SOIL SURVEY OF

Outagamie County, Wisconsin

United States Department of Agriculture
Soil Conservation Service
In cooperation with the
Research Division of the College of Agricultural
and Life Sciences
University of Wisconsin

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 1965–66 and 1970 to 1974. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1974. This survey was made cooperatively by the Soil Conservation Service and the Research Division of the College of Agricultural and Life Sciences, University of Wisconsin. It is part of the technical assistance furnished to the Outagamie County Soil and Water Conservation District.

The fieldwork for this survey was financed in part by the Outagamie County Soil and Water Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, 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, recreation, and residential development.

Locating Soils

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

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

Finding and Using Information

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

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

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

Foresters and others can refer to the section "Woodland Management and Productivity" and "Windbreaks and Environmental Plantings" 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 sections "Engineering" and "Recreation."

Engineers and builders can find, under "Engineering" and "Soil Properties" 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 and Classification of the Soils."

Newcomers in Outagamie County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication and in the section "Environmental Factors Affecting Soil Use."

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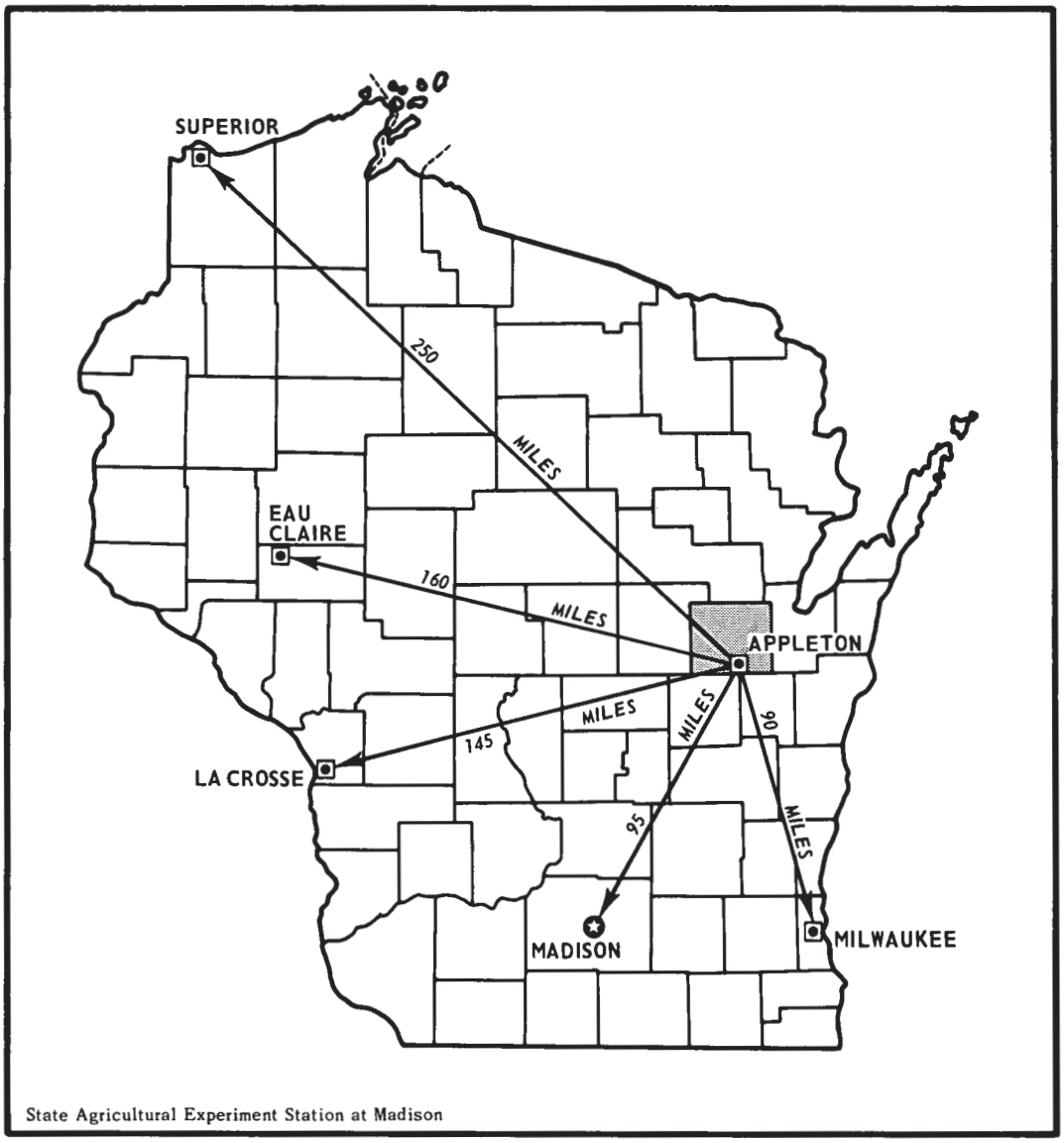

Location of Outagamie County in Wisconsin.

SOIL SURVEY OF OUTAGAMIE COUNTY, WISCONSIN

By Wayne D. Barndt, assisted by Howard E. Lorenz and Steven W. Frings, Soil Conservation Service

Soils surveyed by Howard E. Lorenz, Steven W. Frings, Ernest G. Link, Charles F. Leonard, Dennis E. Hutchinson, Burel S. Butman, and Wayne D. Barndt, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in Cooperation with the Research Division of the College of Agricultural and Life Sciences, University of Wisconsin

OUTAGAMIE COUNTY is in the east-central part of Wisconsin (see facing page). It is about 27 miles from east to west and 24 miles from north to south and is composed of 20 civil townships. The total area of the county is 406,016 acres.

The population was 119,356 in 1970. The city of Appleton, located in the southern part of the county, is the county seat and largest city. Large areas of rapid urban development are located in the southeastern part along the Fox River.

Much of the county's commerce and industry is in the Fox River Valley, and paper-related industries are of primary importance.

The soils in the county are nearly level to very steep. They are suitable for many different crops. Corn, oats, and alfalfa are the chief crops; but specialty crops, such as cabbage, are commonly grown in some areas. The main source of farm income is dairy farming. Wooded areas are scattered throughout the county.

Recreational uses of soils are increasing, especially around lakes and rivers. Wooded areas are in demand for homesites. The increasing demand for homesites, industries, and recreational facilities makes it important to select suitable soils for the intended use. This survey is designed to provide useful information for community and county planning as well as for farming.

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 detailed soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a detailed soil map are called 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 "Descriptions of the Soils."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily useful to different groups of users, among them farmers, managers of woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General Soil Map

The general soil map at the back of this publication shows, in color, the soil associations in the survey area. A soil association is a unique natural landscape that has a distinct pattern of soils and of relief and drainage. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations 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 association differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

The seven soil associations in Outagamie County are described in the pages that follow.

The soil associations and their delineations on the general soil map in this survey do not fully agree with those that appear in previously published surveys of adjacent counties. Some differences result from improvements in the system of classifying soils, particularly in modifications or refinements in concepts of soil series. Other differences from previously published surveys are the pattern of occurrence of some of the major soils and the range in slope that is permitted within some associations described in this survey. Finally, because general soil maps now have more varied uses, the map in this survey is more precise and detailed.

1. *Hortonville-Symco association*

Well drained and somewhat poorly drained, nearly level to steep, medium textured and moderately coarse textured, moderately permeable or moderately slowly permeable soils that are underlain mainly by calcareous loam or clay loam glacial till

This association consists of nearly level to steep soils on glacial till plains. It makes up about 30 percent of the county. It consists of about 49 percent Hortonville soils, 28 percent Symco soils, and about 23 percent minor soils (fig. 1).

Hortonville soils are well drained and gently sloping to steep and are on till plains. The surface layer is silt loam or fine sandy loam. The subsoil is silty clay loam. The substratum is heavy loam to a depth of about 60 inches except in the Hortonville, limestone substratum soils, which are underlain by limestone at a depth of 40 to 60 inches.

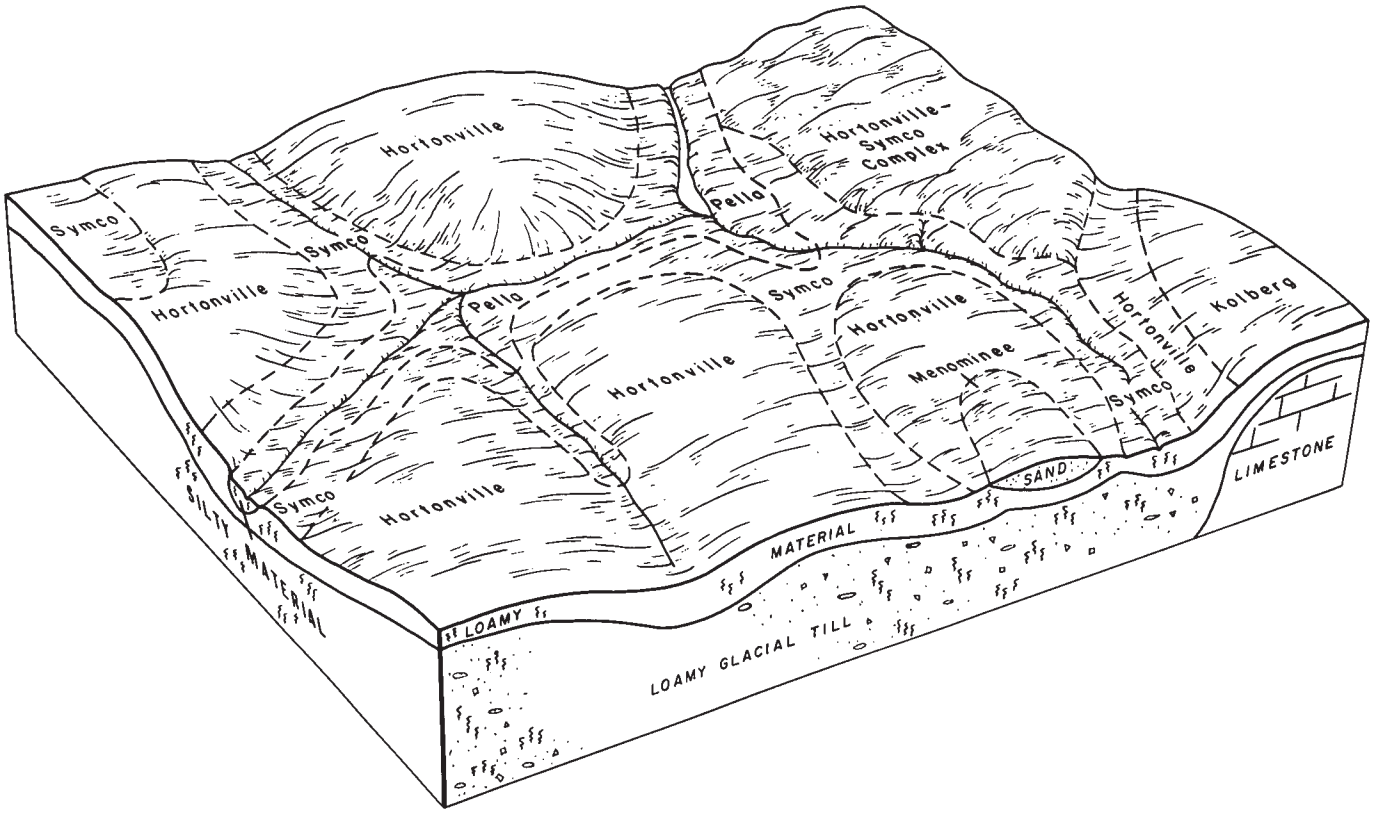

Figure 1.—**Relationship of landscape and underlying material to soils in association 1.**

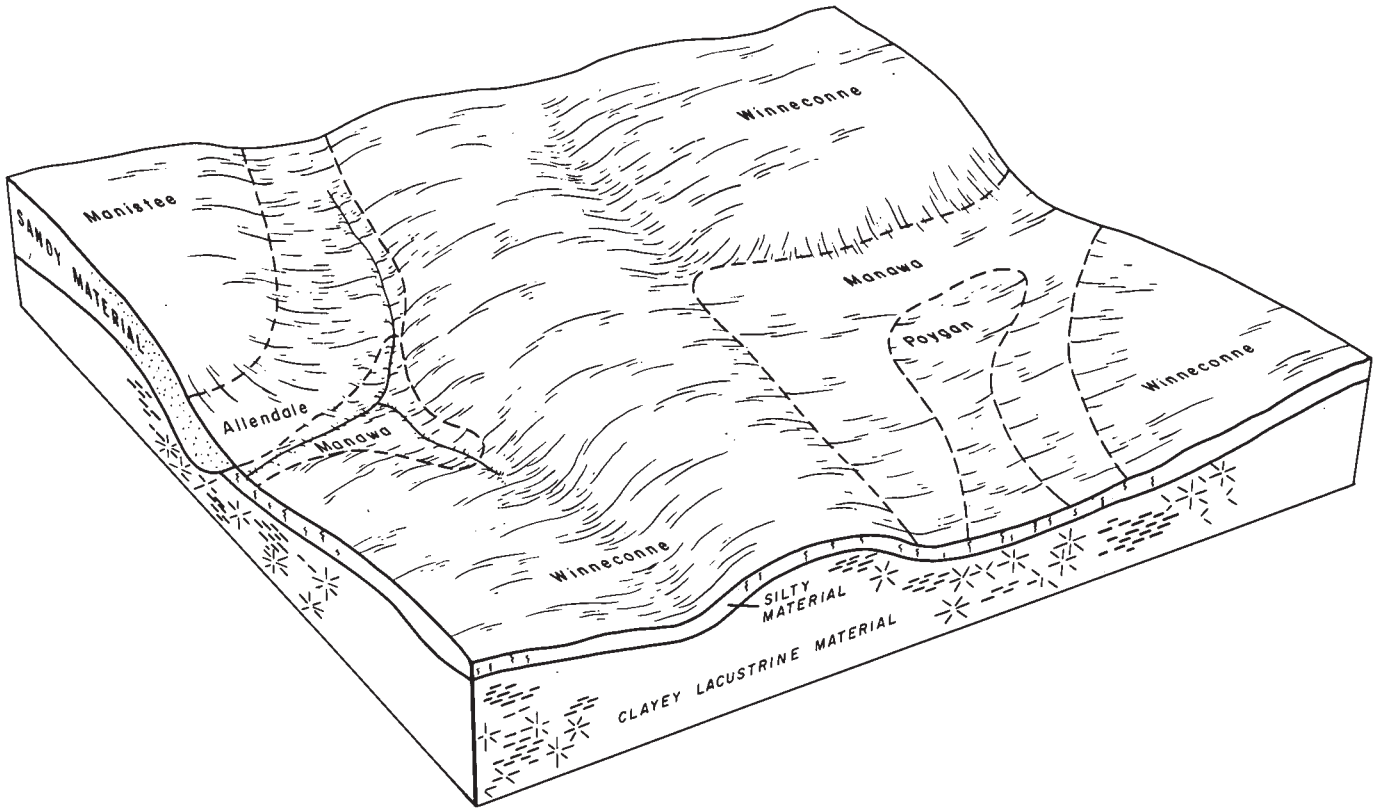

Figure 2.—**Relationship of landscape and underlying material to soils in association 2.**

Symco soils are somewhat poorly drained and nearly level. They are in drainageways and depressions on till plains. The surface layer is silt loam, and the subsoil is clay loam. The substratum to a depth of about 60 inches is heavy loam.

Of minor extent in this association are the Carbondale, Cathro, Kolberg, Manawa, Menominee, and Pella soils and some areas of Rock outcrop. The low-lying drainageways are occupied by the somewhat poorly drained Manawa soils or the poorly drained Pella soils. The swampy depressional areas are occupied by the organic Carbondale and Cathro soils. Areas of Menominee soils are intermingled with areas of Hortonville soils where there is a 20- to 40-inch sandy overburden. Scattered throughout the association are areas of Kolberg soils, where limestone bedrock is at a moderate depth, and areas of Rock outcrop.

Corn, oats, soybeans, and hay grow well on soils of this association. Fertility and available water capacity are moderate to high. The main concerns of management are controlling water erosion, improving drainage, and maintaining tilth and fertility.

Most of this association is used for cultivated crops, but a few steep and undrained wet soils are used for permanent pasture and wildlife habitat. Some areas remain in woodland, and they respond well to management for timber. The major enterprise is dairy farming. The well drained soils of this association have moderate or severe limitations for rural home development if outside municipal sewerage systems.

2. *Winneconne-Manawa association*

Well drained to somewhat poorly drained, nearly level to sloping, medium textured and moderately fine textured, slowly permeable or very slowly permeable soils that are underlain by silty clay glacial till or clay lacustrine sediments

This association consists of nearly level to sloping soils on glacial till plains and in lacustrine basins. It makes up about 17 percent of the county. It consists of about 35 percent Winneconne soils, 20 percent Manawa soils, and 45 percent minor soils (fig. 2).

Winneconne soils are well drained and moderately well drained and are nearly level to sloping. They are in lacustrine basins. The surface layer is silty clay loam. The subsoil is silty clay and clay. The substratum is clay to a depth of about 60 inches.

Manawa soils are somewhat poorly drained and nearly level and gently sloping. They are in drainageways and depressions on till plains. The surface layer and the subsoil are silty clay loam. The substratum is silty clay to a depth of about 60 inches.

Minor soils in this association are Allendale, Briggs-

ville, Kewaunee, Manistee, Poygan, and Suamico soils. The very poorly drained Suamico soils and the poorly drained Poygan soils are in depressions. Briggsville and Kewaunee soils are intermingled with Winneconne soils on till plains. Allendale and Manistee soils are in areas where there is a 20- to 40-inch sandy mantle over glacial till.

Most of the crops commonly grown in the county do well on soils of this association. Fertility is moderate to high, and available water capacity is moderate. The main concerns of management are controlling erosion, maintaining tilth, and improving drainage.

Most of this association is used for crops or pasture. Very steep soils and poorly drained and very poorly drained soils remain in woodland or, where cleared, are used for permanent pasture. The major enterprise is dairy farming. The major soils in this association have severe limitations for rural home development.

3. *Carbondale-Keowns-Cathro association*

Very poorly drained and poorly drained, nearly level, organic and medium textured, moderately slowly permeable to moderately rapidly permeable soils that are underlain by lacustrine silt and fine sand, organic material, or loamy sediments

This association consists of nearly level soils in depressional areas and drainageways. It makes up about 16 percent of the county. It consists of about 40 percent Carbondale soils, 30 percent Keowns soils, 10 percent Cathro soils, and 20 percent minor soils (fig. 3).

Carbondale soils are very poorly drained and nearly level. They are in depressions in glacial lake basins and drainageways. They are organic soils that are more than 51 inches thick.

Keowns soils are poorly drained and nearly level. They occupy depressions in glacial lake basins. The surface layer is silt loam. The subsoil is fine sandy loam. The substratum to a depth of about 60 inches is silt and fine sand.

Cathro soils are very poorly drained and nearly level. They are in depressions in glacial lake basins and drainageways. They are organic soils that are underlain by silt loam.

Minor soils in this association are Lobo, Markey, Pella, Poygan, Rondeau, and Suamico soils. The very poorly drained Lobo, Markey, Rondeau, and Suamico soils are in glacial lake basins and depressions. Pella and Poygan soils are in depressions on till plains.

Most areas of this association remain in swamp woodland and are used for wildlife habitat or are idle. Drained areas are used for crops, sod farming, or permanent pasture. Lobo soils are a good source of sphag-

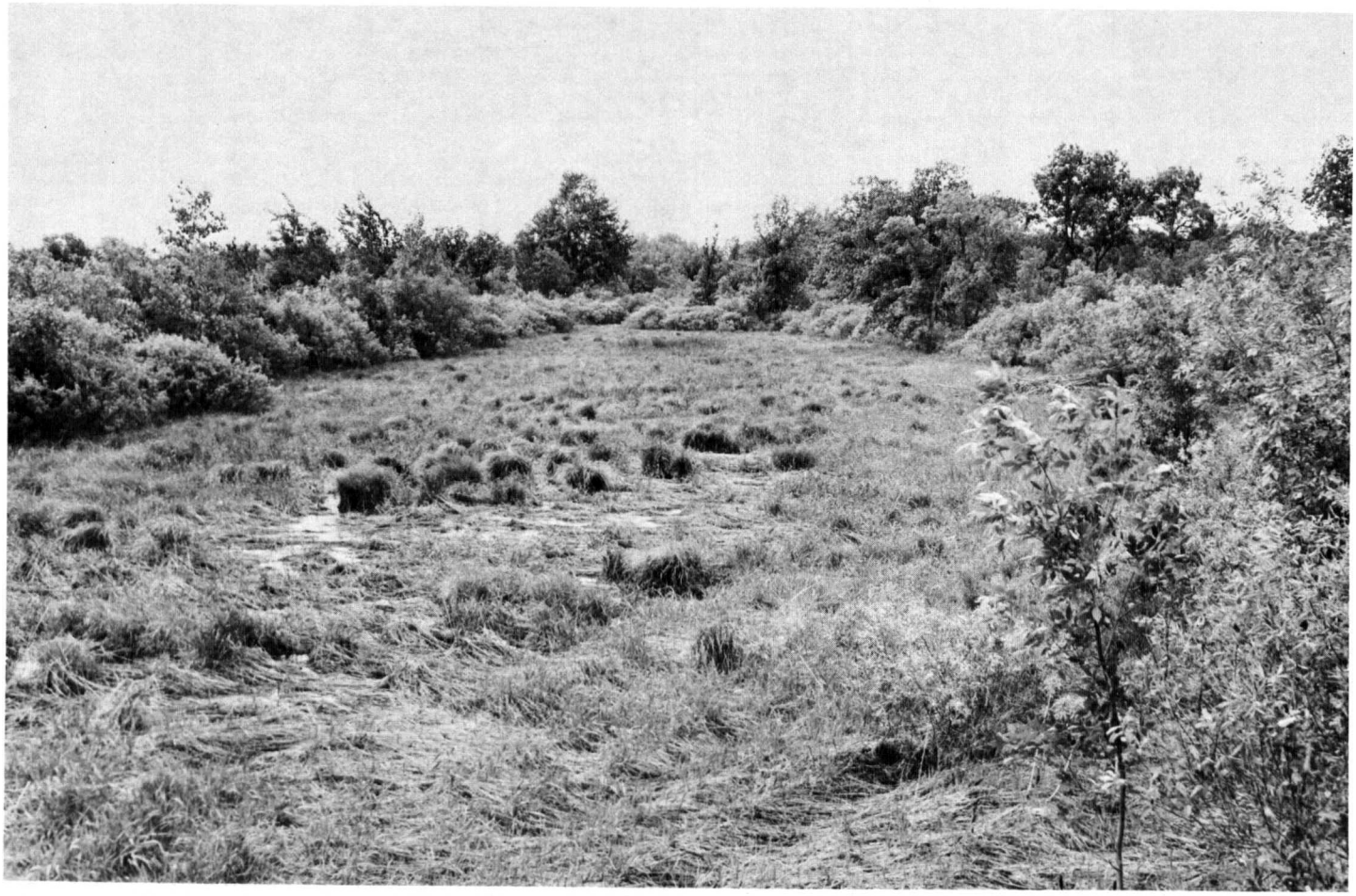

Figure 3.—**A typical landscape of the Carbondale-Keowns-Cathro association, which is suited to wildlife habitat.**

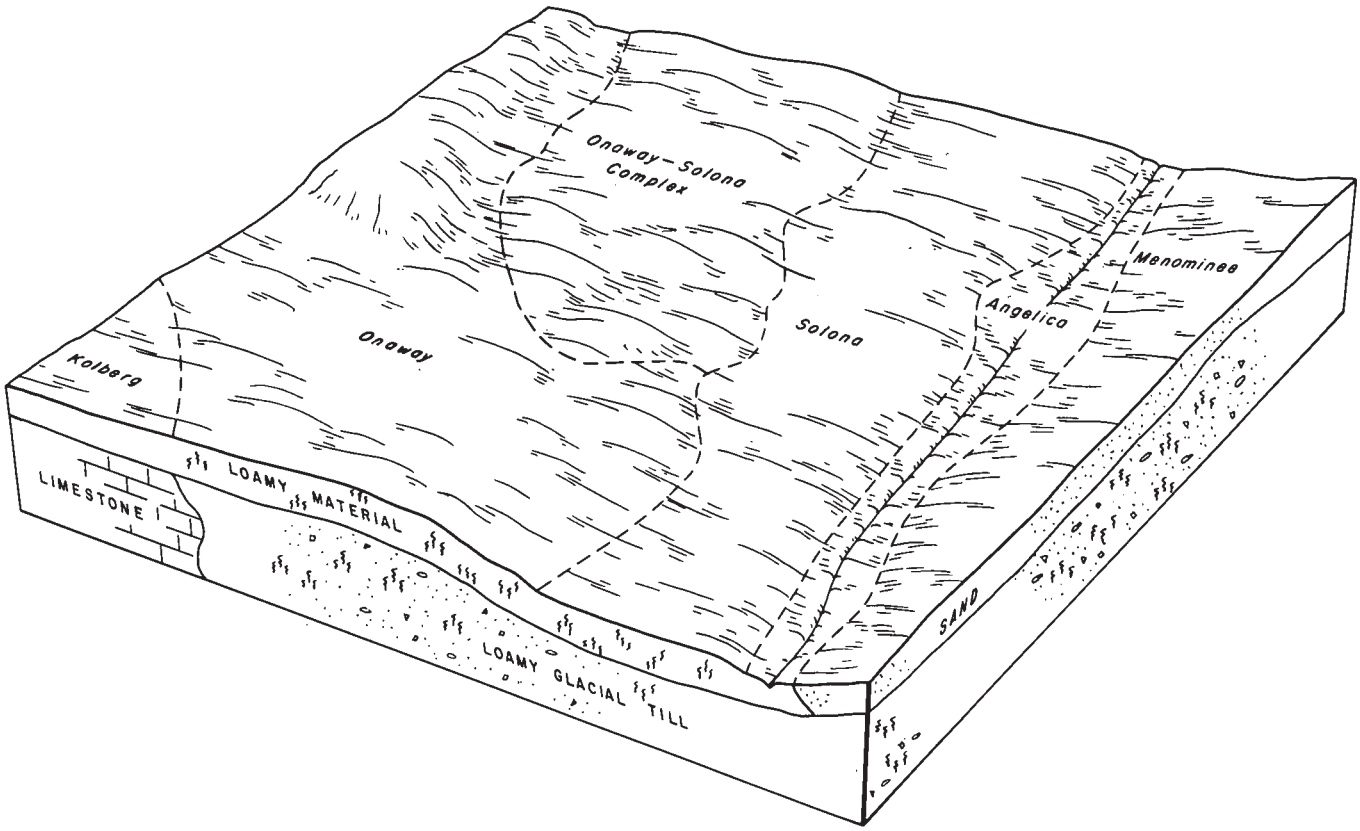

Figure 4.—**Relationship of landscape and underlying material to soils in association 5.**

num moss. The major soils in this association have severe limitations for most nonfarm uses.

4. Shiocton-Nichols association

Somewhat poorly drained and moderately well drained, nearly level and gently sloping, medium textured and moderately coarse textured, moderately permeable soils that are underlain mainly by calcareous silt and very fine sand

This association consists of nearly level and gently sloping soils in relatively flat old glacial lake basins and on river bottom land. It makes up about 12 percent of the county. It is about 40 percent Shiocton soils, 20 percent Nichols soils, and 40 percent minor soils.

Shiocton soils are somewhat poorly drained and nearly level and gently sloping. They are in lacustrine basins. The surface layer is silt loam. The subsoil is silt loam and very fine sandy loam. The substratum is stratified silt and very fine sand to a depth of about 60 inches. Shiocton clayey substratum soils are underlain by clay at a depth of 40 to 60 inches.

Nichols soils are moderately well drained and nearly level and gently sloping. They are on glacial lake plains. The surface layer and subsoil are very fine sandy loam. The substratum is stratified silt and very fine sand to a depth of about 60 inches. Nichols clayey substratum soils are underlain by clay at a depth of 40 to 60 inches.

Minor soils in this association are Grays, Keowns, and Mundelein soils. The poorly drained Keowns soils are in low-lying depressions. The somewhat poorly drained Mundelein soils are intermingled with Shiocton soils. The moderately well drained and well drained Grays soils are intermingled with Nichols soils.

Corn, small grain, hay crops and specialty crops, such as cabbage and cauliflower, grow well on the soils of this association. Fertility and available water capacity are moderate. The main concerns of management are improving drainage, maintaining fertility, and protection from periodic floods.

Most of this association is used for cultivated crops, but wet soils remain in woodland and are used for wildlife habitat. The main enterprises are dairy farming and the growing of cash crops. The major soils of this association have severe limitations for most nonfarm uses.

5. Onaway-Solona association

Well drained to somewhat poorly drained, nearly level to moderately steep, medium textured, moderately permeable soils that are underlain by calcareous loam or sandy loam glacial till

This association consists of nearly level to moderately steep soils on glacial till plains. It makes up about 12 percent of the county. It is about 50 percent Onaway soils, 30 percent Solona soils, and 20 percent minor soils (fig. 4).

Onaway soils are well drained and gently sloping to moderately steep. They are on till plains. The surface layer is loam. The subsoil is fine sandy loam and clay loam. The substratum is loam to a depth of about 60 inches.

Solona soils are somewhat poorly drained and nearly level and gently sloping. They are on till plains. The surface layer is silt loam, and the subsoil is loam. The substratum is loam to a depth of about 60 inches.

