peds when dry; few fine dark oxides; strongly acid; clear boundary.

IIB22t—24 to 27 inches; yellowish brown (10YR 5/4) loam; common fine distinct strong brown (7.5YR 5/6) and few fine distinct grayish brown (10YR 5/2) mottles; weak medium and fine subangular blocky structure; friable; few thin discontinuous clay films; few fine stones; common fine dark oxides; discontinuous gray (10YR 6/1) sand and silt coatings on faces of peds when dry; strongly acid; clear boundary.

IIB3—27 to 47 inches; strong brown (7.5YR 5/6) loam; common medium and fine distinct grayish brown (10YR 5/2) mottles; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; firm; few small very dark grayish brown clay filled root channels; thick continuous gray (10YR 6/1) very fine sand and silt coatings on prism faces in upper part; common dark oxides; medium acid; gradual boundary.

IIC1—47 to 60 inches; strong brown (7.5YR 5/6) loam; common fine distinct grayish brown (10YR 5/2) mottles; massive; firm; few fine organic filled root channels in upper part; neutral; clear boundary.

IIC2—60 to 70 inches; same as IIC1 horizon, but is mildly alkaline; strong effervescence; does not have organic filled root channels.

The solum is typically more than 50 inches thick and ranges from 42 to about 60 inches. Waubeek soils formed in loess and glacial till. The loess is commonly 24 to 40 inches thick and ranges from 20 to 40 inches.

The A1 or Ap horizon is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or very dark gray (10YR 3/1) and is 6 to 10 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3) or 5/3). In some cultivated or eroded areas, all of the A2 horizon is incorporated into the Ap horizon.

The upper part of the B horizon ranges from light to medium silty clay loam in 10YR hue with value of 4 or 5 and chroma of 3 to 6. The lower part is in 10YR or 7.5YR hue with value of 4 or 5 and chroma of 4 to 8 with few to common low chroma mottles. Texture of the lower part ranges from loam or sandy clay loam to light clay loam. A stone line or lenses of sandy loam or loamy sand as much as 10 inches thick separates the loess and the glacial till in most places.

Waubeek soils formed in material similar to that of Dinsdale and Franklin soils. They are associated with Tama soils upslope and Dinsdale soils downslope in the deep loess area in the southwest quadrant of the county. In other areas they are associated with Franklin and Bassett soils. Waubeek soils have a thinner dark A horizon than Dinsdale and Tama soils. They have a browner B horizon than Franklin soils and are better drained. Waubeek soils have less sand and more silt in the upper part of the solum than Bassett soils.

771B—Waubeek silt loam, 2 to 5 percent slopes. This soil is on convex slopes of the uplands.

Included with this soil in mapping are small areas of soils that have more sand in the surface layer than is described for the series. Also included and identified on the soil map by spot symbols are small areas of soils that have dense, weathered, clayey glacial material, or gumbotil, at a depth of 24 to 40 inches and are seepy during wet periods.

This soil is well suited to row crops year after year if well managed. It is subject, however, to erosion. Terrace cuts should be kept to a minimum to avoid exposing the glacial till subsoil, which is lower in fertility. Capability unit IIe-2.

Waukee Series

The Waukee series consists of nearly level to gently sloping, well drained soils on alluvial terraces. These soils are underlain by sand and gravel at a depth of 32 to 40 inches. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown loam about 18 inches thick. The subsoil extends to a depth of 38 inches. It is dark brown loam in the upper part and grades to yellowish brown loam to a depth of 34 inches. Below this is 4 inches of yellowish brown gravelly sandy loam. The substratum is yellowish brown loamy sand and sand.

Waukee soils have moderate permeability in the medium textured material and very rapid permeability in the coarser textured material. They have moderate available water capacity. These soils are acid unless they have been limed within the past 5 years. They are high in organic-matter content. The subsoil is low in available phosphorus and very low in available potassium.

These soils are suited to row crops but are slightly droughty when rainfall is below normal.

Representative profile of Waukee loam, 0 to 2 percent slopes, 251 feet east and 396 feet north of southwest corner SE¼ sec. 6, T. 89 N., R. 14 W., in bluegrass and meadow pasture:

A1—0 to 12 inches; black (10YR 2/1) loam; weak fine granular structure; friable; neutral; clear boundary.

A3—12 to 18 inches; very dark brown (10YR 2/2) loam; weak fine subangular blocky structure; friable; medium acid; clear boundary.

B1—18 to 24 inches; brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; medium acid; clear boundary.

B2—24 to 34 inches; yellowish brown (10YR 5/4) loam; brown (10YR 4/3) coatings on faces of peds; weak medium subangular blocky structure; friable; medium acid; gradual boundary.

IIB3—34 to 38 inches; yellowish brown (10YR 5/6) gravelly sandy loam; yellowish brown (10YR 5/4) coatings on faces of peds; weak fine subangular blocky structure; very friable; medium acid; gradual boundary.

IIC1—38 to 46 inches; yellowish brown (10YR 5/6) loamy sand; some fine gravel; single grained; loose; slightly acid; gradual boundary.

IIC2—46 to 60 inches; yellowish brown (10YR 5/6) sand; few medium distinct dark yellowish brown (10YR 4/4) mottles; some fine gravel; single grained; loose; slightly acid.

Thickness of the solum may or may not correspond with the depth to coarse loamy sand or gravelly sand. Depth to sandy and gravelly material is typically 32 to 40 inches. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The texture is loam or silt loam that is high in sand. The A horizon ranges from 13 to 23 inches in thickness.

The B2 horizon is in 10YR hue, value of 4 or 5, and chroma of 3 to 6. It is loam, sandy clay loam, or heavy sandy loam. Clay content ranges from about 18 to 24 percent.

Texture of the C horizon is coarse loamy sand, gravelly sand, or medium sand. Gravel content is about 10 to 20 percent but ranges to as much as 20 to 50 percent, by volume, in some places.

Waukee soils formed in material similar to that of Saude, Wapsie, Lawler, and Marshan soils. They are deeper to coarse textured material than Saude and Wapsie soils. They have a thicker, dark colored A horizon than Wapsie soils. They have a browner B horizon and are better drained than Lawler and Marshan soils.

178—Waukee loam, 0 to 2 percent slopes. This soil is on alluvial terraces. It has the profile described as typical of the series.

Included with this soil in mapping are areas of soils that have more silt in the surface layer and a few areas of soils that are shallower than 32 inches or deeper than 40 inches to coarse material. Small areas of sand, which outcrop at the surface, are identified on the soil map by spot symbols. These areas are droughty and less productive.

This soil is well suited to row crops year after year, but it is slightly droughty when rainfall is below normal. It is easily tilled, and little or no runoff occurs. Capability unit I–1.

178B—Waukee loam, 2 to 5 percent slopes. This soil is on alluvial terraces. It has a profile similar to the one described as typical of the series, but the dark surface layer is not so thick.

Included with this soil in mapping are areas of soils that have more silt in the surface layer and a few areas of soils that are shallower than 32 inches or deeper than 40 inches to sandy or gravelly material. Small areas of gravel, which outcrop at the surface, are identified on the soil map by spot symbols. These areas are droughty and less productive.

This soil is well suited to row crops year after year if properly managed. It is subject to slight erosion, however, in cultivated areas. This soil is slightly droughty when rainfall is below normal. Minimum tillage, contouring, and stripcropping help to control erosion and conserve moisture. Capability unit IIe–2.

Wiota Series

The Wiota series consists of nearly level, well drained soils on alluvial terraces, along major streams in the county except the Wapsipinicon River. These soils formed in silty alluvium. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and dark brown silt loam 20 inches thick. The subsoil extends to a depth of 60 inches. The upper part is brown light silty clay loam to a depth of 40 inches. The lower part is yellowish brown loam with strong brown mottles to a depth of 52 inches, where it grades to yellowish brown sandy loam. The substratum, below 60 inches, is yellowish brown fine sand.

Wiota soils are moderately permeable and have high available water capacity. They are high in organic-matter content. The subsoil is very low in available phosphorus and potassium.

These soils are mainly used for row crops year after year.

Representative profile of Wiota silt loam, 0 to 2 percent slopes, 220 feet north and 1,278 feet west of southeast corner sec. 12, T. 88 N., R. 13 W., in cultivated field:

Ap—0 to 9 inches; black (10YR 2/1) silt loam; cloddy structure parting to weak fine granular; friable; slightly acid; abrupt boundary.

A12—9 to 16 inches; black (10YR 2/1) silt loam; weak fine granular structure; friable; medium acid; clear boundary.

A3—16 to 20 inches; dark brown (10YR 3/3) heavy silt loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; medium acid; clear boundary.

B1—20 to 25 inches; brown (10YR 4/3) light silty clay loam; very dark grayish brown

(10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; medium acid; clear boundary.

B2—25 to 35 inches; brown (10YR 4/3) light silty clay loam; moderate fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B31—35 to 40 inches; brown (10YR 4/3) light silty clay loam; moderate medium and fine subangular blocky structure; friable; thin discontinuous light gray (10YR 7/1) silt coatings on faces of peds when dry; medium acid; clear boundary.

B32—40 to 52 inches; yellowish brown (10YR 5/4) loam; few fine distinct strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure; friable; thin discontinuous light gray (10YR 7/1) silt and sand coatings on faces of peds when dry; medium acid; abrupt boundary.

IIB33—52 to 60 inches; yellowish brown (10YR 5/4) sandy loam; weak coarse prismatic structure; very friable; medium acid; abrupt boundary.

IIC—60 to 70 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; medium acid.

The solum ranges from 40 to 60 inches in thickness. The A1 horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and is 18 to 24 inches thick. Texture of the A horizon ranges from light silt loam to heavy silt loam.

The B2 horizon has colors of 10YR hue in value of 4 or 5 and chroma of 3 to 6. It ranges from light silty clay loam to heavy silt loam and in clay content from about 22 to 32 percent.

Wiota soils formed in material similar to that of Waukee and Nevin soils. They are associated with Waukee, Nevin, and Saude soils. Wiota soils have less sand throughout the solum than Saude soils. They do not have contrasting textures of sand or loamy sand within 40 inches, which is typical of Saude and Waukee soils. They have a browner B horizon than Nevin soils and are better drained.

7—Wiota silt loam, 0 to 2 percent slopes. This nearly level soil is on alluvial terraces, mainly along the Cedar River and its major tributaries. The surface layer is high in organic-matter content, has granular structure, and has good tilth.

Included with this soil in mapping are some areas of nearly level to gently sloping soils that have a lighter colored, thinner surface layer and are slightly more acid and lower in organic-matter content. Also included are areas of soils that have a silt loam subsoil and areas of soils that have a light silty clay loam layer in the subsoil above 40 inches. Areas of more droughty soils that have a sandy surface layer are included and identified on the soil map by spot symbols.

This soil is well suited to row crops year after year if well managed. It is easily tilled, and erosion control is not a problem. If placed properly, diversion terraces protect the soil from siltation from higher lying soils. Capability unit I–1.

Zook Series

The Zook series consists of nearly level, poorly drained soils in slack-water areas on flood plains. These soils formed in moderately fine and fine textured alluvium. The native vegetation was water-tolerant grasses and sedges.

In a representative profile the surface layer is black silty clay loam 42 inches thick. The subsoil extends to a depth of 60 inches. It is black heavy silty clay loam in the upper part and gray, very heavy silty clay loam in the lower part. The substratum is olive gray loam with brown mottles.

Zook soils have slow permeability and high available water capacity. They are high in organic-matter content. The subsoil is low in available phosphorus and very low in available potassium.

Zook soils are used mainly for cultivated crops and meadow. The major limitation is wetness caused by flooding and by a high water table. Although tile drains generally function satisfactorily, but at a reduced rate in some areas, wetness delays planting in spring. Sites for adequate tile outlets are difficult to locate. Surface drainage and protection by diversion terraces are needed in some areas.

Representative profile of Zook silty clay loam, 0 to 2 percent slopes, 300 feet west and 720 feet north of southeast corner NE¼ sec. 22, T. 88 N., R. 14 W., in meadow:

Ap—0 to 7 inches; black (N 2/0) silty clay loam; cloddy; friable; medium acid; abrupt boundary.

A12—7 to 28 inches; black (N 2/0) silty clay loam; fine granular structure; friable; medium acid; clear boundary.

A13—28 to 42 inches; black (10YR 2/1) silty clay loam; moderate medium prismatic structure parting to moderate fine subangular and angular blocky; firm; medium acid; clear boundary.

B1—42 to 51 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) kneaded; moderate medium prismatic structure parting to moderate medium and fine subangular and angular blocky; firm; slightly acid; clear boundary.

B2g—51 to 60 inches; gray (5Y 5/1) silty clay loam; strong medium prismatic structure parting to moderate medium subangular and angular blocky; firm; slightly acid; abrupt boundary.

IIC—60 to 72 inches; olive gray (5Y 5/2) loam; common fine brown (7.5YR 4/4) mottles; massive; neutral.

The solum is typically more than 40 inches thick and ranges from 36 to 64 inches. The surface layer is black with chroma of 1 or less. Mollic colors range from 36 to 50 inches in thickness. The A horizon is 26 to 40 inches thick. Texture ranges from medium silty clay loam to light silty clay. Reaction is slightly acid or medium acid.

The B horizon ranges from heavy silty clay loam to light silty clay in texture and has colors in 2.5Y or 5Y hue, value of 4 or 5, and chroma of 1 or less. Reaction is neutral, slightly acid, or medium acid.

The C horizon includes moderately coarse textured material but does not have free carbonates to a depth of at least 50 inches. Colors are typically in 5Y hue but include 2.5Y. Value is 4 or 5, and chroma is 2 or less.

Zook soils are associated with Colo, Bremer, Nevin, and Wiota soils and formed in parent material similar to that of Colo and Bremer soils. Zook soils have a thicker, dark colored A horizon than Bremer soils. Zook and Bremer soils have a finer textured subsoil than Colo, Nevin, and Wiota soils. The poorly drained Colo, Bremer, and Zook soils have a grayer subsoil than the well drained Wiota soils and the somewhat poorly drained Nevin soils.

54—Zook silty clay loam, 0 to 2 percent slopes. This soil is in slightly depressed areas of flood plains and on low terraces adjacent to the foot slopes and commonly some distance from main stream channels. Areas are generally small and narrow and commonly elongated. The slightly depressed areas often impound water during periods of frequent rainfall or after flooding.

Included with this soil in mapping are areas of soils that do not have a gray subsoil and are slightly better drained. Also included are areas of silty clay loam soils that have slightly less clay in the surface layer and subsoil. These soils tend to be more friable and are less susceptible to puddling when cultivated. They become hard and cloddy when dry.

Wetness is the major limitation of this soil. Although tile drains reduce wetness, they function slowly and outlets are difficult to establish. Even if tile lines are installed, this soil is wet at times and fieldwork is often delayed. Land leveling to produce a gradient prevents ponding. Surface drains can be used in some places to remove excess water.

In artificially drained areas, this soil is moderately well suited to row crops, but alfalfa may be winter killed during wet periods. Capability unit IIw–2.

Use and Management of the Soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, and as sites for buildings, highways and other transportation systems, sanitary facilities, parks and other recreation facilities, and wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices. The information is useful to equipment dealers, drainage contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil Maps for Detailed Planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

Knowledge of the soil is needed in a successful plan for controlling erosion, improving the soil, selecting crops, and maintaining good yields. The suitability of a soil for certain plants and the management needed depend on drainage, permeability, texture, slope, content of organic matter, and other characteristics, all of which are noted in the soil descriptions.

Drainage is generally indicated by the color and mottling of the subsoil. The subsoil of Bremer soils is dominantly gray, indicating poor drainage, and the subsoil of Tama soils is brown, indicating good drainage. In addition to knowing the drainage class, it is important to know how often and for how long the soil is saturated. It is also important to know the permeability of the major horizons and the capacity of the soil to hold water available to plants.

Permeability is the ability of soil to transmit air and water. Fine textured, compact soils are generally slowly permeable and absorb moisture slowly. The Zook and Donnan soils are examples. Water either ponds or runs off rapidly, depending on slope. This runoff causes erosion, especially if the soil is cultivated. Where artificial drainage is needed, farmers should know the permeability of the soil before deciding on the kind of drainage system to be installed.

Texture is the proportion of sand, silt, and clay in a soil. It affects the amount of water the soil can hold, the permeability, and the ease or difficulty with which the soil can be cultivated and penetrated by plant roots. Texture is considered in determining the kind of drainage system to be installed and the choice of crops. Fine textured soils, such as Bremer and Zook soils, do not absorb moisture rapidly and are difficult to work. Coarse soils, such as Sparta, do not hold much water available to plants. Wiota, Tama, Dinsdale, Muscatine, Klinger, Readlyn, Kenyon, and similar soils have favorable texture for plant growth. The proportion of sand, silt, and clay is such that available water capacity is good and the soils are not difficult to work.

Slope affects runoff and determines the need for controlling erosion. The rate of runoff and the hazard of erosion increase as the degree of slope increases. The soils are subject to erosion in cultivated areas where slope is more than 2 percent. Erosion losses are greater where there is no plant cover. Bassett loam, 5 to 9 percent slopes, moderately eroded, is an example of a soil that has been eroded because of moderate slopes and rapid runoff. Steep slopes limit the use of farm machinery and generally have thinner stands of row crops than the more nearly level slopes.

An adequate supply of plant nutrients must be available. Crops on most of the soils in the county respond to applications of fertilizer. The need for fertilizer depends on the kind of soil, on past and present management, and on the crop that is grown. Additions of lime are generally needed on most soils unless they have been limed within the past 5 years. A few soils, such as Tripoli and Spillville, generally do not need lime. For best results, the amount of lime and the kinds and amounts of fertilizer can best be determined by soil tests.

Of the total 362,880 acres in Black Hawk County, 216,333 acres was in crops and 40,474 acres was in pasture, according to the 1970 State of Iowa Annual Farm Census. Other land in farms totaled 66,810 acres.

Corn, soybeans, oats, and legume-grass are the principal crops grown. Most of the permanent pastures are in bluegrass. Some have been renovated and birdsfoot trefoil has been introduced. Grass-legume mixtures, such as alfalfa-bromegrass, are also pastured. Most of the permanent bluegrass pastures are not in cropland because they are wet and need tile drainage. Each year many acres are tile drained and converted to cropland. Clyde, Floyd, and Marshan are the dominant soils that need tile drainage and are still in pasture.

Many soils are subject to erosion. The major soils that need erosion control are Aredale, Bassett, Dinsdale, Kenyon, Olin, and Tama soils. Providing adequate erosion control and drainage is difficult in Aredale, Bassett, Kenyon, and Olin soils. There is an appreciable difference in the permeability of the loamy surficial material and the underlying glacial till. Water moves more rapidly in the loamy material and tends to accumulate at the till contact, resulting in a seasonally perched water table and sidehill seepage during wet periods. A combination of terracing and tiling can help overcome these problems. Gully control structures and grass waterways could be used to control gullying in watercourses. Tama and Dinsdale soils generally have long, uniform slopes and can be well adapted to erosion control practices.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 2. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes climatically suited to the area and the soil. A few farmers may be obtaining average yields higher than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Capability classes and subclasses

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

TABLE 2.—*Yields per acre of crops and pasture*

[Yields are those that can be expected under a high level of management. The estimates were made in 1975. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Brome-grass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
Wiota:						
7	125	48	98	5.1	8.6	4.2
Colo:						
[2] 11B	105	40	83	4.5	7.3	4.1
Sparta:						
41	63	24	47	2.5	4.3	2.0
41B	61	23	45	2.5	4.3	2.0
41C	56	21	42	2.3	3.8	1.8
41D			35	2.2	3.6	1.6
Bremer:						
43	106	40	85	4.5	7.5	4.0
[2] U43						
Zook:						
54	90	34	72	3.6	6.3	4.0
Chelsea:						
63B	57	21	46	2.4	4.0	2.0
63C	52	20	41	2.2	3.6	1.8
63D			32	1.5	2.5	1.5
Kenyon:						
83B	113	43	90	4.7	7.8	4.2
83C	108	41	86	4.5	7.5	4.0
83C2	105	40	84	4.4	7.3	3.8
83D2	96	36	76	4.0	6.6	3.4
[2] U83C						
Clyde:						
84	102	39	82	4.0	6.6	4.0
Nevin:						
88	114	43	91	4.8	8.0	4.0
Lamont:						
110B	69	26	52	2.5	4.1	2.3
Garwin:						
118	125	47	94	5.0	8.3	4.1
Muscatine:						
119, 119B	131	50	98	5.5	9.1	4.2
Tama:						
120B	125	48	95	5.2	8.6	4.2
T120	127	49	100	5.4	8.8	4.2
Colo:						
133	104	40	83	4.2	7.0	4.2
C133						3.0
Coland:						
135	100	38	80	4.6	7.0	3.8
Marshan:						
151	91	35	73	3.8	6.4	4.2
152	101	38	81	4.0	6.6	
Loamy escarpments:						
154F						1.5
Finchford:						
159	45	15	35	1.5	2.5	1.5
159C	35	14	30	1.2	2.0	1.3

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Brome-grass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
Bremer variant:						
166	95	36	76	3.8	6.3	3.6
Bassett:						
171B	107	40	85	4.5	7.5	4.0
171C2	99	38	80	4.0	6.6	3.5
Dickinson:						
175	83	32	67	3.5	5.8	2.7
175B	81	31	65	3.4	5.6	2.6
Saude:						
177	78	30	62	3.3	5.5	3.0
177B	76	29	62	3.2	5.3	3.0
Waukee:						
178	98	37	78	4.1	6.8	4.0
178B	96	36	77	4.0	6.6	4.0
Klinger:						
184	123	46	92	5.1	8.5	4.2
Floyd:						
198B	106	40	85	4.5	7.5	4.1
Rockton:						
213B	96	36	77	4.0	6.6	3.0
Palms:						
221	89	34	71	3.4	5.6	3.3
Lawler:						
225	85	32	68	3.6	6.0	3.7
226	100	38	80	4.2	7.0	4.0
Flagler:						
284	70	27	56	2.9	4.8	2.3
284B	68	26	54	2.8	4.6	2.1
Dells:						
290	90	34	72	3.8	6.3	3.3
Loamy alluvial land:						
C315	----------	----------	----------	----------	----------	2.5
Marsh:						
354	----------	----------	----------	----------	----------	----------
Dinsdale:						
377B	119	45	95	5.0	8.3	4.1
377C	114	43	91	4.8	8.0	4.0
377C2	111	42	89	4.6	7.6	3.8
Maxfield:						
382	119	45	89	5.0	8.3	4.2
Clyde:						
[2] 391B	100	28	82	4.0	6.6	3.8
Tripoli:						
398	111	42	89	4.5	7.5	4.1
Readlyn:						
399	113	43	90	4.7	7.8	4.1
Olin:						
408B	97	37	73	4.1	6.8	3.0
408C	92	35	70	3.9	6.5	2.8

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Brome-grass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
Sogn:						
412C	41	16	33	1.8	3.0	1.3
Aredale:						
426B	113	43	90	4.7	7.8	4.2
426C	108	41	86	4.5	7.5	4.0
426C2	105	40	84	4.4	7.3	3.8
Oran:						
471	107	40	85	4.5	7.5	3.8
Spillville:						
485	122	46	98	5.1	8.5	4.3
[2] 585	85	26	69	3.4	5.6	3.2
Koszta:						
688	108	41	86	4.5	7.5	3.7
Hayfield:						
725	79	30	63	3.0	5.0	3.0
726	94	36	75	4.0	6.6	4.2
Franklin:						
761	117	44	87	5.0	8.3	4.1
Waubeek:						
771B	113	43	85	4.7	7.8	4.0
Lilah:						
776C	38	15	30	1.3	2.1	1.0
Wapsie:						
777	70	27	56	2.9	4.8	2.6
Donnan:						
782B	70	24	56	2.8	4.6	2.7
782C	65	24	52	2.6	4.3	2.5
Protivin:						
798	90	34	72	4.0	6.6	3.6
Bertram:						
809B	65	25	45	2.2	3.6	2.5
Sawmill:						
933	104	40	83	4.4	7.3	4.0

[1] Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.
[2] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.

unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification (*15*) is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use; they are 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, or that require special conservation practices, or both.

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

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 contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability unit is identified in the description of each soil mapping unit in the section "Soil Maps for Detailed Planning." 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. 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–4 or IIIe–6.

Management of the soils by capability units

In the following pages, the capability units of Black Hawk County are described, and management of the soils is suggested. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all the soils of a given series appear in the unit.

CAPABILITY UNIT I–1

In this unit are the nearly level soils of the Tama, Waukee, and Wiota series. They are dark colored and well drained. They are on alluvial terraces.

These soils have a friable, medium textured to moderately fine textured surface layer. The subsoil is friable, medium textured to moderately fine textured, and moderately permeable. In Waukee soils, however, the lower part of the subsoil and the substratum are coarse materials that are very rapidly permeable.

These soils are well aerated, warm up quickly in spring, and can be worked soon after rains. They are acid unless limed within the past 5 years. The available water capacity ranges from moderate to high.

The soils of this unit are well suited to intensive row crop production. They are not susceptible to erosion, and drainage is no problem. Water does not pond on the surface. Waukee soils tend to be somewhat droughty during extreme seasons of below normal rainfall. The rest are not usually droughty.

Corn, soybeans, oats, and hay are the principal crops. Corn is the major crop. Most of the acreage is cultivated. Soybeans is sometimes substituted for corn in the rotation. The soils are also suitable for pasture, trees, and other less intensive use.

CAPABILITY UNIT I–2

In this unit are the nearly level soils of the Koszta, Franklin, Hayfield, Klinger, Lawler, Muscatine, Nevin, Oran, Readlyn, and Spillville series. These are somewhat poorly drained soils on the uplands and stream benches. They have a friable, medium textured to moderately fine textured surface layer over a friable to firm, medium textured to moderately fine textured subsoil.

Permeability is rapid in the lower part of the subsoil and throughout the substratum of the Hayfield and Lawler soils, which are only 32 to 40 inches deep over sand and gravel, and available water capacity is moderate. Permeability is moderate to moderately slow in the rest of the soils, and available water capacity is high. All are acid unless limed within the past 5 years. All have a seasonal high water table. Sometimes the excess moisture delays fieldwork.

The soils of this unit are well suited to intensive row crop production. Water sometimes stands on the surface for short periods. If these soils are tiled, fieldwork can be more timely. Erosion is not usually a hazard. The Lawler and Hayfield soils tend to be droughty during periods of below normal rainfall.

Most of the acreage is cultivated. Corn is the major crop. Soybeans, oats, and hay are also grown. Soybeans is sometimes substituted for corn in the rotation. The soils are also suitable for pasture, trees, and other less intensive use.

CAPABILITY UNIT IIe–1

The only soil in this unit is Muscatine silty clay loam, 2 to 5 percent slopes. It is a dark colored, gently sloping, and somewhat poorly drained soil on the lower side slopes of the loess-covered uplands adjacent to drainageways. It has a friable, moderately fine textured surface layer and subsoil.

Permeability is moderate, and available water capacity is high.

This soil is subject to sheet erosion. Because of its position on the landscape, it receives surface runoff and lateral subsoil movement of seepage water from higher lying adjacent slopes. Gullies are likely to form in adjacent waterways where water concentrates unless grass waterways are used to carry runoff from the hillsides upslope to the main drainageways below. In some places a combination of erosion control structures, diversions, and grass waterways is needed to control runoff from adjacent hillsides. Tile drainage is needed in some areas to intercept the lateral subsoil movement of seepage water.

If well managed, this soil is well suited to intensive row crop production. It is used mainly for corn, soybeans, small grain, and alfalfa. It is also suitable for pasture, trees, and other less intensive uses.

CAPABILITY UNIT IIe-2

In this unit are the gently sloping soils of the Aredale, Bassett, Dinsdale, Kenyon, Tama, Waubeek, and Waukee series. These soils are dark colored to moderately dark colored and moderately well drained to well drained. They are on uplands and stream benches. They have a friable, medium textured surface layer and a friable to firm, medium textured to moderately fine textured subsoil.

Permeability is very rapid in the substratum of Waukee soils and moderate throughout Tama soils. In the rest of the soils it ranges from moderate in the upper part to moderately slow in the lower part. In all the soils available water capacity ranges from moderate to high. All have good tilth. None are droughty but Waukee soils, which have a lower available water capacity and are somewhat droughty in years of below normal rainfall. All are acid unless limed within the last 5 years.

If well managed, these soils are well suited to intensive row crop production. They are used mainly for corn, soybeans, small grain, and alfalfa. They are also suitable for pasture, trees, and other less intensive uses.

Aredale, Bassett, Dinsdale, Kenyon, and Waubeek soils typically have long, uniform slopes and are well adapted to conservation practices, including minimum tillage. Terrace cuts should be kept to a minimum to avoid exposing the less productive glacial till subsoil of Bassett, Dinsdale, Kenyon, and Waubeek soils, or the sandy substratum of Waukee soils.

CAPABILITY UNIT IIe-3

The one soil in this unit, Rockton loam, 30 to 40 inches to limestone, is a gently sloping, dark colored, well drained soil on the uplands. It has a friable, medium textured surface layer and a friable, medium textured to moderately fine textured subsoil. The subsoil is underlain by fractured limestone bedrock. In the upper part of the rock, between the rock particles, is clayey residuum.

This soil is acid and requires lime unless limed within the last 5 years. Available water capacity is low to moderate. Permeability is moderate.

This soil is well suited to row crops. It is somewhat droughty in some areas unless rainfall is timely. It is used mainly for row crops, small grain, and alfalfa, but is also suited to pasture, trees, and other less intensive uses.

This soil is suited to contouring, stripcropping, and minimum tillage, all of which help to control erosion. In some areas terracing is also beneficial. In others the underlying limestone interferes with terrace construction. To maintain good tilth, all crop residue should be returned to the soil.

CAPABILITY UNIT IIe-4

In this unit are the gently sloping soils of the Olin and Saude series. They are dark colored and well drained and are moderately deep over coarse textured material or glacial till. They are on uplands or alluvial terraces. They have a friable, moderately coarse textured to medium textured surface layer and a friable, moderately coarse to moderately fine textured subsoil.

Permeability is moderately slow in the glacial till subsoil of Olin soils and rapid in the coarse textured substratum of Saude soils but is otherwise moderate to moderately rapid. In both soils available water capacity ranges from low to moderate. Both are acid unless limed within the past 5 years.

These soils are used mainly for corn, small grain, and alfalfa. They are moderately well suited to corn and soybeans. They are also suitable for pasture, trees, and other less intensive use.

These soils are subject to erosion. Contouring and minimum tillage are beneficial in erosion control. The soils also tend to be somewhat droughty in most years, and yields are often reduced unless rainfall is timely. They are not well suited to the construction of terraces. Saude soils are shallow over sand and gravel. Because Olin soils are sandy in the upper 2 feet, maintaining a terrace ridge is difficult. If terraces are built in Saude soils, they should be shallow to avoid the coarse textured material in the terrace channel. The underlying sand and gravel also limit root development of some crops in Saude soils.

CAPABILITY UNIT IIe-5

The one soil in this unit, Donnan loam, 2 to 5 percent slopes, is a gently sloping, somewhat poorly drained to moderately well drained soil on uplands. It has a friable, moderately dark, medium textured surface layer. The upper part of the subsoil is friable and medium textured, and the lower part is extremely firm to very firm and medium textured to fine textured.

This soil has very slow permeability and a high available water capacity. It is sometimes wet because of the moderately high but fluctuating water table. Excess moisture sometimes delays fieldwork. The soil is acid unless limed within the past 5 years.

This soil can be used for corn, soybeans, small grain, and alfalfa, but it is not well suited. It is also used for pasture, trees, and other less intensive use.

Fieldwork can be more timely if the soil is tiled. Tile placement is important because of the clayey, very slowly permeable subsoil. Terraces are not well suited because terrace construction is likely to expose the less productive, very slowly permeable clay subsoil and the extra water entering the soil increases the wetness problem. Because of the long, gentle slopes, sheet erosion is a hazard.

CAPABILITY UNIT IIw-1

In this unit are the nearly level and gently sloping soils of the Clyde, Colo, Sawmill, Floyd, Garwin, Marshan, Coland, Maxfield, Protivin, Ely, and Tripoli series. These soils are dark colored and poorly drained or somewhat poorly drained. They are on the uplands, alluvial benches, or bottom lands. The Clyde-Floyd and Colo-Ely complexes are in narrow upland drainageways. All of the soils have a friable, medium textured and moderately fine textured surface layer and a friable or firm, medium textured and moderately fine textured subsoil.

Permeability is moderate in the upper part of Marshan soils, rapid in the lower part, and slow in Protivin soils. In the rest of the soils, permeability is moderate to moderately slow. Available water capacity is low to moderate in Marshan soils and high in the rest. Protivin soils are medium acid to strongly acid and need lime unless lime has been applied within the past 5 years. The other soils are slightly acid to neutral and generally do not need much lime.

If drained, these soils are well suited to intensive use for row crops. They are used mainly for corn and soybeans but are also suited to small grain, hay, pasture, trees, and other less intensive use. Undrained areas are generally in permanent pasture or trees. Clyde and Marshan soils occasionally become inundated by runoff from adjacent side slopes for short periods, but crop damage is generally slight. Colo, Coland, and Sawmill soils are subject to flooding for longer periods, and some crop losses may occur.

Sheet erosion generally is no problem, but the Colo-Ely and the Clyde-Floyd complexes are subject to gully erosion in areas where runoff concentrates. These soils have a high water table or receive seepage from adjacent steeper slopes. They dry out somewhat slowly in spring and cannot be worked soon after rains. Clyde and Floyd soils have some stones and boulders on the surface.

CAPABILITY UNIT IIw-2

This unit consists of the nearly level soils of the Bremer and Zook series. These are dark colored, poorly drained soils on bottom lands and terraces. They have a friable, moderately fine textured surface layer and a firm, moderately fine textured subsoil.

These soils are slowly permeable and have a high available water capacity. Zook soils are generally acid in the surface layer unless limed within the past 5 years. Bremer soils are generally neutral in reaction and require little lime.

These soils are used for row crops. Bremer soils are occasionally flooded. Zook soils are frequently flooded. They are wet mainly because of overflow and a high water table. Flooding commonly occurs early in spring but ordinarily lasts for only short periods. After floodwater recedes, water is ponded for several days, mainly in the small, slightly depressed areas of Zook soils.

Although these soils have slow internal drainage, they can be drained by properly spaced tile if suitable outlets are available. Sometimes surface drainage is needed in addition to tile lines in the flat or depressional areas. Diversions and levees are needed in some places because runoff from higher areas frequently collects on these soils. Some areas that are not drained by tile or open ditches are in permanent pasture. Small isolated areas are left idle during wet periods or are used for wildlife habitat.

If drained, Bremer soils are well suited to row crops. Zook soils are moderately well suited to row crops, but alfalfa may be winterkilled during wet periods because water ponds.

CAPABILITY UNIT IIw-3

This unit consists of the nearly level soils in the Spillville-Alluvial land complex. These soils are on alluvial flood plains and low alluvial terraces along the major and secondary streams of the county. The topography is uniform. Some areas are dissected to some degree by depressional areas or by discontinuous stream channels.

In more than 50 percent of the areas the soils are dark colored, are somewhat poorly drained, and have a thick, friable surface layer. They are medium textured, moderately permeable, and high in organic-matter content and available water capacity. In less than 50 percent of the areas the soils are well drained to poorly drained, are loamy and sandy and in places highly stratified, and have a dark surface layer less than 24 inches thick. All the soils are underlain by a stratified substratum that contains layers of coarse material 2 to 3 feet thick.

Permeability and available water capacity vary. The soils are generally neutral in reaction and seldom require lime.

These soils are moderately well suited to row crops. The productivity of cultivated crops varies because of the difficulty of draining wet areas, of providing protection from flooding, and of the variations in available water capacity. Many of the areas that are neither drained nor protected from flooding are left in pasture. Frequent flooding causes difficulty in maintaining permanent fencing and creates added management problems for livestock grazing. Many of these areas could be developed for certain recreational and wildlife uses.

CAPABILITY UNIT IIw-4

The one soil in this unit, Bremer silty clay loam, clay subsoil variant, 0 to 2 percent slopes, is nearly level to slightly depressional, dark colored, and poorly drained. It is on alluvial terraces. The subsoil is fine textured.

Permeability is very slow. The organic-matter content is high in most areas but is medium in some small areas. The soil is generally acid unless limed.

This soil is well suited to cultivated crops and is generally used for this purpose. Yields may be reduced, however, and occasionally there is crop loss because of inadequate drainage. Tile does not provide adequate drainage because of the slowly permeable subsoil. Some areas benefit from surface drainage.

This soil is suitable for row crops, hay, and pasture. Alfalfa and red clover can be drowned out in the depressional areas. Phosphate and potash are needed for all crops. Nitrogen is needed for corn.

CAPABILITY UNIT IIs-1

In this unit are the nearly level to gently sloping soils of the Saude and Wapsie series. They are dark and moderately dark, well drained, and moderately deep over coarse textured material. They are dominantly on alluvial terraces throughout the county. They have a friable, medium textured surface layer and a medium textured to coarse and moderately coarse textured subsoil.

Permeability is moderate in the upper part of the soil but very rapid in the underlying coarse textured material. The available water capacity ranges from low to moderate. The soils are acid unless limed within the past 5 years.

These soils are moderately well suited to cultivated crops, but droughtiness is a hazard in most years unless rainfall is timely. They warm up quickly in spring and can generally be worked soon after rains. They are not subject to water erosion but are sometimes subject to soil blowing. Tilth is generally good. Minimum tillage conserves moisture and prevents soil blowing. Yields depend on the amount and timeliness of rainfall.

Principal crops are corn, soybeans, small grain, and alfalfa. The soils are also suited to pasture, trees, and other less intensive uses.

CAPABILITY UNIT IIs-2

In this unit are the nearly level soils of the Dells, Hayfield, and Lawler series. These soils are moderately dark or dark colored, are somewhat poorly drained, and have a friable, medium textured surface layer. They are dominantly on stream benches throughout the county.

Permeability is moderate in the upper part of the soils and rapid in the coarse textured substratum. Available water caapcity is low to moderate. These soils are acid unless limed within the past 5 years.

These soils are moderately well suited to cultivated crops. They are used mainly for corn, soybeans, small grain, and alfalfa but are also suited to pasture, trees, and other less intensive uses.

The fluctuating water table is moderately high in spring but drops rapidly during the growing season. Droughtiness is a hazard, especially in years of average or below average rainfall. Artificial drainage is beneficial during wet periods. Placement of tile is difficult because of the loose water-bearing sand and gravel.

CAPABILITY UNIT IIIe-1

In this unit are the moderately sloping soils of the Aredale, Bassett, Dinsdale, and Kenyon series. They are dark or moderately dark colored, moderately well drained to well drained, and slightly or moderately eroded. They are on uplands. They have a friable, medium textured or moderately fine textured surface layer and a very friable to firm, moderately coarse textured to moderately fine textured subsoil.

Available water capacity is high. Permeability is moderate in the upper part of the soil and moderately slow in the lower part. The soils are acid unless limed.

These soils are well suited to row crops if they are protected from erosion. They are used mainly for corn, soybeans, small grain, and alfalfa, but they are also suited to pasture, trees, and other less intensive use. Corn is grown the most frequently. Soybeans are sometimes substituted for corn in the rotation.

These soils are suited to contouring, stripcropping, or terracing to help control erosion in cultivated fields. Minimum tillage is also beneficial. Terrace cuts should be kept to a minimum to avoid exposing the less productive glacial till subsoil. Grass waterways are needed to prevent the formation of gullies in areas where water concentrates. To maintain good tilth, all crop residue should be returned to the soil.

CAPABILITY UNIT IIIe-2

The one soil in this unit, Olin fine sandy loam, 5 to 9 percent slopes, is a well drained, dark colored soil on uplands. It has a friable, moderately coarse textured surface layer and an upper subsoil that is moderately rapidly permeable. The firm, lower part of the subsoil and the substratum are medium textured and moderately slowly permeable.

This soil has moderate available water capacity and moderate organic-matter content. It is acid unless limed within the past 5 years.

This soil is suited to corn, soybeans, oats, and hay and to pasture, trees, and other less intensive use. It is subject to erosion, and during periods of untimely low rainfall it is droughty. Because of the differences in permeability in the upper part of the subsoil and the lower part, water accumulates and moves laterally at this contact. During periods of high rainfall, seepy spots develop at the base of slopes.

Correctly placed tile along with terraces can be used to intercept excess seepage water. Terraces are difficult to install and maintain on this soil. A combination of contouring, minimum tillage, stripcropping, or terracing helps to control erosion and conserve moisture during periods of low rainfall.

CAPABILITY UNIT IIIe-3

In this unit are the gently sloping soils of the Dickinson, Lamont, and Flagler series and the moderately sloping soils of the Lamont series. These soils are light to dark colored and are somewhat excessively drained. Lamont soils are on uplands, Flagler soils are on alluvial terraces, and Dickinson soils are on uplands or alluvial terraces. The surface layer and the upper part of the subsoil are friable or very friable and moderately coarse textured to medium textured. The substratum is coarse textured.

Permeability is moderately rapid to very rapid, and available water capacity is low. The organic-matter content is low to very low in Lamont soils and moderate in the rest. All are acid unless limed within the past 4 to 5 years.

These soils are suited to corn, soybeans, oats, and hay and are used mainly for those crops. They are also suited to pasture, trees, and other less intensive use.

The slope and droughtiness are limitations. A combination of contouring, minimum tillage, terracing, or contour stripcropping helps to control erosion and conserve moisture on these gently and moderately sloping loamy soils.

CAPABILITY UNIT IIIe-4

The one soil in this unit, Kenyon loam, 9 to 14 percent slopes, moderately eroded, is a dark colored, moderately well drained soil on uplands. It has a friable, medium textured, moderately permeable surface layer and a firm, medium textured, moderately slowly permeable subsoil.

Available water capacity is high. The soil is acid unless limed within the past 5 years.

This soil is mainly used for corn, soybeans, small grain, and alfalfa. It is also used for pasture, trees, and other less intensive use. It is suited to cultivated crops if erosion is controlled.

This soil is suited to contouring, terracing, stripcropping, and minimum tillage. Terrace cuts should be kept to a minimum, however, to avoid exposing the less productive glacial till subsoil. Grass waterways are needed to prevent the formation of gullies in areas where water concentrates. To maintain tilth, all crop residue should be returned to the soil.

CAPABILITY UNIT IIIe-5

The one soil in this unit, Donnan loam, 5 to 9 percent slopes, is a moderately dark colored, somewhat poorly drained to moderately well drained soil on uplands. It has a friable, medium textured, moderately permeable surface layer. The subsoil is friable and medium textured in the upper part. The middle and lower parts are fine textured to moderately fine textured and range from extremely firm to very firm with increasing depth.

Available water capacity is high. Permeability is moderate in the loamy upper part and very slow in the underlying plastic clayey subsoil. This soil is acid unless limed within the past 5 years.

This soil is not well suited to row crops but is used for corn and soybeans. It is also used for small grain and hay. It is suited to pasture, trees, and other less intensive use.

Terrace construction is likely to expose the less productive, very slowly permeable clayey subsoil, and the extra water that enters the soil increases the wetness problem and complicates erosion control practices. A combination of terraces and tile is needed. Other conservation practices that help to control erosion are contouring and minimum tillage. Interceptor tile placed above these soils and across the slopes removes some of the excess seepage water from soils upslope. To maintain tilth, all crop residue should be returned to the soil.

CAPABILITY UNIT IIIw-1

The one soil in this unit, Palms muck, 1 to 4 percent slopes, is dark colored and very poorly drained. It occurs at the base of upland side slopes and stream benches. It has a spongy surface layer that is mainly organic material and will not support heavy equipment when wet. Beneath the organic layer is soil material that is very friable to firm and moderately coarse textured to moderately fine textured.

This soil has very high available water capacity. The surface layer has moderately slow to moderately rapid permeability. Generally no additional lime is needed.

This soil is suited to row crops if well managed and artificially drained. Oats is suited but is subject to lodging. Early-maturing varieties of crops should be grown because of the hazard of frost, which is more severe on this kind of soil than on adjoining areas. The soil has a high water table and is subject to sidehill seepage. In undrained areas the water table is at or near the surface. Because the surface is irregular, water stands in places. When the soil is artificially drained, the organic matter settles.

If tiles are placed in the organic material, shrinkage of this material alters the tile alignment, causing it to function improperly. Tile drains function better if placed in the underlying mineral soil material. In some areas outlets are difficult to obtain. Drained areas are used mainly for corn or soybeans. Undrained areas are poorly suited even to pasture and are generally left idle. Unless drained, the spongy material will not withstand the traffic of grazing livestock.

Areas of muck in Black Hawk County are generally not large, but some are large enough to be used for specialty vegetable crops, such as potatoes or onions.

CAPABILITY UNIT IIIs-1

In this unit are the nearly level, dark colored, somewhat excessively drained soils of the Dickinson and Flagler series. Flagler soils are on stream benches, and Dickinson soils are on uplands and stream benches. These soils have a very friable, coarse textured to moderately coarse textured surface layer and subsoil. The substratum is coarse textured.

Permeability is mainly moderately rapid but is very rapid in the substratum of Flagler soils. Available water capacity is low. All the soils are acid unless limed within the past 2 to 5 years.

These soils are moderately well suited to row crops, but yields depend on the amount and timeliness of rainfall. The chief crops are corn or soybeans, oats, and alfalfa. The soils are also suited to pasture, trees, and other less intensive use.

Droughtiness is a limitation for crops. Soil blowing is a hazard if the surface is unprotected. Blowing sand sometimes damages newly seeded crops. On the nearly level areas of these sandy soils, the kind of minimum tillage that leaves crop residue on the surface helps to control soil blowing and conserves moisture.

CAPABILITY UNIT IVs-1

In this unit are the nearly level to moderately sloping soils of the Finchford, Chelsea, Sogn, Lilah, and Sparta series and the gently sloping and moderately sloping soils of the Bertram series. They are dark to light colored and somewhat excessively drained and excessively drained. Chelsea and Sparta soils are on alluvial terraces or on uplands. Bertram, Lilah, and Sogn soils are on uplands. Finchford soils are on alluvial terraces.

These soils have a loose, friable or very friable, coarse textured to medium textured surface layer and a very friable, friable, or loose, coarse textured to moderately fine textured subsoil. Bertram soils have limestone at a depth of 20 to 40 inches, and Sogn soils have limestone at a depth less than 20 inches.

Lilah, Chelsea, and Sparta soils are rapidly permeable, and Finchford soils very rapidly permeable. Bertram soils are moderately rapidly permeable in the loamy material and moderately slowly permeable in the clayey residuum. Sogn soils are moderately permeable. Available water capacity is very low. All are acid unless limed within the past 3 to 5 years.

These soils can be used for corn and soybeans but are generally used for hay and pasture. Sogn soils are seldom used for row crops because they are shallow over bedrock (fig. 10). All but Sogn soils are suitable for certain kinds of trees. All are suitable for other less intensive uses.

Yields depend on the timeliness of rainfall during the growing season. Droughtiness is the principal limitation. Soil blowing is a hazard on all but Sogn soils. Blowing sand damages new seedlings, not only on these soils but also on adjacent soils.

These soils warm up quickly in spring and can be worked soon after rains. They absorb moisture readily but lose much of it through deep percolation. Sheet erosion is a hazard in sloping areas. Sogn soils are too droughty and too shallow for row crops and unles protected are subject to erosion in cultivated area

Figure 10.—**Sogn soils are shallow over fractured limestone bedrock. As a result, they are droughty and have a limited root zone.**

They are better suited to permanent hay, pasture, or wildlife habitat. On the nearly level Chelsea, Finchford, and Sparta soils where water erosion is not a hazard, the kind of minimum tillage that leaves crop residue on the surface helps to control soil blowing and conserves moisture. On the gently sloping and moderately sloping Lilah, Bertram, Finchford, Chelsea, and Sparta soils, contouring and minimum tillage reduce the hazard of water erosion and soil blowing and conserve moisture.

CAPABILITY UNIT Vw-1

In this unit are Loamy alluvial land, channeled, and Colo silty clay loam, channeled. These are nearly level soils on bottom lands that are dissected by stream channels and oxbows.

Loamy alluvial land, channeled, has a dark to light, coarse textured to medium or moderately fine textured surface layer. It ranges from well drained to very poorly drained and from slightly acid to neutral. Available water capacity and permeability vary.

The one area of Colo silty clay loam, channeled, is in the Black Hawk Creek Valley at the western edge of the county. It is free of sand and gravel bars and coarse textured overwash material and is dissected by channels that vary in size. It is poorly drained. It has a dark surface layer and a high organic-matter content. Available water capacity is high. Permeability is moderately slow.

Both soils are frequently flooded. Wetness is the major hazard. In many places water is ponded during part of the year, and the water table is high. Without major reclamation, the soils are best suited to pasture, woods, or wildlife habitat. Land leveling, flood control, and surface drainage are needed in many places if cultivated crops are grown. Most of the acreage is in permanent pasture or woodland. In a few places the soils in this unit are cultivated with adjacent soils.

CAPABILITY UNIT VIs-1

In this unit are the strongly sloping to moderately steep soils of the Chelsea and Sparta series. These soils are dark to light colored and excessively drained. They are on stream benches or on uplands. They have a very friable, coarse textured surface layer and subsoil.

Chelsea and Sparta soils have rapid permeability and low available water capacity. They are acid unless limed within the past 3 or 4 years.

These soils are not suited to cultivated crops because they are droughty and susceptible to erosion. They absorb moisture readily but lose much of it through deep percolation. They are better suited to pasture, woodland, or wildlife habitat. Small areas that are left idle provide good habitat for wildlife. Trees of suitable species grow reasonably well in places. Areas of these soils should be protected from grazing. Establishing new seedings for pasture is difficult because of the sandy surface layer of Chelsea and Sparta soils. Leaving crop residue on the surface helps to control erosion, protects seedlings from blowing sand, and conserves moisture. Controlled grazing is needed in maintaining good stands of pasture.