Minor soils in this association are Angelica, Kolberg, and Menominee soils. The poorly drained Angelica soils are in low-lying potholes and drainageways. Menominee soils are in areas where there is a sandy overburden. Kolberg soils are in areas where limestone bedrock is at a moderate depth.

Most of the crops commonly grown in the county do well on soils of this association. Fertility and available water capacity are moderate. The main concerns of management are controlling erosion and removing excess water from depressional areas.

Most of this association is used for crops, but many areas are used for permanent pasture or remain in woodland. The soils are very productive for woodland crops. The major enterprise is dairy farming. The major soils in this association have severe limitations for septic tank absorption fields and many other nonfarm uses.

6. *Menominee-Grays-Rousseau association*

Well drained and moderately well drained, nearly level to sloping, coarse textured and medium textured, moderately permeable to rapidly permeable soils that are underlain by lacustrine silt loam and very fine sand, windblown fine sand, or sandy loam glacial till

This association consists of nearly level soils in glacial lake basins or on outwash plains and of gently sloping to steep soils on outwash ridges or glacial till plains. It makes up about 8 percent of the county. It is about 20 percent Menominee soils, 10 percent Grays soils, 10 percent Rousseau soils, and 60 percent minor soils.

Menominee soils are well drained and gently sloping and sloping and are on till plains. The surface layer is loamy fine sand. The subsoil is fine sand in the upper part and clay loam in the lower part. The substratum is sandy loam to a depth of about 60 inches.

Grays soils are well drained and moderately well drained and nearly level and gently sloping. They are in glacial lake basins. The surface layer is silt loam. The subsoil is silty clay loam and silt loam. The substratum, to a depth of about 60 inches, is silt loam and very fine sand.

Rousseau soils are well drained and moderately well drained and gently sloping. They are in lacustrine basins and on outwash plains. The surface layer is loamy fine sand, and the subsoil is fine sand. The substratum is fine sand to a depth of about 60 inches.

Minor soils in this association are in the Boyer, Casco, Deford, Shawano, and Wainola series. The well drained to excessively drained Boyer, Casco, and Shawano soils that are underlain by sand and gravel are on upland ridges. The poorly drained Deford soils and the somewhat poorly drained Wainola soils are in depressions and drainageways.

The suitability of this association for crops varies greatly. Some of the soils are well suited to all crops commonly grown in the county; others are better suited to woodland or wildlife habitat. Fertility and available water capacity range from low to high. The main concerns of management are controlling erosion and soil blowing, removing excess water, and conserving soil moisture.

Much of this association borders and is farmed along with the well defined, more uniform associations of the county. The well drained soils that remain in woodland are commonly used for rural home development, for which they have only slight or moderate limitations. The sandier soils are a good source of sand and gravel.

7. *Wainola-Deford-Rousseau association*

Poorly drained to well drained, nearly level and gently sloping, coarse textured, rapidly permeable soils that are underlain by windblown fine sand or lacustrine fine sand

This association consists of nearly level and gently sloping soils in lacustrine basins and on outwash plains. It makes up about 5 percent of the county. It is about 40 percent Wainola soils, 20 percent Deford soils, 15 percent Rousseau soils, and 25 percent minor soils (fig. 5).

Wainola soils are somewhat poorly drained and nearly level and gently sloping. They are in lacustrine basins and on outwash plains. The surface layer is loamy fine sand, and the subsoil is fine sand. The substratum is fine sand to a depth of about 60 inches.

Deford soils are poorly drained and nearly level and are in lacustrine basins. The surface layer is loamy fine sand, and the substratum is fine sand.

Rousseau soils are well drained and moderately well drained and gently sloping. They are in lacustrine basins and on outwash plains. The surface layer is loamy fine sand, and the subsoil is fine sand. The substratum is fine sand to a depth of about 60 inches.

Minor soils in this association are Boyer, Keowns, Markey, and Shawano soils. Keowns soils are intermingled with Deford soils throughout the association. The organic Markey soils are in very poorly drained depressions. Shawano and Boyer soils are scattered throughout the association. Shawano soils formed in windblown sandy deposits and Boyer soils formed in outwash deposits on ridges.

Corn and small grain are grown in areas that are drained. Specialty crops, such as cabbage and cauliflower, do well on the nearly level, somewhat poorly drained soils. The main concerns of management are removing excess water and protecting the soil from blowing. The better drained soils are droughty.

Most of this association remains in woodland or wetlands. The wooded soils have good potential for recreational development. The poorer drained soils that are cleared and drained are used for permanent pasture or for cash crops. The better drained soils have moderate limitations for rural home development.

Descriptions of the Soils

This section describes each soil series in detail and then, briefly, each mapping unit in that series. Unless

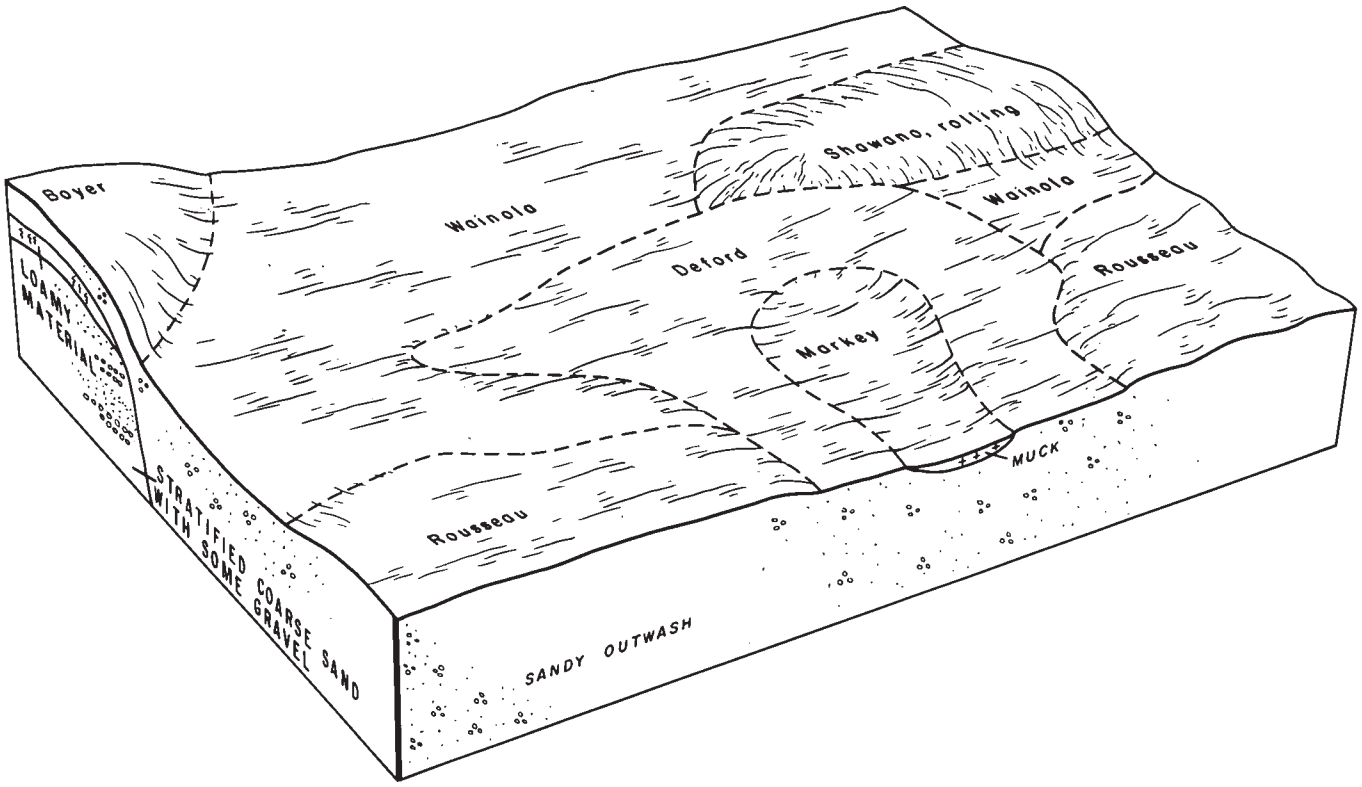

Figure 5.—**Relationship of landscape and underlying material to soils in association 7.**

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

The mapping 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 profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or a geographic feature near the place where a soil of that series was first observed and mapped. Hortonville and Kewaunee, for example, are the names of two soil series in Outagamie County. All the soils in the United States having the same series name have the same characteristics.

The soil profile is an important part of the description of each soil series. The profile of each series is described twice. The first description is brief and in terms familiar to a layman. The second is more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for moist soil unless otherwise stated.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Hortonville silt loam, 2 to 6 percent slopes, is one of several phases within the Hortonville series.

Some mapping units are made up of soils of different series, or of different phases within one series, and some have little or no soil. One kind of mapping unit, the soil complex, is shown on the soil map of Outagamie County.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that it is not feasible to show them separately on the soil map at the scale used. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Onaway-Solona complex, 2 to 6 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called miscellaneous areas and are given descriptive names, such as "Rock outcrop," which is a miscellaneous area in Outagamie County.

Most mapping units include small, scattered areas of soils other than those that appear in the name of the mapping 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 mapping unit. These soils are described in the description of each mapping unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and woodland group in which the mapping unit has been placed. The capability unit and woodland ordination symbol for each soil is listed in the "Guide to Mapping Units" at the back of this survey.

The names of some soils do not agree fully with those appearing in previously published soil surveys of adjacent counties because of changes in concepts of soil series in the application of the soil classification system.

The acreage and proportionate extent of each mapping 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, and in the Soil Survey Manual (*8*)[1].

Allendale Series

The Allendale series consists of nearly level and gently sloping, somewhat poorly drained soils on old lake plains and glacial till plains. These soils formed under mixed vegetation of maple, ash, birch, and popple.

In a representative profile the surface layer is black loamy fine sand about 9 inches thick. The subsurface layer is grayish brown fine sand about 2 inches thick. The subsoil is about 33 inches thick. It is dark yellowish brown and brown mottled fine sand in the upper part, reddish brown mottled fine sandy loam in the middle part, and reddish brown mottled silty clay in the lower part. The substratum is reddish brown silty clay to a depth of about 60 inches.

Allendale soils have moderate available water capacity. Permeability is rapid in the sandy part and slow in the clayey part.

Most areas of these soils are drained and are used for all crops commonly grown in the county. Undrained areas remain in woodland.

Representative profile of Allendale loamy fine sand, 0 to 3 percent slopes, in a cultivated field 1,200 feet south and 200 feet west of the northeastern corner of sec. 31, T. 23 N., R. 15 E.

Ap—0 to 9 inches; black (10YR 2/1) loamy fine sand; moderate medium subangular blocky structure; very friable; many roots; slightly acid; abrupt smooth boundary.

A2—9 to 11 inches; grayish brown (10YR 5/2) fine sand; weak fine subangular blocky structure; very friable; many roots; black (10YR 2/1) coatings on vertical faces of peds; slightly acid; clear smooth boundary.

B2hir—11 to 32 inches; dark yellowish brown (10YR 4/4) fine sand; few fine prominent yellowish brown (10YR 5/8) and light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure; very friable; few roots; slightly acid; clear smooth boundary.

A'2—32 to 35 inches; brown (10YR 5/3) fine sand; few fine prominent yellowish brown (10YR 5/8) and light gray (10YR 7/2) mottles; weak fine subangular blocky structure; very friable; few roots; neutral; abrupt smooth boundary.

B'21t—35 to 39 inches; reddish brown (5YR 4/3) fine sandy loam; few fine prominent yellowish brown (10YR 5/8) and light gray (10YR 7/2) mottles; ped coatings and crack fillings of pale brown (10YR 6/3) fine sand in upper 2 inches; moderate fine subangular blocky structure; very friable; clay bridging; neutral; abrupt smooth boundary.

IIB'22t—39 to 44 inches; reddish brown (5YR 5/3) silty clay; few medium prominent yellowish brown (10YR 5/8) mottles; strong fine subangular blocky structure; firm; many thin continuous clay films on vertical and horizontal faces of peds; neutral; clear smooth boundary.

IIC—44 to 60 inches; reddish brown (5YR 5/3) silty clay; few fine prominent yellowish brown (10YR 5/8) mottles; massive, firm; slight effervescence; mildly alkaline.

The sandy mantle is 20 to 45 inches thick. The A and B horizons range from strongly acid to neutral. The IIB horizon is slightly acid to neutral, and the IIC horizon is slightly acid to moderately alkaline.

The Ap horizon is very dark grayish brown, very dark brown, or black and is 6 to 10 inches thick. The Bhir horizon generally is fine sand and sand and less commonly is loamy sand or loamy fine sand. The B2t horizon is sandy loam, heavy sandy loam, or light sandy clay loam. The IIB and IIC horizons are silty clay or clay.

Allendale soils are near Manawa and Manistee soils. They have a sand overburden which Manawa soils do not have. They are wetter than Manistee soils.

AdA—Allendale loamy fine sand, 0 to 3 percent slopes. This nearly level and very gently sloping soil is in drainageways and on flats on lacustrine and glacial till plains. Most areas are irregular in shape and range from 2 to 160 acres in size.

Included with this soil in mapping are some small areas of better drained soils and some small areas of wetter soils. Some areas have a slight accumulation of organic matter.

This soil has low natural fertility and moderately low organic-matter content. The effective rooting depth is limited by a water table or, where the soil is drained, by a clayey substratum. Runoff is very slow. Management is needed to remove excess water.

[1] Italic numbers in parentheses refer to References, p. 126.

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

Map symbol	Soil name	Acres	Percent
AdA	Allendale loamy fine sand, 0 to 3 percent slopes	3,300	0.8
Ax	Angelica silt loam	4,200	1.0
Bc	Bellevue silt loam	1,550	0.4
BnA	Bonduel silt loam, 0 to 3 percent slopes	960	0.2
BoA	Borth silt loam, 0 to 3 percent slopes	920	0.2
BrB	Boyer loamy sand, 2 to 6 percent slopes	1,300	0.3
BrC2	Boyer loamy sand, 6 to 12 percent slopes, eroded	430	0.1
BrD2	Boyer loamy sand, 12 to 20 percent slopes, eroded	125	(1)
BtA	Briggsville silt loam, 0 to 2 percent slopes	1,400	0.3
BtB	Briggsville silt loam, 2 to 6 percent slopes	5,800	1.4
Ca	Carbondale muck	22,250	5.5
CcB	Casco loam, 2 to 6 percent slopes	2,950	0.7
CcC2	Casco loam, 6 to 12 percent slopes, eroded	1,050	0.3
CcD2	Casco loam, 12 to 20 percent slopes, eroded	410	0.1
Cm	Cathro muck	7,500	1.8
CnB	Channahon silt loam, 2 to 6 percent slopes	560	0.1
De	Deford loamy fine sand	6,600	1.6
ElB	Eleva fine sandy loam, 2 to 6 percent slopes	240	0.1
ElC2	Eleva fine sandy loam, 6 to 15 percent slopes, eroded	250	0.1
Fu	Fluvaquents	5,500	1.4
Gp	Gravel pits	950	0.2
GrA	Grays silt loam, 0 to 2 percent slopes	2,200	0.5
GrB	Grays silt loam, 2 to 6 percent slopes	2,650	0.7
HeB	Hebron loam, 2 to 6 percent slopes	600	0.1
HnB	Hortonville fine sandy loam, 2 to 6 percent slopes	6,250	1.5
HnC2	Hortonville fine sandy loam, 6 to 12 percent slopes, eroded	1,050	0.3
HrB	Hortonville silt loam, 2 to 6 percent slopes	54,000	13.2
HrC2	Hortonville silt loam, 6 to 12 percent slopes, eroded	10,100	2.5
HrD2	Hortonville silt loam, 12 to 20 percent slopes, eroded	1,500	0.4
HrE	Hortonville silt loam, 20 to 30 percent slopes	425	0.1
HsB	Hortonville silt loam, limestone substratum, 2 to 6 percent slopes	1,500	0.4
HsC2	Hortonville silt loam, limestone substratum, 6 to 12 percent slopes, eroded	255	0.1
HtB	Hortonville-Symco silt loams, 2 to 6 percent slopes	3,150	0.8
KaA	Kaukauna silty clay loam, 0 to 3 percent slopes	2,150	0.5
Ke	Keowns silt loam	20,250	5.0
KhB	Kewaunee silt loam, 2 to 6 percent slopes	14,700	3.6
KhC2	Kewaunee silt loam, 6 to 12 percent slopes, eroded	1,100	0.3
KhD2	Kewaunee silt loam, 12 to 20 percent slopes, eroded	160	(1)
KkE3	Kewaunee soils, 20 to 45 percent slopes, severely eroded	2,600	0.6
KlB	Kewaunee-Manawa complex, 2 to 6 percent slopes	2,100	0.5
KoB	Kolberg silt loam, 1 to 6 percent slopes	4,000	1.0
KoC2	Kolberg silt loam, 6 to 12 percent slopes, eroded	990	0.2
Ln	Limestone quarries	420	0.1
Lo	Lobo peat	1,600	0.4
McA	Manawa silty clay loam, 1 to 3 percent slopes	15,560	3.8
MeB	Manistee loamy fine sand, 2 to 6 percent slopes	1,950	0.5
MeC2	Manistee loamy fine sand, 6 to 12 percent slopes, eroded	335	0.1
MfB	Manistee fine sandy loam, 2 to 6 percent slopes	780	0.2
Mk	Markey muck	4,100	1.0
MsB	Menominee loamy fine sand, loamy substratum, 2 to 6 percent slopes	6,150	1.5
MsC2	Menominee loamy fine sand, loamy substratum, 6 to 12 percent slopes, eroded	1,050	0.3
MtA	Mosel silt loam, 0 to 3 percent slopes	700	0.2
MuA	Mundelein silt loam, 0 to 3 percent slopes	4,200	1.0
NaB	Namur silt loam, 1 to 6 percent slopes	570	0.1
NfA	Nichols very fine sandy loam, 0 to 2 percent slopes	2,550	0.6
NfB	Nichols very fine sandy loam, 2 to 6 percent slopes	7,200	1.8
NsA	Nichols very fine sandy loam, clayey substratum, 0 to 2 percent slopes	230	0.1
NsB	Nichols very fine sandy loam, clayey substratum, 2 to 6 percent slopes	750	0.2
OhB	Onaway loam, 2 to 6 percent slopes	14,200	3.6
OhC2	Onaway loam, 6 to 12 percent slopes, eroded	4,100	1.0
OhD2	Onaway loam, 12 to 20 percent slopes, eroded	315	0.1
OlB	Onaway-Solona complex, 2 to 6 percent slopes	9,200	2.3
Pe	Pella silt loam	5,500	1.4
Pf	Poy silty clay loam	1,050	0.3
Po	Poygan silty clay loam	9,300	2.3
Ra	Rock outcrop	600	0.1
Rd	Rondeau muck	410	0.1
RoB	Rousseau loamy fine sand, 2 to 6 percent slopes	9,300	2.3
SeC	Shawano fine sand, rolling	2,100	0.5
SeD	Shawano fine sand, hilly	650	0.2
ShA	Shiocton silt loam, 0 to 3 percent slopes	24,750	6.1
SkA	Shiocton silt loam, clayey substratum, 0 to 3 percent slopes	2,900	0.7
SnB	Shiocton-Nichols complex, 2 to 6 percent slopes	1,500	0.4
SoA	Solona silt loam, 1 to 3 percent slopes	9,500	2.3
Su	Suamico muck	3,700	0.9
SyA	Symco silt loam, 1 to 3 percent slopes	15,400	3.9
SzA	Symco variant, 0 to 3 percent slopes	1,350	0.3
Uf	Udifluvents	890	0.2
Uo	Udorthents	2,550	0.6
WaA	Wainola loamy fine sand, 0 to 3 percent slopes	12,500	3.1
Wb	Will silt loam	770	0.2

See footnote at end of table.

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

Map symbol	Soil name	Acres	Percent	Map symbol	Soil name	Acres	Percent
WnA	Winneconne silty clay loam, 0 to 2 percent slopes	6,600	1.6	ZtA	Zittau silty clay loam, 0 to 3 percent slopes	1,100	0.3
WnB	Winneconne silty clay loam, 2 to 6 percent slopes	12,500	3.1		Water	4,441	1.1
WnC2	Winneconne silty clay loam, 6 to 12 percent slopes, eroded	720	0.2		Total	406,016	100.0

[1] Less than 0.1 percent.

Most areas of this soil are used for crops or pasture, and some areas remain in woodland. This soil is suited to corn, oats, and water-tolerant grasses and legumes. Capability unit IIIw–6; woodland group 3w.

Angelica Series

The Angelica series consists of poorly drained, nearly level soils in depressions and drainageways of glacial till plains. These soils formed under natural vegetation of aspen, alder, white-cedar, and American elm.

In a representative profile the surface layer is very dark brown muck about 4 inches thick over very dark brown silt loam about 8 inches thick. The subsoil is about 21 inches thick. It is dark gray mottled loam in the upper part and grayish brown mottled loam in the lower part. The substratum is reddish brown mottled loam to a depth of about 60 inches.

Available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the substratum.

Most areas of these soils are drained and are used for all crops commonly grown in the county. Undrained areas remain in woodland or are used for wildlife habitat.

Representative profile of Angelica silt loam, in an uncultivated pasture 1,200 feet west and 100 feet south of the northeastern corner of sec. 4, T. 24 N., R. 18 E.

O1—4 inches to 0; very dark brown (10YR 2/2) sapric material; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

A1—0 to 8 inches; very dark brown (10YR 2/2) silt loam; weak fine granular structure; very friable; about 10 percent organic matter; neutral; abrupt smooth boundary.

B21g—8 to 16 inches; dark gray (5Y 4/1) loam; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; many very dark brown (10YR 2/2) organic stains throughout; few small pebbles and dark streaks; neutral; clear wavy boundary.

B22g—16 to 29 inches; grayish brown (2.5Y 5/2) loam; common coarse prominent strong brown (7.5YR 5/6) and yellow (10YR 7/6) mottles; moderate medium subangular blocky structure; firm; neutral; abrupt smooth boundary.

C—29 to 60 inches; reddish brown (5YR 5/4) loam; common medium distinct pinkish gray (7.5YR 6/2) and strong brown (7.5YR 5/6) mottles; massive; firm; gravel up to 2 inches in diameter make up about 5 percent of the horizon; strong effervescence; moderately alkaline.

The solum is 15 to 30 inches thick. In some undisturbed areas, a very dark brown or black organic layer up to 5 inches thick is on the surface. The B horizon is loam, clay loam, or, less commonly, sandy loam. The C horizon is loam, sandy loam, or gravelly loam.

Angelica soils are near Onaway and Solona soils. They are more poorly drained than the somewhat poorly drained Solona soils and the well drained and moderately well drained Onaway soils with which they form a drainage sequence.

Ax—Angelica silt loam. This is a nearly level soil in drainageways and depressions on glacial till plains. Most areas range from 5 to 80 acres in size and are irregular in shape. Slopes are 0 to 2 percent.

Included with this soil in mapping are some areas of Solona soils. Also included are some small areas of gently sloping soils.

This soil has high natural fertility and organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow to ponded. Wetness is the main limitation to use of this soil, and drainage is needed. Tile drainage and surface drainage help remove excess water.

Most undrained areas of this soil are used for limited grazing, woodland, or wildlife. This soil is well suited to corn and oats where it is drained. Capability unit IIw–1; woodland group 4w.

Bellevue Series

The Bellevue series consists of well drained and moderately well drained, nearly level soils on flood plains. These soils formed under a mixed deciduous forest dominantly of hawthorn and oak.

In a representative profile the surface layer is dark brown silt loam about 12 inches thick. The subsoil is about 23 inches thick. It is dark reddish brown heavy loam in the upper part and reddish brown silt loam in the lower part. The substratum is reddish brown heavy sandy loam and loam to a depth of about 60 inches.

Bellevue soils have high available water capacity and moderate permeability.

Most areas of these soils are used for permanent pasture, and some are cultivated.

Representative profile of Bellevue silt loam, on uncultivated river bottom land 1,410 feet east and 2,530 feet north of the southwestern corner of sec. 32, T. 22 N., R. 19 E.

A1—0 to 12 inches; dark brown (7.5YR 3/2) silt loam; moderate fine granular structure; very friable; many roots; mildly alkaline; clear smooth boundary.

B2—12 to 28 inches; dark reddish brown (5YR 3/4) heavy loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; very friable; many roots; few dark brown (7.5YR 4/4) sand lenses; weakly stratified; mildly alkaline; gradual smooth boundary.

B3—28 to 35 inches; reddish brown (5YR 4/4) silt loam; weak medium and coarse subangular blocky structure; very friable; few roots, weakly stratified; mildly alkaline; gradual smooth boundary.

C1—35 to 50 inches; reddish brown (5YR 4/4) heavy sandy loam; massive; very friable; weakly stratified; moderately alkaline; gradual smooth boundary.

C2—50 to 60 inches; reddish brown (5YR 4/4) loam; massive; very friable; weakly stratified; moderately alkaline.

The solum is generally 30 to 40 inches thick but ranges from 25 to 40 inches thick. It is slightly acid to moderately alkaline.

The A horizon is dark brown, very dark brown, very dark grayish brown, or dark yellowish brown and is 10 to 15 inches thick. The B and C horizons are silt loam, loam, or sandy loam. There are mottles in some profiles.

Bellevue soils are near Fluvaquents, Udifluvents, and Kewaunee soils. Bellevue soils are well drained and moderately well drained, Fluvaquents are poorly drained and very poorly drained, and Udifluvents are somewhat poorly drained and well drained.

Bc—Bellevue silt loam. This is a nearly level soil on alluvial flood plains. Most areas are long and narrow and range from 5 to 80 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are some small areas of Fluvaquents and Udifluvents.

This soil has high natural fertility and moderate organic-matter content. The effective root zone is deep. Runoff is slow. Flooding during spring runoff or following heavy rainfall is the main hazard. Protection from flooding is needed for crop production.

Most areas of this soil are now used for permanent pasture, but some are used for crops. This soil is well suited to all crops commonly grown in the county if it is protected from flooding. Capability unit IIw–11; woodland group 3o.

Bonduel Series

The Bonduel series consists of somewhat poorly drained, nearly level and gently sloping soils on glacial till plains. These soils formed under a mixed deciduous forest of elm, ash, maple, and some white-cedar.

In a representative profile the surface layer is black silt loam about 7 inches thick. The subsurface layer is grayish brown mottled silt loam about 3 inches thick. The subsoil is brown mottled loam about 14 inches thick. Light gray consolidated limestone bedrock extends to a depth of about 60 inches or more.

Bonduel soils have low available water capacity and moderate permeability.

Most areas of these soils are cultivated and used for all crops commonly grown in the county.

Representative profile of Bonduel silt loam, 0 to 3 percent slopes, in a woodlot 1,056 feet south and 2,560 feet west of the northeastern corner of sec. 17, T. 21 N., R. 16 E.

A1—0 to 7 inches; black (10YR 2/1) silt loam; moderate fine granular structure; very friable; many roots; neutral; clear smooth boundary.

A2—7 to 10 inches; grayish brown (10YR 5/2) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak thin platy structure parting to moderate fine subangular blocky; very friable; many roots; few fine prominent black (10YR 2/1) worm casts; neutral; abrupt smooth boundary.

B1—10 to 16 inches; brown (10YR 4/3) light loam; few fine distinct light brownish gray (10YR 6/2) and common coarse distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; many roots; mildly alkaline; clear smooth boundary.

B2t—16 to 20 inches; brown (10YR 4/3) heavy loam; few fine distinct light brownish gray (10YR 6/2) and common coarse distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; many roots; thin patchy clay films; mildly alkaline; clear smooth boundary.

B3—20 to 24 inches; brown (7.5YR 4/4) loam; common coarse distinct yellowish brown (10YR 5/6) and few fine distinct light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; many roots; very friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

R—24 to 60 inches; light gray (10YR 7/2) consolidated limestone bedrock.

The solum is 20 to 34 inches thick. Depth to bedrock is 20 to 40 inches. The solum ranges from medium acid to moderately alkaline, and the substratum ranges from neutral to moderately alkaline.

The Ap or A1 horizon is black, very dark brown, or very dark grayish brown and is 6 to 10 inches thick. The B horizon is loam, light clay loam, or in some places is sandy clay loam. In some places Bonduel soils have a thin C horizon that is similar to the B horizon in texture and color.

Bonduel soils are near Channahon, Kolberg, Manawa, and Symco soils. They are more poorly drained than Channahon and Kolberg soils. Bonduel soils have a lower percentage of clay throughout the profile than

Manawa soils. They are underlain by limestone bedrock that Manawa and Symco soils lack.

BnA—Bonduel silt loam, 0 to 3 percent slopes. This nearly level and gently sloping soil is on glacial till plains which are underlain by limestone bedrock at a depth of 20 to 40 inches. Most areas are irregular in shape and range from 2 to 40 acres in size.

Included with this soil in mapping are some small areas of better drained soils. Also included are areas where limestone is at a depth of more than 40 inches.

This soil has high natural fertility and moderate organic-matter content. The effective rooting depth is limited by the high water table or, where drainage has been improved, by depth to bedrock. Runoff is very slow. The main limitation to use of this soil is wetness. Surface field ditches can be used to remove excess water. Any construction is limited by the shallow depth to bedrock.

Most areas of this soil are used for pasture or for crops commonly grown in the county. This soil is well suited to crops such as corn or hay if it is drained. Capability unit IIw–2; woodland group 3o.

Borth Series

The Borth series consists of well drained and moderately well drained, nearly level and gently sloping soils on lacustrine plains. These soils formed under mixed hardwoods, dominantly maple, birch, elm, ash, and basswood.

In a representative profile the surface layer is very dark brown silt loam 9 inches thick. The subsurface layer is brown silt loam 5 inches thick. The subsoil is about 19 inches thick. It is reddish brown heavy silt loam in the upper part and reddish brown silty clay in the lower part. The substratum is brown medium and fine sand to a depth of about 60 inches.

Available water capacity is moderate. Permeability is slow in the clayey subsoil and rapid in the sandy substratum.

Most areas of these soils are used for crops commonly grown in the county.

Representative profile of Borth silt loam, 0 to 3 percent slopes, in a cultivated field 1,230 feet east and 100 feet south of the northwestern corner of sec. 32, T. 24 N., R. 15 E.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam; weak fine subangular blocky structure; friable; few earthworm casts; neutral; abrupt smooth boundary.

A2—9 to 14 inches; brown (7.5YR 4/2) silt loam; weak thin platy structure parting to weak very fine blocky; friable; neutral; abrupt wavy boundary.

B1—14 to 18 inches; reddish brown (5YR 4/3) heavy silt loam; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

B21t—18 to 24 inches; reddish brown (5YR 4/3) silty clay; weak medium blocky structure; firm; coatings of gray silt particles on ped surfaces; thin patchy clay films on faces of peds; neutral; clear wavy boundary.

B22t—24 to 29 inches; reddish brown (5YR 4/3) silty clay; weak medium angular blocky structure; firm; few thin patchy clay films on faces of peds; neutral; clear wavy boundary.

B3—29 to 33 inches; reddish brown (5YR 4/3) silty clay; weak fine subangular blocky structure; firm; few soft accumulations of aggregated calcium carbonates; neutral; abrupt smooth boundary.

IIC—33 to 60 inches; brown (7.5YR 4/4) medium and fine sand; single grained; loose; neutral.

The solum is 20 to 40 inches thick. It ranges from medium acid to moderately alkaline. The C horizon ranges from neutral to moderately alkaline.

The Ap horizon is very dark brown or very dark grayish brown and is 5 to 10 inches thick. Some of the soils in the Borth series lack an A2 horizon. The lower part of the B horizon is dominantly silty clay or clay, but it includes thin or transitional horizons that are silty clay loam or clay loam. The C horizon is dominantly sand, but in some places it is loamy sand. In some places the sandy deposits are underlain by gravel.

Borth soils are near Poy and Zittau soils. They are better drained than Zittau and Poy soils with which they form a drainage sequence.

BoA—Borth silt loam, 0 to 3 percent slopes. This nearly level and gently sloping soil is on outwash plains. Most areas are irregular in shape and range from 3 to 120 acres in size.

Included with this soil in mapping are a few small areas of Winneconne and Zittau soils. Also included are a few small areas where sand is at a depth of less than 20 inches.

This soil has high natural fertility and moderately low organic-matter content. The effective rooting depth is limited by the sandy substratum. Runoff is slow, and this soil is slightly droughty. Maintaining soil tilth is the main management concern. Minimum tillage or application of manure improves tilth.

Most areas of this soil are used for crops, and some areas remain in woodland. This soil is suited to all crops commonly grown in the county, such as corn and oats. It is well suited to hay crops and pasture. Capability unit IIs–7; woodland group 3c.

Boyer Series

The Boyer series consists of well drained, gently sloping to moderately steep soils on outwash plains. These soils formed under mixed hardwoods, dominantly oak, hickory, and maple.

In a representative profile the surface layer is brown loamy sand about 7 inches thick. The subsoil is about 21 inches thick. It is brown loamy sand in the upper part and reddish brown sandy loam in the lower part. The substratum is brown coarse sand to a depth of about 60 inches.

Boyer soils have low available water capacity. Permeability is moderately rapid in the subsoil and very rapid in the substratum.

Most gently sloping and sloping areas of these soils are cultivated and are used for all crops commonly grown in the county. Most moderately steep areas are in pasture or woodland.

Representative profile of Boyer loamy sand, 2 to 6

percent slopes, in a cultivated field 1,050 feet north and 100 feet east of the southwestern corner of sec. 15, T. 22 N., R. 15 E.

Ap—0 to 7 inches; brown (10YR 4/3) loamy sand; weak medium granular structure; very friable; few roots; neutral; abrupt smooth boundary.

B1—7 to 14 inches; brown (7.5YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; neutral; clear wavy boundary.

B2t—14 to 28 inches; reddish brown (5YR 4/4) sandy loam; moderate medium subangular blocky structure; very friable; clay bridging between sand grains; slightly acid; abrupt wavy boundary.

IIC—28 to 60 inches; brown (7.5YR 4/4) coarse sand; single grained; loose; slightly acid.

The solum is 20 to 30 inches thick. It ranges from medium acid to neutral, and the substratum ranges from slightly acid to neutral.

The A horizon is dark grayish brown, very dark grayish brown, or dark brown. The B horizon is dominantly sandy loam or light sandy clay loam but includes thin horizons of loamy sand. The C horizon is typically medium and coarse sand but ranges to fine gravel and coarse sand. In some places there is a ¼- to 1-inch band of loamy sand in the C horizon.

In most areas these soils lack free carbonates in the IIC horizon, and they contain less coarse material than is common for the series. These differences do not alter the usefulness and behavior of these soils.

Boyer soils are near Rousseau and Shawano soils. The Bt horizon of Boyer soils has a higher percentage of clay than similar horizons of Rousseau and Shawano soils.

BrB—Boyer loamy sand, 2 to 6 percent slopes. This gently sloping soil is on sandy outwash plains. Most areas are irregular in shape and range from 2 to 80 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are some small areas of sloping Boyer soils. Also included are some areas of Manistee and Rousseau soils.

This soil has low natural fertility and low organic-matter content. Root penetration is limited by the depth to sand. Runoff is slow. This soil is moderately droughty and is subject to soil blowing. Management should include supplemental irrigation for high crop yields. Using shelterbelts, plowing under organic matter, and proper fertilization are also beneficial practices.

This soil is used mostly for crops, but some areas are in permanent pasture or woodland. It is moderately well suited to crops and is suited to hay crops and pasture. It is well suited to plantings of trees such as red pines. Capability unit IIIs–4; woodland group 2s.

BrC2—Boyer loamy sand, 6 to 12 percent slopes, eroded. This sloping soil is on sandy outwash plains and ridges. Most areas are irregular in shape and range from 2 to 40 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are small areas of soils that are sandy throughout the surface layer and subsoil. Also included, at the base of slopes, are some very small areas of soils that have a clayey substratum.

This soil has low natural fertility and low organic-matter content. Effective root penetration is limited by the depth to sand. Runoff is slow. This soil is moderately droughty and is subject to soil blowing. Erosion is a moderate hazard. Practices such as minimum tillage, using shelterbelts, plowing under organic matter, and proper fertilization help control erosion.

Most areas of this soil are used for small grain and hay, but some are in permanent pasture or woodland. This soil is suited to most crops commonly grown in the county. Capability unit IIIe–7; woodland group 2s.

BrD2—Boyer loamy sand, 12 to 20 percent slopes, eroded. This moderately steep soil is on hillsides on outwash ridges. Most areas are long and narrow and range from 3 to 30 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are small areas of Casco and Shawano soils. Also included are some severely eroded areas of Boyer soils.

This soil has low natural fertility and low organic-matter content. The effective root zone is limited by the depth to sand. Runoff is medium. This soil is moderately droughty and subject to blowing. Erosion is a severe hazard. Maintaining a good cover crop is necessary to control erosion.

Most areas of this soil are in permanent pasture or woodland, but some are used for crops. This soil is suited to hay and pasture but is poorly suited to row crops. Capability unit IVe–7; woodland group 2s.

Briggsville Series

The Briggsville series consists of moderately well drained and well drained, nearly level and gently sloping soils on lacustrine plains. These soils formed under a mixed hardwood forest of maple, oak, hickory, and basswood.

In a representative profile the surface layer is very dark grayish brown silt loam about 5 inches thick. The subsurface layer is brown silt loam about 6 inches thick. The subsoil is about 16 inches thick. It is brown silty clay loam in the upper part and brown silty clay in the lower part. The substratum is brown silty clay loam to a depth of about 60 inches.

Briggsville soils have high available water capacity and moderately slow permeability.

Most areas of these soils are cultivated and used for all crops commonly grown in the county.

Representative profile of Briggsville silt loam, 2 to 6 percent slopes, in wooded area 1,240 feet north and 400 feet east of the southwestern corner of sec. 33, T. 21 N., R. 17 E.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam; moderate coarse granular structure; friable; many roots; medium acid; clear smooth boundary.

A2—5 to 11 inches; brown (10YR 5/3) silt loam; moderate very thick platy structure; friable; many roots; medium acid; clear smooth boundary.

B1t—11 to 15 inches; brown (7.5YR 5/4) silty clay loam; moderate medium subangular

blocky structure; firm; thin patchy clay films; medium acid; many roots; clear smooth boundary.

B2t—15 to 21 inches; brown (7.5YR 4/4) silty clay; moderate medium subangular blocky structure; firm; medium continuous clay films; medium acid; few roots; clear smooth boundary.

B3t—21 to 27 inches; brown (7.5YR 4/4) silty clay; weak medium subangular blocky structure; firm; thin patchy clay films; slightly acid; few roots; gradual smooth boundary.

C—27 to 60 inches; brown (7.5YR 4/4) silty clay loam; massive; firm; evidence of platiness due to original deposition; slight effervescence; mildly alkaline.

The solum is generally 24 to 32 inches thick, but ranges from 24 to 40 inches. The A horizon is strongly acid or medium acid. The B horizon is slightly acid to moderately alkaline. The C horizon is mildly alkaline or moderately alkaline.

The Ap or A1 horizon is black, very dark grayish brown, or very dark brown and ranges from 4 to 9 inches in thickness. In some places, the C horizon is stratified with silt loam. It has slight or strong effervescence in solution with hydrochloric acid.

Briggsville soils are near Hebron and Mosel soils. They contain more clay than Hebron and Mosel soils and are better drained than Mosel soils.

BtA—Briggsville silt loam, 0 to 2 percent slopes. This nearly level soil is on lacustrine plains. Areas are irregular in shape and range from 5 to 240 acres in size. This soil has a thicker surface layer than the soil described as representative of the series.

Included with this soil in mapping are a few areas of gently sloping Briggsville soils and small areas of Manawa soils.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is slow. This soil is relatively easy to maintain in good tilth.

Most of this soil is used for crops. It is well suited to all crops commonly grown in the county. Capability unit IIs–7; woodland group 2c.

BtB—Briggsville silt loam, 2 to 6 percent slopes. This gently sloping soil is on lacustrine plains. Most areas are irregular in shape and range from 5 to 320 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are some small areas of nearly level Briggsville soils. Also included are areas where the subsoil contains more than 35 percent clay.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is medium. Erosion is a slight hazard where this soil is cultivated. Stripcropping and minimum tillage help prevent runoff and erosion.

Most of this soil is used for crops, but some areas remain in woodland. It is well suited to all crops commonly grown in the county. Capability unit IIe–6; woodland group 2c.

Carbondale Series

The Carbondale series consists of very poorly drained, nearly level, organic soils in large basins or glacial depressions. These soils formed under a mixed forest of white-cedar, tamarack, and soft maple in highly decomposed herbaceous organic deposits.

In a representative profile the organic layer is more than 60 inches thick. It is black and very dark brown muck in about the upper 34 inches, very dark brown peaty muck in the middle 22 inches, and very dark brown muck with bands of dark gray marl in the lower part.

Carbondale soils have very high available water capacity. Permeability is moderately slow in the upper part and moderate to moderately rapid in the lower part.

Most of these soils are undrained and remain in woodland. Drained areas are used mainly to grow specialty crops.

Representative profile of Carbondale muck, in a woodlot 100 feet north and 1,520 feet east of the southwestern corner of sec. 10, T. 24 N., R. 17 E.

Oa1—0 to 10 inches; black (10YR 2/1) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; moderate fine granular structure; nonsticky; predominantly herbaceous fibers; neutral; clear smooth boundary.

Oa2—10 to 34 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; moderate fine granular structure; nonsticky; predominantly herbaceous fibers; neutral; abrupt smooth boundary.

Oe—34 to 56 inches; very dark brown (10YR 2/2) broken face and rubbed hemic material; about 30 percent fiber, about 20 percent rubbed; weak fine granular structure; nonsticky; predominantly herbaceous fibers; slightly acid; clear smooth boundary.

Oa3—56 to 60 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; massive; bands of dark gray (5Y 4/1) marl up to 2 inches thick throughout; nonsticky; predominantly herbaceous fibers; neutral.

The organic deposits are more than 51 inches thick. Reaction is medium acid to mildly alkaline throughout. An organic layer more than 10 inches thick that is 25 to 75 percent fibers unrubbed and less than 40 percent fibers rubbed, is at a depth below 16 inches. Woody fibers comprise less than 15 percent of the recognizable fibers.

Carbondale soils are near Cathro, Lobo, Markey, Rondeau, and Suamico soils. They have deeper organic deposits than Cathro soils, which are underlain by loamy material; than Markey soils, which are underlain by sandy material; than Rondeau soils, which are underlain by marl material; and than Suamico soils, which are underlain by clayey material. Carbondale

soils are less acid and have a lower fiber content than Lobo soils.

Ca—Carbondale muck. This is a nearly level soil in wet positions along lakes or stream valleys and pockets on till plains. Areas are irregular in shape and range from 3 to 1,280 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas of shallower organic soils. Also included are some areas that have a higher fiber content than is typical of the series, and some gently sloping Carbondale soils.

This soil has low natural fertility and very high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow to ponded. Ponding of water occurs frequently because the water table is at or near the surface. Drained areas are subject to soil blowing and burn easily. There is a hazard of frost damage to crops that are grown on this soil. Open-ditch drainage or tile drainage can be used to remove excess water.

Most of this soil is in swampland or woodland. Some areas have been cleared and drained and are used for sod production. Where drained, this soil is suited only to crops that have a short growing season. Capability unit IVw–9; woodland group 3w.

Casco Series

The Casco series consists of gently sloping to moderately steep, well drained and somewhat excessively drained soils on outwash plains and morainic ridges. These soils formed under mixed hardwoods dominated by oak.

In a representative profile the surface layer is black loam about 3 inches thick. The subsoil is about 16 inches thick. It is dark yellowish brown loam in the upper part, reddish brown clay loam in the middle part, and reddish brown light sandy loam in the lower part. The substratum is yellowish brown sand and gravel to a depth of about 60 inches.

Casco soils have low available water capacity. Permeability is moderate in the loamy part and very rapid in the sand and gravel.

Most gently sloping and sloping areas of these soils are used for all the cultivated crops commonly grown in the county or for pasture. Most moderately steep areas are in woodland.

Representative profile of Casco loam, 2 to 6 percent slopes, in an uncultivated area, 200 feet east and 1,220 feet north of the southwestern corner of sec. 22, T. 24 N., R. 18 E.

A1—0 to 3 inches; black (10YR 2/1) loam; moderate very fine granular structure; very friable; many roots; neutral; abrupt smooth boundary.

B1—3 to 7 inches; dark yellowish brown (10YR 4/4) loam; moderate fine subangular blocky structure; very friable; many roots; many coarse black (10YR 2/1) worm casts; neutral; clear smooth boundary.

B2t—7 to 15 inches; reddish brown (5YR 4/4) clay loam; moderate fine subangular blocky structure; friable; many roots; thin continuous clay films on faces of peds; neutral; clear wavy boundary.

IIB3t—15 to 19 inches; reddish brown (5YR 4/4) light sandy loam; weak medium subangular blocky structure; very friable; many roots; clay bridging; about 25 percent coarse sand and gravel; mildly alkaline; clear wavy boundary.

IIC—19 to 60 inches; yellowish brown (10YR 5/4) sand and gravel; single grained; loose; violent effervescence; moderately alkaline.

The solum is 10 to 20 inches thick. Some profiles have 15 to 25 percent gravel in the solum. The A horizon is medium acid to neutral, the B horizon is medium acid to mildly alkaline, and the C horizon is mildly alkaline or moderately alkaline.

The A horizon is black or very dark grayish brown and typically is 3 to 5 inches thick. The B horizon is loam, sandy clay loam, or clay loam. A thin layer of light sandy loam or loamy sand is typically above the C horizon.

Casco soils are near the Symco variant and Will soils. Casco soils are better drained and have a thinner solum than those soils.

CcB—Casco loam, 2 to 6 percent slopes. This gently sloping soil is on outwash plains. Most areas are irregular in shape and range from 2 to 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of sloping Casco soils. Also included are a few small areas that have a 20 to 30 inch loamy mantle over sand and gravel and small areas of Boyer soils.

This soil has low natural fertility and low organic-matter content. The effective rooting depth of many crops is limited by the underlying sand and gravel. Runoff is slow. Erosion is a slight hazard where the soil is cultivated, and drought is a moderate hazard. Stripcropping and minimum tillage help preserve moisture and prevent runoff and erosion.

Most areas of this soil are used for crops or pasture. This soil is best suited to shallow-rooted crops. Capability unit IIIe–3; woodland group 3s.

CcC2—Casco loam, 6 to 12 percent slopes, eroded. This sloping soil is on convex morainic ridges and knolls. Most areas are irregular in shape and range from 5 to 60 acres in size. The combined surface layer and subsoil is thinner than in the profile described as representative of the series.

Included with this soil in mapping are small areas of gently sloping Casco soils and areas that are severely eroded. Also included are some small areas of Boyer soils.

This soil has low natural fertility and low organic-matter content. The effective rooting depth of many crops is limited by the underlying sand and gravel. Runoff is medium. Drought and erosion are moderate hazards. Contour stripcropping, grassed waterways, and minimum tillage are important erosion-control practices where this soil is cultivated.

Most areas of this soil are in pasture or woodland, and some are used for crops. This soil is moderately suited to shallow-rooted crops commonly grown in the county. Capability unit IVe–3; woodland group 3s.

CcD2—Casco loam, 12 to 20 percent slopes, eroded. This moderately steep soil is on morainic ridges. Most areas are long and narrow and range from 3 to 40 acres in size. This soil has a thinner solum than the soil described as representative of the series.

Included with this soil in mapping are small areas of sloping Casco soils and a few areas that are severely eroded.

This soil has low natural fertility and low organic-matter content. The effective rooting depth of many crops is limited by the underlying sand and gravel. Runoff is rapid. Erosion is a severe hazard, and drought is a moderate hazard.

Most areas of this soil remain in woodland or permanent pasture. The substratum is a good source of sand and gravel. Capability unit VIe–3; woodland group 3s.

Cathro Series

The Cathro series consists of nearly level, very poorly drained organic soils in glacial lake basins and depressions on lacustrine plains. These soils formed under mixed vegetation of white-cedar, aspen, and soft maple in highly decomposed organic deposits underlain by mildly alkaline loamy material.

In a representative profile the organic layer is very dark brown and black muck about 33 inches thick. The substratum is dark grayish brown silt loam to a depth of about 60 inches.

Cathro soils have very high available water capacity. Permeability is moderately slow to moderately rapid in the muck and moderate to moderately slow in the silt loam.

Most areas of these soils are undrained and remain in woodland. Drained areas are used mainly for specialty crops.

Representative profile of Cathro muck, in marsh 150 feet north and 150 feet east of the southwestern corner of sec. 29, T. 24 N., R. 16 E.

Oa1—0 to 4 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; moderate medium granular structure; nonsticky; primarily herbaceous fibers; many roots; slightly acid; abrupt smooth boundary.

Oa2—4 to 16 inches; black (10YR 2/1) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; moderate medium granular structure; nonsticky; primarily herbaceous fibers; few roots; slightly acid; clear smooth boundary.

Oa3—16 to 33 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; moderate fine subangular blocky structure; primarily herbaceous fibers; few roots; slightly acid; abrupt smooth boundary.

IIC—33 to 60 inches; dark grayish brown (2.5YR 4/2) silt loam; massive; slightly sticky; slight effervescence; mildly alkaline.

The organic material ranges from 16 to 50 inches in thickness, but is dominantly 20 to 40 inches thick. It is generally composed of sapric material; but some thin bands, 1 to 4 inches thick, of hemic material occur throughout the profile in places. Thin layers of sedimentary peat are in some pedons. The organic material is medium acid to mildly alkaline. The IIC horizon is neutral to moderately alkaline. It is sandy loam, loam, or silt loam, but includes thin layers of fine sand and silty clay loam.

Cathro soils are near Carbondale, Lobo, Markey, Rondeau, and Suamico soils. They lack the thick organic deposits that Carbondale and Lobo soils have. Cathro soils are underlain by loamy material, Markey soils are underlain by sand, Rondeau soils are underlain by marl, and Suamico soils are underlain by clay.

Cm—Cathro muck. This is a nearly level soil in shallow glacial lake basins and depressions. Areas are irregular in shape and range from 5 to 640 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are areas of Carbondale, Keowns, and Pella soils. Also included are some small areas where marl overlies the loamy material.

This soil has low natural fertility and very high organic-matter content. The effective rooting depth is limited by the high water table or, in drained areas, by the loamy substratum. Runoff is very slow to ponded. Wetness is a severe hazard. Open-ditch drainage can be used to remove excess water. This soil subsides if it is drained and it becomes very susceptible to soil blowing and burning where water levels are not properly maintained. There is a hazard of frost damage to crops grown on this soil.

Most areas are undrained and are used for pasture or woodland. Drained areas are used for growing truck crops or sod for lawns. This soil is best suited to crops that have a short growing season. It is well suited to wildlife habitat. Capability unit IVw–8; woodland group 3w.

Channahon Series

The Channahon series consists of gently sloping, well drained soils on glacial till plains. These soils are shallow over limestone bedrock. They formed under vegetation of prairie grasses and scattered bur oak.

In a representative profile the surface layer is very dark brown silt loam about 8 inches thick. The subsoil is about 10 inches thick. It is brown silt loam in the upper part and brown light clay loam in the lower part. Limestone bedrock is at a depth of 18 inches.

Channahon soils have low available water capacity and moderate permeability.

Most areas of these soils are used for crops commonly grown in the county.

Representative profile of Channahon silt loam, 2 to 6 percent slopes, in a once cultivated field, now idle, 1,585 feet west and 1,120 feet north of the southeastern corner of sec. 28, T. 22 N., R. 17 E.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam; moderate medium granular structure; very friable; many roots; 3 percent stone content; neutral; abrupt smooth boundary.

B1—8 to 11 inches; brown (7.5YR 4/4) silt loam; moderate medium subangular blocky

structure; friable; few roots; many medium very dark grayish brown (10YR 3/2) worm casts; 5 percent stone content; neutral; clear wavy boundary.

B21t—11 to 16 inches; brown (7.5YR 4/4) light clay loam; moderate medium subangular blocky structure; friable; few roots; few medium very dark grayish brown (10YR 3/2) worm casts; 5 percent stone content; thin continuous clay films on faces of peds; neutral; clear wavy boundary.

B22t—16 to 18 inches; brown (7.5YR 4/4) light clay loam; weak medium subangular blocky structure; friable; few roots; common medium very dark grayish brown (10YR 3/2) worm casts; 5 percent stone content; thin patchy clay films; slight effervescence; mildly alkaline; abrupt smooth boundary.

R—18 to 60 inches; light gray (10YR 7/2) consolidated limestone bedrock.

The thickness of the solum and depth to bedrock range from 10 to 20 inches. The A and B horizons are slightly acid to moderately alkaline. The Ap horizon is 6 to 9 inches thick and is very dark brown or black. The B horizon is heavy loam, silty clay loam, or clay loam.

Channahon soils are near Bonduel and Kolberg soils, and all are underlain by limestone. They are better drained than Bonduel soils and are shallower to limestone than Kolberg soils.

CnB—Channahon silt loam, 2 to 6 percent slopes. This gently sloping soil is on glacial till plains where the underlying limestone is near the surface. Most areas are irregular in shape and range from 3 to 60 acres in size.

Included with this soil in mapping are some Kolberg and Namur soils.

This soil has medium natural fertility and moderately low organic-matter content. The effective rooting depth is limited by the underlying limestone bedrock. Runoff is medium. Erosion and drought are moderate hazards. Minimum tillage and the plowing under of green manure help conserve moisture.

Most areas of this soil are used for pasture or crops and some remain in woodland. This soil is moderately well suited to most crops commonly grown in the county. Capability unit IIIe–3; woodland group 3d.

Deford Series

The Deford series consists of nearly level, poorly drained soils on lacustrine and outwash plains. These soils formed under a vegetation of alder, willow, aspen, and white-cedar.

In a representative profile the surface layer is 5 inches of black muck over 5 inches of very dark brown loamy fine sand. The substratum is grayish brown mottled fine sand to a depth of about 60 inches.

Deford soils have low available water capacity and rapid permeability.

Most areas of these soils are in woodland or marsh. Where drained, these soils are used for crops.

Representative profile of Deford loamy fine sand, in a pasture 250 feet east and 1,550 feet north of the southwestern corner of sec. 7, T. 24 N., R. 17 E.

O1—5 inches to 0; black (10YR 2/1) broken face and rubbed sapric material with many coarse reddish brown (5YR 4/4) fibers; weak fine granular structure; very friable; about 60 percent fine sand; primarily herbaceous fibers; many roots; slightly acid; clear smooth boundary.

A1—0 to 5 inches; very dark brown (10YR 2/2) loamy fine sand; many fine prominent yellowish brown (10YR 5/4) mottles; weak fine granular structure; very friable; few roots; few fine prominent reddish brown (5YR 4/4) fibers; slightly acid; clear smooth boundary.

C1—5 to 14 inches; grayish brown (10YR 5/2) fine sand; many fine prominent yellowish brown (10YR 5/6) mottles; single grained; loose; very dark brown (10YR 2/2) organic stains; few roots; neutral; clear smooth boundary.

C2—14 to 49 inches; grayish brown (10YR 5/2) fine sand; few fine prominent yellowish brown (10YR 5/6) mottles; single grained; loose; mildly alkaline; clear smooth boundary.

C3—49 to 60 inches; grayish brown (10YR 5/1) fine sand; single grained; loose; mildly alkaline.

The A1 horizon is medium acid or slightly acid, and the C horizon is medium acid to moderately alkaline.

The A1 horizon is black, very dark brown, or very dark gray and is 4 to 6 inches thick. It is typically overlain with an organic layer 2 to 6 inches thick, but in some places, this layer is absent. The C horizon is fine sand, very fine sand, or loamy fine sand.

Deford soils are near Rousseau, Shawano, and Wainola soils. They occupy lower positions on the landscape and are wetter than Rousseau, Shawano, or Wainola soils.

De—Deford loamy fine sand. This is a nearly level soil in depressions and drainageways of sandy lacustrine or outwash plains. Areas are irregular in shape and range from 5 to 600 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are some small areas of better drained, sandy soils. Also included are some areas of Markey soils.

This soil has low natural fertility and high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow to ponded. The main management concern is removing excess water.

Most areas of this soil remain in woodland or marsh. Where drained, this soil is used for crops. It is best suited to corn or specialty crops, such as cabbage. It is also used for wildlife habitat. Capability unit IVw–5; woodland group 5w.

Eleva Series

The Eleva series consists of gently sloping to moderately steep, well drained and somewhat excessively drained soils in areas of the county where sandstone is at a moderate depth. The native vegetation included

mixed hardwoods and some conifers and consisted of maple, oak, hickory, birch, and white pine.

In a representative profile the surface layer is black fine sandy loam about 4 inches thick. The subsurface layer is brown fine sandy loam about 4 inches thick. The subsoil is 21 inches thick. It is yellowish brown sandy loam in the upper part, dark yellowish brown and brown sandy loam in the middle part, and yellowish brown loamy sand in the lower part. Yellowish brown and brown weakly cemented sandstone extends to a depth of about 60 inches.

Eleva soils have moderate to moderately rapid permeability and moderate available water capacity.

Most areas of these soils are cultivated and used for all crops commonly grown in the county. Some moderately steep areas remain in woodland.

Representative profile of Eleva fine sandy loam, 6 to 15 percent slopes, eroded, in an uneroded part of the unit 1,150 feet south and 500 feet west of the northeastern corner of sec. 4, T. 22 N., R. 15 E.

A1—0 to 4 inches; black (10YR 2/1) fine sandy loam; moderate fine granular structure; very friable; many roots; many fragments up to ½ inch in size; slightly acid; abrupt smooth boundary.

A2—4 to 8 inches; brown (10YR 5/3) fine sandy loam; weak thin platy structure; very friable; many roots; many fragments up to ½ inch in size; slightly acid; abrupt wavy boundary.

B1—8 to 11 inches; yellowish brown (10YR 5/4) sandy loam; weak fine subangular blocky structure; friable; many roots; many fragments up to ½ inch in size; clay bridging; slightly acid; abrupt wavy boundary.

B21t—11 to 17 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; few roots; many fragments up to ½ inch in size; thin patchy clay films; slightly acid; clear wavy boundary.

B22t—17 to 23 inches; brown (10YR 4/3) sandy loam; weak medium subangular blocky structure; very friable; few roots; many fragments up to ½ inch in size; clay bridging; slightly acid; clear wavy boundary.

B3—23 to 29 inches; yellowish brown (10YR 5/4) loamy sand; single grained; loose; few roots; many fragments up to ½ inch in size; slightly acid; clear wavy boundary.