CAPABILITY UNIT VIIw-1

Only Marsh is in this unit. It consists of areas that are covered by water most of the time. These areas are unfit for most agricultural uses. Waterfowl, muskrats, and upland game animals find food and nesting places in areas of Marsh and around the edges. These areas can be improved as habitat by providing controls so that a more constant water level can be maintained. Marsh can provide income and recreation through the trapping of muskrats and the sale of hunting privileges.

CAPABILITY UNIT VIIs-1

In this unit are the moderately steep to steep Loamy escarpments. They are dark to light colored and well drained to excessively drained. They have a medium textured to moderately coarse textured surface layer and subsoil.

Permeability is variable. Available water capacity is very low.

Use of Loamy escarpments for farming is extremely limited. Most areas are presently in woods or permanent pasture. Renovation of pasture is difficult because slopes are generally too steep for the use of regular farm machinery. The carrying capacity of pasture is low. Controlled grazing is needed in order to prevent erosion.

Woodland Management and Productivity

About 6 percent of Black Hawk County is wooded. Most of the wooded areas are adjacent to streams. The woodland was highly valued by the early settlers for fuel and building material. The settlers harvested the best trees and left the less desirable. Gradually, the less desirable trees dominated the woodland. It was estimated that during the period 1832 to 1859, about 14 percent, or 49,280 acres, of Black Hawk County was wooded. Some of the wooded soils, chiefly Bassett, Lamont, and Wapsie, were cleared for farming and are now eroded. The environment could be improved not only for man but also for wildlife if those soils were replanted to adapted trees.

The present pattern of tree cover is directly related to the seven soil map units in the county (see general soil map). The largest proportion of wooded areas is in units 5 and 6. In other units there are a few woodlots and scattered trees along the drainageways and fence rows and on farmsteads.

The present native woodland can be kept productive under good management, including protection from livestock and fire, selective cuttings, thinning and planting, and weeding. The objective in woodland management is to attain sustained production by cutting the amount of wood that the stand is producing in yearly growth. This cutting can be done each year or periodically every 5 to 10 years. Part of the woodland is of such poor quality, however, that converting it from hardwoods to the more valuable conifers should be considered. Before such conversion, competition from inferior species of trees and shrubs should be eliminated by mowing or by spraying with some type of chemical brush killer.

Several agencies in Iowa can assist woodland owners in improving the stands and marketing the products. The Soil Conservation Service can help woodland owners determine the soils suitable for trees, the best land use, the yields, and the conservation treatment needs. State foresters can assist in developing plans for managing new or old stands of trees.

Table 3 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Mapping unit symbols for soils suitable for wood crops are listed, and the ordination (woodland suitability) symbol for each soil is given. All soils bearing the same ordination symbol require the same general kinds of woodland management and have about the same potential productivity.

The first part of the *ordination symbol,* a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w,* excessive water in or on the soil; *t,* toxic substances in the soil; *d,* restricted root depth; *c,* clay in the upper part of the soil; *s,* sandy texture; *f,* high content of coarse fragments in the soil profile; and *r,* steep slopes. The letter *o* indicates insignificant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the following order: x, w, t, d, c, s, f, and r.

In table 3 the soils are also rated for a number of factors to be considered in management. *Slight, moderate,* and *severe* are used to indicate the degree of major soil limitations.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well-managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings when plant competition is not a limiting factor. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate,* 25 to 50 percent; and *severe,* more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential* productivity of merchantable or *important trees* on a soil is expressed as a *site index.* This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Factors affecting woodland management

This survey can help the owner of a wooded tract determine how he can get the best returns for his investment in woodland management. If the soils are suitable for trees, the owner can justify the time and money spent in managing his woodland carefully. Little management, other than that needed to protect the soils and watershed, is justified on poor sites. Some factors important in woodland management are defined in the following paragraphs.

Moisture.—The growth of trees is directly related to the ability of a soil to supply moisture. The available water capacity of any soil depends largely on slope, depth, texture, permeability, and internal drainage. Chelsea, Sogn, and Sparta soils, for example, have only a limited supply of available moisture.

TABLE 3.—*Woodland management and productivity*

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Important trees	Potential productivity: Site index	Trees to plant
Chelsea: 63B, 63C, 63D	3s	Slight	Slight	Moderate	Slight	White oak	55	Eastern white pine, scotch pine, european larch, eastern redcedar, red pine, jack pine.
Lamont: 110B	3o	Slight	Slight	Slight	Slight	Northern red oak White oak	55 55	Eastern white pine, scotch pine, european larch, eastern redcedar.
Bassett: 171B, 171C2	3o	Slight	Slight	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine, norway spruce, scotch pine, white spruce, european larch, black walnut, sugar maple.
[1] U171D: Bassett part	3o	Slight	Slight	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine, norway spruce, scotch pine, white spruce, european larch, black walnut, sugar maple.
Chelsea part	3s	Slight	Slight	Moderate	Slight	White oak	55	Eastern white pine, scotch pine, european larch, eastern redcedar, red pine, jack pine.
Dells: 290	3o	Slight	Slight	Slight	Slight	Silver maple Northern red oak White ash	80 55 --------	Silver maple, white ash, white spruce.
Oran: 471	3o	Slight	Slight	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine, norway spruce, scotch pine, white spruce, european larch, black walnut, sugar maple.

TABLE 3.—*Woodland management and productivity*—Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
Koszta: 688	3o	Slight	Slight	Slight	Moderate	White oak Northern red oak	55 55	Eastern white pine, red pine, norway spruce, scotch pine, european larch, white spruce, sugar maple.
Hayfield: 725, 726	2o	Slight	Slight	Slight	Moderate	Northern red oak White oak Eastern white pine	63 63 58	Northern red oak, white oak, silver maple, eastern white pine.
Franklin: 761	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, norway spruce, scotch pine, white spruce, european larch, black walnut, sugar maple.
Waubeek: 771B	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, norway spruce, scotch pine, white spruce, european larch, black walnut, sugar maple.
Lilah: 776C	3s	Slight	Slight	Severe	Slight	Northern red oak	55	Eastern white pine, scotch pine, european larch, eastern redcedar.
Wapsie: 777	3o	Slight	Slight	Slight	Moderate	Northern red oak White oak	55 55	Eastern white pine, red pine, norway spruce, scotch pine, white spruce, european larch, black walnut, sugar maple.
Donnan: 782B, 782C	3o	Slight	Moderate	Moderate	Moderate	White oak Northern red oak	55 55	Eastern white pine, red pine, norway spruce, scotch pine, white spruce, european larch, black walnut, sugar maple.

[1] This mapping unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.

Slope.—Woodland management becomes more difficult as the slope increases because runoff increases, the rate of infiltration decreases, and the erosion hazard becomes greater.

Aspect, or direction of exposure.—Forest studies show a definite relationship between the exposure of a site and the rate of growth (*16*). Among the important factors are (1) difference in the rate of evaporation as influenced by the prevailing wind, (2) length of time that snow cover remains on the ground, (3) amount of freezing and thawing, and (4) differences in soil temperature.

Fairly level soils and slopes that face southeast, east, northeast, north, and northwest are considered cool and the more desirable for trees. Less desirable sites are narrow ridgetops, the upper part of slopes, and slopes of more than 14 percent that face south, southwest, and west. These sites are subject to excessive heating and to drying from south or west winds.

Erosion.—Severe erosion removes part of the surface layer and commonly exposes the heavier, less porous subsoil. Thereby it contributes to increased runoff and a lower rate of water intake. A severely eroded soil is less desirable for both natural reseeding and tree growth than an uneroded soil of the same series and same slope. Natural reseeding of hardwoods is not successful on eroded sites. Such sites generally can be used for pine.

Soil reaction and soil fertility.—Reaction and fertility can influence the adaptation and growth of different species of trees. For example, walnut and locust trees grow best on neutral or slightly calcareous soils. Eastern redcedar is tolerant of lime. Pines require a soil that is slightly acid. Most species of pine are poorly suited to soils that are high in lime. On the contrary, hardwoods commonly grow well on those soils. Most of the alluvial soils in Black Hawk County are neutral in reaction. Hardwoods should not be expected to grow rapidly when planted on eroded or depleted, strongly acid upland soils. Conifers grow fairly well on these poorer sites (fig. 11).

Engineering[3]

This section provides information about the use of soils for building sites, sanitary facilities, construction materials, and water management. Among those who can benefit from this section are engineers, landowners,

[3] VOLNEY H. SMITH, assistant State conservation engineer, Soil Conservation Service, helped prepare this section.

***Figure 11.*—Windbreak planting of honeysuckle and Black Hills spruce.**

community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to: (1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 4 shows, for each kind of soil, the degree and kind of limitations for building site development; table 5, for sanitary facilities; and table 7, for water management. Table 6 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 4. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, and open ditches. Such digging or trenching is influenced by the soil wetness of a high seasonal water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 4 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or

TABLE 4.—*Building site development*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Wiota:					
7	Moderate: floods.	Severe: floods	Severe: floods	Severe: floods	Severe: frost action, low strength.
Colo:					
[1] 11B:					
Colo part	Severe: wetness, floods.	Severe: floods, frost action, wetness.	Severe: floods, frost action, wetness.	Severe: floods, frost action, wetness.	Severe: floods, low strength, frost action.
Ely part	Severe: wetness	Moderate: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.
Sparta:					
41, 41B	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
41C	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
41D	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
[1] U41C:					
Sparta part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Dickinson part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Bremer:					
43	Severe: wetness	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.
[1] U43:					
Bremer part	Severe: wetness	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength,	Severe: wetness, shrink-swell, low strength.
Marshan part	Severe: wetness, cutbanks cave, floods.	Severe: wetness, frost action. floods.	Severe: wetness, cutbanks cave, floods.	Severe: wetness, frost action, floods.	Severe: wetness, frost action, floods.
Zook:					
54	Severe: wetness, floods.	Severe: floods, low strength, shrink-swell.	Severe: floods, low strength, shrink-swell.	Severe: floods, low strength, shrink-swell.	Severe: floods, low strength.
Chelsea:					
63B	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
63C	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
63D	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
Kenyon:					
83B	Moderate:[2] wetness.	Moderate: frost action.	Moderate: wetness.	Moderate: frost action.	Moderate: frost action, low strength.
83C, 83C2	Moderate:[2] wetness.	Moderate: frost action.	Moderate: wetness.	Moderate: slope, frost action.	Moderate: frost action, low strength.

TABLE 4.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
83D2	Moderate: slope, wetness.	Moderate: slope, frost action.	Moderate: slope, wetness.	Severe: slope, frost action.	Moderate: slope, frost action, low strength.
[1] U83C: Kenyon part	Moderate:[2] wetness.	Moderate: frost action.	Moderate: wetness.	Moderate: slope, frost action.	Moderate: frost action, low strength.
Clyde part	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: excess humus, floods, frost action.
Clyde: 84	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: excess humus, floods, frost action.
Nevin: 88	Severe: wetness	Severe: floods	Severe: floods	Severe: floods	Severe: frost action, low strength.
Lamont: 110B	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Moderate: low strength.
Garwin: 118	Severe: wetness	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.
Muscatine: 119, 119B	Severe: wetness	Moderate: wetness, low strength, shrink-swell.	Severe: wetness	Moderate: wetness, low strength, shrink-swell.	Severe: low strength, frost action.
Tama: 120B, T120	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
Colo: 133, C133	Severe: wetness, floods.	Severe: floods, frost action, wetness.	Severe: floods, frost action, wetness.	Severe: floods, frost action, wetness.	Severe: floods, low strength, frost action.
Coland: 135	Severe: floods, wetness.	Severe: floods, wetness, frost action.	Severe: floods, wetness, frost action.	Severe: floods, wetness, frost action.	Severe: floods, wetness, frost action.
Marshan: 151, 152	Severe: wetness, cutbanks cave, floods.	Severe: wetness, frost action, floods.	Severe: wetness, cutbanks cave, floods.	Severe: wetness, frost action, floods.	Severe: wetness, frost action, floods.
Loamy escarpments: 154F	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Finchford: 159	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
159C	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
[1] U159: Finchford part	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Flagler part	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.

TABLE 4.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Bremer variant: 166	Severe: wetness	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.
Bassett: 171B	Moderate: [2] wetness.	Moderate: frost action.	Moderate: wetness.	Moderate: frost action.	Moderate: frost action, low strength.
171C2	Moderate: [2] wetness.	Moderate: frost action.	Moderate: wetness.	Moderate: frost action.	Moderate: frost action, low strength.
[1] U171D: Bassett part	Moderate: [2] slope, wetness.	Moderate: slope, frost action.	Moderate: slope, wetness.	Severe: slope, frost action.	Moderate: slope, frost action, low strength.
Chelsea part	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
Dickinson: 175, 175B	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Saude: 177, 177B	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength.
[1] U177: Saude part	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength.
Lawler part	Severe: wetness, cutbanks cave.	Moderate: wetness.	Severe: wetness	Moderate: wetness.	Severe: frost action, low strength.
Waukee: 178, 178B	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength.
Klinger: 184	Severe: wetness	Moderate: wetness, shrink-swell.	Severe: wetness	Moderate: wetness.	Severe: frost action, low strength.
Floyd: 198B	Severe: wetness	Moderate: wetness, low strength.	Severe: wetness	Moderate: wetness, low strength.	Severe: frost action, excess humus, low strength.
Rockton: 213B	Severe: depth to rock.	Slight	Severe: depth to rock.	Slight	Moderate: depth to rock.
Palms: 221	Severe: wetness, excess humus, cutbanks cave.	Severe: wetness, frost action, excess humus.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, low strength.
Lawler: 225, 226	Severe: wetness, cutbanks cave.	Moderate: wetness.	Severe: wetness	Moderate: wetness.	Severe: frost action, low strength.
Flagler: 284, 284B	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Dells: 290	Severe: wetness	Moderate: wetness.	Severe: wetness	Moderate: wetness.	Severe: frost action.

TABLE 4.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Loamy alluvial land:					
C315	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Marsh:					
354	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Dinsdale:					
377B	Slight	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: frost action, low strength.
377C, 377C2	Slight	Moderate: shrink-swell.	Slight	Moderate: slope	Severe: frost action, low strength.
Maxfield:					
382	Severe: wetness	Severe: wetness, frost action, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, frost action, shrink-swell.	Severe: wetness, frost action, shrink-swell.
Clyde:					
[1] 391B:					
Clyde part	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: excess humus, floods, frost action.
Floyd part	Severe: wetness	Moderate: wetness, low strength.	Severe: wetness	Moderate: wetness, low strength.	Severe: frost action, excess humus, low strength.
Tripoli:					
398	Severe: wetness	Severe: wetness, frost action.	Severe: wetness	Severe: wetness, frost action.	Severe: wetness, frost action.
Readlyn:					
399	Moderate: wetness.	Moderate: wetness, low strength.	Severe: wetness	Moderate: wetness, low strength.	Severe: frost action.
Olin:					
408B	Slight	Slight	Slight	Slight	Moderate: frost action, low strength.
408C	Slight	Slight	Slight	Moderate: slope	Moderate: frost action, low strength.
Sogn:					
412C	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Aredale:					
426B	Moderate: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength.
426C, 426C2	Moderate: cutbanks cave.	Slight	Slight	Moderate: slope	Moderate: low strength.
Oran:					
471	Severe: wetness	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Severe: frost action.
Spillville:					
485	Severe: floods, wetness.	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
[1] 585:					
Spillville part	Severe: floods, wetness.	Severe: floods	Severe: floods	Severe: floods	Severe: floods.

TABLE 4.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Alluvial land part	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Koszta: 688	Severe: wetness	Severe: floods	Severe: wetness, floods.	Severe: floods	Severe: low strength, frost action.
Hayfield: 725, 726	Severe: cutbanks cave.	Severe: frost action.	Moderate: wetness.	Severe: frost action.	Severe: frost action.
Franklin: 761	Severe: wetness	Severe: wetness, frost action.	Severe: wetness	Severe: wetness, frost action.	Severe: frost action, low strength.
Waubeek:[2] 771B	Slight	Moderate: shrink-swell.	Moderate: low strength.	Moderate: shrink-swell.	Severe: frost action, low strength.
Lilah: 776C	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Wapsie: 777	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength.
Donnan: 782B, 782C	Severe: wetness, too clayey.	Severe: wetness, shrink-swell, frost action.	Severe: wetness, shrink-swell, frost action.	Severe: wetness, shrink-swell, frost action.	Severe: wetness, shrink-swell, frost action.
Protivin: 798	Moderate: too clayey, wetness.	Moderate: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.
Bertram: 809B	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: slope, depth to rock.	Moderate: depth to rock.
Sawmill: 933	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, low strength.

[1] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.
[2] The water table is generally perched for a short time during extended wet periods.

on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation.

Local roads and streets referred to in table 4 have an all-weather surface that can carry light to medium traffic all year. They consist of subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones, all of which affect stability and ease of excavation, were also considered.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields,

TABLE 5.—*Sanitary facilities*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," and "fair." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Wiota:					
7	Moderate: [1] floods.	Moderate: seepage, excess humus.	Moderate: floods, too clayey.	Moderate: floods.	Fair: thin layer.
Colo:					
[1] 11B:					
Colo part	Severe: percs slowly, wetness, floods.	Severe: excess humus, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Ely part	Severe: wetness	Moderate: excess humus, seepage, wetness.	Severe: wetness	Moderate: wetness.	Fair: too clayey.
Sparta:					
41, 41B	Slight [2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: too sandy.
41C	Slight [2]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: too sandy.
41D	Moderate: [2] slope.	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: too sandy, slope.
[3] U41C:					
Sparta part	Slight [2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: too sandy.
Dickinson part	Slight [2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Bremer:					
43	Severe: [1] percs slowly.	Severe: wetness, excess humus.	Severe: wetness, excess humus.	Severe: wetness	Poor: wetness.
[3] U43:					
Bremer part	Severe: [1] percs slowly.	Severe: wetness, excess humus.	Severe: wetness, excess humus.	Severe: wetness	Poor: wetness.
Marshan part	Severe: [2] wetness, floods.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods.	Poor: wetness.
Zook:					
54	Severe: percs slowly, wetness, floods.	Severe: excess humus, wetness, floods.	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Poor: wetness, too clayey.
Chelsea:					
63B	Slight [2]	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy.
63C	Slight [2]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Poor: too sandy.
63D	Moderate: [2] slope.	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Poor: too sandy.
Kenyon:					
83B	Severe: [4] percs slowly.	Moderate: slope, excess humus.	Slight	Slight	Good.
83C, 83C2	Severe: [4] percs slowly.	Severe: slope	Slight	Slight	Good.
83D2	Severe: slope, percs slowly.	Severe: slope	Slight	Moderate: slope	Fair: slope.
[3] U83C:					
Kenyon part	Severe: [4] percs slowly.	Moderate: slope, excess humus.	Slight	Slight	Good.

TABLE 5.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Clyde part	Severe: floods, wetness.	Severe: excess humus, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Clyde: 84	Severe: floods, wetness.	Severe: excess humus, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Nevin: 88	Severe: [1] wetness.	Moderate: seepage, wetness, excess humus.	Severe: wetness	Moderate: wetness.	Fair: too clayey.
Lamont: 110B	Slight [2]	Severe: seepage	Severe: seepage	Severe: seepage	Good.
Garwin: 118	Severe: wetness, percs slowly.	Severe: wetness, excess humus.	Severe: wetness	Severe: wetness	Poor: wetness.
Muscatine: 119, 119B	Severe: wetness	Severe: wetness	Severe: wetness	Moderate: wetness.	Fair: too clayey.
Tama: 120B	Slight	Moderate: slope, seepage, excess humus.	Moderate: too clayey.	Slight	Fair: too clayey.
T120	Slight	Moderate: seepage, excess humus.	Moderate: too clayey.	Slight	Fair: too clayey.
Colo: 133, C133	Severe: percs slowly, wetness, floods.	Severe: excess humus, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Coland: 135	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Marshan: 151, 152	Severe: [3] wetness, floods.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods.	Poor: wetness.
Loamy escarpments: 154F	Severe: slope	Severe: slope, seepage.	Severe: slope	Severe: slope	Poor: slope.
Finchford: 159, 159C	Slight [2]	Severe: seepage	Severe: too sandy, seepage.	Severe: seepage	Poor: too sandy.
[3] U159: Finchford part	Slight [2]	Severe: seepage	Severe: too sandy, seepage.	Severe: seepage	Poor: too sandy.
Flagler part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Bremer variant: 166	Severe: percs slowly, wetness.	Moderate: excess humus.	Severe: wetness, too clayey.	Severe: wetness	Poor: too clayey, wetness.
Bassett: 171B	Severe: [4] percs slowly.	Moderate: slope	Slight	Slight	Good.
171C2	Severe: [4] percs slowly.	Severe: slope	Slight	Slight	Good.

TABLE 5.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
[8]U171D:					
Bassett part	Severe:[4] percs slowly.	Severe: slope	Slight	Moderate: slope	Fair: slope.
Chelsea part	Moderate: slope	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Poor: too sandy.
Dickinson:					
175, 175B	Slight[2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Saude:					
177, 177B	Slight[2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
[8]U177:					
Saude part	Slight[2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Lawler part	Severe:[2] wetness.	Severe: seepage	Severe: seepage, wetness.	Severe: seepage	Fair: thin layer.
Waukee:					
178, 178B	Slight[2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Klinger:					
184	Severe: wetness, percs slowly.	Moderate: slope, excess humus.	Severe: wetness	Moderate: wetness.	Fair: too clayey.
Floyd:					
198B	Severe: wetness	Moderate: slope, wetness, excess humus.	Severe: wetness	Moderate: wetness.	Good.
Rockton:					
213B	Severe:[2] depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: seepage	Fair: thin layer.
Palms:					
221	Severe: wetness, floods.	Severe: wetness, excess humus, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: excess humus, hard to pack.
Lawler:					
225, 226	Severe:[2] wetness.	Severe: seepage	Severe: seepage, wetness.	Severe: seepage	Fair: thin layer.
Flagler:					
284, 284B	Slight[2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Dells:					
290	Severe: wetness	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness	Fair: thin layer.
Loamy alluvial land:					
C315	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Poor: wetness.
Marsh:					
354	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness	Poor: wetness.
Dinsdale:					
377B	Slight	Moderate: slope	Slight	Slight	Fair: too clayey.
377C, 377C2	Slight	Severe: slope	Slight	Slight	Fair: too clayey.
Maxfield:					
382	Severe: wetness, percs slowly.	Severe: wetness, excess humus.	Severe: wetness	Severe: wetness	Poor: wetness.
Clyde:					
[8]391B:					
Clyde part	Severe: floods, wetness.	Severe: excess humus, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.

TABLE 5.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Floyd part	Severe: wetness	Moderate: slope, wetness, excess humus.	Severe: wetness	Moderate: wetness.	Good.
Tripoli: 398	Severe: wetness, percs slowly.	Moderate: excess humus.	Severe: wetness	Severe: wetness	Poor: wetness.
Readlyn: 399	Severe: percs slowly, wetness.	Moderate: slope, excess humus.	Severe: wetness	Moderate: wetness.	Good.
Olin: 408B	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
408C	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
Sogn: 412C	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: seepage	Poor: thin layer, area reclaim.
Aredale: 426B	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
426C, 426C2	Slight	Severe: slope	Slight	Slight	Good.
Oran: 471	Severe: percs slowly, wetness.	Moderate: slope, wetness.	Severe: wetness	Moderate: wetness.	Good.
Spillville: 485	Severe: floods, wetness.	Severe: floods, wetness, excess humus.	Severe: floods, wetness.	Severe: floods, wetness.	Good.
[3] 585: Spillville part	Severe: floods, wetness.	Severe: floods, wetness, excess humus.	Severe: floods, wetness.	Severe: floods, wetness.	Good.
Alluvial land part	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Poor: wetness.
Koszta: 688	Severe: [1] wetness.	Moderate: wetness, seepage.	Severe: wetness	Moderate: wetness, floods.	Fair: too clayey.
Hayfield: 725, 726	Severe: [2] wetness.	Severe: seepage	Severe: seepage	Moderate: wetness, seepage.	Fair: thin layer.
Franklin: 761	Severe: wetness, percs slowly.	Moderate: slope	Severe: wetness	Moderate: wetness.	Good.
Waubeek: 771B	Slight	Moderate: slope	Slight	Slight	Good.
Lilah: 776C	Slight [2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: too sandy.
Wapsie: 777	Slight [2]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Donnan: 782B	Severe: percs slowly.	Moderate: slope	Severe: too clayey, wetness.	Moderate: wetness.	Poor: area reclaim, thin layer.

TABLE 5.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
782C	Severe: percs slowly.	Severe: slope	Severe: too clayey, wetness.	Moderate: wetness.	Poor: area reclaim, thin layer.
Protivin: 798	Severe: percs slowly, wetness.	Moderate: slope	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey.
Bertram: 809B	Severe:[2] depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: seepage	Poor: area reclaim, thin layer.
Sawmill: 933	Severe: floods, wetness.	Severe: floods	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.