R—29 to 60 inches; yellowish brown (10YR 5/4) and brown (7.5YR 4/4) weakly consolidated sandstone bedrock.

The solum thickness and depth to sandstone are typically 20 to 30 inches but range from 20 to 40 inches. The A and B horizons are strongly acid to slightly acid.

The A horizon is very dark brown or black and is 3 to 9 inches thick. The B horizon is loam, sandy loam, loamy sand, or sand. Sandstone bedrock is fine and medium sand that is weakly consolidated.

Eleva soils are near areas of Rock outcrop and Kolberg soils. They are underlain by sandstone bedrock, and Kolberg soils are underlain by limestone. Rock outcrop is mostly exposures of limestone bedrock.

ElB—Eleva fine sandy loam, 2 to 6 percent slopes. This gently sloping soil occupies sandstone bedrock-controlled uplands. Most areas are long and narrow and range from 2 to 60 acres in size. This soil has a thicker surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are a few small areas of soils that are sandy throughout.

This soil has low natural fertility and low organic-matter content. The effective rooting depth is limited by the underlying sandstone bedrock. Runoff is slow. This soil is droughty. Erosion is a slight hazard. Minimum tillage, crop rotation, and returning crop residue to the soil are beneficial erosion-control and moisture-saving practices where row crops are grown.

Most areas of this soil are used for crops. This soil is moderately suited to all crops commonly grown in the county. Capability unit IIIs–4; woodland group 3o.

ElC2—Eleva fine sandy loam, 6 to 15 percent slopes, eroded. This sloping and moderately steep soil occupies sandstone bedrock-controlled uplands. Most areas are long and narrow and range from 2 to 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are some areas of soils that are sandy throughout.

This soil has low natural fertility and low organic-matter content. The effective rooting depth is limited by the underlying sandstone bedrock. Runoff is medium. The hazard of erosion is moderate. This soil is droughty. Erosion-control practices such as contour stripcropping, grassed waterways, and minimum tillage are beneficial where row crops are grown.

Most areas of this soil are used for crops, and some are in woodland. This soil is best suited to hay crops and the small grains which are commonly grown in the county. Capability unit IIIe–7; woodland group 3o.

Fluvaquents

Fu—Fluvaquents. These are nearly level, poorly drained and very poorly drained alluvial soils on bottom lands and in drainageways. These soils formed under a mixed vegetation of willow, alder, and sedge grasses. Fluvaquents are typically stratified and have a wide range of texture to a depth of 60 inches. Most areas are long and narrow and range from 10 to about 80 acres in size.

Included with these soils in mapping are small areas of Udifluvents.

These soils are too variable to be rated for permeability, available water capacity, organic-matter content, or natural fertility. Runoff is very slow to ponded. These soils are subject to frequent flooding for long periods, and they have a seasonal high water table.

These soils are not suited to crops and are poorly suited to pasture or grazing. They are used for wildlife habitat and recreational areas. Capability unit Vw–14; woodland group 4w.

Gravel Pits

Gp—Gravel pits. These are miscellaneous areas

where sand and gravel have been removed to a depth of several feet or more for highway construction and other engineering projects. Most of these gravel pits are in or near areas of Casco and Boyer soils. Most areas are round or rectangular and range from less than 1 acre to about 5 acres in size.

Included in mapping are areas of soil overburden scraped from the pit areas. Gravel pits are not rated for soil properties or any selected use.

In some places Gravel pits are used for recreation areas or wildlife habitat. Not placed in a capability unit or woodland group.

Grays Series

The Grays series consists of nearly level and gently sloping, well drained and moderately well drained soils on old glacial lake plains. These soils formed under prairie grasses and scattered bur oaks.

In a representative profile the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is about 16 inches thick. It is brown silty clay loam in the upper part and brown silt loam in the lower part. The substratum is brown stratified silt loam and very fine sand to a depth of about 60 inches.

Grays soils have high available water capacity and moderate permeability.

Most areas of these soils are used for all crops commonly grown in the county.

Representative profile of Grays silt loam, 0 to 2 percent slopes, in cropland 396 feet north and 660 feet west of the southeastern corner of sec. 14, T. 22 N., R. 16 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam; moderate fine subangular blocky structure; very friable; common roots; neutral; abrupt smooth boundary.

B21t—9 to 14 inches; brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; friable; reddish brown (5YR 4/4) continuous clay films on faces of peds; upon drying, thin light brownish gray (10YR 6/2) coatings appear on faces of peds; neutral; abrupt wavy boundary.

B22t—14 to 20 inches; brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; friable; reddish brown (5YR 4/4) patchy clay flows; neutral; abrupt wavy boundary.

B3t—20 to 25 inches; brown (7.5YR 4/4) silt loam; moderate fine and medium subangular blocky structure; friable; neutral; abrupt wavy boundary.

IIC—25 to 60 inches; brown (7.5YR 5/4) silt loam and very fine sand; laminated; friable; slight effervescence; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness, but generally is 20 to 30 inches thick. The A and B horizons are medium acid to neutral.

The Ap horizon is very dark gray, very dark grayish brown, dark brown, very dark brown, or black and is 6 to 9 inches thick. The C horizon is commonly stratified silt loam and very fine sand, but some pedons contain lenses of silt, fine sand, or silty clay loam. High-chroma mottles are in the B and IIC horizons in some places.

Grays soils are near Mundelein and Nichols soils. They are better drained than Mundelein soils and have a finer textured B horizon than Nichols soils.

GrA—Grays silt loam, 0 to 2 percent slopes. This nearly level soil is on lacustrine plains. Most areas are irregular in shape and range from 2 to 200 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of gently sloping Grays soils and areas where the surface layer is very fine sandy loam. Also included are some small areas of Mundelein and Nichols soils.

This soil has high natural fertility and moderately low organic-matter content. The effective root zone is deep. Runoff is slow. There are no major management concerns for crop production.

Most areas of this soil are used for crops, and some remain in woodland. This soil is well suited to all crops commonly grown in the county and to specialty crops. Capability unit I–1; woodland group 1o.

GrB—Grays silt loam, 2 to 6 percent slopes. This gently sloping soil is on glacial lake plains. Most areas are irregular in shape and range from 2 to 500 acres in size. This soil has a thinner surface layer than the soil described as representative of the series.

Included with this soil in mapping are areas where the surface layer is very fine sandy loam. Also included are some areas of Mundelein and Nichols soils.

This soil has high natural fertility and moderately low organic-matter content. The effective root zone is deep. Runoff is medium. Erosion is the main hazard on this soil. Where this soil is farmed intensively, erosion control is needed.

Most areas of this soil are used for crops. This soil is well suited to all crops commonly grown in the county and to specialty crops such as peas, green beans, and soybeans. Capability unit IIe–1; woodland group 1o.

Hebron Series

The Hebron series consists of well drained and moderately well drained, gently sloping soils on lacustrine plains and stream valley benches. These soils formed under mixed hardwood forests dominantly of oak, birch, and basswood.

In a representative profile the surface layer is very dark brown loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 5 inches thick. The subsoil is about 26 inches thick. It is dark yellowish brown and brown loam in the upper part and brown silty clay loam and silty clay in the lower part. The substratum is brown silty clay to a depth of about 60 inches.

Hebron soils have high available water capacity and moderately slow permeability.

Most areas of these soils are cultivated and used for all crops commonly grown in the county.

Representative profile of Hebron loam, 2 to 6 percent slopes, in an uncultivated field 330 feet north and 900 feet east of the southwestern corner of sec. 31, T. 21 N., R. 18 E.

A1—0 to 5 inches; very dark brown (10YR 2/2) loam; moderate medium granular structure; very friable; neutral; clear smooth boundary.

A2—5 to 10 inches; dark grayish brown (10YR

4/2) loam; weak medium platy structure; very friable; slightly acid; clear smooth boundary.

B1—10 to 18 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

B21t—18 to 28 inches; brown (7.5YR 4/4) heavy loam; moderate medium subangular blocky structure; friable; thin clay bridging; slightly acid; abrupt smooth boundary.

IIB22t—28 to 32 inches; brown (7.5YR 4/4) silty clay loam; strong fine subangular blocky structure; firm; thin continuous clay films; slightly acid; clear smooth boundary.

IIB23t—32 to 36 inches; brown (7.5YR 4/4) silty clay; weak medium subangular blocky structure; firm; thin patchy clay films; neutral; clear smooth boundary.

IIC—36 to 60 inches; brown (7.5YR 4/4) silty clay; massive; firm; strong effervescence; mildly alkaline.

The solum thickness and the depth to clayey material are 20 to 40 inches. The A horizon and upper part of the B horizon are medium acid or slightly acid. The IIB23t horizon is neutral to moderately alkaline, and the IIC horizon is mildly alkaline or moderately alkaline.

The A horizon is very dark brown or black loam and is 3 to 9 inches thick. The upper part of the B horizon is clay loam, loam, or heavy loam; and the lower part is silty clay loam or silty clay. The IIC horizon is silty clay loam or silty clay.

Hebron soils are near Briggsville and Mosel soils. They have a loamy outwash surface deposit 20 to 40 inches thick which Briggsville soils lack. Hebron soils are better drained than Mosel soils.

HeB—Hebron loam, 2 to 6 percent slopes. This gently sloping soil is on lacustrine plains and benches along stream valleys. Most areas are irregular in shape and range from 2 to 40 acres in size.

Included with this soil in mapping are areas of Hebron soils that are nearly level. Also included are some areas of Mosel soils.

This soil has medium natural fertility and low organic-matter content. The effective rooting depth is limited by the clayey substratum. Runoff is slow. Erosion is the main management concern. Erosion-control practices such as crop rotation, stripcropping, and minimum tillage help control soil loss.

This soil is commonly used for crops and pasture. It is well suited to all crops commonly grown in the county. Capability unit IIe–6; woodland group 2o.

Hortonville Series

The Hortonville series consists of well drained, gently sloping to steep soils on glacial till plains and ridges. These soils formed under mixed hardwoods of dominantly maple, basswood, elm, oak, yellow birch, and beech.

In a representative profile the surface layer is black silt loam about 5 inches thick. The subsurface layer is brown silt loam about 9 inches thick. The subsoil is dark reddish brown silty clay loam about 13 inches thick. The substratum to a depth of about 60 inches is reddish brown heavy loam.

The available water capacity is high, except in the Hortonville limestone substratum soils, where it is moderate. Permeability is moderate or moderately slow.

Most areas of these soils are used for crops or pasture. Some areas are wooded. The gently sloping soils are well suited to crops commonly grown in the county.

Representative profile of Hortonville silt loam, 2 to 6 percent slopes, in a woodlot 300 feet south and 2,600 feet west of the northeastern corner of sec. 29, T. 23 N., R. 17 E.

A1—0 to 5 inches; black (10YR 2/1) silt loam; moderate fine granular structure; very friable; many roots; neutral; abrupt smooth boundary.

A2—5 to 8 inches; brown (10YR 4/3) silt loam; moderate medium platy structure; very friable; many roots; many coarse black (10YR 2/1) worm casts; slightly acid; abrupt smooth boundary.

A&B—8 to 14 inches; brown (10YR 4/3) silt loam (A2) interfingers around dark reddish brown (5YR 3/4) silty clay loam (B2t); moderate medium subangular blocky structure; friable; few roots; medium acid; clear smooth boundary.

B2t—14 to 22 inches; dark reddish brown (5YR 3/4) silty clay loam; moderate fine subangular blocky structure; firm; medium continuous clay films; medium acid; gradual smooth boundary.

B3t—22 to 27 inches; dark reddish brown (5YR 3/4) silty clay loam; weak fine subangular blocky structure; firm; medium continuous clay films; medium acid; gradual smooth boundary.

C—27 to 60 inches; reddish brown (5YR 4/4) heavy loam; massive; friable; few medium prominent yellow (10YR 7/8) calcium carbonate segregations; strong effervescence; mildly alkaline.

The solum is 24 to 40 inches thick. The A and B horizons range from medium acid to mildly alkaline. The C horizon is mildly alkaline or moderately alkaline.

The A1 or Ap horizon is silt loam or fine sandy loam. It is black, very dark brown, very dark gray or dark grayish brown, and ranges from 2 to 8 inches thick. The Bt horizon is silty clay loam, clay loam or heavy loam. The C horizon is heavy loam, light clay loam, or silty clay loam. In some places, Hortonville soils are underlain by limestone bedrock at a depth of 40 to 60 inches.

Hortonville soils are close to and are better drained than Pella and Symco soils.

HnB—Hortonville fine sandy loam, 2 to 6 percent slopes. This gently sloping soil is on glacial till plains. Most areas are irregular in shape and range from 2 to 600 acres in size. The surface layer has a higher sand content than the one described as representative of the series.

Included with this soil in mapping are some areas where the soil contains more clay than is typical of

Hortonville soils. Also included are some areas that have a loam surface layer and small areas of Menominee soils.

This Hortonville soil has medium natural fertility and low organic-matter content. The effective root zone is deep. Runoff is slow. The hazard of erosion is slight. Practices such as crop rotation and minimum tillage are beneficial to this soil.

Most areas of this soil are in crops and some remain in woodland. This soil is well suited to most crops commonly grown in the county. Capability unit IIe–1; woodland group 1o.

HnC2—Hortonville fine sandy loam, 6 to 12 percent slopes, eroded. This sloping soil is on glacial till plains. Most areas are irregular in shape and range from 2 to 200 acres in size. The surface layer is thinner, lighter colored, and has a higher percentage of sand than the one described as representative of the series.

Included with this soil in mapping are a few areas of Kewaunee and Menominee soils. Also included are soils that contain more clay than the Hortonville soils.

This Hortonville soil has medium natural fertility and low organic-matter content. The effective root zone is deep. Runoff is medium. Erosion is a moderate hazard. Management practices such as contour stripcropping, using grassed waterways, and minimum tillage, reduce soil loss.

Most areas of this soil are used for crops or pasture and some remain in woodland. This soil is suited to most crops commonly grown in the county. Capability unit IIIe–1; woodland group 1o.

HrB—Hortonville silt loam, 2 to 6 percent slopes. This gently sloping soil is on glacial till plains. Most areas are irregular in shape and range from 2 to 1,200 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are some areas of Kewaunee, Kolberg, and Symco soils. Also included are some nearly level and sloping Hortonville soils.

This Hortonville soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is medium. Erosion is a slight hazard. Management is needed to maintain plant cover and to reduce runoff and erosion.

Most areas of this soil are cultivated but some are in woodland. This soil is well suited to all crops grown in the county. Capability unit IIe–1; woodland group 1o.

HrC2—Hortonville silt loam, 6 to 12 percent slopes, eroded. This sloping soil is on glacial till ridges. Most areas are irregular in shape and range from 2 to 300 acres in size. This soil has a thinner and lighter colored surface layer than the soil described as representative of the series.

Included with this soil in mapping are some areas of severely eroded Hortonville soils. Also included are a few areas of Kewaunee soils.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is medium. Erosion is a moderate hazard. Management practices, such as contour stripcropping, minimum tillage, grassed waterways, and proper crop rotation help prevent soil loss.

Most areas of this soil are in crops or woodland. This soil is moderately well suited to crops commonly grown in the county. Capability unit IIIe–1; woodland group 1o.

HrD2—Hortonville silt loam, 12 to 20 percent slopes, eroded. This moderately steep soil is on glacial till ridges. Most areas are irregular in shape and range from 2 to 40 acres in size. This soil has a thinner surface layer and is more subject to erosion than the soil described as representative of the series.

Included with this soil in mapping are some areas of severely eroded Hortonville soils. Also included are soils that contain more clay than Hortonville soils.

This Hortonville soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is rapid. Erosion is a severe hazard in cultivated areas (fig. 6).

This soil is mainly in permanent pasture or woodland. It is suited to pasture or hay crops. Capability unit IVe–2; woodland group 1r.

HrE—Hortonville silt loam, 20 to 30 percent slopes. This steep soil is on hillsides on glacial till plains. Most areas are long and narrow, and range from 2 to 30 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are small areas of severely eroded Hortonville soil. Also included are areas of Hortonville soils that have slopes of more than 30 percent.

This Hortonville soil has low organic-matter content and high natural fertility. The effective root zone is deep. Runoff is very rapid. Erosion is a severe hazard.

This Hortonville soil is mainly in woodland, but some areas are used for pasture. This soil generally is unsuited to cultivated crops. Capability unit VIe–1; woodland group 1r.

HsB—Hortonville silt loam, limestone substratum, 2 to 6 percent slopes. This gently sloping soil is on glacial till plains that have limestone relatively near the surface. Most areas are long and narrow and range from 5 to 200 acres in size. This soil has a profile similar to the one described as representative of the series, but it is underlain by limestone bedrock at a depth of 40 to 60 inches.

Included with this soil in mapping are a few small areas of Hortonville soils not underlain by limestone and a few areas of severely eroded Hortonville soils.

This Hortonville soil has high natural fertility and low organic-matter content. The effective rooting depth is limited by the underlying limestone. Runoff is medium. Erosion is a slight hazard.

Most of this soil is cultivated. It is well suited to crops commonly grown in the county. Capability unit IIe–1; woodland group 1o.

HsC2—Hortonville silt loam, limestone substratum, 6 to 12 percent slopes, eroded. This sloping soil is on glacial till ridges that have limestone relatively near the surface. Most areas are irregular in shape and range from 3 to 40 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil are thinner. It is also underlain by limestone bedrock at a depth of 40 to 60 inches.

Included with this soil in mapping are a few areas of Kolberg and Onaway soils. Also included are a few

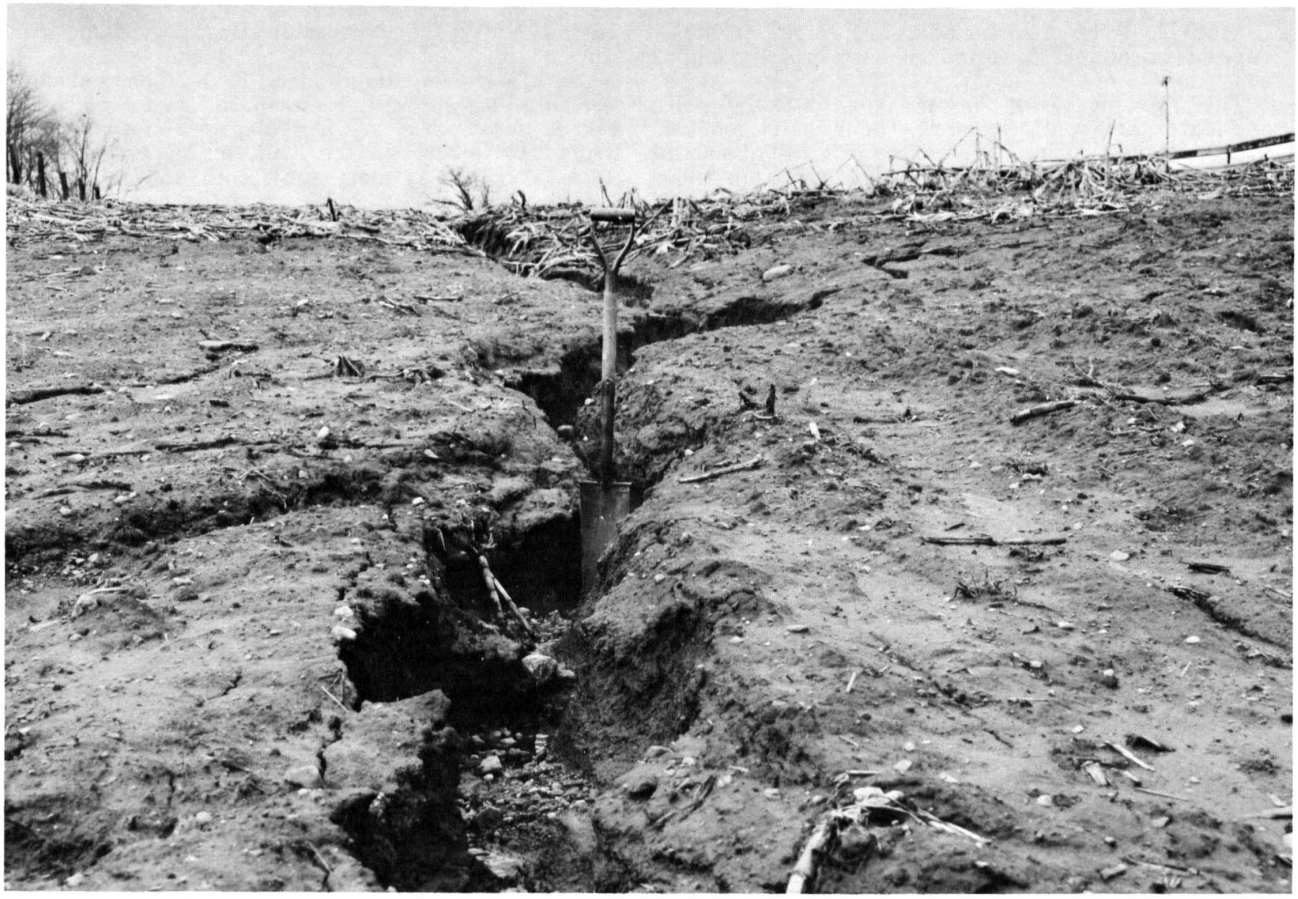

Figure 6.—**Cultivation of this area of Hortonville silt loam, 12 to 20 percent slopes, eroded, has led to severe gully erosion. This soil is better suited to pasture and hay crops.**

areas of Hortonville soils that are severely eroded or that do not have a limestone substratum.

This soil has high natural fertility and low organic-matter content. The effective rooting depth is limited by the underlying limestone. Runoff is medium. Erosion is a moderate hazard. Erosion-control practices such as contour stripcropping, grassed waterways, proper crop rotation, and minimum tillage are beneficial where row crops are grown.

Most of this soil is cultivated. It is suited to all crops commonly grown in the county. Capability unit IIIe–1; woodland group 1o.

HtB—Hortonville-Symco silt loams, 2 to 6 percent slopes. These gently sloping soils are on glacial till plains. Most areas are irregular in shape and range from 5 to about 200 acres in size. This complex is about 60 percent Hortonville silt loam and 20 percent Symco silt loam. Hortonville soils are on convex side slopes on uplands. Symco soils are in wet drainageways and depressions. These soils are so closely intermingled that they cannot be mapped individually at the scale used.

Included with this complex in mapping are some areas of Menominee, loamy substratum, soils and Pella soils. Also included are some areas where the surface layer is sandy loam.

Runoff is very slow to medium. Erosion is the main hazard on Hortonville soils and wetness is the main hazard on Symco soils. Management is needed on Hortonville soils to maintain plant cover and to reduce runoff and erosion. Symco soils need drainage for dependable crop production.

Most of this complex is cultivated. Uncultivated areas are mostly Symco soils in woodland or in pasture. If properly managed, the soils in this complex are well suited to all crops commonly grown in the county. Capability unit IIe–1; woodland group 1o.

Kaukauna Series

The Kaukauna series consists of moderately well drained and well drained, nearly level and gently sloping soils on glacial lake plains. These soils formed under mixed vegetation of maple, oak, ash, and basswood.

In a representative profile the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The subsoil is about 25 inches thick. It is dark reddish

brown mottled clay in the upper part and brown mottled clay in the lower part. The substratum to a depth of about 60 inches is light brown mottled silt that is stratified with layers of very fine sand.

Kaukauna soils have moderate available water capacity. Permeability is slow in the clayey part and moderate to moderately slow in the loamy part.

Most areas of these soils are cultivated and used for all crops commonly grown in the county.

Representative profile of Kaukauna silty clay loam, 0 to 3 percent slopes, in hayland 1,435 feet east and 1,020 feet south of the northwestern corner of sec. 14, T. 21 N., R. 18 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate very fine granular structure; friable; many roots; neutral; abrupt smooth boundary.

B21t—9 to 18 inches; dark reddish brown (5YR 3/4) clay; strong medium angular blocky structure; very firm; thin continuous clay films on all faces of peds; mildly alkaline; clear smooth boundary.

B22t—18 to 27 inches; dark reddish brown (5YR 3/3) clay; few fine prominent yellowish brown (10YR 5/3) mottles; weak coarse subangular blocky structure; very firm; thin continuous clay films on vertical faces of peds; neutral; clear smooth boundary.

IIB3t—27 to 34 inches; brown (7.5YR 4/4) silt loam; many fine prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; friable; thin patchy clay films on vertical faces of peds; mildly alkaline; clear smooth boundary.

IIC—34 to 60 inches; light brown (7.5YR 6/4) silt with thin layers of very fine sand; common fine prominent yellowish brown (10YR 5/8) mottles; weak thin platy structure; very friable; common fine distinct pinkish gray (7.5YR 7/2) calcium carbonate segregations; violent effervescence; moderately alkaline.

The solum is typically 30 to 40 inches thick. The A horizon is medium acid to mildly alkaline, the B horizon is neutral to moderately alkaline, and the IIC horizon is mildly alkaline or moderately alkaline.

The A horizon is black, dark reddish brown, very dark brown, or very dark grayish brown and is 6 to 10 inches thick. The B horizon is clay or silty clay in the upper part and silt loam, loam, or very fine sandy loam in the lower part. The C horizon is silt that is stratified with thin layers of very fine sand or very fine sandy loam.

Kaukauna soils are near Manawa and Winneconne soils. They have thinner clayey layers than Winneconne soils and are better drained than Manawa soils.

KaA—Kaukauna silty clay loam, 0 to 3 percent slopes. This nearly level and gently sloping soil is on glacial lake plains. Most areas are long and narrow and range from 5 to 100 acres in size.

Included with this soil in mapping are areas of Grays and Winneconne soils. Also included are some small areas of wet soils.

Kaukauna soils have high natural fertility and moderately low organic-matter content. The effective root zone is deep. Runoff is slow. Maintaining favorable tilth is difficult, especially if this soil is tilled when wet. However, minimum tillage and plowing under green manure are beneficial.

Most areas of this soil are cultivated. This soil is well suited to all crops commonly grown in the county. Capability unit IIs–7; woodland group 2c.

Keowns Series

The Keowns series consists of nearly level, poorly drained soils in depressions on glacial lake plains. These soils formed under native vegetation of swamp hardwoods and some prairie grasses.

In a representative profile the surface layer is very dark brown silt loam about 8 inches thick. The subsoil is dark gray mottled fine sandy loam about 13 inches thick. The substratum is dark gray mottled silt and fine sand to a depth of about 60 inches.

Keowns soils have high available water capacity and moderate permeability.

Most areas of this soil are in woodland or pasture. Drained areas are used for crops such as corn and cabbage.

Representative profile of Keowns silt loam, in a woodlot 1,900 feet east and 150 feet north of the southwestern corner of sec. 4, T. 24 N., R. 16 E.

A1—0 to 8 inches; very dark brown (10YR 2/2) silt loam; moderate fine granular structure; very friable; many roots; neutral; abrupt smooth boundary.

Bg—8 to 21 inches; dark gray (5Y 4/1) fine sandy loam; common medium prominent yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; friable; many roots; mildly alkaline; gradual smooth boundary.

C1g—21 to 34 inches; dark gray (5Y 4/1) silt and fine sand; common medium prominent yellowish red (5YR 4/6) mottles; weak thin platy structure due to original deposition; massive; mildly alkaline; clear smooth boundary.

C2g—34 to 60 inches; dark gray (5Y 4/1) fine sand; common medium prominent yellowish red (5YR 4/6) mottles; single grained; loose; many coarse prominent very dark brown (10YR 2/2) organic stains; mildly alkaline.

The solum is 15 to 30 inches thick. The A and B horizons are neutral to moderately alkaline, and the C horizon is mildly alkaline or moderately alkaline.

The A1 or Ap horizon is black or very dark brown and is 6 to 10 inches thick. The B horizon is very fine sandy loam, fine sandy loam, sandy loam, or silt loam. The C horizon is typically stratified silt and fine sand, but in places it includes thin layers of silty clay loam.

Keowns soils are near Mundelein and Shiocton soils. They have a lower clay content in the B horizon than Mundelein soils. Keowns soils are wetter than Mundelein and Shiocton soils.

Ke—Keowns silt loam. This is a nearly level soil in depressions on lacustrine plains. Most areas are irreg-

ular in shape and range from 2 to 1,200 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas of Cathro, Mundelein, and Shiocton soils. Also included are small areas of soils that contain more silt and clay in the subsoil than Keowns soils.

This soil has high natural fertility and high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow to ponded. Wetness is the main limitation of this soil. Open-ditch drainage can be used to remove excess water.

Most areas of this soil are in woodland or pasture, but many are cleared and used for crops. This soil is well suited to wetland tree species and is also suited to crops, such as corn and cabbage, if it is drained. Capability unit IIIw–3; woodland group 1w.

Kewaunee Series

The Kewaunee series consists of well drained and moderately well drained, gently sloping to very steep soils on glacial till plains. The natural vegetation was forest of mainly maple, oak, basswood, and elm.

In a representative profile the surface layer is very dark grayish brown silt loam about 4 inches thick. The subsurface layer is brown silt loam about 2 inches thick. The subsoil is 21 inches thick. It is brown silty clay loam in the upper part and reddish brown silty clay in the lower part. The substratum is reddish brown light silty clay to a depth of about 60 inches.

Kewaunee soils have moderate available water capacity and moderately slow and slow permeability.

Most areas of the gently sloping and sloping soils are used for cultivated crops. Moderately steep and steep soils are used mostly for pasture and woodland. Steep soils mostly remain in woodland.

Representative profile of Kewaunee silt loam, 2 to 6 percent slopes, in an uncultivated field 600 feet west and 660 feet north of the southeastern corner of sec. 15, T. 21 N., R. 17 E.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam; moderate fine subangular blocky structure; friable; many roots; neutral; abrupt smooth boundary.

A2—4 to 6 inches; brown (10YR 4/3) silt loam; weak thin platy structure; friable; many roots; slightly acid; abrupt smooth boundary.

B1—6 to 9 inches; brown (7.4YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; many roots; slightly acid; abrupt wavy boundary.

B21t—9 to 18 inches; reddish brown (5YR 4/4) silty clay; strong medium subangular blocky structure; very firm; thick continuous clay films; neutral; clear wavy boundary.

B22t—18 to 22 inches; reddish brown (5YR 4/4) silty clay; strong medium angular blocky structure; very firm; thick continuous clay films; neutral; clear wavy boundary.

B3—22 to 27 inches; reddish brown (5YR 5/4) silty clay; strong coarse prismatic structure; extremely hard; thin patchy clay films; neutral; clear wavy boundary.

C—27 to 60 inches; reddish brown (5YR 4/3) light silty clay; strong medium prismatic structure; extremely hard; many coarse prominent light brownish gray (10YR 6/2) calcium carbonate segregations; few coarse pebbles; violent effervescence; moderately alkaline.

The solum is 20 to 40 inches thick. The A and B horizons are medium acid to mildly alkaline and the C horizon is mildly alkaline or moderately alkaline.

The A1 or Ap horizon is dark brown, dark grayish brown, and very dark grayish brown and is 3 to 8 inches thick. The B horizon is clay, heavy silty clay loam, or silty clay. The C horizon is heavy silty clay loam, silty clay, and light clay.

Kewaunee soils are near Bellevue, Manawa, and Poygan soils. They are on uplands, and Bellevue soils are in drainageways. Kewaunee soils are better drained than Manawa and Poygan soils.

KhB—Kewaunee silt loam, 2 to 6 percent slopes. This gently sloping soil is on glacial till plains. Most areas are irregular in shape and range from 3 to 800 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are some areas of Hortonville and Manawa soils. Also included are some small areas of nearly level and sloping Kewaunee soils.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is medium. Erosion is a slight hazard where this soil is cultivated. Maintaining good tilth is difficult in eroded areas. Minimum tillage, returning crop residue to the soil and crop rotation are practices that reduce soil loss and maintain good tilth.

Most areas of this soil are cultivated, and a few are in woodland. This soil is well suited to all crops commonly grown in the county. Capability unit IIe–6; woodland group 2c.

KhC2—Kewaunee silt loam, 6 to 12 percent slopes, eroded. This sloping soil is on hillsides on glacial till plains. Most areas are irregular in shape and range from 2 to 80 acres in size. This soil has a slightly thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are some gently sloping and moderately steep areas.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is medium. Erosion is a moderate hazard. Stripcropping, grassed waterways, and minimum tillage reduce runoff and help control erosion. This soil has a moderate tilth problem, but green manuring will improve tilth.

Most areas of this soil are used for crops or pasture, and some remain in woodland. This soil is moderately well suited to all crops commonly grown in the county. Capability unit IIIe–6; woodland group 2c.

KhD2—Kewaunee silt loam, 12 to 20 percent slopes, eroded. This moderately steep soil is on glacial till ridges. Most areas are long and narrow and range from 2 to 30 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are some small areas of Kewaunee soils that are severely eroded. Also

included are some areas where the surface layer is sandy loam.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is rapid. Erosion is a severe hazard. Stripcropping and minimum tillage reduce runoff and help control erosion. This soil has a moderate tilth problem, but green manuring will improve tilth.

Most areas of this soil are used for pasture, and some areas are in woodland. This Kewaunee soil is best suited to hay and pasture. Capability unit IVe–2; woodland group 2c.

KkE3—Kewaunee soils, 20 to 45 percent slopes, severely eroded. These steep and very steep soils are on side slopes of till plains along rivers and streams. The surface layer is silty clay loam, clay loam, or clay. Most areas are long and narrow and range from 10 to 200 acres in size. These soils have a thinner surface layer and subsoil than the soil described as representative of the series.

Included with these soils in mapping are small areas of sandy soils. Also included are small areas of soils that are steeper than 45 percent and other areas where slopes are less than 20 percent.

These soils have high natural fertility and low organic-matter content. Runoff is very rapid. Erosion and slippage are vere severe hazards.

Most of these soils are in woodland, but some areas are in pasture. These soils are unsuited to cultivated crops and are poorly suited to pasture. Capability unit VIIe–6; woodland group 2c.

KlB—Kewaunee-Manawa complex, 2 to 6 percent slopes. These gently undulating soils are on glacial till plains. Most areas are irregular in shape and range from 5 to about 200 acres in size. This complex is about 45 percent Kewaunee silt loam and 40 percent Manawa silty clay loam. Kewaunee soils are on convex side slopes on uplands. Manawa soils are in drainageways and depressions. The soils in this complex are in such small areas and are so closely intermingled that they cannot be mapped individually at the scale used.

Included in mapping are areas of Poygan soils in wet depressions.

Runoff is very slow to medium. Erosion is the main hazard on Kewaunee soils, and wetness is the main hazard on Manawa soils. Good tilth is moderately difficult to maintain on both soils. Random tile drainage helps remove excess water. Green manuring, proper crop rotation, and minimum tillage reduce erosion and maintain good tilth.

Most of this complex is cultivated. If properly managed, these soils are well suited to all crops commonly grown in the county. Uncultivated areas are mostly Manawa soils. They are used for pasture or woodland. Capability unit IIw–2; woodland group 2c.

Kolberg Series

The Kolberg series consists of nearly level to sloping, well drained soils on glacial till plains that are underlain by limestone at a moderate depth. These soils formed under mixed vegetation of deciduous and coniferous forests, dominantly maple, beech, white pine, hemlock, and birch.

In a representative profile the surface layer is very dark brown silt loam about 5 inches thick. The subsoil is about 22 inches thick. It is mostly reddish brown silty clay loam in the upper part, reddish brown clay in the middle part, and reddish brown loam in the lower part. Consolidated limestone bedrock is at a depth of about 27 inches.

Kolberg soils have low available water capacity and moderately slow or slow permeability.

Most areas of these soils are cultivated and are used for all crops commonly grown in the county. Some areas are in woodland.

Representative profile of Kolberg silt loam, 1 to 6 percent slopes, in an uncultivated area 1,980 feet west and 600 feet south of the northeastern corner of sec. 36, T. 24 N., R. 18 E.

A1—0 to 5 inches; very dark brown (10YR 2/2) silt loam; moderate fine granular structure; very friable; few roots; mildly alkaline; clear smooth boundary.

B&A—5 to 9 inches; brown (10YR 4/3) silt loam (A2) interfingers around reddish brown (5YR 4/4) silty clay loam (B2t); moderate medium subangular blocky structure; friable; few roots; few medium faint very dark grayish brown (10YR 3/2) worm casts; neutral; clear wavy boundary.

B21t—9 to 14 inches; reddish brown (5YR 4/4) clay; strong coarse subangular blocky structure; firm; medium continuous clay films on all faces of peds; neutral; gradual smooth boundary.

B22t—14 to 22 inches; reddish brown (5YR 4/4) clay; moderate medium subangular blocky structure; firm; medium continuous clay films on all faces of peds; mildly alkaline; gradual smooth boundary.

B3t—22 to 27 inches; reddish brown (5YR 4/4) heavy loam; weak fine and medium subangular blocky structure; friable; many fine and coarse prominent pale brown (10YR 6/3) glacial pebbles, about 15 percent; thin patchy clay films on vertical faces of peds; mildly alkaline; abrupt smooth boundary.

R—27 to 60 inches; light gray (10YR 7/2) consolidated limestone bedrock.

The solum thickness and depth to limestone bedrock range from 20 to 40 inches, but are generally 25 to 35 inches. The A horizon is medium acid to neutral, and the B horizon is neutral or mildly alkaline.

The A horizon is very dark brown or very dark grayish brown and is less than 6 inches thick. The B horizon is light clay, silty clay, silty clay loam, gravelly loam, loam, or heavy clay loam. The bedrock is consolidated limestone with a few large cracks.

Kolberg soils are near Bonduel, Channahon, and Namur soils. They have a thicker solum and are deeper to limestone than Channahon and Namur soils. Kolberg soils are better drained than Bonduel soils.

KoB—Kolberg silt loam, 1 to 6 percent slopes. This gently sloping soil is on glacial till plains which are underlain by limestone at a moderate depth. Most areas are irregular in shape and range from 2 to 100 acres in

size. This soil has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Bonduel and Hortonville soils. Also included are some areas of severely eroded Kolberg soils.

This Kolberg soil has medium natural fertility and low organic-matter content. The effective rooting depth is limited by bedrock. Runoff is medium. Erosion is a slight or moderate hazard on this soil, and drought is a moderate hazard. Erosion-control practices, such as stripcropping, minimum tillage, proper crop rotation, and grassed waterways, reduce runoff and erosion.

Most areas of this soil are used for crops or pasture, and some remain in woodland. This soil is well suited to all crops commonly grown in the county, especially oats and hay. Capability unit IIe–2; woodland group 2c.

KoC2—Kolberg silt loam, 6 to 12 percent slopes, eroded. This sloping soil is on glacial till plains which are underlain by limestone at a moderate depth. Most areas are irregular in shape and range from 3 to 30 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are some areas of Channahon and Hortonville soils. Also included are some areas of severely eroded Kolberg soils.

This soil has medium natural fertility and low organic-matter content. The effective rooting depth is limited by bedrock. Runoff is medium. Erosion and drought are moderate hazards. Management practices such as minimum tillage, contour stripcropping, grassed waterways, and proper crop rotation reduce water loss and soil loss.

Most areas of this soil are used for pasture or woodland, and some are used for crops. This soil is best suited to oats and hay. Capability unit IIIe–2; woodland group 2c.

Limestone Quarries

Ln—Limestone quarries. These are miscellaneous areas where limestone has been removed and crushed for highway construction and other engineering projects. Most limestone quarries are in or near areas of Channahon, Kolberg, or Namur soils or Rock outcrop. Most areas are square or rectangular and range from less than 1 acre to about 5 acres in size.

Included in mapping are areas of soil overburden scraped from the pit areas.

Limestone quarries are not rated for soil properties or for any selected use.

Without reclamation, which would include filling and smoothing, these areas are generally not suited to uses other than quarries. Not placed in a capability unit or woodland group.

Lobo Series

The Lobo series consists of very poorly drained, nearly level, organic soils in old glacial lake basins. The natural vegetation consists of scattered spruce and shrubs such as leatherleaf, bog rosemary, Labrador-tea, and cranberry. Sphagnum moss is the principal ground cover.

In a representative profile the organic layer is 60 inches or more thick. It is light yellowish brown and very dark grayish brown peat about 40 inches thick in the upper part and is very dark brown and black mucky peat in the lower part.

Permeability is rapid in the upper part and moderate to moderately rapid in the lower part. The available water capacity is very high.

All areas of these soils are undrained and in natural vegetation. These soils are best suited to wildlife habitat.

Representative profile of Lobo peat in an uncultivated area 600 feet west and 660 feet north of the southeastern corner of sec. 3, T. 24 N., R. 15 E.

Oi1—0 to 36 inches; light yellowish brown (10YR 6/4) broken face and pressed fibric material; about 100 percent fiber, about 100 percent rubbed; massive; nonsticky; primarily sphagnum moss fibers; the upper 1 inch is live; extremely acid; abrupt wavy boundary.

Oi2—36 to 40 inches; very dark grayish brown (10YR 3/2) broken face and pressed fibric material; about 100 percent fiber, about 85 percent rubbed; massive; nonsticky; primarily sphagnum moss fibers; extremely acid; abrupt wavy boundary.

Oe1—40 to 45 inches; very dark brown (10YR 2/2) broken face and rubbed hemic material; about 60 percent fiber, about 30 percent rubbed; weak medium and thick platy structure; nonsticky; primarily herbaceous fibers; extremely acid; gradual wavy boundary.

Oe2—45 to 49 inches; black (10YR 2/1) broken face and rubbed hemic material; about 60 percent fibers, about 20 percent rubbed; weak medium subangular blocky structure; nonsticky; primarily herbaceous fibers; extremely acid; abrupt wavy boundary.

Oe3—49 to 60 inches; black (10YR 2/1) broken face and rubbed hemic material; about 70 percent fibers, about 35 percent rubbed; massive; nonsticky; primarily herbaceous fibers; extremely acid.

The Oi horizon is extremely acid and the Oe horizon is extremely acid or very strongly acid. Organic deposits are more than 51 inches thick. The content of woody fiber in the control section ranges from 0 to 20 percent. Fiber content of the fibric layer ranges from 75 to 100 percent, from 60 to 100 percent rubbed. Fibric material is primarily derived from sphagnum moss; hemic material is primarily derived from herbaceous material, but some woody materials are present.

Lobo soils are near Carbondale and Cathro soils. They are more acid and have a higher fiber content than Carbondale soils. Lobo soils have thicker organic deposits and have a higher fiber content in the upper part than Cathro soils.

Lo—Lobo peat. This is a nearly level soil in old glacial lake basins. Most areas are rounded to oblong and range from 100 to 1,000 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas where the organic layer is less than 51 inches thick. A

few small areas where the organic soil contains less fibrous material are also included.

This soil has low natural fertility and very high organic-matter content. The effective rooting zone is limited by a high water table. Runoff is very slow but not ponded. The extreme acidity and high fiber content limit the use of this soil. There is a hazard of frost damage to crops that are grown on this soil.

All areas of this soil are undrained and used primarily for wildlife areas. This soil is a good source of sphagnum moss for nurseries and greenhouses. Capability unit VIIw–10; woodland group 4w.

Manawa Series

The Manawa series consists of nearly level and gently sloping, somewhat poorly drained soils in depressions and drainageways on glacial till plains and in lacustrine basins. These soils formed under natural vegetation of mixed hardwoods and conifers, mainly maple, oak, and white pine.

In a representative profile the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The subsurface layer is dark grayish brown silty clay loam about 2 inches thick. The subsoil is reddish brown mottled clay about 19 inches thick. The substratum is yellowish red silty clay to a depth of about 60 inches.

Manawa soils have high available water capacity and slow permeability.

Many areas of these soils are drained and used for all crops commonly grown in the county. Undrained areas are in woodland or wildlife habitat.

Representative profile of Manawa silty clay loam, 1 to 3 percent slopes, in a cultivated field 2,112 feet west and 30 feet north of the southeastern corner of sec. 20, T. 22 N., R. 19 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine subangular blocky structure; firm; few roots; neutral; abrupt smooth boundary.

A2—9 to 11 inches; dark grayish brown (10YR 4/2) silty clay loam; many coarse prominent gray (10YR 5/1) and reddish brown (5YR 4/4) mottles; weak medium platy structure parting to moderate fine subangular blocky; few roots; neutral; abrupt smooth boundary.

B21t—11 to 15 inches; reddish brown (5YR 4/3) silty clay; few coarse distinct grayish brown (10YR 5/2) mottles; strong coarse subangular blocky structure; very firm; few roots; thin continuous clay films on faces of peds; neutral; clear wavy boundary.

B22t—15 to 26 inches; reddish brown (5YR 4/4) clay; common fine distinct light brownish gray (10YR 6/2) and yellowish red (5YR 4/8) mottles; strong coarse prismatic structure; very firm; thin continuous clay films on faces of peds; neutral; clear wavy boundary.

B3—26 to 30 inches; reddish brown (5YR 4/4) light clay; common coarse prominent yellowish red (5YR 4/8) mottles; moderate coarse subangular blocky structure; very firm; slight effervescence; mildly alkaline; clear wavy boundary.

C—30 to 60 inches; yellowish red (5YR 4/6) silty clay; massive; very firm; violent effervescence; moderately alkaline.

The solum is 24 to 36 inches thick. The A horizon is neutral or mildly alkaline, the B horizon is slightly acid to moderately alkaline, and the C horizon is moderately alkaline.

The A horizon is very dark grayish brown, very dark brown, or black and is 7 to 10 inches thick. The Bt and C horizons are heavy silty clay loam, silty clay, or clay.

Manawa soils are near Allendale, Bonduel, Kewaunee, Poygan, and Winneconne soils. They lack the sandy overburden of Allendale soils and the limestone bedrock which underlies Bonduel soils. Manawa soils are better drained than Poygan soils and are wetter than Kewaunee and Winneconne soils.

McA—Manawa silty clay loam, 1 to 3 percent slopes. This nearly level and gently sloping soil is in drainageways and depressions on till plains and in glacial lake basins. Most areas are irregular in shape and range from 2 to 600 acres in size.

Included with this soil in mapping are some small areas of Kewaunee, Poygan, and Winneconne soils. Some small areas of Manawa soils that have slopes up to 5 percent are also included.

This soil has high natural fertility and moderate organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow. Wetness and poor tilth are the main limitations to use of this soil. Tile drainage and surface drainage help improve crop production. Applying manure and plowing under crop residue help maintain good tilth.

Where drained, most areas of this soil are used for crops. Undrained areas are mostly in woodland or are used for wildlife habitat. Where drained, this soil is well suited to most crops commonly grown in the county. Capability unit IIw–2; woodland group 2c.

Manistee Series

The Manistee series consists of well drained and moderately well drained, gently sloping and sloping soils on lacustrine or till plains. These soils formed under forest vegetation of mostly northern hardwoods, typically sugar maple, oak, hickory, and basswood.

In a representative profile the surface layer is very dark grayish brown fine sandy loam about 9 inches thick. The subsurface layer is grayish brown loamy fine sand about 5 inches thick. The subsoil is about 24 inches thick. It is reddish brown sand in the upper part, brown sand in the middle part, and reddish brown clay in the lower part. The substratum to a depth of about 60 inches is reddish brown clay.

Manistee soils have moderate available water capacity. Permeability is rapid in the sandy part and slow in the clayey part.

Most areas of these soils are used for crops, but some remain in woodland.

Representative profile of Manistee fine sandy loam, 2 to 6 percent slopes, 600 feet east of the southwestern corner of sec. 31, T. 23 N., R. 15 E.

Ap—0 to 9 inches; very dark grayish brown (10YR

3/2) fine sandy loam, light brownish gray (10YR 6/2) dry; moderate fine granular structure; very friable; few roots; slightly acid; abrupt smooth boundary.

A2—9 to 14 inches; grayish brown (10YR 5/2) loamy fine sand, light gray (10YR 7/2) dry; weak medium platy structure; very friable; few roots; slightly acid; abrupt smooth boundary.

B21ir—14 to 20 inches; reddish brown (5YR 4/4) sand; weak coarse subangular blocky structure; hard; weakly cemented; medium acid; abrupt smooth boundary.

B22ir—20 to 31 inches; brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; medium acid; abrupt smooth boundary.

IIB23t—31 to 38 inches; reddish brown (5YR 4/4) light clay with medium brown (7.5YR 5/2) coatings on peds in the upper 4 inches (A2); strong medium subangular blocky structure; thin patchy clay films on horizontal faces of peds; medium acid; gradual smooth boundary.

IIC—38 to 60 inches; reddish brown (5YR 5/4) light clay; massive; very firm; slight effervescence; mildly alkaline.

The sandy material is 20 to 40 inches thick. The A horizon is strongly acid to slightly acid, the B horizon is medium acid to neutral, and the C horizon is mildly alkaline or moderately alkaline.

The A horizon is fine sandy loam or loamy fine sand. It is very dark grayish brown, dark grayish brown, or dark gray and is 4 to 10 inches thick. The Bir horizon is loamy sand or sand. The IIC horizon is clay or silty clay.

Manistee soils are near Allendale and Winneconne soils. They are better drained than Allendale soils and are coarser textured in the upper part of the solum than Winneconne soils.

MeB—Manistee loamy fine sand, 2 to 6 percent slopes. This gently sloping soil is on glacial till and lacustrine plains. Most areas are irregular in shape and range from 2 to 160 acres in size. The surface layer has more sand and the soil is droughtier than the one described as representative of the series.

Included with this soil in mapping are some small areas of Manistee fine sandy loam and some areas of Allendale, Kewaunee, and Winneconne soils.

This soil has low natural fertility and low organic-matter content. The effective rooting depth is limited by the clayey substratum. Runoff is slow. Droughtiness and soil blowing are moderate hazards. Shelterbelts and mulch cover reduce blowing and help preserve moisture. Supplemental irrigation is also beneficial on this soil.

Most areas of this soil are used for crops. This soil is suited to the more drought-resistant crops, such as alfalfa. It is best to plant early in spring before the soil has a chance to dry out. Capability unit IIIe–4; woodland group 2s.

MeC2—Manistee loamy fine sand, 6 to 12 percent slopes, eroded. This sloping soil is on hillsides on glacial till and lacustrine plains. Most areas are long and narrow and range from 2 to 60 acres in size. The surface layer of this soil is thinner and has more sand than the one described as representative of the series.

Included with this soil in mapping are a few small areas of Kewaunee soils and some areas of gently sloping Manistee loamy fine sand. Also included are a few small areas of Manistee fine sandy loam.

This soil has low natural fertility and low organic-matter content. Runoff is slow. The effective rooting depth is limited by the clayey substratum. Droughtiness, water erosion, and soil blowing are moderate hazards. The use of contour stripcropping, shelterbelts, and proper crop rotation reduces runoff and erosion. The use of shelterbelts and mulch cover reduces soil blowing.

Most areas of this soil are used for hay or are in woodland. This soil is suited to hay crops and pasture. Capability unit IVe–4; woodland group 2s.

MfB—Manistee fine sandy loam, 2 to 6 percent slopes. This gently sloping soil is on glacial till and lacustrine plains. Areas are irregular in shape and range from 2 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of wet soils and some small areas of Kewaunee and Winneconne soils. Also included are some areas of nearly level Manistee loamy fine sand.

This soil has low natural fertility and low organic-matter content. The effective rooting depth is limited by the clayey substratum. Runoff is slow. Erosion is a slight hazard on this soil, and droughtiness is a moderate hazard. Applications of organic matter and a mulch cover are beneficial in conserving moisture and reducing runoff and erosion.

Most areas of this soil are used for crops. This soil is suited to most crops commonly grown in the county. Capability unit IIIe–4; woodland group 2s.

Markey Series

The Markey series consists of nearly level, very poorly drained, organic soils in depressions on outwash plains. These soils formed under a mixed vegetation of alder, aspen, white-cedar, tamarack, and elm.

In a representative profile the organic layer is very dark brown muck about 25 inches thick. The underlying material is grayish brown mottled sand to a depth of about 60 inches.

Markey soils have moderate available water capacity. Permeability is moderately slow to moderately rapid.

Most areas of these soils are undrained and used for woodland or wildlife habitat.

Representative profile of Markey muck, in an uncultivated area 660 feet north and 990 feet east of the southwestern corner of sec. 32, T. 24 N., R. 16 E.

Oa1—0 to 12 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; about 9 percent fiber, less than 5 percent rubbed; moderate fine granular structure; very friable; many roots; medium acid; clear smooth boundary.

Oa2—12 to 25 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material and about 10 percent sand; less than 5 percent fibers, unrubbed and rubbed; moderate fine granular structure; very

friable; medium acid; abrupt smooth boundary.

IIC—25 to 60 inches; grayish brown (2.5Y 5/2) sand; common medium prominent brownish yellow (10YR 6/6) mottles; single grained; loose; neutral.

The organic layer is commonly 20 to 30 inches thick, but ranges to 51 inches thick. It is medium acid to mildly alkaline. The IIC horizon is slightly acid to moderately alkaline.

The organic layer is very dark brown or black muck. The fiber content is less than 10 percent in all organic layers after rubbing. The IIC horizon is typically fine or medium sand and is less commonly loamy sand.

Markey soils are near Carbondale, Cathro, Rondeau, and Suamico soils. They have shallower organic deposits than Carbondale soils. Markey soils are underlain by sand, Cathro soils are underlain by loamy material, Suamico soils are underlain by clay, and Rondeau soils are underlain by marl.

Mk—Markey muck. This is a nearly level soil in depressions on outwash plains and stream bottoms. Most areas are irregular in shape and range from 10 to 300 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are a few small areas of Carbondale and Deford soils. Also included are some small areas of Markey soils that have slopes up to 4 percent.

The soil has low natural fertility and very high organic-matter content. The effective rooting depth is limited by the water table and, in drained areas, by depth to sand. Runoff is slow or ponded. Wetness is the major limitation to use of this soil. Where drained and cultivated, this soil is subject to subsidence, burning, and soil blowing. There is also a hazard of frost damage to crops that are grown on this soil.

Most areas of this soil are in woodland or wildlife habitat. This soil is suited to wetland trees and to wildlife areas. Capability unit IVw–7; woodland group 3w.

Menominee Series

The Menominee series consists of well drained, gently sloping and sloping soils on glacial till plains. The natural vegetation consists of northern hardwoods and conifers.

In a representative profile the surface layer is black loamy fine sand about 4 inches thick. The subsurface layer is brown fine sand about 2 inches thick. The subsoil is about 38 inches thick. It is dark brown, yellowish brown, and light brown fine sand in the upper part and reddish brown clay loam in the lower part. The substratum is reddish brown sandy loam to a depth of about 60 inches.

Menominee soils have moderate available water capacity. Permeability is rapid in the sandy part and moderate in the loamy part.

Many areas of these soils are cultivated and used for the more drought-resistant crops commonly grown in the county. The remaining areas are in woodland.

Representative profile of Menominee loamy fine sand, loamy substratum, 2 to 6 percent slopes, in a woodlot 1,420 feet north and 1,000 feet west of the southeastern corner of sec. 11, T. 24 N., R. 18 E.

A1—0 to 4 inches; black (N 5/0) loamy fine sand; weak very fine granular structure; very friable; common roots; pinkish gray (5YR 7/2) clear quartz grains cover about 30 percent of surface; strongly acid; abrupt wavy boundary.

A2—4 to 6 inches; brown (7.5YR 5/2) fine sand; weak very thin platy structure; common roots; loose; medium acid; abrupt irregular boundary.

B21ir—6 to 11 inches; dark brown (7.5YR 4/4) fine sand; weak medium subangular blocky structure; weakly cemented; common roots; medium acid; clear wavy boundary.

B22ir—11 to 16 inches; dark brown (7.5YR 4/4) fine sand; strong coarse subangular blocky structure; weakly cemented; common roots; medium acid; clear wavy boundary.

B23ir—16 to 21 inches; yellowish brown (10YR 5/4) fine sand; weak fine subangular blocky structure; loose; slightly acid; abrupt wavy boundary.

A'2—21 to 27 inches; light brown (7.5YR 6/4) fine sand; weak thin platy structure; loose; medium acid; clear wavy boundary.

IIB&A—27 to 36 inches; reddish brown (5YR 4/4) light clay loam, light brown (7.5YR 6/4) fine sand coatings on faces of peds (A'2); moderate medium subangular blocky structure; friable; medium acid; abrupt wavy boundary.

IIB'2t—36 to 44 inches; reddish brown (5YR 4/4) light clay loam; moderate medium subangular blocky structure; firm; slightly acid; clear wavy boundary.

IIC—44 to 60 inches; reddish brown (5YR 4/4) sandy loam; massive; firm; slight effervescence; mildly alkaline.

The sandy overburden is 18 to 40 inches thick. The A and B horizons are strongly acid to slightly acid in the upper sandy part and medium acid to moderately alkaline in the lower loamy part. The IIC horizon is medium acid to moderately alkaline.

The A horizon is black, very dark gray, brown, or reddish brown and is 1 to 7 inches thick. The Bir horizon is fine sand or very fine sand. The Bt horizon is heavy loam, sandy clay loam, or light clay loam. The C horizon is loam or sandy loam.

Menominee soils are near Onaway and Solona soils. They have a higher percentage of sand than the Onaway and Solona soils. Menominee soils are better drained than Solona soils.

MsB—Menominee loamy fine sand, loamy substratum, 2 to 6 percent slopes. This gently sloping soil is on glacial till plains. Most areas are irregular in shape and range from 2 to 400 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are some small areas of nearly level and sloping Menominee, loamy substratum soils, and some areas that are severely eroded. Areas of Hortonville and Onaway soils are also included.

This soil has low natural fertility and low organic-

matter content. The effective rooting zone is deep. Runoff is slow. Drought is a moderate hazard, and water erosion is a slight hazard. Applying organic matter to this soil helps conserve moisture and reduce runoff and erosion. This soil is also subject to soil blowing, which can be reduced by the use of shelterbelts and plant residue.

This soil is used for crops and woodland. It is well suited to woodland and is suited to the more drought-resistant crops commonly grown in the county. Capability unit IIIe–4; woodland group 1s.

MsC2—Menominee loamy fine sand, loamy substratum, 6 to 12 percent slopes, eroded. This sloping soil is on glacial till plains. Most areas are irregular in shape and range from 2 to 200 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are some areas of Menominee soil that is severely eroded or has slopes of less than 6 percent. A few areas of Hortonville fine sandy loam are also included.

This soil has low natural fertility and low organic-matter content. The effective rooting zone is deep. Runoff is slow. Erosion and drought are moderate hazards, and this soil is subject to blowing. Good management practices to control erosion are using shelterbelts and plowing under organic matter.

Most of this soil is in pasture, native grassland, or woodland. This soil is well suited to woodland. Capability unit IVe–4; woodland group 1s.

Mosel Series

The Mosel series consists of nearly level and gently sloping, somewhat poorly drained soils on lacustrine plains and terraces on outwash plains. These soils formed under a mixed vegetation of woodland and prairie grass.