[1] Some areas are underlain by sand and gravel at depths below 5 feet.
[2] Excessive permeability rate may cause pollution of ground water.
[3] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.
[4] The water table is generally perched for a short time during extended wet periods.

sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 5 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight,* soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil (*5*). Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table could be installed or the size of the absorption field could be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have

TABLE 6.—*Construction materials*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Road fill	Sand	Gravel	Topsoil
Wiota:				
7	Poor: frost action, low strength.	Unsuited	Unsuited	Good.
Colo:				
[1] 11B:				
Colo part	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor:[2] wetness.
Ely part	Poor: frost action, low strength.	Unsuited	Unsuited	Good.
Sparta:				
41, 41B, 41C, 41D	Good	Good	Unsuited	Poor: too sandy.
[1] U41C:				
Sparta part	Good	Good	Unsuited	Poor: too sandy.
Dickinson part	Good	Fair: excess fines	Unsuited	Good.
Bremer:				
43	Poor: shrink-swell, frost action, low strength.	Unsuited	Unsuited	Poor:[2] wetness.
[1] U43:				
Bremer part	Poor: shrink-swell, frost action, low strength.	Unsuited	Unsuited	Poor:[2] wetness.
Marshan part	Poor: wetness, frost action.	Fair: excess fines	Unsuited	Poor:[2] wetness.
Zook:				
54	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor: wetness, too clayey.
Chelsea:				
63B, 63C, 63D	Good	Fair: excess fines	Unsuited	Poor: too sandy.
Kenyon:				
83B, 83C, 83C2	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
83D2	Fair: low strength, frost action.	Unsuited	Unsuited	Fair: slope.
[1] U83C:				
Kenyon part	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
Clyde part	Poor: excess humus, wetness, frost action.	Unsuited	Unsuited	Poor:[2] wetness.
Clyde:				
84	Poor: excess humus, wetness, frost action.	Unsuited	Unsuited	Poor:[2] wetness.
Nevin:				
88	Poor: frost action, low strength.	Unsuited	Unsuited	Good.
Lamont:				
110B	Fair: low strength	Fair: excess fines	Unsuited	Good.[3]
Garwin:				
118	Poor: wetness, low strength, frost action.	Unsuited	Unsuited	Poor:[2] wetness.

TABLE 6.—*Construction materials*—Continued

Soil name and map symbol	Road fill	Sand	Gravel	Topsoil
Muscatine: 119, 119B	Poor: low strength, excess humus.	Unsuited	Unsuited	Good.
Tama: 120B, T120	Poor: low strength, excess humus.	Unsuited	Unsuited	Good.
Colo: 133, C133	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor:[2] wetness.
Coland: 135	Poor: low strength, excess humus, frost action.	Unsuited	Unsuited	Poor:[2] wetness.
Marshan: 151, 152	Poor: wetness, frost action.	Fair: excess fines	Unsuited	Poor:[2] wetness.
Loamy escarpments: 154F	Poor: slope			Poor: slope.
Finchford: 159, 159C	Good	Good	Fair: excess fines	Poor: too sandy.
[1] U159: Finchford part	Good	Good	Fair: excess fines	Poor: too sandy.
Flagler part	Good	Good	Fair: excess fines	Poor: area reclaim.
Bremer variant: 166	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey.
Bassett: 171B, 171C2	Fair: low strength, frost action.	Unsuited	Unsuited	Good.[3]
[1] U171D: Bassett part	Fair: low strength, frost action.	Unsuited	Unsuited	Fair: slope.
Chelsea part	Good	Fair: excess fines	Unsuited	Poor: too sandy.
Dickinson: 175, 175B	Good	Fair: excess fines	Unsuited	Good.
Saude: 177, 177B	Good	Good	Fair: excess fines	Good.
[1] U177: Saude part	Good	Good	Fair: excess fines	Good.
Lawler part	Good	Good	Fair: excess fines	Good.
Waukee: 178, 178B	Good	Good	Fair: excess fines	Good.
Klinger: 184	Poor: frost action, excess humus, low strength.	Unsuited	Unsuited	Good.
Floyd: 198B	Poor: excess humus, frost action, low strength.	Unsuited	Unsuited	Good.

TABLE 6.—*Construction materials*—Continued

Soil name and map symbol	Road fill	Sand	Gravel	Topsoil
Rockton:				
213B	Fair:[4] thin layer	Unsuited	Unsuited	Poor: area reclaim.
Palms:				
221	Poor: wetness, excess humus.	Unsuited	Unsuited	Poor: wetness.
Lawler:				
225, 226	Good	Good	Fair: excess fines	Good.
Flagler:				
284, 284B	Good	Good	Fair: excess fines	Poor: area reclaim.
Dells:				
290	Poor: frost action	Fair: excess fines	Unsuited	Fair: thin layer.
Loamy alluvial land:				
C315	Poor: wetness, frost action.	Fair	Fair	Good.
Marsh:				
354	Poor: wetness	Unsuited	Unsuited	Poor: wetness.
Dinsdale:				
377B, 377C, 377C2	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: too clayey.
Maxfield:				
382	Poor: wetness, frost action, excess humus.	Unsuited	Unsuited	Poor:[3] wetness.
Clyde:				
[1] 391B:				
Clyde part	Poor: excess humus, wetness, frost action.	Unsuited	Unsuited	Poor:[3] wetness.
Floyd part	Poor: excess humus, frost action, low strength.	Unsuited	Unsuited	Good.
Tripoli:				
398	Poor: wetness, frost action.	Unsuited	Unsuited	Poor:[3] wetness.
Readlyn:				
399	Poor: frost action	Unsuited	Unsuited	Good.
Olin:				
408B, 408C	Fair: low strength, frost action.	Poor: excess fines, thin layer.	Unsuited	Good.
Sogn:				
412C	Poor: thin layer	Unsuited	Unsuited	Poor: area reclaim.
Aredale:				
426B, 426C, 426C2	Fair: low strength	Unsuited	Unsuited	Good.
Oran:				
471	Poor: frost action	Unsuited	Unsuited	Good.
Spillville:				
485	Fair: shrink-swell, wetness, frost action.	Unsuited	Unsuited	Good.
[1] 585:				
Spillville part	Fair: shrink-swell, wetness, frost action.	Unsuited	Unsuited	Good.
Alluvial land part	Poor: wetness, frost action.	Fair	Fair	Good.

TABLE 6.—*Construction materials*—Continued

Soil name and map symbol	Road fill	Sand	Gravel	Topsoil
Koszta: 688	Poor: low strength	Unsuited	Unsuited	Fair: thin layer.
Hayfield: 725, 726	Fair: wetness	Good	Poor: excess fines	Good.[3]
Franklin: 761	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer.
Waubeek: 771B	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer.
Lilah: 776C	Good	Good	Fair: excess fines	Poor: area reclaim.
Wapsie: 777	Good	Good	Fair: excess fines	Good.[3]
Donnan: 782B, 782C	Poor: wetness, shrink-swell, frost action.	Unsuited	Unsuited	Poor: area reclaim, thin layer, too clayey.
Protivin: 798	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: area reclaim.
Bertram: 809B	Poor:[4] area reclaim	Unsuited	Unsuited	Poor: area reclaim.
Sawmill: 933	Poor: wetness, frost action, low strength.	Unsuited	Unsuited	Poor:[2] wetness.

[1] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.
[2] When dry, the upper 2 feet is a good source of topsoil.
[3] Only a thin layer is high in organic matter.
[4] If crushed, limestone rock is a good source of road fill.

moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness may be a limitation because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

In the trench type of landfill, ease of excavation also affects the suitability of a soil for this purpose, so the soil must be deep to bedrock and free of large stones and boulders. Where the seasonal water table is high, water seeps into trenches and causes problems in filling.

Unless otherwise stated, the limitations in table 5 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 6 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are

TABLE 7.—*Water management*

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Wiota:						
7	Seepage	Compressible, low strength, shrink-swell.	Not needed	Favorable	Favorable	Favorable.
Colo:						
[1] 11B:						
Colo part	Favorable	Compressible, low strength, hard to pack.	Floods, wetness.	Floods, wetness.	Not needed	Wetness.
Ely part	Favorable	Low strength, compressible, shrink-swell.	Favorable	Favorable	Wetness	Favorable.
Sparta:						
41, 41B, 41C, 41D	Seepage	Piping	Not needed	Seepage, droughty.	Too sandy	Droughty.
[1] U41C:						
Sparta part	Seepage	Piping	Not needed	Seepage, droughty.	Too sandy	Droughty.
Dickinson part	Seepage	Seepage, piping.	Not needed	Soil blowing, droughty, fast intake.	Too sandy, soil blowing, complex slope.	Droughty.
Bremer:						
43	Favorable	Compressible, unstable fill, shrink-swell.	Percs slowly	Slow intake, wetness.	Not needed	Not needed.
[1] U43:						
Bremer part	Favorable	Compressible, unstable fill, shrink-swell.	Percs slowly	Slow intake, wetness.	Not needed	Not needed.
Marshan part	Seepage	Unstable fill, seepage, erodes easily.	Wetness, cutbanks cave, floods.	Wetness, floods.	Wetness	Wetness, erodes easily.
Zook:						
54	Favorable	Shrink-swell, low strength, hard to pack.	Floods, wetness, percs slowly.	Floods, wetness, percs slowly.	Not needed	Wetness.
Chelsea:						
63B, 63C, 63D	Seepage	Piping, erodes easily, seepage.	Not needed	Droughty, erodes easily, seepage.	Complex slope, piping, too sandy.	Droughty, erodes easily, slope.
Kenyon:						
83B, 83C, 83C2, 83D2	Favorable	Favorable	Not needed	Slope	Favorable	Percs slowly, wetness.
[1] U83C:						
Kenyon part	Favorable	Favorable	Not needed	Slope	Favorable	Percs slowly, wetness.
Clyde part	Favorable	Low strength, compressible, hard to pack.	Favorable	Wetness, floods.	Not needed	Wetness, large stones.
Clyde:						
84	Favorable	Low strength, compressible, hard to pack.	Favorable	Wetness, floods.	Not needed	Wetness, large stones.

TABLE 7.—*Water management*—Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Nevin:						
88	Seepage	Compressible, low strength, shrink-swell.	Favorable	Favorable	Not needed	Not needed.
Lamont:						
110B	Seepage	Piping, erodes easily, seepage.	Not needed	Droughty, soil blowing, seepage.	Erodes easily, piping, too sandy.	Droughty, erodes easily.
Garwin:						
118	Seepage	Compressible, low strength, excess humus.	Favorable	Wetness, slow intake.	Not needed	Wetness.
Muscatine:						
119, 119B	Seepage	Compressible, low strength, shrink-swell.	Favorable	Favorable	Favorable	Favorable.
Tama:						
120B, T120	Seepage	Compressible, low strength, erodes easily.	Not needed	Erodes easily	Favorable	Favorable.
Colo:						
133, C133	Favorable	Compressible, low strength, hard to pack.	Floods, wetness.	Floods, wetness.	Not needed	Wetness.
Coland:						
135	Seepage	Compresssible, low strength, excess humus.	Floods, wetness.	Wetness, floods.	Wetness	Wetness.
Marshan:						
151, 152	Seepage	Unstable fill, seepage, erodes easily.	Wetness, cutbanks cave, floods.	Wetness, floods.	Wetness	Wetness, erodes easily.
Loamy escarpments:						
154F	Seepage	Erodes easily	Not needed	Slope	Slope	Slope.
Finchford:						
159, 159C	Seepage	Piping, erodes easily, seepage.	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
[1] U159:						
Finchford part	Seepage	Piping, erodes easily, seepage.	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Flagler part	Seepage	Seepage, piping.	Not needed	Droughty, fast intake.	Too sandy, piping.	Droughty.
Bremer variant:						
166	Favorable	Shrink-swell	Percs slowly, wetness.	Slow intake, percs slowly, wetness.	Not needed	Not needed.
Bassett:						
171B, 171C2	Favorable	Low strength, compressible.	Not needed	Slope	Percs slowly	Percs slowly, wetness.
[1] U171D:						
Bassett part	Favorable	Low strength, compressible.	Not needed	Slope	Percs slowly	Percs slowly, wetness.
Chelsea part	Seepage	Piping, erodes easily, seepage.	Not needed	Droughty, erodes easily, seepage.	Complex slope, piping, too sandy.	Droughty, erodes easily, slope.

TABLE 7.—*Water management*—Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Dickinson: 175, 175B	Seepage	Seepage, piping.	Not needed	Soil blowing, droughty, fast intake.	Too sandy, soil blowing, complex slope.	Droughty.
Saude: 177, 177B	Seepage	Seepage, piping.	Not needed	Droughty	Complex slope, piping.	Droughty.
[1] U177: Saude part	Seepage	Seepage, piping.	Not needed	Droughty	Complex slope, piping.	Droughty.
Lawler part	Seepage	Piping, seepage.	Cutbanks cave	Wetness	Wetness, rooting depth.	Rooting depth, wetness.
Waukee: 178, 178B	Seepage	Piping, seepage.	Not needed	Favorable	Complex slope	Favorable.
Klinger: 184	Favorable	Compressible, low strength.	Favorable	Favorable	Favorable	Wetness.
Floyd: 198B	Favorable	Low strength, piping.	Favorable	Wetness	Wetness, piping.	Wetness.
Rockton: 213B	Depth to rock	Thin layer	Not needed	Rooting depth	Depth to rock	Depth to rock.
Palms: 221	Seepage	Compressible, hard to pack, low strength.	Wetness, floods, cutbanks cave.	Wetness, fast intake, soil blowing.	Not needed	Not needed.
Lawler: 225, 226	Seepage	Piping, seepage.	Cutbanks cave	Wetness	Wetness, rooting depth.	Rooting depth, wetness.
Flagler: 284, 284B	Seepage	Seepage, piping.	Not needed	Droughty, fast intake.	Too sandy, piping.	Droughty.
Dells: 290	Seepage	Piping	Favorable	Wetness	Not needed	Not needed.
Loamy alluvial land: C315	Favorable	Piping	Floods	Floods	Not needed	Not needed.
Marsh: 354	Favorable	Unstable fill	Poor outlets	Floods, wetness.	Not needed	Wetness.
Dinsdale: 377B, 377C, 377C2	Favorable	Compressible, shrink-swell.	Not needed	Erodes easily, slope.	Favorable	Favorable.
Maxfield: 382	Favorable	Compressible, low strength, shrink-swell.	Favorable	Wetness, slow intake.	Not needed	Wetness.
Clyde: [1] 391B: Clyde part	Favorable	Low strength, compressible, hard to pack.	Favorable	Wetness, floods.	Not needed	Wetness, large stones.
Floyd part	Favorable	Low strength, piping.	Favorable	Wetness	Wetness, piping.	Wetness.
Tripoli: 398	Favorable	Favorable	Favorable	Wetness	Not needed	Not needed.

TABLE 7.—*Water management*—Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Readlyn: 399	Favorable	Favorable	Favorable	Wetness	Wetness	Not needed.
Olin: 408B, 408C	Favorable	Low strength	Not needed	Fast intake, slope, soil blowing.	Soil blowing, piping.	Erodes easily, wetness.
Sogn: 412C	Depth to rock	Thin layer	Not needed	Rooting depth	Depth to rock	Rooting depth.
Aredale: 426B, 426C, 426C2	Favorable	Low strength	Not needed	Favorable	Favorable	Favorable.
Oran: 471	Favorable	Low strength	Favorable	Wetness	Wetness	Not needed.
Spillville: 485	Seepage	Hard to pack, piping, excess humus.	Not needed	Favorable	Favorable	Favorable.
[1] 585: Spillville part	Seepage	Hard to pack, piping, excess humus.	Not needed	Favorable	Favorable	Favorable.
Alluvial land part	Favorable	Piping	Floods	Floods	Not needed	Not needed.
Koszta: 688	Seepage	Compressible, low strength, shrink-swell.	Not needed	Favorable	Wetness	Favorable.
Hayfield: 725, 726	Seepage	Seepage	Not needed	Favorable	Favorable	Favorable.
Franklin: 761	Favorable	Compressible, low strength.	Favorable	Favorable	Favorable	Wetness.
Waubeek: 771B	Favorable	Compressible, shrink-swell, low strength.	Not needed	Erodes easily, slope.	Favorable	Favorable.
Lilah: 776C	Seepage	Seepage, piping.	Not needed	Droughty, seepage.	Too sandy, piping, complex slope.	Droughty, rooting depth.
Wapsie: 777	Seepage	Seepage, piping.	Not needed	Droughty	Complex slope, piping.	Droughty.
Donnan: 782B, 782C	Favorable	Compressible, shrink-swell, low strength.	Percs slowly, complex slope.	Percs slowly, wetness, slope.	Percs slowly, wetness.	Percs slowly, wetness.
Protivin: 798	Favorable	Shrink-swell, low strength.	Percs slowly	Percs slowly, wetness.	Percs slowly, wetness.	Percs slowly, wetness.
Bertram: 809B	Depth to rock, seepage.	Thin layer, piping.	Not needed	Droughty, fast intake, rooting depth.	Depth to rock, rooting depth, piping.	Rooting depth, droughty.
Sawmill: 933	Favorable	Shrink-swell, low strength.	Floods	Wetness, floods.	Not needed	Not needed.

[1] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.

important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 10 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 6 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 10.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slopes, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soil rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 6 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 7 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability, texture, depth to bedrock, hardpan, or other layers that affect the rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Wildlife Habitat[4]

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, wheat, oats, and barley. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, lovegrass, bromegrass, clover, and alfalfa. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluestem, goldenrod, beggarweed, wheatgrass, and grama. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Examples of native plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated good are Russian-olive, autumn-olive, and crabapple. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Examples are pine, spruce, fir, cedar, and juniper. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, arrowhead, cattail, rushes, sedges, and reeds. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are marshes, waterfowl feeding areas, and ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, red fox, killdeer, and woodchuck.

[4] BILL D. WELKER, biologist, Soil Conservation Service, prepared this section.

TABLE 8.—*Wildlife*

[See text for definitions of "good," "fair," "poor," and "very poor."

Soil name and map symbol	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
Wiota: 7	Good	Good	Good	Good
Colo: [1] 11B: Colo part	Good	Good	Good	Fair
Ely part	Good	Good	Good	Good
Sparta: 41, 41B, 41C, 41D	Poor	Fair	Fair	Fair
[1] U41C: Sparta part	Poor	Fair	Fair	Fair
Dickinson part	Fair	Fair	Fair	Fair
Bremer: 43	Good	Good	Good	Fair
[1] U43: Bremer part	Good	Good	Good	Fair
Marshan part	Good	Good	Good	Fair
Zook: 54	Good	Fair	Good	Fair
Chelsea: 63B, 63C, 63D	Poor	Fair	Fair	Poor
Kenyon: 83B	Good	Good	Good	Good
83C, 83C2, 83D2	Fair	Good	Good	Good
[1] U83C: Kenyon part	Fair	Good	Good	Good
Clyde part	Good	Good	Good	Fair
Clyde: 84	Good	Good	Good	Fair
Nevin: 88	Good	Good	Good	Good
Lamont: 110B	Good	Good	Good	Good
Garwin: 118	Good	Good	Good	Fair
Muscatine: 119, 119B	Good	Good	Good	Good
Tama: 120B, T120	Good	Good	Good	Good
Colo: 133, C133	Good	Good	Good	Fair
Coland: 135	Good	Good	Good	Fair
Marshan: 151, 152	Good	Good	Good	Fair

habitat potentials

Absence of an entry indicates that the soil was not rated]

Potential for habitat elements—Continued			Potential as habitat for—		
Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Good	Poor	Poor	Good	Good	Poor.
Poor	Fair	Very poor	Good	Fair	Poor.
Good	Fair	Very poor	Good	Good	Poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Good	Good	Good	Fair	Good.
Poor	Good	Good	Good	Fair	Good.
Poor	Good	Good	Good	Fair	Good.
Poor	Good	Good	Fair	Fair	Good.
Poor	Very poor	Very poor	Fair	Poor	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Fair	Good	Good	Fair.
Good	Poor	Fair	Good	Good	Fair.
Poor	Good	Good	Good	Fair	Good.
Poor	Good	Good	Good	Fair	Good.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good	Fair	Good.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good	Fair	Good.
Fair	Good	Good	Good	Fair	Good.
Poor	Good	Good	Good	Fair	Good.

TABLE 8.—*Wildlife*

Soil name and map symbol	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
Loamy escarpments: 154F	Very poor	Very poor	Fair	Fair
Finchford: 159, 159C	Poor	Poor	Fair	Poor
[1] U159: Finchford part	Poor	Poor	Fair	Poor
Flagler part	Fair	Fair	Fair	Fair
Bremer variant: 166	Good	Good	Good	Fair
Bassett: 171B	Good	Good	Good	Good
171C2	Fair	Good	Good	Good
[1] U171D: Bassett part	Poor	Fair	Fair	Poor
Chelsea part	Poor	Fair	Fair	Poor
Dickinson: 175, 175B	Fair	Fair	Fair	Fair
Saude: 177, 177B	Good	Good	Good	Good
[1] U177: Saude part	Good	Good	Good	Good
Lawler part	Good	Good	Good	Good
Waukee: 178, 178B	Good	Good	Good	Good
Klinger: 184	Good	Good	Good	Good
Floyd: 198B	Good	Good	Good	Fair
Rockton: 213B	Good	Good	Good	Good
Palms: 221	Good	Poor	Poor	Poor
Lawler: 225, 226	Good	Good	Good	Good
Flagler: 284, 284B	Fair	Fair	Fair	Fair
Dells: 290	Good	Good	Good	Good
Loamy alluvial land: C315	Poor	Fair	Fair	Fair
Marsh: 354	Very poor	Very poor	Very poor	Very poor
Dinsdale: 377B	Good	Good	Good	Good
377C, 377C2	Fair	Good	Good	Good

habitat potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—		
Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Fair	Very poor	Very poor	Good	Fair	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Good	Good	Good	Fair	Good.
Good	Poor	Fair	Good	Good	Fair.
Good	Poor	Fair	Good	Good	Poor.
Poor	Very poor	Very poor	Fair	Poor	Very poor.
Poor	Very poor	Very poor	Fair	Poor	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Fair	Good	Good	Good	Fair	Good.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Fair	Poor	Good.
Good	Fair	Fair	Good	Good	Fair.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Poor	Good	Fair	Fair	Fair	Fair.
Very poor	Good	Good	Fair	Very poor	Good.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.

TABLE 8.—*Wildlife*

Soil name and map symbol	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
Maxfield: 382	Good	Good	Good	Fair
Clyde: [1]391B: Clyde part	Good	Good	Good	Fair
Floyd part	Good	Good	Good	Fair
Tripoli: 398	Good	Good	Good	Fair
Readlyn: 399	Good	Good	Good	Fair
Olin: 408B	Good	Good	Good	Good
408C	Fair	Good	Good	Good
Sogn: 412C	Very poor	Very poor	Poor	Poor
Aredale: 426B	Good	Good	Good	Good
426C, 426C2	Fair	Good	Good	Good
Oran: 471	Good	Good	Good	Good
Spillville: 485	Good	Good	Good	Good
[1]585: Spillville part	Good	Good	Good	Good
Alluvial land part	Poor	Fair	Fair	Fair
Koszta: 688	Good	Good	Good	Good
Hayfield: 725, 726	Good	Good	Good	Good
Franklin: 761	Good	Good	Good	Good
Waubeek: 771B	Good	Good	Good	Good
Lilah: 776C	Poor	Fair	Fair	Fair
Wapsie: 777	Good	Good	Good	Good
Donnan: 782B	Good	Good	Good	Good
782C	Fair	Good	Good	Good
Protivin: 798	Fair	Fair	Good	Fair
Bertram: 809B	Fair	Fair	Fair	Fair
Sawmill: 933	Good	Good	Good	Fair

[1] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior

habitat potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—		
Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Poor	Good	Good	Good	Fair	Good.
Poor	Good	Good	Good	Fair	Good.
Fair	Good	Good	Good	Fair	Good.
Poor	Good	Good	Good	Fair	Good.
Fair	Fair	Fair	Good	Fair	Fair.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Poor	Good	Good	Poor.
Fair	Very poor	Very poor	Very poor	Poor	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Very poor	Poor	Good	Good	Poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.
Poor	Good	Fair	Fair	Fair	Fair.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Poor	Good	Good	Poor.
Fair	Very poor	Very poor	Poor	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Poor	Good	Good	Poor.
Fair	Fair	Fair	Fair	Fair	Fair.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Fair	Poor	Poor	Good	Fair	Poor.

characteristics of the map unit.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include woodpeckers, fox, squirrels, raccoon, and white-tailed deer.

Wetland habitat consists of open, marshy or swampy, shallow-water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver, and kingfishers.