In a representative profile the surface layer is very dark gray silt loam about 9 inches thick. The subsoil is about 18 inches thick. It is brown sandy loam in the upper part, brown sandy clay loam in the middle part, and reddish brown silty clay loam in the lower part. The substratum is reddish brown silty clay loam to a depth of about 60 inches.

Mosel soils have high available water capacity. Permeability is moderate in the upper part and moderately slow in the lower part.

Most areas of these soils are drained and used for all crops commonly grown in the county.

Representative profile of Mosel silt loam, 0 to 3 percent slopes, in a cultivated field 1,400 feet south and 75 feet east of the northwestern corner of sec. 20, T. 21 N., R. 17 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam; moderate medium granular structure; friable; many roots; neutral; abrupt smooth boundary.

B1—9 to 13 inches; brown (10YR 5/3) light sandy loam; few medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

B21t—13 to 21 inches; brown (7.5YR 4/4) sandy clay loam; few fine prominent light brownish gray (10YR 6/2) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; neutral; clear wavy boundary.

IIB22t—21 to 27 inches; reddish brown (5YR 4/4) heavy silty clay loam; few fine prominent light brownish gray (10YR 6/2) mottles; moderate medium and coarse subangular blocky structure; firm; about 10 percent small stones; mildly alkaline; clear smooth boundary.

IIC—27 to 60 inches; reddish brown (5YR 4/4) heavy silty clay loam; few fine prominent light brownish gray (10YR 6/2) mottles; massive; strong effervescence; mildly alkaline.

The solum is 24 to 40 inches thick. The A and B horizons are medium acid to mildly alkaline. The IIB and IIC horizons are mildly alkaline or moderately alkaline.

The A1 horizon is very dark gray, very dark grayish brown, dark brown, very dark brown, or black and is 6 to 10 inches thick. The B horizon is sandy loam, loam, or sandy clay loam. The IIB horizon is heavy silty clay loam, silty clay, or clay. The IIC horizon is mostly silty clay loam but is silty clay in some pedons. It is also stratified with loamy or sandy material in some pedons.

Mosel soils are near and are wetter than Briggsville and Hebron soils.

MtA—Mosel silt loam, 0 to 3 percent slopes. This nearly level and gently sloping soil is in depressions on lacustrine plains and on terraces on outwash plains. Most areas are irregular in shape and range from 3 to 40 acres in size.

Included with this soil in mapping are some small areas of Hebron and Manawa soils and some Mosel soils with more than 3 percent slopes.

This soil has high natural fertility and moderate organic-matter content. The effective rooting depth is limited by the water table or by the clayey substratum. Runoff is very slow. Wetness is the main limitation to use of this soil. Drainage greatly improves crop production.

Most areas of this soil are used for crops. Where drained, this soil is well suited to most crops commonly grown in the county. Capability unit IIw–2; woodland group 2o.

Mundelein Series

The Mundelein series consists of somewhat poorly drained, nearly level and gently sloping soils on glacial lake plains. The natural vegetation was prairie grasses.

In a representative profile the surface layer is black silt loam about 10 inches thick. The subsoil is brown, mottled silty clay loam about 17 inches thick. The substratum to a depth of about 60 inches is light brown, mottled, stratified silt loam and very fine sand.

Mundelein soils have high available water capacity. Permeability is moderate or moderately slow.

Most areas of these soils are drained and used for crops. Undrained areas are used for pasture, woodland, or wildlife habitat.

Representative profile of Mundelein silt loam, 0 to 3 percent slopes, in a cultivated field 1,320 feet south and

400 feet east of the northwestern corner of sec. 23, T. 22 N., R. 16 E.

Ap—0 to 10 inches; black (10YR 2/1) silt loam; moderate medium granular structure; friable; many roots; neutral; abrupt smooth boundary.

B2t—10 to 22 inches; brown (7.5YR 5/4) silty clay loam; many fine distinct strong brown (7.5YR 5/8) and grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; friable; many roots to 15 inches; thin patchy clay films; neutral; clear smooth boundary.

B3t—22 to 27 inches; brown (7.5YR 5/4) light silty clay loam; many fine distinct strong brown (7.5YR 5/8) and grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure; friable; thin very patchy clay films; mildly alkaline; clear smooth boundary.

C—27 to 60 inches; light brown (7.5YR 6/4) silt loam and very fine sand; stratified few fine distinct strong brown (7.5YR 5/8) and grayish brown (10YR 5/2) mottles; moderate fine platy structure; friable; many fine prominent brown (7.5YR 5/2) calcium carbonate concretions; violent effervescence; moderately alkaline.

The solum is 24 to 36 inches thick. The A and B horizons are medium acid to mildly alkaline, and the C horizon is slightly acid to moderately alkaline.

The A horizon is dark grayish brown or black and is 8 to 12 inches thick. The C horizon is dominantly stratified silt loam and very fine sand.

Mundelein soils are near Grays and Shiocton soils. They are wetter than Grays soils and have a higher clay content in the B horizon than Shiocton soils.

MuA—Mundelein silt loam, 0 to 3 percent slopes. This nearly level and gently sloping soil is on glacial lake plains. Most areas are irregular in shape and range from 2 to 400 acres in size.

Included with this soil in mapping are small areas of Grays, Keowns, and Shiocton soils.

This soil has high natural fertility and high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow. Wetness is the main limitation to use of this soil. Surface drainage is beneficial for crop production.

Most drained areas of this soil are used for crops. Undrained areas are used mostly for pasture, woodland, or wildlife habitat. If drained this soil is well suited to most crops commonly grown in the county. Capability unit IIw–4; woodland group 4o.

Namur Series

The Namur series consists of well drained, nearly level and gently sloping soils that formed in a thin silt loam mantle in areas that are shallow or very shallow to limestone bedrock. The native vegetation was mixed deciduous and coniferous forests.

In a representative profile the surface layer is very dark brown silt loam about 5 inches thick. It is underlain to a depth of at least 60 inches by light gray consolidated limestone bedrock.

Namur soils have very low available water capacity and moderate permeability.

Most areas of these soils are in woodland or wildlife habitat and some are used for pasture.

Representative profile of Namur silt loam, 1 to 6 percent slopes, in a woodlot 1,380 feet south and 325 feet west of the northeastern corner of sec. 30, T. 22 N., R. 15 E.

A1—0 to 5 inches; very dark brown (10YR 2/2) silt loam; moderate fine and medium subangular blocky structure; very friable; neutral; abrupt smooth boundary.

R—5 to 60 inches; light gray (10YR 7/2) consolidated limestone bedrock.

The thickness of the solum and depth to limestone bedrock are 3 to 12 inches. The bedrock is consolidated limestone which is creviced in some areas. The A horizon is slightly acid to mildly alkaline. It is very dark brown or black and is 3 to 12 inches thick.

Namur soils are near Kolberg soils and areas of Rock outcrop. They are thinner over limestone than Kolberg soils. Namur soils do not have the exposures of limestone that are characteristic of Rock outcrop.

NaB—Namur silt loam, 1 to 6 percent slopes. This nearly level and gently sloping soil is on uplands that are shallow or very shallow to limestone. Most areas are long and narrow and range from 5 to 100 acres in size.

Included with this soil in mapping are a few small areas of Bonduel, Channahon, and Kolberg soils and some areas of Rock outcrop.

This soil has low natural fertility and moderately low organic-matter content. The effective rooting depth is limited by limestone. Runoff is medium. Erosion is a slight or moderate hazard and drought is a very severe hazard.

Most areas of this soil are in woodland or wildlife habitat, but some are in pasture. This soil is best suited to wildlife habitat. Capability unit VIs–5; woodland group 4d.

Nichols Series

The Nichols series consists of moderately well drained, nearly level and gently sloping soils on old glacial lake plains. These soils formed under mixed northern hardwoods consisting of maple, ash, birch, and aspen.

In a representative profile the surface layer is dark grayish brown, very fine sandy loam about 8 inches thick. The subsoil is brown and dark brown, very fine sandy loam about 18 inches thick. The substratum to a depth of about 60 inches is yellowish brown, stratified silt and very fine sand.

Nichols soils have high available water capacity and moderate permeability. Permeability is slow where the substratum is clayey.

Most areas of these soils are used for cultivated crops. Some areas remain in woodland or pasture.

Representative profile of Nichols very fine sandy loam, 2 to 6 percent slopes, in a cultivated area 660 feet east and 100 feet north of the southwestern corner of sec. 15, T. 23 N., R. 15 E.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) very fine sandy loam; moderate very

fine granular structure; very friable; slightly acid; abrupt smooth boundary.

B1—8 to 11 inches; brown (10YR 5/3) very fine sandy loam; moderate fine subangular blocky structure; very friable; neutral; abrupt wavy boundary.

B2—11 to 17 inches; dark brown (7.5YR 4/4) very fine sandy loam; weak medium platy structure parting to moderate fine subangular blocky; very friable; neutral; gradual smooth boundary.

B3—17 to 26 inches; dark brown (7.5YR 4/4) very fine sandy loam; moderate thick platy structure parting to moderate medium subangular blocky; very friable; slight effervescence; mildly alkaline.

C—26 to 60 inches; yellowish brown (10YR 5/4) silt and very fine sand, stratified; residual platy structure; very friable; violent effervescence; moderately alkaline.

The solum is 24 to 30 inches thick. The A and B horizons are slightly acid to mildly alkaline, and the C horizon is moderately alkaline.

The A horizon is dark grayish brown, very dark grayish brown, or very dark brown and is 4 to 9 inches thick. The C horizon is mostly silt and very fine sand which is stratified. Some pedons contain strata which range from sandy to clayey.

Nichols soils are near Grays and Shiocton soils. They are better drained than Shiocton soils and lack the B2t horizon that is characteristic of Grays soils.

NfA—Nichols very fine sandy loam, 0 to 2 percent slopes. This nearly level soil is on glacial lake plains. Most areas are irregular in shape and range from 5 to 500 acres in size. This soil has a thicker combined surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are some gently sloping Nichols soils and a few areas of Shiocton soils. Also included are some small areas that have a silt loam surface layer.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is slow. Removal of excess surface water during extended periods of heavy rain is the main management concern. Surface drainage is beneficial.

Most areas of this soil are used for crops. This soil is well suited to all crops commonly grown in the county and to specialty crops, such as cabbage or cauliflower. Capability unit I–1; woodland group 1o.

NfB—Nichols very fine sandy loam, 2 to 6 percent slopes. This gently sloping soil is on glacial lake plains. Most areas are irregular in shape and range from 3 to 600 acres in size. This soil has the profile described as representative of the series.

Included with the soil in mapping are some areas of nearly level and sloping Nichols soils and some small areas of Nichols soils that have a silt loam surface layer. Also included are some areas of Grays and Shiocton soils.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is slow. Erosion is the main hazard. Terraces, strip-cropping, and crop rotation are practices that reduce runoff and erosion.

Most areas of this soil are used for cultivated crops. Some areas remain in woodland or pasture. This soil is well suited to all crops commonly grown in the county and to specialty crops, such as cabbage and cauliflower. Capability unit IIe–1; woodland group 1o.

NsA—Nichols very fine sandy loam, clayey substratum, 0 to 2 percent slopes. This nearly level soil is in glacial lake basins. Most areas are irregular in shape and range from 5 to 200 acres in size. This soil has a profile similar to the one described as representative of the series, but it is underlain by clayey material at a depth of 40 to 60 inches.

Included with this soil in mapping are a few areas of Grays and Shiocton soils and some areas of Nichols soils that have a silt loam surface layer. A few small areas of Nichols soils that do not have a clayey substratum are also included.

This soil has high natural fertility and low organic-matter content. The effective rooting depth is limited by the clayey substratum. Runoff is slow. The accumulation of excess surface water during extended periods of heavy rain is the main limitation. Surface drainage is beneficial in removing this excess water.

This soil is mostly used for crops. It is well suited to most crops in the county and to specialty crops, such as cabbage and cauliflower. Capability unit I–1; woodland group 1o.

NsB—Nichols very fine sandy loam, clayey substratum, 2 to 6 percent slopes. This gently sloping soil is in glacial lake basins. Most areas are irregular in shape and range from 3 to 120 acres in size. This soil has a profile similar to the one described as representative of the series, but it is underlain by clayey material at a depth of 40 to 60 inches.

Included with this soil in mapping are a few small areas of Shiocton soils. Also included are some small areas of Nichols soils that have a silt loam surface layer and a few areas that do not have a clayey substratum.

This soil has high natural fertility and low organic-matter content. The effective rooting depth is limited by the clayey substratum. Runoff is slow. Erosion is the main hazard. Practices such as minimum tillage, mulching, and plowing under crop residue reduce runoff and erosion.

Most areas of this soil are used for crops. This soil is well suited to most crops commonly grown in the county and to specialty crops, such as cabbage and cauliflower. Capability unit IIe–1; woodland group 1o.

Onaway Series

The Onaway series consists of well drained and moderately well drained, gently sloping to moderately steep soils on glacial till plains and moraines. The native vegetation included northern red oak, white pine, white ash, sugar maple, beech, aspen, and basswood.

In a representative profile the surface layer is very dark grayish brown loam about 4 inches thick. The subsurface layer is pinkish gray fine sandy loam about 1 inch thick. The subsoil is about 22 inches thick. It is dark brown fine sandy loam in the upper part, pinkish gray fine sandy loam in the middle part, and reddish brown clay loam in the lower part. The substratum to a depth of about 60 inches is brown loam.

Onaway soils have high available water capacity and moderate to moderately slow permeability.

Most gently sloping areas of these soils are used for crops. Most sloping and moderately steep areas are used for pasture or woodland.

Representative profile of Onaway loam, 2 to 6 percent slopes, in a woodlot 1,430 feet north and 770 feet west of the southeastern corner of sec. 11, T. 24 N., R. 18 E.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) loam; moderate fine granular structure; very friable; many roots; neutral; abrupt smooth boundary.

A2—4 to 5 inches; pinkish gray (7.5YR 6/2) fine sandy loam; moderate medium platy structure; very friable; many roots; slightly acid; abrupt wavy boundary.

B2ir—5 to 10 inches; dark brown (7.5YR 4/4) fine sandy loam; moderate medium subangular blocky structure; friable; many roots; medium acid; abrupt wavy boundary.

A'2—10 to 12 inches; pinkish gray (7.5YR 6/2) fine sandy loam; weak medium platy structure parting to moderate fine subangular blocky; very friable; few roots; few coarse prominent very dark grayish brown (10YR 3/2) worm casts; medium acid; abrupt wavy boundary.

B&A'—12 to 15 inches; pinkish gray (7.5YR 6/2) fine sandy loam (A'2) and thick coatings surrounding peds of reddish brown (5YR 4/4) clay loam (Bt); moderate medium subangular blocky structure; friable; few roots; medium acid; abrupt wavy boundary.

B'21t—15 to 20 inches; reddish brown (5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; few roots; thin patchy clay films on faces of peds; slightly acid; clear wavy boundary.

B'22t—20 to 24 inches; reddish brown (5YR 4/4) clay loam; moderate coarse subangular blocky structure; firm; few roots; thin continuous clay films on faces of peds; mildly alkaline; clear wavy boundary.

B'3—24 to 27 inches; reddish brown (5YR 4/4) clay loam; weak coarse subangular blocky structure; firm; few roots; thin patchy clay films on vertical faces of peds; many coarse distinct light reddish brown (5YR 6/3) calcium carbonate segregations; slight effervescence; mildly alkaline; abrupt wavy boundary.

C—27 to 60 inches; brown (7.5YR 5/4) loam; massive; friable; strong effervescence; mildly alkaline.

The solum is generally 25 to 30 inches thick. It ranges from medium acid in the upper part to mildly alkaline in the lower part. The C horizon is mildly alkaline or moderately alkaline.

The A horizon is very dark grayish brown, very dark brown, or very dark gray and is from 3 to 6 inches thick. The B horizon is loam or fine sandy loam in the upper part and clay loam, silty clay loam, or heavy loam in the lower part. The C horizon is silt loam, loam, or sandy loam.

Onaway soils are near Menominee and Solona soils. Onaway soils have less sand than Menominee soils and are better drained than Solona soils.

OhB—Onaway loam, 2 to 6 percent slopes. This gently sloping soil is on glacial till plains. Most areas are irregular in shape and range from 2 to 600 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Solona soils in drainageways and wet depressions. Small areas of Menominee soils are also included where there is a sandy overburden. Also included are small areas of severely eroded Onaway soils and sloping Onaway soils.

This soil has medium natural fertility and low organic-matter content. The root zone is deep. Runoff is slow. The hazard of erosion is slight. Erosion-control measures such as stripcropping and contour cultivation reduce runoff and erosion.

Much of this Onaway soil is used for crops, but some areas remain in woodland. This soil is well suited to all crops commonly grown in the county. Capability unit IIe–2; woodland group 2d.

OhC2—Onaway loam, 6 to 12 percent slopes, eroded. This sloping soil is on glacial till plains. Most areas are irregular in shape and range from 2 to 200 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are some areas of severely eroded Onaway soils. Also included are some areas of soils that have less clay and silt in the subsoil than is typical of the series or that have moderate available water capacity.

This soil has low organic-matter content and medium natural fertility. The effective root zone is deep. Runoff is medium. The erosion hazard is moderate. Management practices such as minimum tillage and stripcropping reduce runoff and erosion.

Many areas of this soil are in woodland. Some areas are cultivated. This soil is well suited to woodland. It is suited to small grain, hay, and some corn grown in rotation. Capability unit IIIe–2; woodland group 2d.

OhD2—Onaway loam, 12 to 20 percent slopes, eroded. This moderately steep soil is on glacial till plains and ridges. Most areas are long and range from 3 to 80 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are a few small areas of Onaway soils that have slopes of more than 20 percent and some areas that are severely eroded.

This soil has medium natural fertility and low organic-matter content. The effective root zone is deep. Runoff is rapid, and the hazard of erosion is severe. Management practices such as stripcropping and minimum tillage help control runoff and lessen erosion.

Most areas of this soil are in permanent pasture or woodland. Some areas that were once cultivated are reverting to woodland. This soil is well suited to timber production. Capability unit IVe–2; woodland group 2d.

OlB—Onaway-Solona complex, 2 to 6 percent slopes. These gently undulating soils are on glacial till plains. Most areas are irregular in shape and range from 5 to

about 200 acres in size. This complex is about 60 percent Onaway loam and 35 percent Solona silt loam. Onaway soils are on convex side slopes on uplands. Solona soils are in drainageways and depressions. The soils in this complex are in such small areas and are so closely intermingled that it is not feasible to map them individually at the scale used.

Included in mapping are small areas of Angelica soils in wet depressions.

Runoff is very slow or slow. Erosion is the main hazard on Onaway soils, and wetness is the main hazard on Solona soils. Surface drainage and tile drainage help remove excess water. Stripcropping, contour cultivation, and minimum tillage reduce runoff and erosion.

Most of this complex is cultivated. If properly managed, the soils are well suited to all crops commonly grown in the county. Uncultivated areas are mostly Solona soils. They are used for pasture or woodland. Capability unit IIe–2; Onaway soil in woodland group 2d, Solona soil in woodland group 2o.

Pella Series

The Pella series consists of nearly level, poorly drained soils in depressions and drainageways on glacial till plains. These soils formed under native vegetation of northern white-cedar and black ash. Where the soils are extremely wet, marsh grasses and sedges are predominant.

In a representative profile the surface layer is very dark brown and very dark grayish brown silt loam in the upper 14 inches and very dark gray silty clay loam in the lower 5 inches. The subsoil is dark gray mottled silty clay loam stratified with loam in the lower part and is about 10 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, yellow, and gray clay loam stratified with layers of sandy loam and silt loam.

Pella soils have high available water capacity and moderate premeability.

Most areas of these soils are undrained and remain in woodland. Drained areas are used for corn and other row crops commonly grown in the county.

Representative profile of Pella silt loam, in an uncultivated area, 1,980 feet east and 1,980 feet north of the southwestern corner of sec. 34, T. 21 N., R. 16 E.

A11—0 to 9 inches; very dark brown (10YR 2/2) heavy silt loam; moderate fine granular structure; very friable; many roots; neutral; clear smooth boundary.

A12—9 to 14 inches; very dark grayish brown (10YR 3/2) heavy silt loam; moderate fine granular structure; very friable; many roots; neutral; clear wavy boundary.

A3—14 to 19 inches; very dark gray (10YR 3/1) light silty clay loam; moderate fine and medium subangular blocky structure; friable; many roots; many medium very dark brown (10YR 2/2) worm casts; neutral; clear wavy boundary.

B2g—19 to 26 inches; dark gray (10YR 4/1) silty clay loam; common fine prominent dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; distinct very dark brown (10YR 2/2) worm casts; neutral; abrupt wavy boundary.

IIB3g—26 to 29 inches; dark gray (10YR 4/1) stratified silty clay loam and loam; many coarse distinct dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/6) mottles; moderate coarse prismatic structure; firm; neutral; abrupt wavy boundary.

IIC—29 to 60 inches; mixed dark yellowish brown (10YR 4/4), yellow (10YR 7/6), and gray (10YR 5/1) light clay loam stratified with layers of sandy loam and silt loam; massive; friable; slight effervescence; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness, but generally is 25 to 35 inches thick. The A and B horizons are slightly acid or neutral, and the IIC horizon is mildly alkaline or moderately alkaline. The A horizon is very dark gray, very dark brown, or black and is 14 to 20 inches thick. The IIC horizon is mainly clay loam or silty clay loam stratified with layers of sandy loam or silt loam.

Pella soils are near and are wetter than Hortonville and Symco soils.

Pe—Pella silt loam. This nearly level soil is in drainageways and depressions on glacial till plains. Most areas are long and narrow and range from 2 to 200 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas that have a thin organic layer up to 16 inches thick. Also included are some small areas of Pella soils with slopes up to 4 percent and some areas of Cathro soils.

This soil has high natural fertility and high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow or ponded. Wetness is a limitation on this soil. Tile drainage and surface drainage are beneficial in removing excess water.

Most areas of this soil are undrained and remain in woodland. Drainage is necessary for dependable crop production; and, if drained, this soil is well suited to continuous row cropping. Undrained areas of this soil are used for late-summer pasture or wildlife habitat. Capability unit IIw–1; woodland group 3w.

Poy Series

The Poy series consists of poorly drained, nearly level soils in depressions and along drainageways. The native vegetation included a mixed deciduous swamp forest of ash, elm, beech, swamp white oak, and a ground cover of marsh grasses.

In a representative profile the surface layer is very dark brown silty clay loam about 8 inches thick. The subsoil is about 16 inches thick. It is dark gray mottled silty clay in the upper part, dark grayish brown mottled clay in the middle part, and reddish brown mottled silty clay in the lower part. The substratum to a depth of about 60 inches is brown medium sand.

Poy soils have low available water capacity. Perme-

ability is slow in the subsoil and rapid in the substratum.

Most areas of these soils are drained and used for all crops commonly grown in the county. Undrained areas are in woodland.

Representative profile of Poy silty clay loam, in cropland 2,510 feet north and 1,320 feet east of the southwestern corner of sec. 31, T. 21 N., R. 16 E.

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

B1g—8 to 10 inches; dark gray (N 4/0) silty clay; few medium prominent reddish brown (5YR 5/4) and olive (5Y 4/3) mottles; moderate fine subangular blocky structure; firm; many roots; few coarse prominent very dark brown (10YR 2/2) worm casts; neutral; clear wavy boundary.

B2g—10 to 14 inches; dark grayish brown (2.5Y 4/2) clay; common fine prominent brown (7.5YR 5/4) mottles; moderate fine subangular blocky structure; firm; few roots; neutral; clear wavy boundary.

B3—14 to 24 inches; reddish brown (5YR 4/3) silty clay; few fine prominent pinkish gray (5YR 6/2) mottles; weak fine subangular blocky structure; firm; few medium prominent yellowish brown (10YR 5/8) mottles at the transition to the C horizon; some sandy loam pockets at this transition; neutral; abrupt smooth boundary.

IIC—24 to 60 inches; brown (10YR 5/3) medium sand; single grained; loose; slight effervescence; mildly alkaline.

The solum is 20 to 40 inches thick. The A horizon is medium acid to moderately alkaline, the B horizon is neutral to moderately alkaline, and the C horizon is mildly alkaline or moderately alkaline. The Ap or A1 horizon is black, very dark brown, or very dark gray and is 3 to 9 inches thick. The B horizon is typically silty clay or clay, and less commonly is heavy silty clay loam. The IIC horizon is dominantly sand with some gravel.

Poy soils are near Borth and Zittau soils and formed in similar parent material. Poy soils are wetter than those soils.

Pf—Poy silty clay loam. This is a nearly level soil in drainageways and depressions. Most areas are irregular in shape and range from 2 to 40 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are some areas of Poygan, Will, and Zittau soils. Some areas that have a silty clay or clay surface layer are also included.

This soil has high natural fertility and high organic-matter content. The effective rooting depth is limited by the water table and, in drained areas, by the underlying sandy substratum. Runoff is very slow or ponded. This soil is too wet for cultivation unless it is drained. Shallow ditches help remove excess water.

Most areas of this soil are in woodland, and some are used for pasture or wildlife habitat. This soil is well suited to most crops commonly grown in the county if adequate drainage is provided. Capability unit IIw–5; woodland group 2w.

Poygan Series

The Poygan series consists of poorly drained, nearly level soils in depressions and drainageways on lacustrine and glacial till plains. These soils formed under a mixed vegetation of elm, maple, and ash.

In a representative profile the surface layer is black silty clay loam about 8 inches thick. The subsoil is about 16 inches thick. It is very dark gray and dark gray mottled silty clay in the upper part; brown mottled clay in the middle part; and dark reddish gray mottled clay in the lower part. The substratum is reddish brown mottled clay to a depth of about 60 inches.

Poygan soils have moderate available water capacity and slow permeability.

Most areas of these soils are undrained and in woodland. Some areas are drained and used for all crops commonly grown in the county.

Representative profile of Poygan silty clay loam, in an uncultivated area 600 feet south and 250 feet east of the northwestern corner of sec. 31, T. 21 N., R. 19 E.

A1—0 to 8 inches; black (10YR 2/1) silty clay loam; few fine prominent yellowish red (5YR 4/8) mottles; strong fine granular structure; firm; many roots; neutral; abrupt smooth boundary.

B21g—8 to 11 inches; very dark gray (5Y 3/1) silty clay; moderate fine subangular blocky structure; firm; many roots; slickensides on faces of peds; neutral; abrupt smooth boundary.

B22g—11 to 17 inches; dark gray (5Y 4/1) silty clay; moderate fine subangular blocky structure; firm; many roots; slickensides on faces of peds; neutral; abrupt wavy boundary.

B23g—17 to 19 inches; brown (7.5YR 4/2) clay; few medium prominent reddish yellow (5YR 6/8) mottles; strong fine subangular blocky structure; firm; continuous slickensides on faces of peds; neutral; clear smooth boundary.

B24g—19 to 24 inches; dark reddish gray (5YR 4/2) clay; fine prominent yellowish red (5YR 5/8) mottles; strong fine subangular blocky structure; firm; mildly alkaline; clear smooth boundary.

C—24 to 60 inches; reddish brown (5YR 4/3) clay; few fine prominent yellowish red (5YR 5/8) mottles; massive; firm; strong effervescence; mildly alkaline.

Thickness of the solum and the depth to free carbonates typically are 20 to 27 inches. The A and B horizons are neutral to moderately alkaline and the C horizon is mildly alkaline or moderately alkaline.

The A horizon is black or very dark brown and is 3 to 9 inches thick. In some places a thin organic layer covers the surface. The B horizon is silty clay or clay and less commonly is heavy silty clay loam. The C horizon is clay or silty clay.

Poygan soils are near and are wetter than Kewaunee, Manawa, and Winneconne soils.

Po—Poygan silty clay loam. This is a nearly level soil in drainageways and depressions on lacustrine and glacial till plains. Most areas are irregular in shape and range from 2 to 600 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are some areas of Manawa and Suamico soils.

This soil has high natural fertility and organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow or ponded. The major management concerns are wetness and maintenance of good tilth. Tile drainage and surface drainage are beneficial in removing excess water. Minimum tillage (especially not cultivating when the soil is wet) and additions of organic matter help maintain good tilth.

Most large areas of this soil remain in woodland and are used for wildlife habitat. This soil is well suited to woodland. If drained, it is well suited to most crops commonly grown in the county. Capability unit IIw–1; woodland group 2w.

Rock Outcrop

Ra—Rock outcrop. This is a miscellaneous area consisting of steep and very steep escarpments of limestone bedrock and, in a few places, exposed sandstone bedrock. Most areas are long and narrow and range from 3 to 35 acres in size.

Included in mapping are small areas of Bonduel, Kolberg, and Namur soils. Also included are stones and boulders at the foot of the escarpments. Soil material fills crevices in the dolomite (limestone) in many areas.

Runoff is very rapid. Erosion is a slight hazard. Rock outcrop is not rated for soil properties or for any selected use.

Rock outcrop is unsuited to farming, but some areas are wooded. Trees grow in soil-filled crevices in the bedrock. The bedrock is used as a source of lime, sand, and building stone. Areas of Rock outcrop are valuable for their scenic beauty and as wildlife habitat. Capability unit VIIIs–10; woodland group not assigned.

Rondeau Series

The Rondeau series consists of very poorly drained, nearly level, organic soils in depressions in glacial lake basins. The native vegetation was primarily sedges and grasses, with scattered willow and alder.

In a representative profile the organic layer is about 22 inches thick. It is black muck in the upper 15 inches, very dark brown mucky peat in the middle 5 inches, and black muck in the lower 2 inches. The substratum is dark gray and gray marl to a depth of about 60 inches.

Rondeau soils have very high available water capacity. Permeability is moderately slow to moderately rapid in the organic layers and slow in the underlying marl.

Representative profile of Rondeau muck, in an uncultivated area 2,820 feet north and 2,640 feet west of the southeastern corner of sec. 7, T. 21 N., R. 15 E.

Oa1—0 to 15 inches; black (10YR 2/1) broken face and rubbed sapric material; about 15 percent fiber, less than 5 percent rubbed; moderate medium granular structure; nonsticky herbaceous fibers; many roots; mildly alkaline; abrupt smooth boundary.

Oe1—15 to 20 inches; very dark brown (10YR 2/2) broken face and very dark grayish brown (10YR 3/2) rubbed hemic material; 65 percent fiber, less than 40 percent rubbed; massive; nonsticky herbaceous fibers; mildly alkaline; abrupt smooth boundary.

Oa2—20 to 22 inches; black (10YR 2/1) broken face and rubbed sapric material; about 50 percent fiber, less than 10 percent rubbed; massive; nonsticky herbaceous fibers; 2 percent white (10YR 8/1) snail shells; mildly alkaline; abrupt smooth boundary.

Lca—22 to 60 inches; mixed dark gray (5Y 4/1) and gray (5Y 5/1) marl; massive; slightly sticky; about 2 percent detritus; 25 percent white (10YR 8/1) snail shells; violent effervescence; mildly alkaline.

The organic layers are 16 to 51 inches thick. They are mostly sapric material, but hemic layers less than 10 inches thick are in some pedons.

Rondeau soils are near Carbondale, Cathro, Markey, and Suamico soils and formed in similar organic deposits. Rondeau soils are underlain by marl within a depth of 51 inches. Cathro soils are underlain by loamy material, Markey soils are underlain by sand, and Suamico soils are underlain by clayey material. Carbondale soils formed in organic deposits that are more than 51 inches thick.

Rd—Rondeau muck. This is a nearly level soil in glacial lake basins. Most areas are irregular in shape and range from 2 to 240 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are a few small areas of Carbondale, Cathro, and Markey soils.

This soil has low natural fertility and very high organic-matter content. The effective rooting depth is limited by the high water table and by marl. Runoff is very slow or ponded. Wetness is a severe limitation. Open-ditch drainage can be used to remove excess water. This soil subsides if it is drained and is subject to soil blowing and burning. There is a hazard of frost damage to crops that are grown on this soil.

Most areas of this soil are used for wetland wildlife habitat. Capability unit IVw–7; woodland group 5w.

Rousseau Series

The Rousseau series consists of gently sloping, moderately well drained and well drained soils on lacustrine and outwash plains. These soils formed under natural vegetation of sugar maple, red maple, white birch, aspen, and beech.

In a representative profile the surface layer is black loamy fine sand about 3 inches thick. The subsurface layer is grayish brown fine sand about 3 inches thick. The subsoil is about 15 inches thick. It is dark reddish brown fine sand in the upper part, yellowish red fine sand in the middle part, and strong brown fine sand in

the lower part. The substratum is brown fine sand to a depth of about 60 inches.

Rousseau soils have low available water capacity and rapid permeability.

Most areas of these soils are used for woodland and wildlife habitat.

Representative profile of Rousseau loamy fine sand, 2 to 6 percent slopes, in a woodlot 650 feet north and 660 feet east of the southwestern corner of sec. 4, T. 24 N., R. 19 E.

A1—0 to 3 inches; black (10YR 2/1) loamy fine sand; weak fine granular structure; very friable; many roots; strongly acid; abrupt wavy boundary.

A2—3 to 6 inches; grayish brown (10YR 5/2) fine sand; weak thin platy structure; very friable; few roots; medium acid; abrupt wavy boundary.

B21ir—6 to 9 inches; dark reddish brown (5YR 3/4) fine sand; moderate fine subangular blocky structure; friable; few roots; strongly acid; abrupt wavy boundary.

B22ir—9 to 14 inches; yellowish red (5YR 4/6) fine sand; weak fine subangular blocky structure; very friable; few roots; strongly acid; clear wavy boundary.

B3—14 to 21 inches; strong brown (7.5YR 5/6) fine sand; weak fine subangular blocky structure; very friable to loose; few roots; slightly acid; clear wavy boundary.

C—21 to 60 inches; brown (7.5YR 5/4) fine sand; single grained; loose; slightly acid.

The solum is 20 to 30 inches thick. The A and B horizons are strongly acid to slightly acid and the C horizon is medium acid or slightly acid. The A horizon is black or very dark brown and is 3 to 6 inches thick.

Rousseau soils are near Boyer, Deford, and Wainola soils. They are more sandy in the B horizon than Boyer soils and are better drained than Deford and Wainola soils.

RoB—Rousseau loamy fine sand, 2 to 6 percent slopes. This gently sloping soil is on sandy lacustrine and outwash plains. Most areas are irregular in shape and range from 2 to 120 acres in size.

Included with this soil in mapping are some small areas of nearly level Rousseau soils and some small areas that are severely eroded. Also included are some small areas of Shawano and Wainola soils and some soils that are very fine sand throughout.

This soil has low natural fertility and low organic-matter content. The effective root zone is deep. Runoff is slow. A low natural fertility level and low available water capacity are the main limitations to use of this soil. This soil is also subject to soil blowing. Management is needed for dependable crop production. Supplemental irrigation, additions of organic matter, fertilization, and protection from blowing are beneficial to this soil.

Most areas of this soil are in pasture or woodland. This soil is best suited to woodland and wildlife habitat. Capability unit IVs–3; woodland group 2s.

Shawano Series

The Shawano series consists of excessively drained rolling and hilly soils on sand dunes and outwash ridges. The native vegetation consisted of red oak, sugar maple, white ash, basswood, white pine, and red pine.

In a representative profile the surface layer is very dark grayish brown fine sand about 5 inches thick. The subsoil is brown fine sand about 23 inches thick. The substratum is yellowish brown fine sand to a depth of about 60 inches (fig. 7).

Shawano soils have low available water capacity and rapid permeability.

Representative profile of Shawano fine sand, rolling, on a pine plantation 350 feet south and 350 feet east of the northwestern corner of sec. 29, T. 24 N., R. 16 E.

O1—½ inch to 0; leaf litter.

A11—0 to 2 inches; very dark grayish brown (10YR 3/2) fine sand; weak medium granular structure; very friable; few roots; medium acid; abrupt wavy boundary.

A12—2 to 5 inches; very dark grayish brown (10YR 3/2) fine sand; weak medium granular structure; very friable; slightly acid; abrupt wavy boundary.

B2—5 to 28 inches; brown (7.5YR 4/4) fine sand;

Figure 7.—**Profile of a Shawano fine sand.**

weak fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.

C—28 to 60 inches; yellowish brown (10YR 5/6) fine sand; single grained; loose; slightly acid.

The solum is 20 to 40 inches thick and is medium acid or slightly acid. The C horizon is medium acid to mildly alkaline. The A horizon is very dark grayish brown or black and is typically less than 6 inches thick. The B horizon is fine sand or very fine sand.

Shawano soils are near Boyer and Rousseau soils. They have more sand in the B horizon and finer sand in the C horizon than Boyer soils. Shawano soils have less iron accumulation in the solum than Rousseau soils.

SeC—Shawano fine sand, rolling. This soil is on sand dunes in areas of glacial outwash. Most areas are elongated and range from 3 to 120 acres in size. Slopes are 6 to 12 percent. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Boyer and Wainola soils. Also included are some undulating and hilly Shawano soils and some areas where the surface layer is loamy fine sand.

This soil has low natural fertility and very low organic-matter content. The effective root zone is deep. Runoff is slow. The main hazards are soil blowing and erosion. Management practices that maintain a permanent plant cover are needed to reduce these hazards.

Most areas of this soil are used for woodland or wildlife habitat and are suited to these uses. This soil is unsuited to commercial crop production. Capability unit VIIs–9; woodland group 2s.

SeD—Shawano fine sand, hilly. This soil is on sand dunes in areas of glacial outwash. Most areas are elongated and range from 2 to 40 acres in size. Slopes are 12 to 20 percent.

Included with this soil in mapping are some small areas of Boyer and Rousseau soils. Also included are some areas of Shawano soils with slopes of less than 12 percent and areas with slopes up to 35 percent.

This soil has low natural fertility and very low organic-matter content. The effective root zone is deep. Runoff is medium or rapid. This soil is subject to soil blowing, and erosion is a severe hazard. It is also droughty. Management practices that maintain a permanent plant cover are needed.

Most areas of this soil are used for woodland or wildlife habitat, to which they are suited. This soil is unsuited to commercial crop production. Capability unit VIIs–9; woodland group 2s.

Shiocton Series

The Shiocton series consists of somewhat poorly drained, nearly level and gently sloping soils on lacustrine plains. The natural vegetation included red maple, white ash, birch, and red oak.

In a representative profile the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsoil is about 16 inches thick. It is brown mottled silt loam with lenses of very fine sand in the upper part and light yellowish brown, yellowish brown, and strong brown very fine sandy loam with lenses of silt in the lower part. The substratum to a depth of about 60 inches is brown mottled silt stratified with very fine sand.

Shiocton soils have high available water capacity. Permeability is moderate, except it is very slow in the substratum of the Shiocton clayey substratum soils.

These soils are used for crops and pasture. Undrained areas are mostly in woodland or wildlife habitat.

Representative profile of Shiocton silt loam, 0 to 3 percent slopes, in cropland 2,030 feet south and 50 feet west of the northeastern corner of sec. 21, T. 22 N., R. 17 E.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam; weak medium and fine subangular blocky structure; very friable; common roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

B2—10 to 15 inches; brown (7.5YR 4/4) silt loam with lenses of very fine sand; many medium and coarse prominent strong brown (7.5YR 5/8) and common medium distinct grayish brown (10YR 5/2) mottles; weak very thick platy structure parting to weak coarse subangular blocky; very friable; few roots; strong effervescence; moderately alkaline; clear wavy boundary.

B3—15 to 26 inches; mixed yellowish brown (10YR 5/8), light yellowish brown (10YR 6/4), and strong brown (7.5YR 5/6 and 5/8) very fine sandy loam with lenses of coarse silt; weak and moderate medium platy structure parting to weak medium and coarse subangular blocky; very friable; strong effervescence; moderately alkaline; clear wavy boundary.

C1—26 to 30 inches; brown (7.5YR 5/4) coarse silt and very fine sand, stratified; many fine and medium prominent yellowish brown (10YR 5/8) and few fine distinct light brownish gray (10YR 6/2) mottles; weak thin platy structure; friable; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—30 to 60 inches; brown (7.5YR 5/4) very fine sand and silt, stratified; many fine and medium prominent yellowish brown (10YR 5/8) and common fine distinct light brownish gray (10YR 6/2) mottles; massive; friable; violent effervescence; moderately alkaline.

The solum is 20 to 36 inches thick. It is slightly acid to mildly alkaline in the upper part and neutral to moderately alkaline in the lower part. The C horizon is neutral to moderately alkaline.

The A horizon is very dark grayish brown, very dark gray, black, or very dark brown and is 8 to 15 inches thick. The B horizon is silt loam or very fine sandy loam with lenses of very fine sand in some pedons. The C horizon is silt and very fine sandy loam that is stratified with very fine sand, medium sand, silty clay loam, or silty clay.

Shiocton soils are near Keowns, Mundelein, and Nichols soils. They have less clay in the B horizon than Mundelein soils, are wetter than Nichols soils, and are better drained than Keowns soils.

ShA—Shiocton silt loam, 0 to 3 percent slopes. This nearly level and gently sloping soil is on lacustrine plains. Most areas are irregular in shape and range from 2 to 1,200 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of Shiocton soil where the surface layer is very fine sandy loam and a few areas of Mundelein and Nichols soils.

This soil has high natural fertility and high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow. Wetness is the main limitation of this soil. This soil is subject to flooding for brief periods. Surface drainage removes excess water.

This soil is used for crops or pasture. Many areas remain in woodland and are used for wildlife habitat. If drained, this soil is well suited to most crops commonly grown in the county and to specialty crops, such as cabbage and cauliflower. It is also well suited to growing row crops year after year. Capability unit IIw–4; woodland group 1o.

SkA—Shiocton silt loam, clayey substratum, 0 to 3 percent slopes. This nearly level and gently sloping soil is on lacustrine plains. Most areas are elongated and range from 5 to 200 acres in size. This soil is similar to the one described as representative of the series, but it is underlain by clayey material at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Keowns and Mundelein soils. Also included are areas where the clayey substratum is at a depth of 30 to 40 inches and some areas that lack a clayey substratum.

This soil has high natural fertility and high organic-matter content. The effective root zone is limited by the water table and, in drained areas, by the underlying clayey substratum. This soil is subject to frequent flooding. Surface drainage can be used to remove excess water.

Where drained, most areas of this soil are used for crops and pasture. This soil is well suited to continuous row cropping and woodland. Undrained areas are used for permanent pasture, woodland, or wildlife habitat. Capability unit IIw–4; woodland group 1o.

SnB—Shiocton-Nichols complex, 2 to 6 percent slopes. These undulating soils are on lacustrine plains. Most areas are irregular in shape and range from 40 to 200 acres in size. This complex is about 50 percent Shiocton silt loam and about 30 percent Nichols very fine sandy loam. Shiocton soils are in depressions and drainageways. Nichols soils are on the higher, more convex side slopes. The soils in this complex are in such small areas and are so closely intermingled that it is not feasible to map them individually at the scale used.

Included in mapping are some Grays, Keowns, and Mundelein soils.

Runoff is slow. Erosion is the main hazard on Nichols soils, and wetness is the main hazard on Shiocton soils. Management practices are needed on Nichols soils that maintain plant cover and reduce runoff and erosion. Drainage is needed on Shiocton soils for dependable crop production.

Most of this complex is cultivated. If they are properly drained and erosion is controlled, the soils are well suited to all crops commonly grown in the county and to specialty crops, such as cabbage and cauliflower. Capability unit IIe–1; woodland group 1o.

Solona Series

The Solona series consists of somewhat poorly drained, nearly level and gently sloping soils on glacial till plains. The natural vegetation was dominantly mixed deciduous forest consisting of elm, ash, maple, some white-cedar, and red oak.

In a representative profile the surface layer is black silt loam about 8 inches thick. The subsurface layer is dark grayish brown mottled silt loam about 3 inches thick. The subsoil is brown mottled heavy loam 13 inches thick. The substratum is reddish brown mottled loam to a depth of about 60 inches.

Solona soils have high available water capacity and moderate permeability.

Most areas of these soils are drained and used for all crops commonly grown in the county. Undrained areas are in woodland.

Representative profile of Solona silt loam, 1 to 3 percent slopes, in an uncultivated area 200 feet north and 1,980 feet west of the southeastern corner of sec. 6, T. 24 N., R. 19 E.

A1—0 to 8 inches; black (10YR 2/1) silt loam; moderate fine granular structure; very friable; many roots; neutral; abrupt wavy boundary.

A2—8 to 11 inches; dark grayish brown (10YR 4/2) silt loam; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium platy structure parting to moderate fine subangular blocky; very friable; many roots; common coarse distinct black (10YR 2/1) worm casts; neutral; abrupt wavy boundary.

B21t—11 to 18 inches; brown (7.5YR 4/4) heavy loam; few fine distinct strong brown (7.5YR 5/6) and light brownish gray (10YR 6/2) mottles; thin patchy clay films on faces of peds; moderate medium subangular blocky structure; friable; mildly alkaline; clear smooth boundary.

B22t—18 to 24 inches; brown (7.5YR 4/4) heavy loam; few fine distinct strong brown (7.5YR 5/6) and brown (7.5YR 5/2) mottles; thin patchy clay films on faces of peds; moderate medium subangular blocky structure; firm; mildly alkaline; clear smooth boundary.

C—24 to 60 inches; reddish brown (5YR 5/4) loam; common medium distinct strong brown (7.5YR 5/6) and pinkish gray (7.5YR 6/2) mottles; massive; firm; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 20 to 40 inches but are generally less than 30 inches. The A and B horizons are neutral to mildly alkaline, and the C horizon is mildly alkaline or moderately alkaline.

The A1 or Ap horizon is very dark brown or black and is 4 to 9 inches thick. The B2t horizon is loam,

sandy loam, or clay loam. The C horizon is loam or sandy loam.

Solona soils are near Angelica, Menominee, and Onaway soils. They are better drained than Angelica soils. Solona soils are lower on the landscape and are wetter than Onaway and Menominee soils. They lack the sandy overburden that Menominee soils have.

SoA—Solona silt loam, 1 to 3 percent slopes. This nearly level and gently sloping soil is in depressions and drainageways on glacial till plains. Areas are irregular in shape and range from 2 to 120 acres in size.

Included with this soil in mapping are areas of soils that are similar to Solona soils but have more clay in the substratum. Some small areas of Angelica and Onaway soils are also included.

This soil has high natural fertility and moderate organic-matter content. The effective root zone is limited by the water table. Runoff is very slow. Wetness is the main limitation to use of this soil. Tile drainage and surface drainage are beneficial to crop production.

Most areas of this soil are used for crops, and some remain in woodland. This soil is well suited to woodland. Where adequate drainage is provided, it is well suited to all crops commonly grown in the county. Capability unit IIw–2; woodland group 2o.

Suamico Series

The Suamico series consists of nearly level, very poorly drained, organic soils in glacial lake basins and depressions on glacial till plains. These soils formed under a mixed vegetation of grasses, reeds, sedges, alder, aspen, willow, dogwood, and elm.

In a representative profile the organic layer is very dark brown muck about 26 inches thick. The substratum is dark gray mottled silty clay to a depth of about 60 inches.

Suamico soils have high available water capacity. Permeability is moderately rapid in the organic layer and very slow in the underlying clayey substratum.

Representative profile of Suamico muck, in an uncultivated area 1,560 feet west and 2,300 feet south of the northeastern corner of sec. 22, T. 23 N., R. 15 E.

Oa1—0 to 22 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; about 5 percent fiber, a trace when rubbed; moderate medium granular structure; nonsticky; few roots; neutral; gradual smooth boundary.

Oa2—22 to 26 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; about 15 percent fiber, less than 5 percent rubbed; massive; nonsticky; neutral; abrupt smooth boundary.

IIC—26 to 60 inches; dark gray (10YR 4/1) silty clay; many fine and coarse prominent brown (7.5YR 4/4) and strong brown (7.5YR 5/8) mottles; massive; very sticky; neutral.

The organic material ranges from 16 to 51 inches in thickness, but is generally 22 to 34 inches thick. It is mostly derived from herbaceous plants. The organic layers are slightly acid or neutral. The IIC horizon is neutral to moderately alkaline. It is silty clay, heavy clay loam, or clay.

Suamico soils are near Carbondale, Cathro, Markey, and Rondeau soils. They are now classified within the range of the Cathro series. They have shallower organic layers than Carbondale soils have. Suamico soils are underlain by clayey material, Cathro soils are underlain by loamy material, Markey soils are underlain by sandy material, and Rondeau soils are underlain by marl.

Su—Suamico muck. This nearly level soil is in glacial lake basins and in depressions on glacial till plains. Most areas are irregular in shape and range from 5 to 300 acres in size.

Included with this soil in mapping are some small areas of Carbondale and Poygan soils. Also included are some pedons which have less decomposed organic layers.

This soil has low natural fertility and very high organic-matter content. The effective rooting zone is limited by the water table and, in drained areas, by the clayey substratum. Runoff is very slow or ponded. Wetness is the main limitation of this soil. If drained, this soil is subject to subsidence and soil blowing. There is a hazard of frost damage to crops that are grown on this soil. Surface drainage and tile drainage can be used to remove excess water.

Most areas of this soil are in woodland or pasture. Some drained areas are used for truck crops or sod. Capability unit IVw–8; woodland group 3w.

Symco Series

The Symco series consists of somewhat poorly drained, nearly level and gently sloping soils on glacial till plains. The native vegetation was a deciduous forest of mainly elm, ash, and maple.

In a representative profile the surface layer is black silt loam about 7 inches thick. The subsurface layer is dark grayish brown heavy silt loam about 4 inches thick. The subsoil is about 14 inches thick. It is dark brown mottled clay loam in the upper part and reddish brown mottled clay loam in the lower part. The substratum is reddish brown mottled heavy loam to a depth of about 60 inches.

Symco soils have high available water capacity and moderately slow permeability.

Most areas of these soils are drained and used for all crops commonly grown in the county. Undrained areas are in woodland.

Representative profile of Symco silt loam, 1 to 3 percent slopes, in an uncultivated pasture 2,440 feet north and 1,290 feet west of the southeastern corner of sec. 28, T. 21 N., R. 16 E.

A1—0 to 7 inches; black (10YR 2/1) silt loam; moderate medium subangular blocky structure; friable; many roots; neutral; abrupt wavy boundary.

A2—7 to 11 inches; dark grayish brown (10YR 4/2) heavy silt loam; few fine distinct brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; friable; few roots; few coarse distinct black (10YR 2/1) worm casts; mildly alkaline; clear wavy boundary.

B21t—11 to 14 inches; dark brown (7.5YR 4/4) clay loam; few fine distinct dark grayish

brown (10YR 4/2) and yellowish red (5YR 4/6) mottles; moderate fine and medium subangular blocky structure; friable; few roots; thin patchy clay films; few coarse prominent black (10YR 2/1) worm casts; mildly alkaline; abrupt wavy boundary.

B22t—14 to 22 inches; reddish brown (5YR 4/4) heavy clay loam; few fine distinct dark grayish brown (10YR 4/2) and yellowish red (5YR 4/6) mottles; moderate fine subangular blocky structure; friable; medium continuous clay films; mildly alkaline; clear wavy boundary.

B3t—22 to 25 inches; reddish brown (5YR 4/4) clay loam; few fine distinct dark grayish brown (10YR 4/2) and yellowish red (5YR 4/6) mottles; weak coarse subangular blocky structure; firm; thin patchy clay films; many coarse prominent yellow (10YR 8/6) calcium carbonate segregations; slight effervescence; moderately alkaline; clear wavy boundary.

C—25 to 60 inches; reddish brown (5YR 4/4) heavy loam; few fine distinct dark grayish brown (10YR 4/2) and yellowish red (5YR 4/6) mottles; massive; firm; many coarse prominent yellow (10YR 8/6) calcium carbonate segregations; violent effervescence; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness, but generally is 22 to 28 inches thick. The depth to free carbonates is generally the same. The A horizon is neutral or mildly alkaline, and the B and C horizons are mildly alkaline to moderately alkaline.

The A horizon is very dark brown or black and is 6 to 20 inches thick. The B horizon is clay loam or silty clay loam and less commonly is heavy silt loam. The C horizon is heavy loam, clay loam, or silty clay loam.

Symco soils are near Bonduel, Hortonville, and Pella soils. They lack the limestone bedrock substratum that is characteristic of Bonduel soils. Symco soils are wetter than Hortonville soils and not so wet as Pella soils.

SyA—Symco silt loam, 1 to 3 percent slopes. This nearly level and gently sloping soil is in depressions and drainageways on glacial till plains. In drainageways, most areas are long and narrow, and in depressions they are irregular in shape. Areas range from 2 to 160 acres in size.

Included with this soil in mapping are small areas of Hortonville and Pella soils.

This soil has high natural fertility and moderate organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow. Wetness is the main limitation to use of this soil. It needs to be drained for best crop growth.

Most areas of this soil are used for crops. This soil is well suited to crops commonly grown in the county if it is drained. It is also well suited to woodland production. Capability unit IIw–2; woodland group 1o.

Symco Variant

The Symco variant consists of somewhat poorly drained, nearly level and gently sloping soils on outwash plains. The natural vegetation was northern red oak, white oak, hickory, ash, and basswood.

In a representative profile the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer is brown mottled silt loam about 4 inches thick. The subsoil is about 14 inches thick. It is dark yellowish brown mottled silty clay loam in the upper part and brownish yellow mottled sandy loam in the lower part. The substratum is yellowish brown mottled sand and gravel to a depth of about 60 inches.

Symco variant soils have moderate available water capacity. Permeability is moderate in the solum and rapid in the substratum.

Representative profile of Symco variant, 0 to 3 percent slopes, in a cultivated field now idle, 400 feet west and 1,380 feet north of the southeastern corner of sec. 36, T. 21 N., R. 16 E.

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

A2—8 to 12 inches; brown (10YR 5/3) silt loam; many coarse faint grayish brown (10YR 5/2) and common fine prominent yellowish brown (10YR 5/6) mottles; thin platy structure parting to very fine subangular blocky; friable; many medium distinct very dark grayish brown (10YR 3/2) worm casts; neutral; clear wavy boundary.

B2t—12 to 22 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; thin patchy clay films; neutral; clear wavy boundary.

IIB3t—22 to 26 inches; brownish yellow (10YR 6/6) sandy loam; few medium prominent light gray (10YR 7/1) and few medium distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; very friable; clay bridging between sand grains; violent effervescence; mildly alkaline; clear wavy boundary.

IIC—26 to 60 inches; yellowish brown (10YR 5/4) sand and gravel; few medium distinct reddish yellow (7.5YR 6/6) mottles; single grained; loose; violent effervescence; moderately alkaline.

The solum thickness and the depth to sand and gravel are 24 to 40 inches. The A1 or Ap horizon is very dark brown or very dark grayish brown and is 6 to 10 inches thick. The B horizon is sandy loam, silty clay loam, or clay loam. The C horizon is sand and gravel.

Symco variant soils are near Casco and Will soils. They have a thicker solum and are wetter than Casco soils and are better drained than Will soils.

SzA—Symco variant, 0 to 3 percent slopes. This nearly level and gently sloping soil is in depressions along streams on outwash plains. Most areas are long and narrow and range from 2 to 40 acres in size.

Included with this soil in mapping are some areas of poorly drained soils.

This soil has high natural fertility and moderate

organic-matter content. The effective rooting depth is limited by the water table and the underlying gravelly substratum. Runoff is very slow. Wetness is the major limitation to use of this soil. It can be drained by open ditches or by tile lines.

Most drained areas of this soil are used for crops or pasture. Undrained areas remain in woodland or wildlife habitat. This soil is well suited to most crops commonly grown in the county. Capability unit IIw–5; woodland group 2w.

Udifluvents

Uf—Udifluvents. These are well drained to somewhat poorly drained, nearly level and gently sloping soils adjacent to well defined, nondissected stream channels. Udifluvents consist of loamy unconsolidated alluvium that is mostly stratified and that ranges widely in texture. Most areas are elongated and range from 5 to 80 acres in size. Slopes are 0 to 4 percent.

Included in mapping are small areas of Fluvaquents.

These soils vary too much to rate for permeability. The available water capacity and organic-matter content are mostly moderate, and natural fertility is high. These soils are subject to frequent flooding, and some areas have a seasonal high water table.

Most areas of these soils are uncultivated and are used for pasture, woodland, or wildlife habitat. Some areas are cultivated and are suited to most farm crops commonly grown in the county if the soil is protected from overflow. Capability unit IIw–11; woodland group 3o.

Udorthents

Uo—Udorthents. These are well drained, nearly level and gently sloping soils in filled and smoothed areas where the fill varies but is mainly loamy and clayey. Most areas are square or rectangular and range from 3 to several hundred acres in size.

Included in mapping are some areas where the fill includes cinders, broken concrete, and industrial waste.

Although they are mainly loamy and clayey, Udorthents vary too much to rate for available water capacity, organic-matter content, or natural fertility. Permeability varies but is mostly slow or very slow.

Most areas of Udorthents are in urban centers, especially in downtown business and industrial areas and around shopping centers. Not placed in a capability unit or a woodland group.

Wainola Series

The Wainola series consists of somewhat poorly drained, nearly level and gently sloping soils on lacustrine and outwash plains. The present vegetation is chiefly northern red oak, aspen, willow, swamp oaks, and shrubs and grasses.

In a representative profile the surface layer is black loamy fine sand about 9 inches thick. The subsurface layer is dark grayish brown fine sand about 8 inches thick. The subsoil is dark brown mottled fine sand in the upper 6 inches and strong brown mottled fine sand in the lower 10 inches. The substratum is yellowish brown mottled fine sand to a depth of about 60 inches.

Wainola soils have low available water capacity and rapid permeability.

Most areas of these soils are in woodland or undrained pasture.

Representative profile of Wainola loamy fine sand, 0 to 3 percent slopes, in an uncultivated area 1,320 feet south and 660 feet east of the northwestern corner of sec. 6, T. 24 N., R. 17 E.

A1—0 to 9 inches; black (10YR 2/1) loamy fine sand; moderate very fine granular structure; very friable; many roots; strongly acid; abrupt smooth boundary.

A2—9 to 17 inches; dark grayish brown (2.5Y 4/2) fine sand; weak thin platy structure parting to weak fine subangular blocky; very friable; many roots; few medium distinct black (10YR 2/1) worm casts; strongly acid; clear smooth boundary.

B21ir—17 to 23 inches; dark brown (7.5YR 4/4) fine sand; few fine faint brown (10YR 4/3) and few fine distinct strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; very friable; medium acid; clear smooth boundary.

B22ir—23 to 33 inches; strong brown (7.5YR 5/6) fine sand; few fine faint yellowish brown (10YR 5/6) and few fine prominent light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.

C—33 to 60 inches; yellowish brown (10YR 5/4) fine sand; few fine distinct yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; single grained; loose; neutral.