Recreation

Black Hawk County has abundant recreational facilities in the parks and open spaces that serve the local residents and attract many visitors to the county. There are 68 city parks in Waterloo-Cedar Falls totaling more than 2,600 acres, 18 county regulated parks of nearly 3,000 acres, 2 State-owned access areas, the George Wyth State Park, and many country clubs, trap shoots, and riding stables. The winding channels of the Cedar and Wapsipinicon Rivers and small tributaries provide fishing, hunting, camping, and canoeing as well as nature trails and scenic beauty.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 5, and interpretations for dwellings without basements and for local roads and streets, given in table 4.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping the site or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Soil Properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classification, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

TABLE 9.—*Recreational development*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Wiota:				
7	Moderate: too clayey.	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey.
Colo:				
[1] 11B:				
Colo part	Severe: floods, wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness.
Ely part	Moderate: wetness	Moderate: wetness	Moderate: wetness, slope.	Moderate: wetness.
Sparta:				
41	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
41B	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy, slope.	Moderate: too sandy.
41C	Moderate: too sandy	Moderate: too sandy	Severe: slope	Moderate: too sandy.
41D	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope	Moderate: too sandy.
[1] U41C:				
Sparta part	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy, slope.	Moderate: too sandy.
Dickinson part	Slight	Slight	Moderate: slope	Slight.
Bremer:				
43	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
[1] U43:				
Bremer part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Marshan part	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Zook:				
54	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness.
Chelsea:				
63B, 63C	Moderate: too sandy	Moderate: too sandy	Severe: too sandy, slope.	Moderate: too sandy.
63D	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: too sandy, slope.	Moderate: too sandy.
Kenyon:				
83B	Moderate: percs slowly.	Slight	Moderate: slope	Slight.
Kenyon:				
83C, 83C2	Moderate: percs slowly.	Slight	Severe: slope	Slight.
83D2	Moderate: slope, percs slowly.	Moderate: slope	Severe: slope	Slight.
[1] U83C:				
Kenyon part	Moderate: percs slowly.	Slight	Severe: slope	Slight.
Clyde part	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Clyde:				
84	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.

TABLE 9.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Nevin: 88	Moderate: wetness, too clayey.	Moderate: wetness, too clayey.	Moderate: wetness, too clayey.	Moderate: wetness, too clayey.
Lamont: 110B	Slight	Slight	Moderate: slope	Slight.
Garwin: 118	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Muscatine: 119, 119B	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Tama 120B	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey, slope.	Moderate: too clayey.
T120	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey.
Colo: 133, C133	Severe: floods, wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness.
Coland: 135	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Marshan: 151, 152	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Loamy escarpments: 154F	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Finchford: 159	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
Finchford: 159C	Moderate: too sandy	Moderate: too sandy	Moderate: slope, too sandy.	Moderate: too sandy.
[1] U159: Finchford part	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
Flagler part	Slight	Slight	Slight	Slight.
Bremer variant: 166	Severe: percs slowly, wetness, too clayey.	Severe: too clayey, wetness.	Severe: percs slowly, wetness, too clayey.	Severe: wetness, too clayey.
Bassett: 171B	Moderate: percs slowly.	Slight	Moderate: slope	Slight.
171C2	Moderate: percs slowly.	Slight	Severe: slope	Slight.
[1] U171D: Bassett part	Moderate: slope, percs slowly.	Moderate: slope	Severe: slope	Slight.
Chelsea part	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: too sandy, slope.	Moderate: too sandy.
Dickinson: 175	Slight	Slight	Slight	Slight.
175B	Slight	Slight	Moderate: slope	Slight.
Saude: 177, 177B	Slight	Slight	Slight	Slight.

TABLE 9.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
[1] U177:				
Saude part	Slight	Slight	Slight	Slight.
Lawler part	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Waukee:				
178	Slight	Slight	Slight	Slight.
178B	Slight	Slight	Moderate: slope	Slight.
Klinger:				
184	Moderate: wetness	Moderate: wetness	Moderate: wetness, slope.	Moderate: wetness.
Floyd:				
198B	Moderate: wetness	Moderate: wetness	Moderate: slope, wetness.	Moderate: wetness.
Rockton:				
213B	Slight	Slight	Moderate: depth to rock, slope.	Slight.
Palms:				
221	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.
Lawler:				
225, 226	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Flagler:				
284	Slight	Slight	Slight	Slight.
284B	Slight	Slight	Moderate: slope	Slight.
Dells:				
290	Moderate: wetness	Moderate: wetness	Moderate: wetness	Slight.
Loamy alluvial land:				
C315	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
Marsh:				
354	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Dinsdale:				
377B	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey, slope.	Moderate: too clayey.
377C, 377C2	Moderate: too clayey	Moderate: too clayey	Severe: slope	Moderate: too clayey.
Maxfield:				
382	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Clyde:				
[1] 391B:				
Clyde part	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Floyd part	Moderate: wetness	Moderate: wetness	Moderate: slope, wetness.	Moderate: wetness.
Tripoli:				
398	Severe: wetness, percs slowly.	Severe: wetness	Severe: wetness	Severe: wetness.
Readlyn:				
399	Moderate: wetness	Moderate: wetness	Moderate: wetness, slope.	Moderate: wetness.
Olin:				
408B	Slight	Slight	Moderate: slope	Slight.
408C	Slight	Slight	Severe: slope	Slight.

TABLE 9.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Sogn:				
412C	Slight	Slight	Severe: depth to rock.	Slight.
Aredale:				
426B	Slight	Slight	Moderate: slope	Slight.
426C, 426C2	Slight	Slight	Severe: slope	Slight.
Oran:				
471	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Spillville:				
485	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
[1] 585:				
Spillville part	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
Alluvial land part	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
Koszta:				
688	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Hayfield:				
725, 726	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Franklin:				
761	Moderate: wetness	Moderate: wetness	Moderate: wetness, slope.	Moderate: wetness.
Waubeek:				
771B	Slight	Slight	Moderate: slope	Slight.
Lilah:				
776C	Slight	Slight	Moderate: slope	Slight.
Wapsie:				
777	Slight	Slight	Moderate: slope	Slight.
Donnan:				
782B	Severe: percs slowly	Moderate: wetness	Severe: percs slowly	Moderate: wetness.
782C	Severe: percs slowly	Moderate: wetness	Severe: percs slowly, slope.	Moderate: wetness.
Protivin:				
798	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Moderate: wetness.
Bertram:				
809B	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Sawmill:				
933	Severe: floods, wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness.

[1] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.

Engineering properties

Table 10 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 10 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil Maps for Detailed Planning."

Texture is described in table 10 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A–1, A–2, and A–7 groups are further classified as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 13. The estimated classification, without group index numbers, is given in table 10. Also in table 10 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Ranges in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted in table 10.

Physical and chemical properties

Table 11 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture–that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 11. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and

TABLE 10.—*Engineering properties*

[The symbol < means less than; > means greater than.

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Wiota: 7.	0–20	Silt loam	CL, OL	A–6
	20–40	Silty clay loam	CL	A–7
	40–52	Loam	CL, CL–ML	A–4, A–6
	52–70	Sandy loam, loamy sand, fine sand	SM, SC, SP–SM, SP	A–2, A–3, A–4
Colo: [1] 11B: Colo part.	0–48	Silty clay loam	CL, CH	A–7
	48–60	Silty clay loam	CL, CH	A–7
Ely part.	0–29	Silt loam	CL, OL, CL–ML	A–7, A–6
	29–60	Silty clay loam	CL	A–7, A–6
Sparta: 41, 41B, 41C, 41D.	0–26	Loamy fine sand	SM, SP–SM	A–2
	26–60	Sand	SP	A–3
[1] U41C: Sparta part.	0–26	Loamy fine sand	SM, SP–SM	A–2
	26–60	Sand	SP	A–3
Dickinson part.	0–32	Fine sandy loam	SM, SC	A–4
	32–44	Loamy fine sand	SM, SP	A–2
	44–60	Sand, loamy sand	SP, SM	A–3, A–2
Bremer: 43.	0–20	Silty clay loam	MH, CH	A–7
	20–51	Silty clay loam, silty clay	CH	A–7
	51–60	Loam	CL	A–6
[1] U43: Bremer part.	0–20	Silty clay loam	MH, CH	A–7
	20–51	Silty clay loam, silty clay	CH	A–7
	51–60	Loam	CL	A–6
Marshan part.	0–20	Clay loam	CL, CH	A–7
	20–33	Loam	CL	A–7, A–6
	33–60	Loamy sand, gravelly sandy loam, loamy fine sand.	SP, SW, SP–SM, SM	A–1, A–2
Zook: 54.	0–60	Silty clay loam	MH, CH, CL, OL	A–7
Chelsea: 63B, 63C, 63D.	0–19	Loamy fine sand	SM	A–2–4
	19–60	Fine sand	SP, SM	A–3, A–2–4
Kenyon: 83B, 83C, 83C2, 83D2.	0–19	Loam	CL	A–6
	19–48	Loam, clay loam	CL	A–6
	48–60	Loam	CL	A–6
[1] U83C: Kenyon part.	0–19	Loam	CL	A–6
	19–48	Loam, clay loam	CL	A–6
	48–60	Loam	CL	A–6
Clyde part.	0–24	Clay loam	OL, MH, CL	A–7
	24–37	Loam, clay loam	CL	A–6, A–7
	37–60	Loam	CL, SC	A–6
Clyde: 84.	0–24	Clay loam	OL, MH, CL	A–7
	24–37	Loam, clay loam	CL	A–6, A–7
	37–60	Loam	CL, SC	A–6

and classifications

Absence of an entry indicates that data were not estimated]

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	100	90–95	30–40	10–20
0	100	100	95–100	90–95	41–50	15–25
0	100	95–100	75–95	65–80	25–35	5–15
0	100	90–100	50–85	3–50	<30	NP–10
0	100	100	90–100	90–100	41–60	15–30
0	100	100	90–100	90–100	41–55	15–30
0	100	100	95–100	95–100	30–55	5–25
0	100	100	95–100	95–100	35–50	11–25
0	100	100	60–70	10–20	----------------	NP
0	100	100	65–75	1–5	----------------	NP
0	100	100	60–70	10–20	----------------	NP
0	100	100	65–75	1–5	----------------	NP
0	100	100	85–95	35–50	15–30	NP–10
0	100	100	80–95	5–20	10–30	NP–5
0	100	100	70–90	5–20	----------------	NP
0	100	100	100	95–100	45–60	25–40
0	100	100	100	95–100	50–65	20–35
0	100	100	85–95	60–75	30–40	11–20
0	100	100	100	95–100	45–60	25–40
0	100	100	100	95–100	50–65	20–35
0	100	100	85–95	60–75	30–40	11–20
0	95–100	95–100	95–100	85–95	40–60	15–25
0	95–100	95–100	70–90	60–75	30–50	15–25
0–3	65–90	60–90	20–80	2–20	----------------	NP
0	100	100	95–100	95–100	45–70	20–40
0	100	100	65–80	10–35	----------------	NP
0	100	100	65–80	3–15	----------------	NP
0	100	95–100	85–95	65–75	30–40	10–20
0–5	90–95	85–95	80–90	50–65	30–40	10–20
0–5	90–95	85–95	80–90	50–65	25–35	10–20
0	100	95–100	85–95	65–75	30–40	10–20
0–5	90–95	85–95	80–90	50–65	30–40	10–20
0–5	90–95	85–95	80–90	50–65	25–35	10–20
0	100	100	80–90	55–75	45–60	15–25
0	95–100	90–95	75–90	50–75	30–50	10–20
0–5	90–95	85–90	75–90	45–65	25–35	10–20
0	100	100	80–90	55–75	45–60	15–25
0	95–100	90–95	75–90	50–75	30–50	10–20
0–5	90–95	85–90	75–90	45–65	25–35	10–20

TABLE 10.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Nevin. 88.	0–18	Silty clay loam	CL, OL	A-6, A-7
	18–53	Silty clay loam	CL	A-7
	53–60	Silty clay loam	CL	A-7
Lamont. 110B.	0–17	Fine sandy loam	SM-SC, SC	A-2, A-4
	17–50	Fine sandy loam, loam, sandy clay loam	SM-SC, SC	A-2, A-4
	50–60	Loamy fine sand, loamy sand	SM, SP-SM	A-2, A-3
Garwin: 118.	0–23	Silty clay loam	CL, OH, CH	A-7
	23–49	Silty clay loam	CH, CL	A-7
	49–60	Silt loam	CL	A-6
Muscatine: 119, 119B.	0–16	Silty clay loam	CL, OL	A-7
	16–50	Silty clay loam	CL	A-7
	50–60	Sandy loam	SM	A-2
	60–65	Loam, clay loam	CL	A-6
Tama: 120B, T120.	0–22	Silty clay loam	ML, CL, OL	A-6, A-7
	22–52	Silty clay loam	CL	A-7
	52–60	Silty clay loam, silt loam	CL	A-6, A-7
Colo: 133.	0–48	Silty clay loam	CL, CH	A-7
	48–60	Silty clay loam	CL, CH	A-7
C133.	0–48	Silty clay loam	CL, CL-ML	A-4, A-6
	48–60	Silty clay loam	CL, CH	A-7
Coland: 135.	0–33	Clay loam	OL, CL, CH, MH	A-6, A-7
	33–56	Loam, sandy loam	CL, SC	A-4, A-6
Marshan. 151, 152.	0–20	Clay loam	CL, CH	A-7
	20–33	Loam	CL	A-7, A-6
	33–60	Coarse sand, gravelly coarse sand, loamy fine sand.	SP, SW, SP-SM, SM	A-1, A-2
Loamy escarpments: 154F.	0–60			
Finchford: 159, 159C.	0–18	Loamy sand	SP-SM, SM	A-2, A-3
	18–30	Coarse sand, loamy sand	SW-SM	A-1
	30–60	Coarse sand	SW	A-1
[1] U159: Finchford part.	0–18	Loamy sand	SP-SM, SM	A-2, A-3
	18–30	Coarse sand, loamy sand	SW-SM	A-1
	30–60	Coarse sand	SW	A-1
Flagler part.	0–21	Sandy loam	SC, SM-SC	A-2, A-4
	21–42	Sandy loam	SC, SM-SC	A-2, A-4
	42–60	Loamy sand, gravelly sand	SP-SM, SW, SP, SW-SM	A-1, A-3
Bremer variant: 166.	0–20	Silty clay loam, silty clay	CL, CH	A-7
	20–36	Silty clay, clay	CH	A-7
	36–60	Silty clay loam, loam	CL	A-6, A-7
	60–70	Loamy fine sand	SM	A-2, A-3

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	100	90–95	35–45	10–20
0	100	100	95–100	90–95	40–50	20–30
0	100	100	95–100	90–95	40–50	20–30
0	100	100	80–95	25–50	15–25	5–10
0	100	100	85–95	30–50	20–30	5–10
0	100	100	70–90	5–25	----------------	NP
0	100	100	100	95–100	45–55	20–30
0	100	100	100	95–100	45–55	25–35
0	100	100	100	95–100	30–40	15–20
0	100	100	100	95–100	40–50	15–25
0	100	100	100	95–100	40–50	20–30
0	100	95–100	80–90	25–35	<25	NP–5
2–5	90–95	85–95	80–90	50–65	25–40	10–20
0	100	100	100	95–100	35–50	10–20
0	100	100	100	95–100	40–50	15–25
0	100	100	100	95–100	35–45	15–25
0	100	100	90–100	90–100	41–60	15–30
0	100	100	90–100	90–100	41–55	15–30
0	100	100	95–100	95–100	25–40	5–15
0	100	100	90–100	90–100	41–55	15–30
0	100	100	95–100	70–90	45–55	20–30
0	100	95–100	60–70	40–60	20–40	8–15
0	95–100	95–100	95–100	85–95	40–60	15–25
0	95–100	95–100	70–90	60–75	30–50	15–25
0–3	65–90	60–90	20–80	2–20	----------------	NP
0	85–95	70–80	50–60	5–15	----------------	NP
0	80–90	60–70	25–40	5–10	----------------	NP
0	75–85	55–65	20–35	3–5	----------------	NP
0	85–95	70–80	50–60	5–15	----------------	NP
0	80–90	60–70	25–40	5–10	----------------	NP
0	75–85	55–65	20–35	3–5	----------------	NP
0	95–100	90–95	60–70	25–40	15–25	5–10
0	95–100	90–95	50–70	25–40	15–25	5–10
0–5	70–90	70–85	20–40	3–12	----------------	NP
0	100	100	95–100	95–100	45–55	20–30
0	100	100	95–100	95–100	55–75	35–45
0	100	100	95–100	75–90	35–50	15–25
0	100	100	60–70	5–20	----------------	NP

TABLE 10.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Bassett: 171B, 171C2.	0–12	Loam	CL, CL–ML	A–4, A–6
	12–46	Loam, clay loam, sandy clay loam	CL	A–6
	46–70	Loam	CL	A–6
[1] U171D. Bassett part.	0–12	Loam	CL, CL–ML	A–4, A–6
	12–46	Loam, clay loam, sandy clay loam	CL	A–6
	46–70	Loam	CL	A–6
Chelsea part.	0–19	Loamy fine sand	SM	A–2–4
	19–60	Fine sand	SP, SM	A–3, A–2–4
Dickinson: 175, 175B.	0–32	Fine sandy loam	SM, SC	A–4
	32–44	Loamy fine sand	SM, SP	A–2
	44–60	Sand	SP, SM	A–3, A–2
Saude: 177, 177B.	0–17	Loam	CL, CL–ML	A–6
	17–30	Loam, sandy loam	CL, SC, CL–ML, SM–SC	A–4, A–6
	30–60	Loamy sand, gravelly coarse sand	SW, SM	A–1
[1] U177: Saude part.	0–17	Loam	CL, CL–ML	A–6
	17–30	Loam, sandy loam	CL, SC, CL–ML, SM–SC	A–4, A–6
	30–60	Loamy sand, gravelly coarse sand	SW, SM	A–1
Lawler part.	0–17	Loam	OL, CL	A–6, A–7
	17–26	Loam, sandy clay loam	CL, SC	A–6
	26–60	Stratified sandy loam to gravelly loam, and gravelly sand.	SW, SW–SM	A–1
Waukee: 178, 178B.	0–18	Loam	CL	A–4, A–6
	18–34	Loam, sandy clay loam, sandy loam	CL, SM–SC, SC, CL–ML	A–6, A–4
	34–60	Gravelly sand, loamy coarse sand	SW, SM	A–1, A–2
Klinger: 184.	0–18	Silty clay loam	CL, OL	A–7
	18–32	Silty clay loam	CL	A–7
	32–60	Loam, clay loam	CL	A–6
Floyd: 198B.	0–24	Loam	OL, MH	A–7
	24–39	Loam, clay loam	CL	A–6
	39–45	Sandy loam	SM, SM–SC	A–2
	45–65	Loam	CL	A–6
Rockton: 213B.	0–15	Loam	ML, CL–ML	A–4
	15–34	Loam, sandy clay loam, clay loam	CL, SC	A–6, A–7
	34	Weathered bedrock.		
Palms: 221.	0–20	Sapric material	Pt	----------
	20–60	Clay loam, loam, silt loam	CL–ML, CL	A–4, A–6
Lawler: 225, 226:	0–17	Loam	OL, CL	A–6, A–7
	17–26	Loam, sandy clay loam	CL, SC	A–6
	26–60	Stratified sandy loam to gravelly loam, and gravelly sand.	SW, SW–SM	A–1

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	95–100	85–95	65–85	20–30	5–15
2–5	90–95	85–95	80–90	50–65	30–40	10–20
2–5	90–95	85–95	80–90	50–65	30–40	10–20
0	100	95–100	85–95	65–85	20–30	5–15
2–5	90–95	85–95	80–90	50–65	30–40	10–20
2–5	90–95	85–95	80–90	50–65	30–40	10–20
0	100	100	65–80	10–35	-------	NP
0	100	100	65–80	3–15	-------	NP
0	100	100	85–95	35–50	15–30	NP–10
0	100	100	80–95	5–20	10–30	NP–5
0	100	100	70–90	5–20	-------	NP
0	100	90–100	70–90	50–75	25–35	5–15
0–5	85–95	80–95	70–85	36–60	20–30	5–15
2–10	50–90	50–85	20–40	3–25	-------	NP
0	100	90–100	70–90	50–75	25–35	5–15
0–5	85–95	80–95	70–85	36–60	20–30	5–15
2–10	50–90	50–85	20–40	3–25	-------	NP
0	100	90–100	70–90	55–75	35–45	10–25
0–5	85–95	80–95	70–85	45–65	25–40	10–20
2–10	50–90	50–85	20–40	3–10	-------	NP
0	100	90–100	70–90	50–75	30–40	10–20
0–5	85–95	80–95	65–85	40–60	20–35	5–15
2–10	60–90	60–85	20–40	3–25	-------	NP
0	100	100	100	95–100	40–50	15–25
0	100	100	100	95–100	40–50	20–30
0–5	90–95	85–90	75–85	55–65	25–35	10–20
0	100	100	80–90	55–75	45–60	15–20
2–8	90–95	70–80	50–70	50–65	25–35	11–20
2–5	90–95	70–80	50–70	15–35	15–20	NP–5
2–5	90–95	85–95	70–85	50–65	25–35	11–20
0	90–100	90–100	85–95	50–75	25–35	5–10
0	90–100	90–100	75–90	45–70	30–45	10–20
-------	-------	-------	-------	-------	-------	-------
0	85–100	80–100	70–95	50–80	20–35	5–15
0	100	90–100	70–90	55–75	35–45	10–25
0–5	85–95	80–95	70–85	45–65	25–40	10–20
2–10	50–90	50–85	20–40	3–10	-------	NP

TABLE 10.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Flagler: 284, 284B:	0–21	Sandy loam	SC, SM–SC	A–2, A–4
	21–42	Sandy loam	SC, SM–SC	A–2, A–4
	42–60	Loamy sand, gravelly sand	SP–SM, SW, SP, SW–SM	A–1, A–3
Dells: 290.	0–13	Silt loam	ML, CL–ML	A–4, A–6
	13–36	Silty clay loam, silt loam	CL	A–6
	36–60	Loamy sand, sandy loam	SP–SM, SM	A–3, A–2
Loamy alluvial land: C315.	0–60	Variable.		
Marsh: 354.	0–60	Variable.		
Dinsdale: 377B, 377C, 377C2.	0–15	Silty clay loam	ML, CL, OL	A–6, A–7
	15–36	Silty clay loam	CL	A–7
	36–73	Loam	CL	A–6
Maxfield: 382.	0–17	Silty clay loam	CL, OH, CH	A–7
	17–30	Silty clay loam, silt loam	CH, CL	A–7
	30–66	Loam	CL	A–6
Clyde: [1]391B:				
Clyde part.	0–24	Clay loam	OL, MH, CL	A–7
	24–37	Loam, clay loam	CL	A–6, A–7
	37–60	Loam	CL, SC	A–6
Floyd part.	0–24	Loam	OL, MH	A–7
	24–39	Loam, clay loam	CL	A–6
	39–45	Sandy loam	SM, SM–SC	A–2
	45–65	Loam	CL	A–6
Tripoli: 398.	0–19	Clay loam	CL	A–6, A–7
	19–45	Clay loam, loam	CL	A–6
	45–60	Loam	CL	A–6
Readlyn: 399.	0–22	Loam	CL	A–6
	22–44	Loam	CL	A–6
	44–70	Loam	CL	A–6
Olin: 408B, 408C.	0–33	Fine sandy loam	SM–SC, SC	A–2, A–4
	33–60	Loam	CL, SC	A–6
	60–70	Loam	CL	A–6
Sogn: 412C.	0–17	Loam	CL	A–6, A–7
	17	Unweathered bedrock.		
Aredale: 426B, 426C, 426C2.	0–13	Loam	CL, CL–ML	A–4, A–6
	13–22	Loam, clay loam	CL, SC, CL–ML	A–4, A–6
	22–45	Sandy loam, loamy sand	SC, SM	A–2, A–4
	45–60	Loam	CL	A–6
Oran: 471.	0–12	Loam	CL, CL–ML	A–4, A–6
	12–53	Loam, clay loam, sandy clay loam	CL	A–6
	53–60	Loam	CL	A–6

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	95–100	90–95	60–70	25–40	15–25	5–10
0	95–100	90–95	50–70	25–40	15–25	5–10
0–5	70–90	70–85	20–40	3–12		NP
0	100	100	95–100	90–95	25–35	5–15
0	100	100	90–100	85–95	30–40	15–20
0	100	95–100	45–55	5–15		NP
0	100	100	100	95–100	30–50	10–20
0	100	100	100	95–100	40–50	15–25
0–5	90–95	85–90	75–85	55–65	25–35	10–20
0	100	100	100	95–100	45–55	20–30
0	100	100	100	95–100	45–55	25–35
0–5	90–95	85–90	75–85	55–65	25–35	10–20
0	100	100	80–90	55–75	45–60	15–25
0	95–100	90–95	75–90	50–75	30–50	10–20
0–5	90–95	85–90	75–90	45–65	25–35	10–20
0	100	100	80–90	55–75	45–60	15–20
2–8	90–95	70–80	50–70	50–65	25–35	11–20
2–5	90–95	70–80	50–70	15–35	15–20	NP–5
2–5	90–95	85–95	70–85	50–65	25–35	11–20
0	100	100	85–95	55–75	35–45	15–25
2–5	90–95	85–90	75–85	55–65	30–40	11–20
2–5	90–95	85–90	75–85	55–65	30–40	11–20
0	100	100	85–95	55–75	30–40	15–25
2–5	90–95	85–90	75–85	55–65	30–40	10–20
2–5	90–95	85–90	75–85	55–65	25–35	10–20
0	100	95–100	85–95	30–50	20–30	5–10
2–5	90–95	85–95	80–90	45–65	25–35	10–20
2–5	90–95	85–95	80–90	50–65	25–35	10–20
0–10	85–100	85–100	85–100	80–95	25–45	11–23
0	100	95–100	85–95	55–75	25–35	5–15
2–5	90–95	85–95	80–90	40–60	25–35	5–15
2–5	90–95	85–95	70–90	30–50	15–20	NP–10
2–5	90–95	85–95	80–90	50–65	25–35	11–20
0	100	100	85–95	55–75	25–35	5–15
2–5	90–95	85–90	75–85	55–65	30–40	10–20
2–5	90–95	85–90	75–85	55–65	30–40	10–20

TABLE 10.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Spillville: 485.	0–60	Loam	CL, OL	A–6
[1] 585: Spillville part.	0–60	Loam	CL, OL	A–6
Alluvial land part.	0–60	Variable.		
Koszta: 688.	0–13	Silt loam	CL	A–6
	13–53	Silty clay loam	CL	A–7
	53–60	Sandy loam, loamy sand, sand	SM, SP–SM, SP	A–2, A–3
Hayfield: 725, 726.	0–16	Loam	ML, CL	A–6
	16–34	Loam, silt loam	ML, CL	A–4, A–6
	34–60	Coarse sand, loamy fine sand, fine sand	SP–SM, SM	A–1, A–2, A–3
Franklin: 761.	0–12	Silt loam	CL–ML, CL	A–4, A–6
	12–26	Silty clay loam	CL	A–7
	26–60	Loam	CL	A–6
Waubeek: 771B.	0–8	Silt loam	CL–ML, CL	A–4, A–6
	8–24	Silty clay loam	CL	A–7
	24–70	Loam	CL	A–6
Lilah: 776C.	0–9	Sandy loam	SM–SC, SC	A–2, A–4
	9–60	Gravelly loamy sand, loamy sand, coarse sand	SW, SW–SM	A–1–B
Wapsie: 777.	0–10	Loam	CL	A–4
	10–27	Loam, sandy clay loam	CL, SC, CL–ML, SM–SC	A–4, A–6
	27–60	Fine sandy loam, gravelly loamy sand, gravelly sand.	SW, SM	A–1
Donnan: 782B, 782C.	0–20	Loam	CL–ML, CL, ML	A–4, A–6
	20–29	Clay	CH	A–7
	29–60	Clay loam	CL	A–6, A–7
Protivin: 798.	0–22	Loam, clay loam	MH, OL, CL	A–7
	22–60	Clay loam	CL	A–6
Bertram: 809B.	0–23	Fine sandy loam	SM–SC, SC	A–2, A–4
	23–27	Sandy loam	SM–SC, SC	A–2, A–4
	27–34	Sandy clay loam	SC, CL	A–6, A–7
	34	Unweathered bedrock.		
Sawmill: 933.	0–29	Silty clay loam	CL, CH	A–7
	29–60	Silty clay loam	CL, CH	A–7, A–6

[1] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	95–100	85–95	60–80	25–40	10–20
0	100	95–100	85–95	60–80	25–40	10–20
0 0 0	100 100 100	100 100 95–100	95–100 95–100 80–90	95–100 95–100 3–20	30–40 40–50 <25	10–20 20–30 NP–5
0 0 0–3	100 98–100 85–100	100 95–100 75–98	90–98 70–90 30–80	70–90 65–80 5–35	30–40 25–40 ---	10–20 5–15 NP
0 0 0–5	100 100 90–95	100 100 85–90	100 100 75–85	95–100 95–100 55–65	25–35 40–50 25–35	5–15 20–30 10–20
0 0 0–5	100 100 90–95	100 100 85–95	100 100 75–85	100 100 55–65	25–35 40–50 25–35	5–15 15–25 10–20
0–5 0–10	90–95 70–80	80–90 50–70	60–70 30–50	25–40 3–12	15–25 ---	5–10 NP
0 0	100 85–95	90–100 80–95	70–90 70–85	50–75 40–60	25–35 20–35	5–10 5–15
0	60–90	60–85	20–40	3–25	---	NP
0 0–5 2–5	100 95–100 95–100	100 90–95 85–95	85–95 80–90 80–90	65–80 60–75 55–75	30–40 55–70 35–45	5–20 30–40 15–25
0 2–5	100 90–95	100 85–90	85–95 75–85	60–75 55–65	45–55 35–40	15–20 15–25
0 0 0	100 100 85–95	95–100 95–100 80–90	85–95 80–90 70–80	30–50 25–40 45–65	25–35 15–25 35–45	5–10 5–10 20–30
0 0	100 100	100 100	95–100 95–100	90–100 90–100	40–60 40–60	20–30 20–30

characteristics of the map unit.

TABLE 11.—*Physical and chemical*

[Dashes indicate that data were not available. The symbol < means less than; > means greater than. Entries under "Erosion
entry indicates that data

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Wiota:					
7.	0–20	0.6–2.0	0.21–0.23	5.6–6.0	<2
	20–40	0.6–2.0	0.18–0.20	5.6–6.5	<2
	40–52	0.6–2.0	0.18–0.20	5.6–6.5	<2
	52–70	6.0–20	0.04–0.13	5.6–6.5	<2
Colo:					
[1] 11B:					
Colo part.	0–48	0.2–0.6	0.21–0.23	5.6–7.3	<2
	48–60	0.2–0.6	0.18–0.20	6.1–7.3	<2
Ely part.	0–29	0.6–2.0	0.21–0.23	5.6–7.3	<2
	29–60	0.6–2.0	0.18–0.20	6.1–7.3	<2
Sparta:					
41, 41B, 41C, 41D.	0–26	6.0–20	0.06–0.08	5.6–6.5	<2
	26–60	6.0–20	0.04–0.08	5.6–6.5	<2
[1] U41C:					
Sparta part.	0–26	6.0–20	0.12–0.14	5.6–6.0	<2
	26–60	6.0–20	0.06–0.08	5.6–6.0	<2
Dickinson part.	0–32	2.0–6.0	0.12–0.15	5.6–6.5	<2
	32–44	6.0–20	0.08–0.10	5.6–6.5	<2
	44–60	6.0–20	0.02–0.04	5.6–6.5	<2
Bremer:					
43.	0–20	0.2–0.6	0.21–0.23	5.6–7.3	<2
	20–51	0.06–0.2	0.15–0.17	6.1–7.3	<2
	51–60	0.2–0.6	0.18–0.20	6.1–7.3	<2
[1] U43:					
Bremer part.	0–20	0.2–0.6	0.21–0.23	5.6–7.3	<2
	20–51	0.06–0.6	0.15–0.17	6.1–7.3	<2
	51–60	0.2–0.6	0.18–0.20	6.1–7.3	<2
Marshan part.	0–20	0.6–2.0	0.20–0.22	5.6–7.3	<2
	20–33	0.6–2.0	0.15–0.19	5.6–7.3	<2
	33–60	6.0–20	0.02–0.05	6.1–7.3	<2
Zook:					
54.	0–60	0.2–0.6	0.18–0.23	5.6–7.8	<2
Chelsea:					
63B, 63C, 63D.	0–19	6.0–20	0.10–0.15	6.1–6.5	<2
	19–60	6.0–20	0.06–0.08	5.1–5.5	<2
Kenyon:					
83B, 83C, 83C2, 83D2.	0–19	0.6–2.0	0.20–0.22	5.6–6.5	<2
	19–48	0.2–0.6	0.17–0.19	5.1–7.3	<2
	48–60	0.2–0.6	0.17–0.19	6.6–8.4	<2
[1] U83C:					
Kenyon part.	0–19	0.6–2.0	0.20–0.22	5.6–6.5	<2
	19–48	0.2–0.6	0.17–0.19	5.1–7.3	<2
	48–60	0.2–0.6	0.17–0.19	7.4–8.4	<2
Clyde part.	0–24	0.6–2.0	0.21–0.23	6.6–7.3	<2
	24–37	0.6–2.0	0.18–0.20	6.6–7.3	<2
	37–60	0.2–0.6	0.17–0.19	6.6–8.4	<2
Clyde:					
84.	0–24	0.6–2.0	0.21–0.23	6.6–7.3	<2
	24–37	0.6–2.0	0.18–0.20	6.6–7.3	<2
	37–60	0.2–0.6	0.17–0.19	6.6–8.4	<2

properties of soils

factors (T)" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an were not estimated]

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate	Moderate	Moderate	0.32	5	7
Moderate	Moderate	Low	0.43		
Moderate	Moderate	Low	0.43		
Low	Low	Low	0.24		
High	High	Moderate			7
High	High	Moderate			
Moderate	High	Moderate	0.32	5	7
Moderate	High	Low	0.43		
Low	Low	Low	0.17	5	2
Low	Low	Low	0.17		
Low	Low	Low	0.17	5	2
Low	Low	Low	0.17		
Low	Low	Moderate	0.20	4	3
Low	Low	Moderate	0.20		
Low	Low	Moderate	0.15		
High	Moderate	Moderate			7
High	Moderate	Moderate			
Moderate	Moderate	Moderate			
High	Moderate	Moderate			7
High	Moderate	Moderate			
Moderate	Moderate	Moderate			
Moderate	High	Moderate			7
Moderate	High	Moderate			
Low	High	Low			
High	High	Moderate			7
Low	Low	Low	0.17	5	2
Low	Low	Low	0.17		
Low	Moderate	Moderate	0.28	5	6
Low	Moderate	Moderate	0.28		
Low	Moderate	Moderate	0.37		
Low	Moderate	Moderate	0.28	5	6
Low	Moderate	Moderate	0.28		
Low	Moderate	Moderate	0.37		
Moderate	High	Low			7
Moderate	High	Low			
Moderate	High	Low			
Moderate	High	Low			7
Moderate	High	Low			
Moderate	High	Low			

TABLE 11.—*Physical and chemical*

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Nevin:					
88.	0–18	0.6–2.0	0.21–0.23	6.1–7.3	<2
	18–53	0.2–2.0	0.18–0.20	6.1–7.3	<2
	53–60	0.2–2.0	0.18–0.20	6.6–7.3	<2
Lamont:					
110B.	0–17	2.0–6.0	0.16–0.18	5.1–7.3	<2
	17–50	2.0–6.0	0.14–0.16	5.1–6.0	<2
	50–60	>20	0.09–0.11	5.1–6.0	<2
Garwin:					
118.	0–23	0.2–0.6	0.21–0.23	5.6–6.5	<2
	23–49	0.2–0.6	0.18–0.20	6.1–7.3	<2
	49–60	0.6–2.0	0.20–0.22	6.6–7.3	<2
Muscatine:					
119, 119B.	0–16	0.6–2.0	0.22–0.24	5.1–7.3	<2
	16–50	0.6–2.0	0.18–0.20	4.5–6.5	<2
	50–60	6.0–20	0.05–0.13	6.1–6.5	<2
	60–65	0.2–0.6	0.17–0.19	6.6–7.8	<2
Tama:					
120B, T120.	0–22	0.6–2.0	0.22–0.24	5.1–7.3	<2
	22–52	0.6–2.0	0.18–0.20	5.1–5.5	<2
	52–60	0.6–2.0	0.18–0.20	5.6–6.0	<2
Colo:					
133.	0–48	0.2–0.6	0.21–0.23	5.6–7.3	<2
	48–60	0.2–0.6	0.18–0.20	6.1–7.3	<2
C133.	0–48	0.2–0.6	0.21–0.23	5.6–7.3	<2
	48–60	0.2–0.6	0.18–0.20	6.1–7.3	<2
Coland.					
135.	0–33	0.2–0.6	0.20–0.22	5.6–7.3	<2
	33–56	2.0–6.0	0.13–0.17	6.1–7.3	<2
Marshan:					
151, 152.	0–20	0.6–2.0	0.20–0.22	5.6–7.3	<2
	20–33	0.6–2.0	0.15–0.19	5.6–7.3	<2
	33–60	6.0–20	0.02–0.05	6.1–7.3	<2
Loamy escarpments. 154F.	0–60	----------------	----------------	----------------	------------
Finchford:					
159, 159C.	0–18	>6.0	0.10–0.12	6.1–7.3	<2
	18–30	>20	0.04–0.06	5.1–5.5	<2
	30–60	>20	0.02–0.04	5.6–6.0	<2
[1] U159:					
Finchford part.	0–18	>6.0	0.10–0.12	6.1–7.3	<2
	18–30	>20	0.04–0.06	5.1–5.5	<2
	30–60	>20	0.02–0.04	5.6–6.0	<2
Flagler part.	0–21	2.0–6.0	0.12–0.14	5.6–7.3	<2
	21–42	2.0–6.0	0.11–0.13	5.1–6.5	<2
	42–60	>20	0.02–0.04	5.1–7.3	<2
Bremer variant:					
166.	0–20	0.06–0.2	0.18–0.20	5.1–6.0	<2
	20–36	>0.06	0.12–0.16	5.1–6.0	<2
	36–60	0.2–0.6	0.18–0.20	6.1–7.3	<2
	60–70	6.0–20	0.10–0.12	6.6–7.3	<2
Bassett:					
171B, 171C2.	0–12	0.6–2.0	0.19–0.21	5.1–6.5	<2
	12–46	0.2–0.6	0.17–0.19	4.5–5.5	<2
	46–70	0.2–0.6	0.17–0.19	5.1–7.8	<2

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate Moderate Moderate	High High High	Low Low Low	0.32 0.43 0.43	5	7
Very low Very low Very low	Low Low Low	Moderate Moderate Moderate	0.24 0.24 0.17	5	3
High High Moderate	High High High	Moderate Moderate Moderate	--- --- ---	---	7
Moderate Moderate Low Low	High High Low Moderate	Moderate Moderate Moderate Moderate	0.28 0.43 0.28 0.37	5	6
Moderate Moderate Moderate	Moderate Moderate Moderate	Moderate Moderate Moderate	0.32 0.43 0.43	5	7
High High	High High	Moderate Moderate	--- ---	---	7
High High	High High	Moderate Moderate	--- ---	---	7
High Low	High High	Low Low	--- ---	---	7
Moderate Moderate Low	High High High	Moderate Moderate Low	--- --- ---	---	7
---	---	---	---	---	---
Low Low Low	Low Low Low	Low Low Low	0.17 0.17 0.17	5	2
Low Low Low	Low Low Low	Low Low Low	0.17 0.17 0.17	5	2
Low Low Low	Moderate Moderate Moderate	Low Low Low	0.20 0.20 0.20	4	3
Very high Very high High Very high	High High High High	High High High High	--- --- --- ---	---	7
Low Low Low	Moderate Moderate Moderate	Moderate Moderate Moderate	0.28 0.28 0.37	5	6

TABLE 11.—*Physical and chemical*

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Bassett:					
[1] U171D:					
Bassett part.	0–12	0.6–2.0	0.19–0.21	5.1–6.5	<2
	12–46	0.2–0.6	0.17–0.19	4.5–5.5	<2
	46–70	0.2–0.6	0.17–0.19	5.1–7.8	<2
Chelsea part.	0–19	6.0–20	0.10–0.15	6.1–6.5	<2
	19–60	6.0–20	0.06–0.08	5.1–5.5	<2
Dickinson: 175, 175B.	0–32	2.0–6.0	0.12–0.15	5.6–6.5	<2
	32–44	6.0–20	0.08–0.10	5.6–6.5	<2
	44–60	6.0–20	0.02–0.04	5.6–6.5	<2
Saude: 177, 177B.	0–17	0.6–2.0	0.20–0.22	5.6–6.5	<2
	17–30	0.6–6.0	0.15–0.19	5.6–6.0	<2
	30–60	>20	0.02–0.06	5.1–6.0	<2
[1] U177:					
Saude part.	0–17	0.6–2.0	0.20–0.22	5.6–6.5	<2
	17–30	0.6–6.0	0.15–0.19	5.6–6.0	<2
	30–60	>20	0.02–0.06	5.1–6.0	<2
Lawler part.	0–17	0.6–2.0	0.20–0.22	5.6–7.3	<2
	17–26	0.6–2.0	0.16–0.18	5.6–6.5	<2
	26–60	6.0–20	0.02–0.04	6.1–6.5	<2
Waukee: 178, 178B.	0–18	0.6–2.0	0.20–0.22	5.6–7.3	<2
	18–34	0.6–2.0	0.15–0.19	5.6–6.0	<2
	34–60	>20	0.02–0.06	5.6–6.5	<2
Klinger: 184.	0–18	0.6–2.0	0.22–0.24	5.1–7.3	<2
	18–32	0.6–2.0	0.18–0.20	6.1–6.5	<2
	32–60	0.2–0.6	0.17–0.19	6.1–7.8	<2
Floyd: 198B.	0–24	0.6–2.0	0.20–0.22	6.6–7.3	<2
	24–39	0.6–2.0	0.16–0.18	6.6–7.3	<2
	39–45	2.0–6.0	0.11–0.13	6.6–7.3	<2
	45–65	0.2–0.6	0.16–0.18	6.6–7.8	<2
Rockton: 213B.	0–15	0.6–2.0	0.20–0.22	5.1–7.3	<2
	15–34	0.6–2.0	0.17–0.19	5.1–6.5	<2
	34	-----	-----	-----	-----
Palms: 221.	0–20	0.2–6.0	0.35–0.45	5.1–7.8	<2
	20–60	0.2–2.0	0.05–0.19	6.1–8.4	<2
Lawler: 225, 226:	0–17	0.6–2.0	0.20–0.22	5.6–7.3	<2
	17–26	0.6–2.0	0.16–0.18	5.6–6.5	<2
	26–60	6.0–20	0.02–0.04	6.1–6.5	<2
Flagler: 284, 284B.	0–21	2.0–6.0	0.12–0.14	6.1–7.3	<2
	21–42	2.0–6.0	0.11–0.13	5.1–6.5	<2
	42–60	>20	0.02–0.04	5.1–7.3	<2
Dells: 290.	0–13	0.6–2.0	0.20–0.22	5.6–7.3	<2
	13–36	0.6–2.0	0.18–0.20	5.1–5.5	<2
	36–60	6.0–20	0.06–0.09	5.6–6.0	<2
Loamy alluvial land: C315.	0–60	-----	-----	-----	-----

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Low	Moderate	Moderate	0.28	5	6
Low	Moderate	Moderate	0.28		
Low	Moderate	Moderate	0.37		
Low	Low	Low	0.17	5	2
Low	Low	Low	0.17		
Low	Low	Moderate	0.20	4	3
Low	Low	Moderate	0.20		
Low	Low	Moderate	0.15		
Low	Low	Moderate	0.28	4	5
Low	Low	Moderate	0.28		
Very low	Low	Moderate	0.10		
Low	Low	Moderate	0.28	4	5
Low	Low	Moderate	0.28		
Very low	Low	Moderate	0.10		
Low	High	Moderate	0.28	4	6
Low	High	Moderate	0.28		
Very low	High	Moderate	0.10		
Low	Low	Moderate	0.24	4	6
Low	Low	Moderate	0.32		
Very low	Low	Moderate	0.10		
Moderate	High	Moderate	0.32	5	6
Moderate	High	Moderate	0.43		
Low	High	Moderate	0.43		
Moderate	High	Low	0.24	5	6
Low	High	Low	0.32		
Low	High	Low	0.32		
Low	High	Low	0.32		
Low	Low	Low	0.28	4	6
Moderate	Low	Low	0.28		
---	---	---	---		
---	High	Moderate	---	---	3
Low	High	Low	---		
Low	High	Moderate	0.28	4	6
Low	High	Moderate	0.28		
Very low	High	Moderate	0.10		
Low	Moderate	Low	0.20	4	3
Low	Moderate	Low	0.20		
Low	Moderate	Low	0.20		
Low	High	Moderate	0.32	4	6
Moderate	High	Moderate	0.43		
Low	Low	Moderate	0.15		
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TABLE 11.—*Physical and chemical*

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Marsh:					
354.	0–60		---	---	---
Dinsdale:					
377B, 377C, 377C2.	0–15	0.6–2.0	0.21–0.23	5.1–6.0	<2
	15–36	0.6–2.0	0.18–0.20	5.1–5.5	<2
	36–73	0.2–0.6	0.17–0.19	5.6–8.4	<2
Maxfield:					
382.	0–17	0.2–0.6	0.21–0.23	6.6–7.3	<2
	17–30	0.2–0.6	0.18–0.20	6.6–7.3	<2
	30–66	0.2–0.6	0.17–0.19	6.1–7.3	<2
Clyde:					
[1] 391B:					
Clyde part.	0–24	0.6–2.0	0.21–0.23	6.6–7.3	<2
	24–37	0.6–2.0	0.18–0.20	6.6–7.3	<2
	37–60	0.2–0.6	0.17–0.19	6.6–8.4	<2
Floyd part.	0–24	0.6–2.0	0.20–0.22	6.6–7.3	<2
	24–39	0.6–2.0	0.16–0.18	6.6–7.3	<2
	39–45	2.0–6.0	0.11–0.13	6.6–7.3	<2
	45–65	0.2–0.6	0.16–0.18	6.6–7.8	<2
Tripoli:					
398.	0–19	0.6–2.0	0.19–0.21	6.6–7.3	<2
	19–45	0.2–0.6	0.17–0.19	7.4–7.8	<2
	45–60	0.2–0.6	0.17–0.19	7.4–8.4	<2
Readlyn:					
399.	0–22	0.6–2.0	0.20–0.22	5.1–7.3	<2
	22–44	0.2–0.6	0.17–0.19	5.1–7.8	<2
	44–70	0.2–0.6	0.17–0.19	6.6–7.8	<2
Olin:					
408B, 408C.	0–33	2.0–6.0	0.13–0.15	5.1–7.3	<2
	33–60	0.2–0.6	0.17–0.19	5.1–6.0	<2
	60–70	0.2–0.6	0.17–0.19	7.4–8.4	<2
Sogn:					
412C.	0–17	0.6–2.0	0.17–0.22	6.1–6.5	<2
	17	---	---	---	---
Aredale:					
426B, 426C, 426C2.	0–13	0.6–2.0	0.20–0.22	5.6–7.3	<2
	13–22	0.6–2.0	0.17–0.19	5.1–6.5	<2
	22–45	2.0–6.0	0.11–0.13	5.6–6.0	<2
	45–60	0.2–0.6	0.17–0.19	5.6–6.0	<2
Oran:					
471.	0–12	0.6–2.0	0.18–0.20	4.5–7.3	<2
	12–53	0.2–0.6	0.17–0.19	5.1–7.3	<2
	53–60	0.2–0.6	0.17–0.19	6.6–7.3	<2
Spillville:					
485.	0–60	0.6–2.0	0.19–0.21	6.1–7.3	<2
[1] 585:					
Spillville part.	0–60	0.6–2.0	0.19–0.21	6.1–7.3	<2
Alluvial land part.	0–60	---	---	---	---
Koszta:					
688.	0–13	0.6–2.0	0.20–0.24	5.6–7.3	<2
	13–53	0.6–2.0	0.15–0.19	5.1–7.3	<2
	53–60	>6.0	0.05–0.13	5.6–6.5	<2

properties of soils—Continued

Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
---	---	---	---	---	---
Moderate	Moderate	Moderate	0.32	5	7
Moderate	Moderate	Moderate	0.43		
Low	Moderate	Moderate	0.43		
High	High	Moderate	---	---	6
High	High	Moderate	---		
Low	High	Moderate	---		
Moderate	High	Low	---	---	7
Moderate	High	Low	---		
Moderate	High	Low	---		
Moderate	High	Low	0.24	5	6
Low	High	Low	0.32		
Low	High	Low	0.32		
Low	High	Low	0.32		6
Moderate	High	Moderate	---	---	
Low	High	Moderate	---		
Low	High	Moderate	---		
Low	High	Moderate	0.24	5	6
Low	High	Moderate	0.32		
Low	High	Moderate	0.32		
Very low	Moderate	Moderate	0.20	5	3
Low	Moderate	Moderate	0.32		
Low	Moderate	Moderate	0.32		
Moderate	Low	Low	0.28	1	4L
---	---	---	---		
Low	Moderate	Moderate	0.28	5	6
Low	Moderate	Moderate	0.28		
Very low	Moderate	Moderate	0.28		
Low	Moderate	Moderate	0.37		
Low	High	Moderate	0.28	5	6
Low	High	Moderate	0.28		
Low	High	Moderate	0.37		
Moderate	High	Moderate	0.28	5	6
Moderate	High	Moderate	0.28	5	6
---	---	---	---	---	---
Moderate	Moderate	Moderate	---	---	7
Moderate	Moderate	Moderate	---		
Low	Low	Moderate	---		

TABLE 11.—*Physical and chemical*

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Hayfield: 725, 726.	0–16	0.6–2.0	0.20–0.24	5.6–6.5	<2
	16–34	0.6–2.0	0.17–0.22	5.1–6.0	<2
	34–60	6.0–20	0.02–0.04	5.1–6.0	<2
Franklin: 761.	0–12	0.6–2.0	0.21–0.23	4.5–7.3	<2
	12–26	0.6–2.0	0.18–0.20	4.5–6.0	<2
	26–60	0.2–0.6	0.17–0.19	5.1–8.4	<2
Waubeek: 771B.	0–8	2.0–6.0	0.21–0.23	6.1–7.3	<2
	8–24	0.6–2.0	0.18–0.20	5.6–6.0	<2
	24–70	2.0–0.6	0.17–0.19	5.1–7.8	<2
Lilah: 776C.	0–9	6.0–20	0.11–0.13	5.1–6.5	<2
	9–60	>20	0.02–0.04	4.5–5.5	<2
Wapsie: 777.	0–10	0.6–2.0	0.18–0.20	5.1–7.3	<2
	10–27	0.6–2.0	0.15–0.17	5.1–6.0	<2
	27–60	>20	0.02–0.06	5.1–6.0	<2
Donnan: 782B, 782C.	0–20	0.6–2.0	0.20–0.22	5.1–7.3	<2
	20–29	<0.06	0.11–0.14	5.6–6.5	<2
	29–60	0.2–0.6	0.17–0.19	5.6–6.5	<2
Protivin: 798.	0–22	0.6–2.0	0.18–0.20	5.1–6.5	<2
	22–60	0.06–0.2	0.15–0.17	6.1–7.8	<2
Bertram: 809B.	0–23	2.0–6.0	0.12–0.14	5.6–7.3	<2
	23–27	2.0–6.0	0.11–0.13	5.6–7.3	<2
	27–34	0.2–0.6	0.14–0.16	5.6–7.8	<2
	34	----------	----------	----------	----------
Sawmill: 933.	0–29	0.2–2.0	0.18–0.23	6.1–7.8	<2
	29–60	0.2–2.0	0.11–0.20	6.6–7.3	<2

[1] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior

added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help or avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate	Low	Moderate	---	---	6
Moderate	Low	Moderate	---		
Low	Low	Moderate	---		
Moderate	High	Moderate	0.32	5	6
Moderate	High	Moderate	0.43		
Low	High	Moderate	0.43		
Moderate	Moderate	Moderate	0.32	5	6
Moderate	Moderate	Moderate	0.43		
Low	Moderate	Moderate	0.43		
Low	Low	High	0.20	2	3
Very low	Low	High	0.20		
Low	Low	High	0.28	4	6
Low	Low	High	0.28		
Very low	Low	High	0.10		
Low	High	Moderate	0.28	4	6
High	High	Moderate	0.28		
Moderate	High	Moderate	0.37		
Moderate	High	Moderate	0.28	3	6
Moderate	High	Moderate	0.37		
Low	Low	Moderate	0.20	4	3
Low	Low	Moderate	0.20		
Moderate	Low	Moderate	0.20		
---	---	---	---		
High	High	Low	---	---	7
High	High	Low	---		

characteristics of the map unit.

of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 12 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have beeen wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep to deep, moderately well drained to well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the soil mapping. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Engineering test data

Table 13 contains engineering test data for two soil series in Blackhawk County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density.* As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material as has been explained for table 10.

Shrinkage limit is the percentage of moisture at which shrinkage of the soil material stops.

Shrinkage ratio is the relation of change in volume of the soil material to the water content of the soil material when at the shrinkage limit. The change in volume is expressed as a percentage of the air-dry volume of the soil material, and the water content is expressed as a percentage of the weight of the soil material when ovendry.

Linear shrinkage is the decrease in one dimension, expressed as a percentage of the original dimension, of the soil mass when the moisture content is reduced from the given value to the shrinkage limit.

Formation of Soils

Explained on the pages that follow are factors that affected the formation of the soils in Black Hawk County and the classification of the soils by higher categories. Profiles considered representative of the series are described in detail in the section "Soil Maps for Detailed Planning."

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (a) the physical and mineralogical composition of the parent material, (b) the climate under which the soil accumulated and existed since accumulation, (c) the plant and animal life on and in the soil, (d) the relief, or lay of the land, and (e) the length of time the forces of soil formation have acted on the soil material (*6*).

Climate and vegetation are the active factors in the formation of soil. They act on the parent material that accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. The effects of climate and vegetation are conditioned by relief. Parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of parent material into a soil profile. It may be much or little, but some time is required for horizon differentiation. A long period generally is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material and geology

The accumulation of parent material is the first step in the formation of a soil. Some soils in the survey area formed as a result of weathering of the bedrock. Most of the soils, however, formed in material that was transported from the site of the parent rock and redeposited at a new location through the action of glacial ice, water, wind, and gravity.

The principal parent materials in Black Hawk County are glacial drift, alluvium, loess, and eolian, or wind-deposited, sand. Much less extensive are organic deposits and residuum.

Glacial drift consists of all rock material in transport by glacier ice, all deposits made by glacier ice, and all deposits of dominantly glacial origin made in the sea or in bodies of glacial melt water. It also includes glacial till, an unsorted sediment, the particles of which range in size from boulders to clay (*12*).

Glacial drift is the most important parent material in the formation of the soils of Black Hawk County. At least twice during the glacial period, continental ice or glaciers moved over the land. The record of these ice invasions is contained in the unconsolidated rock material that was deposited by the melting ice and melt-water streams.

The older ice sheet, known as the Nebraskan, occurred some 750,000 years ago (*7*). It was followed by the Aftonian interglacial period. The Kansan glaciation is thought to have started about 500,000 years ago. A more recent glaciation was recognized by Leighton (*8*) as the Iowan substage of the Wisconsin glaciation, but recent studies of the presence and identification of Iowan glacial till indicate that the conclusions formed from studies made before 1960 are questionable. Intensive, detailed, geomorphic, and stratigraphic work shows that the landscape is a multilevel sequence of erosion surfaces, and that many of the levels are cut into Kansan and Nebraskan till (*11*).

Landscapes similar to those in Black Hawk County have been studied in detail by Ruhe (*11*). Subsurface investigations and study demonstrated that the Iowan till does not exist, but that an erosion-surface complex does exist in the Iowan region. The Iowan surface is multilevel and is arranged in a series of steps from major drainageways toward bounding divides. It is marked where it cuts Kansan and Nebraskan till by a stone line (fig. 12). The stone line occurs on all levels of the stepped surfaces where they occur and passes under the alluvium along the drainageways.

The soils formed in glacial drift and glacial till on the Iowan erosion surface are Aredale, Bassett, Clyde, Donnan, Floyd, Kenyon, Oran, Protivin, Readlyn, and Tripoli. They have a loamy surficial sediment about 1 to 2 feet thick over the glacial material. The sediment is thicker in the lower concave slopes and waterways in such soils as Clyde and Floyd. A stone line or pebble band commonly separates the friable, loamy surficial sediment from the firm loam or clay loam glacial till (fig. 13). Donnan soils formed in loamy material and clayey paleosol derived from glacial till.

Alluvium is sediment that has been transported and laid down by water. It is the second most extensive parent material in Black Hawk County. These alluvial deposits of Late Wisconsin age occur under the flood plains and terraces of watercourses. This material occurs as lenses and layers of sand, gravel, silt, and clay. It varies in thickness. Along major streams it is as much as 80 feet thick.

When streams overflow their channels and the water

TABLE 12.—*Soil and*

[Absence of an entry indicates that the feature is not a concern. See text for descriptions of symbols

Soil name and map symbol	Hydrologic group	Flooding		
		Frequency	Duration	Months
Wiota: 7	B	Rare		
Colo: [1] 11B: Colo part	B/D	Common	Brief	Feb-Nov
Ely part	B	None		
Sparta: 41, 41B, 41C, 41D	A	None		
[1] U41C: Sparta part	A	None		
Dickinson part	B	None		
Bremer: 43	C	Rare to occasional	Very brief	Feb-Nov
[1] U43: Bremer part	C	Rare to occasional	Very brief	Feb-Nov
Marshan part	B/D	Rare to common	Very brief	Feb-Nov
Zook: 54	C/D	Common	Brief	Feb-Nov
Chelsea: 63B, 63C, 63D	A	None		
Kenyon: 83B, 83C, 83C2, 83D2	B	None		
[1] U83C: Kenyon part	B	None		
Clyde part	B/D	Frequent	Very brief	Feb-Nov
Clyde: 84	B/D	Frequent	Very brief	Feb-Nov
Nevin: 88	C	Rare		
Lamont: 110B	B	None		
Garwin: 118	B/D	None		
Muscatine: 119, 119B	B	None		
Tama: 120B, T120	B	None		
Colo: 133, C133	B/D	Common	Brief	Feb-Nov
Coland: 135	B/D	Common	Brief	Feb-Nov
Marshan: 151, 152	B/D	Rare to occasional	Very brief	Feb-Nov
Loamy escarpments: 154F	B	None		

water features

and such terms as "rare," "brief," and "perched." The symbol < means less than; > means greater than]

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0			>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
3.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
1.0–3.0	Apparent	Nov-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Low.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
1.0–3.0	Apparent	Nov-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
2.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Low.
1.0–3.0	Apparent	Nov-Jun	>60		High.
2.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Low.

TABLE 12.—*Soil and*

Soil name and map symbol	Hydro-logic group	Flooding		
		Frequency	Duration	Months
Finchford: 159, 159C	A	Rare		
[1] U159: Finchford part	A	Rare		
Flagler part	B	None		
Bremer variant: 166	D	Rare		
Bassett: 171B, 171C2	B	None		
[1] U171D: Bassett part	B	None		
Chelsea part	A	None		
Dickinson: 175, 175B	B	None		
Saude: 177, 177B	B	None		
[1] U177: Saude part	B	None		
Lawler part	B	None		
Waukee: 178, 178B	B	None		
Klinger: 184	B	None		
Floyd: 198B	B	None		
Rockton: 213B	B	None		
Palms: 221	A/D	Frequent	Long	Nov-May
Lawler: 225, 226	B	None		
Flagler: 284, 284B	B	None to rare		
Dells: 290	C	Rare		
Loamy alluvial land: C315	B	Frequent	Brief	Feb-Nov
Marsh: 354		Frequent	Very long	Jan-Dec
Dinsdale: 377B, 377C, 377C2	B	None		
Maxfield: 382	B/D	None		
Clyde: [1] 391B: Clyde part	B/D	Frequent	Very brief	Feb-Nov

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
1.0–3.0	Apparent	Nov-Jun	>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
2.0–5.0	Apparent	Nov-Jun	>60		High.
6.0			>60		Low.
2.0–5.0	Apparent	Nov-Jun	>60		High.
2.0–4.0	Apparent	Nov-Jun	>60		High.
>6.0			20–40	Hard	Moderate.
0–1.0	Apparent	Jan-Dec	>60		High.
2.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Low.
2.0–5.0	Apparent	Nov-Jun	>60		High.
0–4.0	Apparent	Nov-Jun	>60		High.
0–1.0	Apparent	Jan-Dec	>60		
>6.0			>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.

TABLE 12.—*Soil and*

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months
Floyd part	B	None		
Tripoli: 398	B/D	None		
Readlyn: 399	B	None		
Olin: 408B, 408C	B	None		
Sogn: 412C	D	None		
Aredale: 426B, 426C, 426C2	B	None		
Oran: 471	B	None		
Spillville: 485	B	Common	Very brief	Feb-Nov
[1] 585: Spillville part	B	Common	Very brief	Feb-Nov
Alluvial land part	B	Frequent	Brief	Feb-Nov
Koszta: 688	B	Rare		
Hayfield: 725, 726	B	None		
Franklin: 761	B	None		
Waubeek: 771B	B	None		
Lilah: 776C	A	None		
Wapsie: 777	B	None		
Donnan: 782B, 782C	C	None		
Protivin: 798	C	None		
Bertram: 809B	B	None		
Sawmill: 933	B/D	Common	Brief	Feb-Nov

[1] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
2.0–4.0	Apparent	Nov-Jun	>60		High.
2.0–4.0	Apparent	Nov-Jun	>60		High.
2.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Moderate.
>6.0			4–20	Hard	Low.
>6.0			>60		Moderate.
2.0–5.0	Apparent	Nov-Jun	>60		High.
3.0–5.0	Apparent	Nov-Jun	>60		Moderate.
3.0–5.0	Apparent	Nov-Jun	>60		Moderate.
0–4.0	Apparent	Nov-Jun	>60		High.
2.0–5.0	Apparent	Nov-Jun	>60		High.
3.0–5.0	Apparent	Nov-Jun	>60		High.
2.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		High.
>6.0			>60		Low.
>6.0			>60		Low.
2.0–3.0	Perched	Nov-Jun	>60		High.
2.0–4.0	Apparent	Nov-Jun	>60		High.
>6.0			20–40	Hard	Moderate.
1.0–3.0	Apparent	Nov-Jun	>60		High.

characteristics of the map unit.

TABLE 13.—*Engineering*

Soil name and location	Parent material	Report number AAD4–	Depth	Moisture density[1]	
				Maximum	Optimum
			In	*lb/cu ft*	*Pct*
Finchford loamy sand: 150 feet South of NE corner of SW¼, NE¼, sec. 13, T. 87N., R. 12 W. (Modal.)	Coarse textured Alluvial sediments.	3127 3128 3129	0–8 18–30 30–60	103 120 121	20 10 9
Flagler sandy loam: 96 feet East and 450 feet North of SW corner NE¼, SE¼, 7–88N–12W (Modal.)	Moderately coarse textured alluvium.	3149 3150 3151	0–21 21–42 42–60	122 123 114	11 10 13

[1] Based on AASHTO Designation: T 99–57, Method A (*1*).
[2] Mechanical analysis according to the AASHTO Designation: T 88–57 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of the material, including that coarser than 2 millimeters in diameter. In the SCS procedure, the fine material is analyzed by the pipette method

spreads over the flood plains, the coarse textured material is deposited first. While the floodwater continues to spread, it moves more slowly, and fine textured sediment, such as silt, is deposited. After the flood passes, the finest particles, or clays, settle from the water that is left standing in the lowest part of the flood plain, generally some distance from the main channel.

Near the channel, or within the present meander belt, are recent alluvial soils or Loamy alluvial land, channeled. Loamy alluvial land, channeled, consists of some sandbars next to the channel and various amounts of sand, silt, and clay. On bottom land away from the meander belts, such soils as Spillville formed.

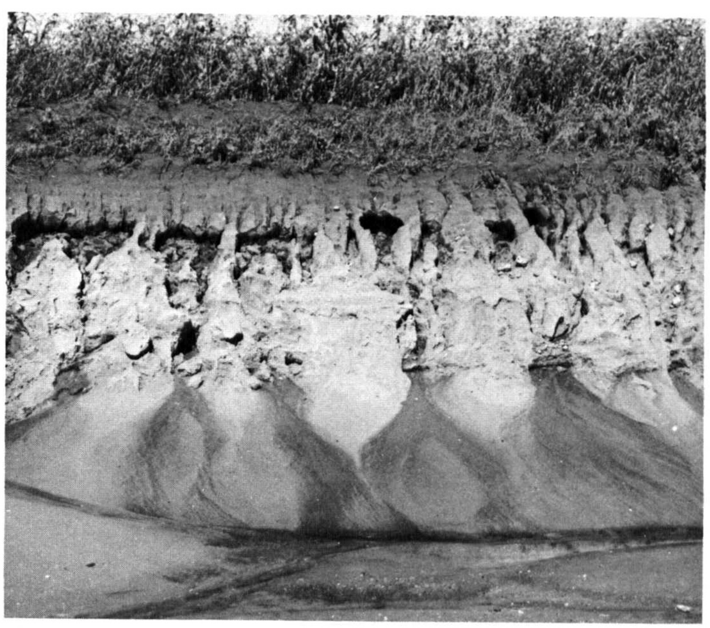

Figure 12.—**Stone line and sand wedges, in a road cut, a typical feature of Kenyon soils in the Kenyon-Clyde-Floyd unit.**

The Spillville-Alluvial land complex is in this area. These soils are mainly silts and sands. Some are clays. Beyond them, and commonly as much as one-half mile from the present channel, the finer textured Colo and Zook soils occur. These soils, especially Zook, contain a higher percentage of clay than the other alluvial soils and generally are at a lower elevation than Spillville soils or the Spillville-Alluvial land complex.

The soils on the alluvial benches or second and third bottoms are at a relatively higher elevation. They also formed in alluvium and vary in texture. Waukee and Saude soils formed in loamy alluvium and the underlying sand and gravel.

Some alluvial material has been transported only a short distance and has accumulated at the foot of the slope on which it originated. This material is called "local" alluvium and retains many characteristics of the soils in the areas from which it has eroded. The silty Ely soil, for example, occurs at the foot of the slopes directly below loess-derived soils. Clyde and Floyd soils are examples of loamy soils that formed partly in sediment removed from adjacent side slopes of glacial till. In contrast, Bremer silty clay loam, clay subsoil variant, formed in alluvium that is much higher in clay content than any known parent material accessible to erosion in Black Hawk County.

Textural differences are accompanied by some differences in chemical and mineralogical composition of the alluvium. Alluvial soils in the survey area are mostly free of carbonates and are neutral to slightly acid. One exception is Bremer silty clay loam, clay subsoil variant, which is medium acid.

Loess of Wisconsin age is the third most extensive parent material in the survey area. It consists of accumulated particles of silt and clay that have been deposited by wind. Unweathered loess is silt loam in texture. It is calcareous. The principal area of existing loess deposition is the southwestern quadrant of the county. Loess also occurs in a wedge-shaped area that diagonally cuts across the northeast corner. In most instances it was deposited as a mantle or covering over *test data*

Percentage passing sieve—[2]			Percentage smaller than—[2]				Liquid limit	Plasticity index	Classification	
No. 10	No. 40	No. 200	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHTO [3]	Unified [4]
							Pct			
95	48	15	12	9	5	3	19	2	A-1-b(0)	SM
95	68	20	13	9	5	4	17	0	A-2-4(0)	SM
85	51	10	7	5	3	1	17	0	A-3(0)	SP-SM
100	77	31	26	19	10	8	21	5	A-2-4(0)	SM-SC
99	73	26	23	16	9	7	16	2	A-2-4(0)	SM
91	40	5	3	3	2	1	----------	NP [5]	A-1-b(0)	GW-GM

and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3] Based on AASHTO Designation: M 145-49 (*1*).
[4] Based on ASTM Designation: 2487-69 (*2*).
[5] Nonplastic.

the glacial drift. Small areas of loess also occur on high alluvial benches in all four townships of tier 89.

Loess is generally less than 10 feet thick in Black Hawk County. Tama, Muscatine, and Garwin soils formed in loess more than 40 inches thick. They are lower in sand content than most other soils in the county. In areas of the uplands where loess deposition was not so deep or where erosion has reduced the thickness of the remaining loess to between 20 and 40 inches, Dinsdale, Waubeek, Franklin, Klinger, and Maxfield soils formed. They formed in loess and the underlying glacial till.

Eolian sand, or wind-deposited sand, occurs in the uplands and on benches. In the glacial till uplands, sand occurs as low mounds or dunes underlain by till at various depths. It also occurs in areas intermingled with the loess soils. The wind-deposited sand is largely quartz, which is very fine and fine in size and is highly resistant to weathering. It has not been altered appreciably since it was deposited. The soils in Black Hawk County that formed mainly in wind-deposited sand are Chelsea, Dickinson, Lamont, and Sparta (fig. 14).

Organic deposits consist of plant material that has accumulated in old lakebeds or swamps that supported a thick growth of plants that require water. The organic soils occupy small, wet areas in the county where poor drainage has retarded the decay of plant remains that have accumulated over a long period. In Black Hawk County the thickness of the organic material ranges from about 18 to 52 inches, but in a few areas it is thicker than 52 inches. Palms soils formed in this organic material.

Residuum, the material in place derived from the weathering of sedimentary rock, is a very minor source of parent material in this county. The underlying bedrock is of the Devonian period (*3*).

Climate

According to available evidence the soils of Black Hawk County formed under the influence of a midcon-

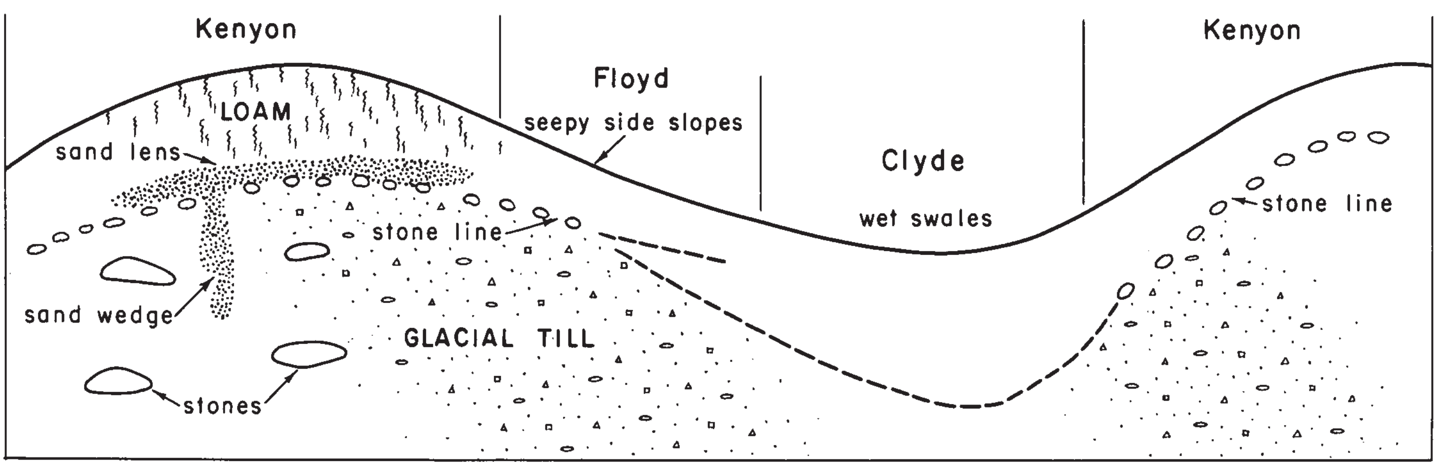

***Figure 13.*—Parent materials of the Kenyon-Floyd-Clyde soils.**

Figure 14.—**Eolian sand underlain by stratified coarse textured alluvium.**

tinental, subhumid climate for at least 5,000 years. Between 5,000 and 16,000 years ago, the climate was conducive to the growth of forest vegetation (*9*). The morphology of most soils in the county indicates that the climate under which the soils formed is similar to the present one. Currently the climate is fairly uniform throughout the county, but it is marked by wide seasonal extremes in temperature. Precipitation is distributed throughout the year.

Climate is a major factor in determining what soils formed in various plant material. The rate and intensity of hydrolysis, carbonation, oxidation, and other important chemical reactions in the soil are influenced by the climate. Temperature, rainfall, relative humidity, and length of the frost-free period are important in determining the vegetation.

The influence of general climate of the region is somewhat modified by local conditions in or near the forming soil. For example, south-facing, dry, sandy slopes have a local climate or microclimate that is warmer and less humid than the average climate of nearby areas. Low-lying, poorly drained areas are wetter and colder than most areas around them. These contrasts account for some of the differences in soils within the same general climatic regions.

Plant and animal life

All living organisms are important to soil formation. These include vegetation, animals, bacteria, and fungi. Vegetation is responsible for the amount of organic matter, the color of the surface layer, and the amount of nutrients. Animals such as earthworms and burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant food.

Most soils in Black Hawk County formed under prairie grasses or a mixture of prairie grasses and water-tolerant plants. Because the grasses have many roots and tops that have decayed on or in the soils, the soils that formed under these conditions have a thick, dark surface layer. Tama and Muscatine soils are examples.

The soils that formed under timber vegetation have a thinner, lighter surface layer. The organic matter is derived mainly from leaf deposition on the surface of the soil. Lamont and Chelsea soils are examples of these light colored soils.

In many areas a number of soils first formed under prairie grasses and then under a mixture of prairie grasses and timber. These soils are intermediate between those soils that formed entirely under grass and those under timber. Franklin, Bassett (fig. 15), and Waubeek soils are examples.

Dinsdale and Waubeek soils formed in the same parent material and in a comparable environment except for native vegetation. Differences in native vegetation account for the main differences in morphology of these soils.

Relief

Relief, or topography, influences soil formation mainly through its effect on drainage, runoff, and erosion. In Black Hawk County the relief generally ranges from level to moderately steep, but some small areas are very steep. Water soaks into the nearly level areas that are not flooded. As the slope becomes steeper, more water runs off and less water penetrates the soil. Dinsdale, Klinger, and Maxfield soils are examples of soils that formed in the same kind of parent material under similar vegetation but differ because of topographic position. Maxfield soils are in wide, level or nearly level heads of drainageways. Klinger soils are on nearly level ridges and long, gentle, concave slopes. Dinsdale soils are on the gently sloping to moderately sloping uplands.

In depressions, which collect and impound water, the soils are more poorly drained and have a distinct, lighter colored subsurface layer and a gray subsoil. Some depressional areas within areas of Koszta and Dells soils are examples.

Soils on steep slopes have weak profile development. Most of the water that falls on the surface runs off. Sogn soils are an example.

Soils formed in alluvium, such as Colo, Spillville, and Wiota, occur on the bottom lands or alluvial benches. Even though they are nearly level, their microrelief affects runoff, depth to water table, and the amount of new sediment. Colo soils are at the low elevations, have a high water table, and impound water for short periods. Spillville soils are at slightly higher elevations, but they are somewhat poorly drained. Wiota soils are at still higher elevations, are well drained, are seldom flooded, and do not impound water.

Aspect, as well as gradient, has significant influence. South-facing slopes generally are warmer and drier than north-facing slopes and consequently support a different kind and amount of vegetation.

Figure 15.—**Native grass and timber on gently sloping, moderately well drained Bassett soils.**

The influence of porous, rapidly permeable parent material overrides the influence of topography. Dickinson soils, for example, are somewhat excessively drained, even though they are nearly level to gently sloping because they have moderately rapid permeability.

Time

The length of time that soil material remains in place and is acted on by soil-forming processes affects the kind of soil that forms. Older soils show strongly developed, well defined genetic horizons. Tama, Bassett, and Donnan soils are examples. Younger soils show only weakly developed horizons. Some soils formed in alluvium show little or no profile development because fresh material is deposited periodically. The materials have not been in place long enough for the climate and vegetation to develop well defined genetic horizons in the profile. Spillville is an example of a very young soil. In steep areas, soil material is removed before it has time to form into a deep soil profile. The Sogn soil is an example.

Another factor that modifies the effect of time is the resistance of materials. Soils formed in material resistant to weathering, such as quartz sand, do not change much with time. Examples are Chelsea and Sparta soils.

Where trees and other organic material have been buried by later deposition through the action of ice, water, or wind, the age of a landscape can be determined by a process known as radiocarbon dating (*10*).

The loess that covered Black Hawk County, in which Tama, Muscatine, and Garwin soils formed, is probably 14,000 to 20,000 years old (*11*). Recent studies by Ruhe et al. (*11*) show that the Iowan erosion surface formed during the period of loess deposition. The Iowan surface beneath the loess could be as young as 14,000 years, which dates the close of the major loess deposition in Iowa. The surface not covered by loess can also be younger than the loess. The Iowan surface where covered by loam surficial sediment is younger than 14,000 years (*11*), and soils on the slopes are probably much younger. Such soils as Bassett, Kenyon, and Readlyn are on this surface. Floyd, Clyde, and Tripoli soils are younger because they are cut in and below these higher lying soils.

Man's influence on the soil

Important changes occurred when man settled in Black Hawk County. Some had little effect on soil productivity, and others had drastic effects.

Changes caused by water erosion are the most apparent. Cultivation changes the soil by making the sloping areas more susceptible to erosion, which removes the topsoil, organic matter, and plant nutrients. Sheet erosion, which is the most prevalent in this county, removes a few inches of topsoil at a time. Cultivation, however, generally destroys all evidence of this loss.

When man cultivates the soil, soil blowing becomes active. The light textured soils blow, especially if the land is left bare and the topsoil is dry. On the nearly level fall plowed fields, dark topsoil can be mixed with snow or piled along the fence rows and road ditches.

In fields under continuous cultivation, the well developed granular structure of the surface layer, so apparent in virgin grassland, begins to break down. The surface layer bakes and becomes hard when dry. The fine textured soils that have been plowed continuously when wet tend to puddle and are less permeable than similar soils in undisturbed areas. In some finer textured soils, a compact layer has formed below the plow layer. This layer becomes hard when dry and is less permeable than the subsoil. It is called a plow sole or plowpan.

Man has also done much to increase productivity and to reclaim areas not suitable for crops. He has established drainage ditches and diversions at the foot of slopes to prevent flooding of the lowlands, which can now be used for cultivated crops. He has installed tile and terraces that provide drainage as well as protection from erosion. He has also added commercial fertilizers to counteract deficiencies in plant nutrients so that the soil can be made more productive than the virgin soil.

The moderately eroded phases of Bassett, Dinsdale, and Kenyon soils, for example, indicate influence by man. This erosion has occurred since man began cultivating the hillsides.

Processes of Soil Formation

Four processes were involved in the formation of horizons in the soils of this county. These processes are the accumulation of organic matter, the leaching of calcium carbonates and bases, the reduction and transfer of iron, and the formation and translocation of silicate clay minerals. In most soils, more than one of these processes has been active in the formation of horizons.

The accumulation of organic matter in the upper part of the profile to form an A1 horizon has been important. In general, the soils that contain much organic matter have a thick, dark colored surface layer and produce the most grass in their natural environment. Garwin soils have a thick, dark colored surface layer and are high in organic-matter content.

Carbonates and bases have been leached from the upper part of the horizons of nearly all soils of this county. This leaching is generally believed to precede the translocation of silicate clay minerals.

Clay particles accumulate in pores and form films on the surface of peds along which water moves. Leaching of bases and the translocation of silicate clays are among the more important processes in horizon differentiation. In Muscatine soils, for example, translocated silicate clays have accumulated in the B2t horizon in the form of clay films.

Gleying, or the reduction and transfer of iron, is evident in some poorly drained soils, such as Coland and Tripoli. The gray color of the subsoil indicates the reduction and loss of iron. Mottles, which occur in some horizons, indicate segregation of iron.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey (*14*) has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 14, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquolls (*Hapl*, meaning simple horizons, plus aquoll, the suborder of Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the

TABLE 14.—*Classification of the soils*

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics of this taxadjunct that are outside the range of the series]

Soil name	Family or higher taxonomic class
Aredale	Fine-loamy, mixed, mesic Typic Hapludolls
Bassett	Fine-loamy, mixed, mesic Mollic Hapludalfs
Bertram	Coarse-loamy, mixed, mesic Typic Hapludolls
*Bremer	Fine, montmorillonitic, mesic Typic Argiaquolls
Bremer Variant	Very fine, montmorillonitic mesic Typic Argiaquolls
Chelsea	Mixed, mesic Alfic Udipsamments
Clyde	Fine-loamy, mixed, mesic Typic Haplaquolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
*Dells	Fine-silty over sandy or sandy-skeletal, mixed, mesic Aquollic Hapludalfs
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Dinsdale	Fine-silty, mixed, mesic Typic Argiudolls
Donnan	Fine-loamy over clayey, mixed, mesic Aquollic Hapludalfs
Ely	Fine-silty, mixed, mesic Cumulic Hapludolls
Finchford	Sandy, mixed, mesic Entic Hapludolls
Flagler	Coarse-loamy, mixed, mesic Typic Hapludolls
Floyd	Fine-loamy, mixed, mesic Aquic Hapludolls
Franklin	Fine-silty, mixed, mesic Udollic Ochraqualfs
Garwin	Fine-silty, mixed, mesic Typic Haplaquolls
Hayfield	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquollic Hapludalfs
Kenyon	Fine-loamy, mixed, mesic Typic Hapludolls
Klinger	Fine-silty, mixed, mesic Aquic Hapludolls
Koszta	Fine-silty, mixed, mesic Udollic Ochraqualfs
Lamont	Coarse-loamy, mixed, mesic Typic Hapludalfs
Lawler	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Lilah	Sandy, mixed, mesic Psammentic Hapludalfs
Loamy alluvial land	Loamy, mixed, mesic Fluvents
Loamy escarpments	Udolls
Marsh	Aquolls
Marshan	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Maxfield	Fine-silty, mixed, mesic Typic Haplaquolls
Muscatine	Fine-silty, mixed, mesic Aquic Hapludolls
Nevin	Fine-silty, mixed, mesic Aquic Argiudolls
Olin	Coarse-loamy, mixed, mesic Typic Hapludolls
Oran	Fine-loamy, mixed, mesic Udollic Ochraqualfs
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Protivin	Fine-loamy, mixed, mesic Aquic Argiudolls
Readlyn	Fine-loamy, mixed, mesic Aquic Hapludolls
Rockton	Fine-loamy, mixed, mesic Typic Argiudolls
Saude	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Sawmill	Fine-silty, mixed, mesic Cumulic Haplaquolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Sparta	Sandy, mixed, mesic Entic Hapludolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Tama	Fine-silty, mixed, mesic Typic Argiudolls
Tripoli	Fine-loamy, mixed, mesic Typic Haplaquolls
Wapsie	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Mollic Hapludalfs
Waubeek	Fine-silty, mixed, mesic Mollic Hapludalfs
Waukee	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Wiota	Fine-silty, mixed, mesic Typic Argiudolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

soil properties used as family differentiae. An example is fine-loamy, mixed, mesic, Typic Haplaquolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Additional Information About the County

History and Development

The land in Black Hawk County was acquired by the United States as part of the Louisiana Purchase in 1803. The first permanent settlement was in 1845. By 1870, most of the county had been homesteaded and the population had grown to 21,706.

The total population of the county, 132,916 in 1970, has continued to increase, but the increase has been urban and largely centered on industry. In 1970, more than 40 percent of the earned income employment in Waterloo was from industrial production.

The farm population has decreased steadily since 1890. In 1970, it had diminished to 6,649. There is now a movement back to rural areas, but for residences, not for farms. Fewer than 1,600 farms are now in Black Hawk County, but there are more than 2,300 rural residences, and they are increasing rapidly.

Farming

Although the trend in recent years has been toward a decrease in the number of farms in the county, the size of individual farms generally has increased. Livestock farms outnumber all other types, and most of the harvested crops are consumed by livestock on the farms where the crops are grown.

The county had a total of 1,580 farms in 1970, according to the 1970 Assessors Annual Farm Census of Iowa. In the same year 323,780 acres was in farms, and the average size of the farms was 205 acres. The percentage of land that was owned by the operator was 53.5 percent, and that which was tenant operated was 46.5 percent. The percentage of owner-operator farms in Black Hawk County is higher than the State average, which is 52.8 percent.

Livestock and livestock products

Most of the farm income in Black Hawk County is derived from the sale of livestock and livestock products. According to the Iowa Annual Farm Census, the various kinds of livestock raised and sold in 1970 were as follows:

	Number
Sows farrowing fall 1970	8,803
Sows farrowing spring 1971	9,366
Milk cows and heifers 2 years or older	6,651
Beef cows and heifers 2 years or older	5,586
Lambs born	2,125
Hogs marketed	144,181
Grain-fed cattle marketed	27,498
Grain-fed sheep and lambs marketed	2,757
Commercial broilers produced	4,900
Hens and pullets of laying age	143,270
Turkeys raised	100,710

Crops

Except for soybeans and seed corn, most field crops grown in Black Hawk County are fed to livestock. Some corn is sold as a cash crop, but the amount varies from year to year and depends largely on the price of feeder cattle, the market for hogs, the cash price for corn, and the quality of the corn. Although corn is the principal grain crop, the acreage in soybeans has increased in the past few years. The acreage in various crops in Black Hawk County in 1970 is as follows:

	Acres
Corn for all purposes	116,093
Oats	17,681
Soybeans for beans	61,171
Sorghum for grain	40
Sorghum for other purposes	82
Wheat for grain	20
Barley for grain	9
Rye for grain	27
Popcorn	1

Relief and Drainage

Black Hawk County is mainly on a glacial drift plain that slopes gently toward the southeast and is drained by two major streams. The topography is characterized by a generally subdued land surface. The greatest relief is in areas adjacent to the Cedar River.

Typical upland features of the topography are the generally flat horizon, the low relief, and a gently undulating surface. Topography along the Cedar River is hilly and steep in a few areas; in several areas the valley walls are sheer cliffs. These steeper areas adjacent to the Cedar River are either on the east or south side. The highest ground elevation in Black Hawk County is in the northeast quarter of Lincoln Township. There are three areas where the elevation is more than 1,050 feet above sea level (*4*). The lowest elevation, 750 to 800 feet, is in the bed of the Cedar River at the southeast corner of the county.

The major rivers draining Black Hawk County are the Cedar and Wapsipinicon. They flow diagonally across the county in a southeasterly course. The Shell Rock River enters Black Hawk County from the north and joins the West Fork of the Cedar River within 1 mile.

The Cedar River and its tributaries drain about 80 percent of the county. This river is a wide, meandering stream with a broad flood plain bordered by wide, distinct second and third bottoms, or alluvial benches, which are slightly higher in elevation than the immediate flood plain. Its elevation is between 850 and 900 feet above sea level where it enters the county and falls to less than 800 feet in the exact southeast corner before entering Benton and Buchanan Counties. Cedar River has meandered considerably in the past. In some places it has cut new channels, leaving islands of glacial till more than ½ mile wide and 1 mile long, as in Washington Township.

The Wapsipinicon River also enters the county from the north. In Black Hawk County this river is much narrower than the Cedar and is fairly shallow. The flood plain is also much narrower, and the adjacent second bottoms, or low alluvial benches, are not so broad nor so pronounced. This river is at an elevation of 900 to 950 feet in Black Hawk County. The Wapsipinicon receives drainage from about 15 percent of the county.

Most secondary streams on the west side of the rivers, except for Crane and Rock Creeks, flow east and northeast. Those on the east side flow to the southwest. Crane Creek enters the county from the north and flows southeasterly to Dunkerton and then east to the Wapsipinicon River. Rock Creek flows south into Tama County. Other secondary streams are Black Hawk, Beaver, Miller, Spring, and Wolf Creeks. They have large watersheds draining many thousands of acres. With the exception of Miller Creek, they have watersheds in parts of several counties. Some secondary streams, such as Virden Creek, are smaller in terms of area drained but sometimes reach flood stage and cause damage in terms of property, crop, and livestock losses and are a potential hazard to human life because of the population density within the lower areas of the watershed.

Transportation, Industries, and Markets

Federal, State, and county highways throughout the survey area provide routes for auto, bus, and truck traffic and for the transportation of farm products. U.S. Highway 20 crosses the county from east to west, and Highway 63 from north to south. U.S. 218 crosses diagonally from the northwest to the southeast mainly on the west side of the Cedar River.

State Highways 21, 57, 58, 175, and 412 provide a variety of transportation routes from the metropolitan area south and west. Highway 281 connects Waterloo and Dunkerton.

Scheduled airline flights serve the Waterloo Airport, and bus transportation is available for many parts of the county. Railroads or motor freight lines serve every trading center in the county.

Even though Black Hawk County is mainly agricultural, the Waterloo-Cedar Falls metropolitan area, the largest industrial center, has a large variety of industries. One of the largest industrial plants in Black Hawk County manufactures farm tractors. Besides the smaller industries related to the manufacture of farm tractors, other industries include construction, the processing of food and livestock feed, manufacture of other farm machinery and recreation equipment, power, and transportation.

The home office of a major meatpacking company is in Waterloo. This company not only provides a large local market for hogs but also receives hundreds daily from buying stations throughout northeast Iowa.

Beef cattle and other livestock are marketed through various community sale barns in and around the county. Corn and other grains are bought and sold through local grain dealers.

A considerable amount of bulk milk is collected and delivered to processing plants in the county. This milk is used locally and in surrounding counties, and some is shipped for distribution in high population areas outside of Iowa.

Natural Resources

Black Hawk County is abundantly supplied with a variety of natural resources other than agricultural land. Among these are limestone, gravel, sand, lumber, and glacial boulders.

Limestone is near the surface in several areas (fig. 16). It is used commercially for roadbuilding, concrete, and as a source of lime for agronomic use. Some limestone is used as decorative stone and flagstone.

The most extensive source of sand and gravel is from several areas adjacent to the Cedar River, which are currently being dredged. Another source is in the uplands or on the high alluvial terraces. Many of these areas are small and have been abandoned or unworked for many years.

Quantities of native timber, mainly adjacent to the Cedar River, are used for crating and shipping of manufactured products and for building construction and firewood.

Glacial deposits are a good source of boulders. Many buildings have foundations built with glacial boulders. Boulders are used for commercial and community landscaping as well as by private individuals. Rocks and boulders are often for sale at local garden centers and horticultural nurseries.

Water Supply

On most farms in the county, water for domestic use and livestock comes from wells. The wells are 12 to about 280 feet deep. On some farms streams or farm ponds are a supplemental source of water for livestock. In the river valleys an abundant supply of water generally can be obtained from sand points driven 12 to 40 feet deep. In the uplands it is generally necessary to drill through the overlying material and into the underlying limestone to reach a dependable source of good water.

The wells that supply the municipal water systems in the county are similar to those described in the foregoing paragraph. They draw from the free underground water in the stream valleys and are generally 80 to 130 feet deep.

Municipal water and sewage disposal systems service Waterloo, Cedar Falls, Evansdale, Elk Run Heights, Hudson, La Porte City, Gilbertville, and Dunkerton.

The rapid increase in rural residences serviced by individual water wells and sewage disposal fields could become a source of water contamination. The city and county health officers can provide information on planning and maintaining water and sewage disposal systems.

Climate[5]

Black Hawk County, in the southeast part of northeast Iowa, is represented by weather data recorded at Waterloo. Data on temperature and precipitation are given in table 15, and data on spring and fall freezes in table 16.

Annual precipitation ranges from about 31.5 inches to 32.5 inches. The smallest amounts have been recorded in the northwestern part of the county. No consistent gradient is evident across the county for individual months. The average monthly precipitation at Waterloo is given in table 15, as well as extremes, 1 year in 10, which might be expected. June is the wettest month. May, July, and September have about 1 inch less rainfall than June. During the 1951-1960 period, Waterloo averaged 20 days per year with ½ inch or more of rainfall and 56 days with 0.10 inch or more. About 75 percent of the warm season rainfall occurs as showers, and some are heavy enough to cause erosion problems. Individual showers vary widely across the county. The probability of receiving 1 inch or more of rainfall in a 1-week period is about 4 years in 10 in June and decreases to between 2 and 3 years in 10 in July and August. Well developed crops use more than 1 inch per week.

Temperatures recorded at Waterloo represent the

[5] By ROBERT H. SHAW, climatologist, Iowa State University.

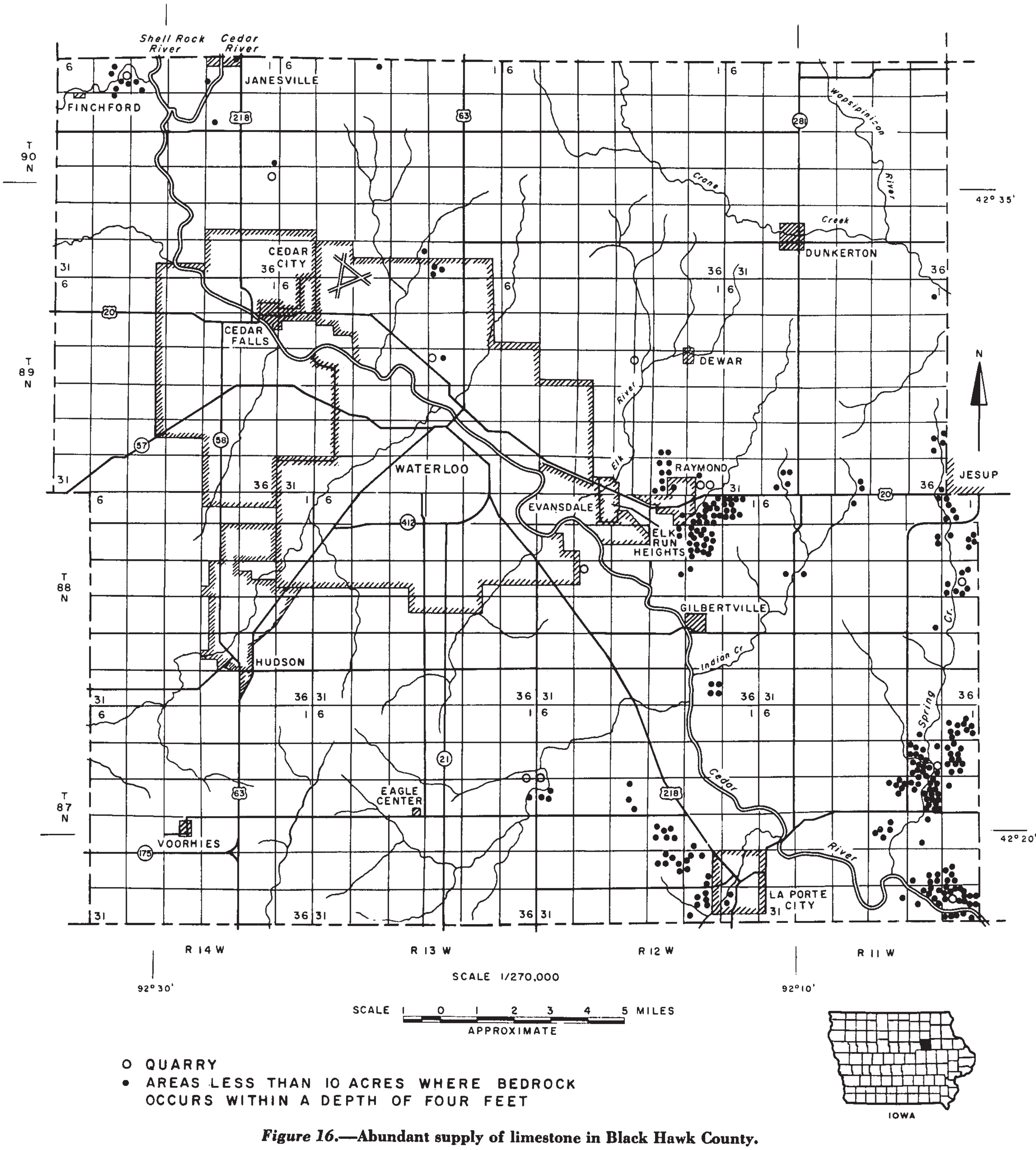

Figure 16.—**Abundant supply of limestone in Black Hawk County.**

TABLE 15.—*Temperature and precipitation*

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average monthly maximum	Average monthly minimum	Average monthly total	1 year in 10 will have— Less than—	1 year in 10 will have— More than—	Number days with snow over 1.0 in. or more	Average depth of snow on days with snow cover
	°F	°F	°F	°F	In	In	In		In
January	27	9	46	−18	1.2	0.1	2.0	22	5
February	30	12	49	−11	1.0	T	1.7	18	3
March	41	23	67	1	2.1	0.9	3.9	11	5
April	58	36	81	22	2.7	1.1	5.2		4
May	71	49	87	32	3.7	1.9	6.8		
June	82	59	92	43	4.8	2.2	8.3		
July	86	62	95	50	3.8	1.4	8.9		
August	84	60	93	45	3.4	0.5	6.0		
September	75	50	89	33	3.8	0.6	8.1		
October	64	40	82	23	2.1	0.5	4.0		
November	44	25	67	7	1.8	0.2	3.0	4	3
December	32	14	52	−11	1.1	0.4	2.0	13	4
Year	58	37	96	−20	31.5	22.8	44.6	69	4

TABLE 16.—*Probabilities of last freezing temperatures in spring and first in fall*

Probability	Dates for given probability and temperature: 16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 years in 10 later than	April 6	April 17	April 25	May 4	May 13
2 years in 10 later than	March 31	April 11	April 20	April 29	May 8
5 years in 10 later than	March 21	March 31	April 9	April 19	April 28
Fall:					
1 years in 10 earlier than	October 27	October 21	October 13	October 4	September 19
2 years in 10 earlier than	November 1	October 26	October 19	October 9	September 24
5 years in 10 earlier than	November 12	November 6	October 30	October 20	October 4

county fairly well, particularly maximum temperatures, but it should be recognized that temperatures average slightly cooler in the northern part of the county than in the southern part. At Waterloo, on an average of 19 days per year, the maximum temperature is equal to or greater than 90° F. Such temperatures are too high for optimum crop production. Minimum temperatures vary more across the county. Areas that are low, as compared with surrounding areas, have minimum temperatures lower than urban or upland areas on clear, calm nights. The monthly temperature is summarized in table 15.

Probabilities of freezing temperatures in spring and fall are listed in table 16. The average date of the last 32° F temperature in spring is April 28; the first in fall is October 4. Thus, the average growing season is 159 days.

For good production both adequate warm-season rainfall and subsoil moisture reserves are needed. On April 15, the average soil moisture in this area is nearly 8 inches; there is about a 10 percent chance or less of having less than 5 inches. An adequate reserve is 7 to 8 inches. A level of 5 inches is considered very low. In years of low moisture reserve, a better than normal warm-season rainfall is needed if average crop yields are to be obtained.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

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.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Compressible. Excessive decrease in volume of soft soil under load.

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; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, 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 classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Leaching. The removal of soluble material from soil or other material by percolating water.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded 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 of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Organic matter. Decomposed plant residue in the soil. The following broad classes are used to estimate the amount of organic matter in the soil.

Less than 0.5 percent	Very low
0.5–1.0 percent	Low
1.0–2.0 percent	Moderate low
2.0–4.0 percent	Moderate
4.0–8.0 percent	High
8.0–16.0 percent	Very high

Paha. A loess-capped prominence, elongated as ridges miles in length, or shortened to elliptical hills that stand apart on the Iowan plains or that merge with similar features to form lengthy ridges or broad plateaus.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percolation. The downward movement of water through the soil.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Profile, soil. A vertical section of the soil extending through all its horizons and 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 described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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