The solum is 18 to 34 inches thick and is strongly acid to slightly acid. The C horizon is medium acid or slightly acid. The surface layer in cultivated areas is 6 to 10 inches thick. In undisturbed areas the A1 horizon is 3 to 9 inches thick. The A1 or Ap horizon is black, very dark brown, very dark grayish brown, or very dark gray. The B and C horizons are dominantly fine sand but in some areas are loamy fine sand.

Wainola soils are near Deford and Rousseau soils. They form a drainage sequence with the well drained to moderately well drained Rousseau soils and poorly drained Deford soils.

WaA—Wainola loamy fine sand, 0 to 3 percent slopes. This nearly level and gently sloping soil is on lacustrine and outwash plains. Most areas are irregular in shape and range from 2 to 600 acres in size.

Included with this soil in mapping are a few small areas of Deford and Rousseau soils. Also included are some small areas where the surface layer is fine sandy loam and small areas that have silt and fine sand stratified layers in the subsoil and substratum.

This soil has low natural fertility and high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow. Wetness is the main limitation to use of this soil. Surface drainage can be used to remove excess water.

Most of the areas of this soil that are undrained are used for pasture or woodland. Drained areas are used for crops. This soil is poorly suited to most crops

commonly grown in the county. It is suited to wood crop production. Capability unit IVw–5; woodland group 3w.

Will Series

The Will series consists of poorly drained, nearly level soils on outwash plains. These soils formed under a mixed vegetation of red maple and ash and marshy vegetation of sedges and reeds.

In a representative profile the surface layer is black silt loam about 10 inches thick. The subsoil is dark gray mottled loam about 16 inches thick. The substratum is grayish brown mottled sand and gravel to a depth of about 60 inches.

Will soils have low available water capacity. Permeability is moderate in the subsoil and rapid in the substratum.

Most areas of these soils are in woodland or used for wildlife habitat. Some cleared areas are used for late summer pasture.

Representative profile of Will silt loam, in an uncultivated drainageway 1,730 feet north and 200 feet east of the southwestern corner of sec. 20, T. 21 N., R. 15 E.

A1—0 to 10 inches; black (10YR 2/1) silt loam; moderate fine granular structure; friable; many roots; neutral; abrupt wavy boundary.

B21g—10 to 21 inches; dark gray (5Y 4/1) loam; few fine prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; common fine distinct black (10YR 2/1) worm casts; neutral; gradual smooth boundary.

B22g—21 to 26 inches; dark gray (5Y 4/1) loam; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; common coarse prominent white (10YR 8/1) lime segregations in the lower part; neutral; abrupt irregular boundary.

IIC—26 to 60 inches; grayish brown (2.5Y 5/2) sand and gravel; many coarse prominent dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; single grained; loose; violent effervescence; moderately alkaline.

The solum ranges from 24 to 40 inches in thickness, but is commonly 24 to 28 inches thick. The A and B horizons are slightly acid to moderately alkaline. The A1 horizon is very dark gray, very dark grayish brown, very dark brown, or black and is about 10 to 16 inches thick. The B2 horizon is silt loam, loam, or silty clay loam. The IIC horizon is sand and gravel or gravelly loamy sand. In some pedons very coarse sand and some gravel are in the substratum.

Will soils are near and are wetter than Casco and Symco soils.

Wb—Will silt loam. This nearly level soil is in drainageways and depressions on outwash plains. Most areas are long and narrow and range from 2 to 80 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are some small areas of soils that have a higher amount of clay in the surface layer and subsoil and some areas of soils that have a thin organic surface layer.

This soil has high natural fertility and organic-matter content. The effective rooting depth is limited by the water table and, in drained areas, by the sand and gravel substratum. Runoff is very slow or ponded. This soil has a high water table and is subject to stream overflow in spring and in late fall. Surface drainage is the best way to remove excess water.

Most areas of this soil are in woodland or used for wildlife habitat. Some cleared areas are used for late summer pasture. Drained areas are well suited to most crops commonly grown in the county. Capability unit IIw–5; woodland group 4w.

Winneconne Series

The Winneconne series consists of well drained and moderately well drained, nearly level to sloping soils on lacustrine plains. The natural vegetation was prairie grasses, but areas that were protected from fire have tree species which include maple, oak, elm, ash, and basswood.

In a representative profile the surface layer is very dark brown silty clay loam about 9 inches thick. The subsoil is about 22 inches thick. It is dark reddish brown silty clay in the upper part and reddish brown clay in the lower part. The substratum is dark reddish brown clay to a depth of about 60 inches.

Winneconne soils have moderate available water capacity and slow or very slow permeability.

Most areas are used for all cultivated crops commonly grown in the county.

Representative profile of Winneconne silty clay loam, 0 to 2 percent slopes, in cropland 960 feet north and 132 feet west of the southeastern corner of sec. 7, T. 22 N., R. 15 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam; moderate very fine granular structure; friable; few roots; neutral; abrupt smooth boundary.

A12—7 to 9 inches; very dark brown (10YR 2/2) silty clay loam; moderate medium granular structure; friable; few roots; neutral; clear smooth boundary.

B21t—9 to 13 inches; dark reddish brown (5YR 3/3) silty clay; moderate very fine angular blocky structure; firm; thin patchy clay films on vertical faces of peds; few roots; neutral; abrupt smooth boundary.

B22t—13 to 27 inches; reddish brown (5YR 4/3) clay; strong fine and medium subangular blocky structure; very firm; medium continuous clay films on horizontal and vertical faces of peds; neutral; clear smooth boundary.

B3t—27 to 31 inches; reddish brown (5YR 4/4) clay; strong coarse subangular blocky structure; firm; thin patchy clay films on vertical faces of peds; mildly alkaline; clear smooth boundary.

C—31 to 60 inches; dark reddish brown (5YR 3/4) clay; massive; firm; common coarse distinct light reddish brown (5YR 6/4) and few medium prominent white (10YR 8/1)

soft lime segregations; violent effervescence; mildly alkaline.

The solum thickness and the depth to free carbonates typically are 25 to 35 inches. The solum is slightly acid to mildly alkaline. The C horizon is mildly alkaline or moderately alkaline. The A horizon is very dark brown, dark brown, or very dark grayish brown and is 6 to 10 inches thick. The B horizon is mostly clay except the upper part is silty clay in some pedons.

Winneconne soils are near Manawa, Manistee, and Poygan soils. They have less sand in the A and B horizons than Manistee soils and are not so wet as Manawa and Poygan soils.

WnA—Winneconne silty clay loam, 0 to 2 percent slopes. This nearly level soil is on lacustrine plains. Most areas are irregular in shape and range from 5 to 300 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are some small areas of Borth, Manawa, and Poygan soils.

This soil has high natural fertility and moderately low organic-matter content. The effective root zone is deep. Runoff is slow. Because of the clayey subsoil, rainwater does not readily enter this soil and the surface layer becomes saturated. This soil has poor tilth where it has been cultivated when wet. Surface drainage helps remove excess water. Minimum tillage, incorporating crop residue into the soil, and applying manure help maintain good soil tilth.

Most areas of this soil are cleared and used for agricultural crops. This soil is well suited to all crops commonly grown in the county. Capability unit IIs–7; woodland group 2c.

WnB—Winneconne silty clay loam, 2 to 6 percent slopes. This gently sloping soil is on lacustrine plains. Most areas are irregular in shape and range from 3 to 400 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are small areas of Borth and Manawa soils. Also included are some small areas that are severely eroded.

This soil has high natural fertility and moderately low organic-matter content. The effective root zone is deep. Runoff is medium. Saturation of the surface layer and erosion caused by slow permeability of the subsoil are the main hazards. Maintaining good soil tilth is also a problem. Using minimum tillage, applying manure, and plowing under crop residue are ways to maintain good soil tilth. Surface drainage helps to remove excess water.

Most areas of this soil are used for crops. This soil is well suited to all crops commonly grown in the county. Capability unit IIe–6; woodland group 2c.

WnC2—Winneconne silty clay loam, 6 to 12 percent slopes, eroded. This sloping soil is on hillsides on lacustrine plains. Most areas are long and narrow and range from 2 to 60 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are small areas of severely eroded Winneconne soils on knobs and the edges of escarpments.

This soil has high natural fertility and moderately low organic-matter content. The effective root zone is deep. Runoff is rapid. Erosion is the main hazard. Good tilth is difficult to maintain on this soil. Contour stripcropping and waterways help control runoff and erosion. Minimum tillage, applying manure, and plowing under crop residue help maintain good soil tilth.

Most areas of this soil are used for crops or permanent pasture. This soil is suited to most crops commonly grown in the county. Capability unit IIIe–6; woodland group 2c.

Zittau Series

The Zittau series consists of somewhat poorly drained, nearly level and gently sloping soils in lacustrine basins and on terraces. These soils formed under mixed hardwood vegetation consisting of maple, ash, and elm.

In a representative profile the surface layer is very dark grayish brown silty clay loam about 8 inches thick. The subsoil is about 24 inches thick. It is dark brown mottled silty clay loam in the upper part and reddish brown mottled silty clay in the lower part. The substratum is dark brown sand to a depth of about 60 inches.

Zittau soils have moderate available water capacity. Permeability is slow in the clayey subsoil and rapid in the sandy substratum.

Most areas of these soils are drained and used for all crops commonly grown in the county. Undrained areas are in woodland.

Representative profile of Zittau silty clay loam, 0 to 3 percent slopes, in an idle field that was once cultivated, 2,640 feet north and 2,500 feet east of the southwestern corner of sec. 19, T. 24 N., R. 15 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

B1—8 to 11 inches; dark brown (7.5YR 4/4) silty clay loam; many medium distinct brown (7.5YR 5/2) and strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

B21t—11 to 22 inches; dark brown (7.5YR 4/4) silty clay; many fine distinct brown (7.5YR 5/2) and strong brown (7.5YR 5/6) mottles; weak medium blocky structure; firm; thin patchy clay films; neutral; clear wavy boundary.

B22t—22 to 28 inches; reddish brown (5YR 4/4) silty clay; many fine distinct strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) mottles; moderate fine blocky structure; very firm; thick clay films; neutral; gradual wavy boundary.

B3t—28 to 32 inches; reddish brown (5YR 4/3) silty clay; common fine distinct and prominent reddish yellow (7.5YR 6/6) and grayish brown (10YR 5/2) mottles; weak medium blocky structure; very firm; neutral; abrupt smooth boundary.

IIC—32 to 60 inches; dark brown (7.5YR 4/4) medium sand; single grained; loose; few

soft calcium carbonate segregations; moderately alkaline.

The solum ranges from 24 to 40 inches thick but is commonly 25 to 36 inches thick. The A and B horizons are medium acid to neutral, and the IIC horizon is neutral to moderately alkaline.

The A horizon is very dark brown, very dark grayish brown, or black and is 6 to 20 inches thick. The B horizon is silty clay or clay. The C horizon is typically stratified sand and some gravel, but includes sand or loamy sand in some pedons.

Zittau soils are near Borth and Poy soils. They form a drainage sequence with the well drained Borth soils and the poorly drained Poy soils.

ZtA—Zittau silty clay loam, 0 to 3 percent slopes. This nearly level and gently sloping soil is in lacustrine basins and on terraces. Most areas are irregular in shape and range from 5 to 100 acres in size.

Included with this soil in mapping are some small areas of Zittau soils where the surface layer is silt loam. Some areas of Poy soils are also included.

This soil has high natural fertility and moderate organic-matter content. The effective rooting depth is limited by the water table or, in drained areas, by the sandy substratum. Runoff is very slow. Wetness is the main limitation to use of this soil. Suitable drainage can be used to remove excess water.

Most areas of this soil are used for pasture or crops. With drainage, this soil is well suited to most crops commonly grown in the county. Capability unit IIw–5; woodland group 3c.

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 tank disposal 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, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for 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.

Management for Crops and Pasture

Agriculture is an important part of the economy of Outagamie County. In 1969, the market value of all farm products sold in the county was approximately 32 million dollars. This is an increase of about a third over the value of agricultural products in 1964.

By 1969, approximately 73 percent of the land was farmed, as against 80 percent in 1964. Both the number of farms and total farm acreage are declining; however, the average size of a farm is increasing. In 1969 there were 2,140 farms in the county with an average size of 139.2 acres. Much of the acreage has been taken from farms for urban development, especially in the southern half of the county.

Approximately two-thirds of the total farm production is dairy products. Another major source of income is the sale of cattle, calves, hogs, and sheep. Poultry products are also an important source of farm income.

Hay made up the largest acreage of crops harvested in 1969. The acreage in hay declined slightly from 1965, but there was an increase in the total tons of hay produced. Corn ranked second highest in the county in acreage. Although soybean production increased significantly from 1964 to 1969, the acreage of this crop is minor. Other important crops are vegetables for canning, cabbage, and small grain, especially oats. About one-tenth of the total farm acreage is in permanent pasture. Other sources of farm income are forest products, orchards, and nursery stock.

Basic practices of management

The soils of Outagamie County vary in their suitability for specific crops and require widely different management. Some basic management practices are needed, however, for most of these soils.

Successful farming requires the application of basic principles of soil management. The soils need to be maintained in good tilth by returning organic matter and furnishing plant nutrients, and erosion must be controlled. Which basic practices are needed on a particular farm depends on the number and kind of live-

stock, machinery and related equipment, labor requirements, and available capital.

The following paragraphs discuss the basic practices of good soil management as they apply to the survey area. Such basic practices are needed for maintaining good soil structure, tilth, and fertility; for providing drainage and controlling erosion; for selecting a suitable cropping system; and for pasture management. Consideration should also be given to the practices suggested in the capability units. Technical assistance in planning and applying practices suitable for the soils on a particular farm can be obtained from a local representative of the Soil Conservation Service or of the Extension Service.

Soil structure and tilth.—Soils that have good structure and tilth take in and hold more available water than soils in which tilth has been destroyed by plowing. Good tilth also helps decrease runoff and erosion. It provides a favorable seedbed where soils have granular or subangular blocky structure. Such a seedbed absorbs moisture and favors the vigorous germination and emergence of small seeded crops. In most soils in Outagamie County, especially those of the glacial uplands, tilth has deteriorated because of a decrease in organic matter and an increase of erosion caused by tillage. Heavy manuring, more years of hay in the rotation, and minimum tillage are practices that help maintain the tilth of cultivated soils.

The organic-matter content of Outagamie County soils ranges from less than 1 percent to more than 20 percent. The well-decomposed organic matter, or humus, in the soil has a great effect on the ability of a soil to hold nutrients. It also influences the infiltration rate, tilth, and available water capacity of the surface layer. The suggested rates of application of many of the newer herbicides are based on the organic-matter content of the surface layer. Crop damage or lack of weedkill results if the application rates are not followed.

Most cultivated soils in Outagamie County need additional organic matter. Application of barnyard manure, plowing under the green manure and crop residue, and more years of hay in the cropping system help maintain or increase organic-matter content in the soil. The addition of organic matter is especially beneficial to sandy soils because it helps to increase the available water capacity and natural fertility. It is beneficial to upland soils because it increases the water intake and decreases runoff and erosion.

The general level of organic matter is given for each soil series in the section "Descriptions of the Soils." The classes of organic matter, as used in this survey, are defined in the Glossary.

Maintaining fertility.—Fertility can be maintained or increased by the use of a cropping system that provides for regular additions of organic matter and commercial fertilizers to the soils. The amount and kind of commercial fertilizer to be applied depend on the supply of plant nutrients in the soil, the ability of the soil to hold nutrients, the available water capacity, the kinds of crops to be grown, and the crop rotation. If lime and fertilizer are needed, the amount of lime and the kind and amount of fertilizer to be applied should be determined by soil tests. An indirect benefit of a higher level of fertility is the production of more plant litter and organic matter, which reduces erosion and promotes good tilth. Heavy applications of lime and potassium are usually needed for alfalfa, hay, and pasture. Changes in soil acidity affect the availability of plant nutrients. If the soil is neutral, phosphorus and nitrogen are more readily available to plants. Less lime is generally required to neutralize sandy soils, such as the Rousseau and Shawano soils, than to neutralize silty or clayey soils. However, the lime leaches out more quickly from sandy soils, making more frequent applications of lime necessary.

Ratings of available water capacity to a depth of 5 feet of soil or to bedrock are given in the capability unit descriptions and are also listed for each series in the section "Descriptions of the Soils." These ratings are defined in the "Glossary." If the water required by a crop during its peak use period is known, the number of days that a given soil will support the crop without rainfall can be determined from the ratings of available water capacity. For example, assume that alfalfa and corn require 0.30 inch of water per day during their peak use period. The soils that have a high available water capacity (between 9 and 12 inches) will support these crops for 30 to 40 days without rain if their moisture content is at field capacity at the start of this period. In contrast, soils that have a low available water capacity (between 3 and 6 inches) will support these crops for only 10 to 20 days under similar conditions. This is a very important consideration in determining fertilization levels and plant population where no irrigation is planned. A high level of fertilization is generally not justified on soils that have very low or low available water capacity, because crop growth is limited by the lack of water. In addition, such soils are coarse textured or have a thin solum, and excessive additions of nitrate fertilizer can be quickly leached from these soils and may contaminate surface or ground water.

Providing drainage.—Drainage can be improved in most of the wet soils in the county if there are suitable outlets. Draining a wet soil makes it more favorable for growth of upland plants and soil organisms which, in turn, improves the subsoil structure. Furthermore, it reduces the damage to roots of plants, particularly alfalfa and sweetclover, that results from alternate freezing and thawing. Drainage increases the root zone by lowering the seasonal high water table, and thereby makes more nutrients available to plants. If excess water is drained, a soil warms earlier in spring because surface evaporation is reduced and less heat is dissipated. Inadequately drained soils are likely to be 5 to 15 degrees cooler in spring than well drained soils.

Drainage is provided by surface drains, tile drains, open-ditch drains, or a combination of these. Diversions can be used in some places to protect soils from runoff from adjacent areas. Soils on flood plains need additional protection from flooding.

Some soils, such as those of the Angelica, Pella, Solona, and Symco series, are well suited to both surface and tile drainage. Soils formed in lacustrine sediment, such as those of the Keowns series, generally are not suited to tile drainage unless the silt and fine sand are prevented from entering into the tile lines. These soils are well suited to surface and open-ditch drainage. There is a hazard of over-draining sandy soils, such as

those of the Deford series, and causing droughtiness. Organic soils, such as those of the Carbondale series, are well suited to both tile and open-ditch drainage, but there is a hazard of frost damage to crops grown on them.

Subsidence is a hazard if organic soils are drained. It lowers the organic soils in Wisconsin approximately ½ to 1 inch a year. The Carbondale soils have a high subsidence potential. Subsidence is caused mainly by loss of ground water buoyancy, consolidation, compaction, and biochemical activity. The first three factors result in initial subsidence, which normally occurs within 3 years after the water table is lowered. Initial subsidence of organic soils typically reduces the thickness of the material above the water table by one-half. Biochemical oxidation of the organic material then causes continued subsidence at a fairly uniform rate until either mineral material or the water table is reached. The rate of subsidence increases with depth to the water table—it can be stopped or slowed by keeping the water level as high as possible for the proposed soil use.

Controlling erosion.—The majority of the cultivated soils in the survey area are subject to erosion. The erosion hazard ranges from slight to very severe. There are several methods of controlling erosion on different kinds of soil. One of the most effective methods is maintaining a good vegetative cover, either a growing crop or plant residue from a previous crop. Other practices to be used individually or in various combinations are terracing, contour tillage, contour stripcropping, minimum tillage, use of grassed waterways, and growing a sod cover crop during critical periods of the year. Soil blowing can be controlled by stripcropping at right angles to the prevailing winds, stubble mulching, growing cover crops, and planting shelterbelts.

Suitable cropping system.—Soils of the entire farm should be considered when planning a cropping system. Soils that have few or slight limitations can be cropped intensively; that is, row crops can be grown year after year or frequently in relation to hay and small grain. These soils respond well to lime and fertilizer and are capable of producing high yields, and there is little or no erosion hazard. Steep, sandy, or wet soils are more limited in use. A cropping system should be used on these soils that fits the limitations and protects them from damage.

Managing pasture.—Good management of pasture is needed to provide high quality forage and to maintain vigorous plants. The goal of grazing management for grass-legume pasture is to maintain legumes in the stand for as long as possible. Suitable management practices for tame grass as well as for legume-grass pasture are as follows:

1. Delay grazing (a) in spring until upright legumes, such as alfalfa, are 8 to 10 inches tall and until prostrate legumes, such as Ladino clover, are 6 to 8 inches high; and (b) after prolonged rainy spells when the clayey soils are saturated.
2. Divide the fields to permit rotational grazing and allow plants to recover between grazing periods. Short grazing periods are better for legumes because there is less trampling, forage waste, and soil compaction than with long grazing periods.
3. Remove animals when most plants have been grazed to a height of 2 inches.
4. Clip stubble if the pasture has been unevenly grazed or if tall grass is left in bunches that might smother the legumes.
5. Do not graze legume pastures between September 1 and October 10.

The best yields can be maintained for established pasture if the pasture is topdressed, according to needs indicated by a soil test. On grass pasture that contains no legumes, it is beneficial to topdress with nitrogen early in spring and to delay grazing until the grass is 4 inches tall.

Basic practices needed to improve perennial pasture by seeding of legumes and grasses are as follows:

1. Lime and fertilize according to soil tests. Apply lime, if needed, several months before seeding. Apply fertilizer at the time of seeding.
2. Remove stones or other obstructions, if feasible, to facilitate seedbed preparation and future management.
3. Start preparing the seedbed several months in advance of seeding to eliminate unwanted species and to allow the lime, if applied, to work into the soil.
4. On sloping land, work on the contour and leave mulch on the surface to lessen the hazard of erosion.
5. Inoculate the legume seed.
6. Use small grain in the seeding mixture to aid in erosion control. Graze the nurse crop when it is about 8 to 10 inches high to keep it from competing with young forage plants.
7. Do not graze new seeding when the field is wet or during the month of September. Avoid overgrazing.

Delay spring grazing on wet soils or after heavy rains until the soil becomes firm. Overgrazing sandy soils is hazardous. Because these soils are droughty and produce a relatively thin vegetative cover, overgrazing makes them subject to soil blowing.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops (*9*). 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 unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils 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.

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. The classes 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 careful management, 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 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, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–1 or IIIs–4. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Outagamie County are described. The capability units are not numbered consecutively, because not all of the units used in Wisconsin are in this county.

CAPABILITY UNIT I–1

This unit consists of well drained and moderately well drained, nearly level soils that have a silt loam or very fine sandy loam surface layer. These soils are on lacustrine plains.

These soils have moderate permeability and high natural fertility. They have high available water capacity and low or moderately low organic-matter content. These soils are easy to maintain and have slight limitations.

These soils are well suited to all crops commonly grown in the county. Peas, beans, cabbage, and sweet corn are frequently grown. These soils are favorable for rowcropping year after year.

The main management concern is to maintain the organic-matter content, tilth, and fertility of the soils. This can be done by manuring, fertilizing, leaving crop residue on the soil, maintaining high plant populations, and minimum tillage.

CAPABILITY UNIT IIe–1

This unit consists mainly of well drained to somewhat poorly drained, gently sloping soils that have a very fine sandy loam, fine sandy loam, or silt loam surface layer. These soils are on till plains, lacustrine plains, or in areas of the county where limestone is relatively near the surface.

These soils have moderate or moderately slow permeability and high or moderate available water capacity. The organic-matter content is low to high, and natural fertility is medium or high. The hazard of erosion is slight. Tilth is fairly easy to maintain.

These soils are well suited to all crops commonly grown in the county. Corn, oats, and alfalfa are the main crops; and cabbage, peas, beans, and sweet corn are frequently grown on the lacustrine soils. These soils are also well suited to pasture.

The management requirements are maintaining organic-matter content and fertility and controlling erosion. Manuring, fertilizing, leaving crop residue on the soil, and minimum tillage help maintain organic-matter content and fertility and reduce erosion. Stripcropping, terracing, and the use of waterways help control runoff and erosion.

CAPABILITY UNIT IIe–2

This unit consists of well drained to somewhat poorly drained, nearly level and gently sloping soils that have a loam or silt loam surface layer. These soils are on glacial till plains.

These soils have moderate or moderately slow permeability, and low to high available water capacity. They have low or moderate organic-matter content and medium or high natural fertility. The hazard of erosion is slight. The soils that have limestone bedrock at a depth of 20 to 40 inches are slightly droughty.

These soils are well suited to all crops commonly grown in the county. They are also well suited to pasture and northern hardwood timber.

The management requirements are maintaining organic-matter content, fertility, and soil structure and controlling erosion. Manuring, fertilizing, leaving crop residue on the soil, and minimum tillage help maintain organic-matter content, fertility, and soil structure. Contour stripcropping, terracing, and the use of waterways help control runoff and erosion.

CAPABILITY UNIT IIe–6

This unit consists of well drained and moderately well drained, gently sloping soils that have a loam or silty clay loam surface layer and a very firm subsoil. These soils are on glacial till and lacustrine plains.

These soils have moderately slow or slow permeability and moderate to very high available water capacity. They have a low or moderately low organic-matter content and medium or high natural fertility. The hazard of erosion is slight. Maintaining tilth is generally difficult on soils that are eroded.

These soils are used for crops, pasture, and northern hardwood timber. Corn, oats, and alfalfa are the crops commonly grown in the county.

Plowing under crop residue, manuring, and fertilizing help maintain organic-matter content, fertility, and soil tilth. Contour stripcropping, terracing, and the use of waterways help control runoff and erosion. Although not extensively used, the practice of land leveling in combination with field tile or waterways is effective in removing surface water.

CAPABILITY UNIT IIw–1

This unit consists of poorly drained, nearly level soils that have a silt loam or silty clay loam surface layer and a firm subsoil. The soils are in drainageways and depressions on glacial till and lacustrine plains.

These soils have moderate or slow permeability and moderate or high available water capacity. They have high organic-matter content and natural fertility. These soils have a high water table and are subject to frequent flooding. Soil tilth is difficult to maintain.

These soils are suited to crop production if flood protection and adequate drainage are provided. Corn is the main crop, but some oats and hay are also grown. Unimproved areas are best suited to late summer pasture, wildlife habitat, or woodland.

Surface drainage and tile drainage are used to remove excess water. Diversions are used to provide some protection from overflow. Plowing under crop residue, manuring, and fertilizing help maintain organic-matter content, fertility, and soil tilth.

CAPABILITY UNIT IIw–2

This unit consists mainly of somewhat poorly drained, nearly level and gently sloping soils that have a silt loam or silty clay loam surface layer and a friable to firm subsoil. These soils are in depressions and drainageways on glacial till and lacustrine plains and in areas of the county where limestone bedrock is relatively near the surface.

These soils have high natural fertility and moderate or high organic-matter content. They have low or high available water capacity and moderate to slow permeability. These soils have a high water table and are subject to occasional flooding.

These soils are well suited to continuous row crops if adequate drainage and protection from stream overflow are provided. Corn, oats, and hay are the crops commonly grown in the county. Undrained areas are used for pasture, wildlife habitat, or woodland.

Manuring, leaving crop residue on the soil, and minimum tillage help maintain organic-matter content and soil tilth. Diversions are used to provide protection from flooding. Surface drainage or tile drainage removes excess water.

CAPABILITY UNIT IIw–4

This unit consists of somewhat poorly drained, nearly level and gently sloping soils that have a silt loam surface layer. These soils are on broad lacustrine plains.

These soils have high available water capacity, natural fertility, and organic-matter content. They have moderate or moderately slow permeability. These soils have a high water table and are subject to occasional flooding.

Cabbage, peas, snap beans, table beets, and sweet corn are the crops commonly grown on these soils; but corn and hay are also grown. Undrained areas are used for pasture, wildlife habitat, or woodland.

Surface drainage is used to remove excess water; dikes and diversions are used to provide flood protection. Manuring, fertilizing, and plowing under crop residue help maintain soil tilth, fertility, and organic-matter content.

CAPABILITY UNIT IIw–5

This unit consists of somewhat poorly drained and poorly drained, nearly level and gently sloping soils that have a silt loam or silty clay loam surface layer and friable or firm subsoil. These soils are on outwash plains.

These soils have low or moderate available water capacity. They have moderate or high organic-matter content and high natural fertility. Permeability is moderate or slow in the subsoil and rapid in the substratum. These soils have a high water table and are subject to occasional flooding.

Corn and hay are the main crops commonly grown in the county. Unprotected areas are generally suited to pasture, wildlife habitat, or woodland.

Minimum tillage, leaving crop residue on the soil, manuring, and fertilizing help maintain organic-matter content, fertility, and soil structure. Diversions are used to provide protection from flooding; surface drainage helps remove excess water.

CAPABILITY UNIT IIw–11

This unit consists of well drained to somewhat poorly drained, nearly level and gently sloping soils that have mainly a silt loam surface layer. These soils are on stream benches and alluvial bottoms that are subject to stream overflow.

These soils have moderate or high available water capacity. They have moderate organic-matter content and high natural fertility. Permeability is moderate or varies too much to rate. These soils are subject to frequent flooding.

These soils are suited to all crops commonly grown in the county if adequate flood protection is provided. They are used for pasture, wildlife habitat, or woodland if intensive management is not used.

Manuring, fertilizing, leaving crop residue on the soil, and minimum tillage are practices that maintain organic-matter content, fertility, and soil structure. Diversions reduce runoff from adjacent slopes; dikes are used to provide protection from stream overflow. Drainage helps to assure dependable crop production.

CAPABILITY UNIT IIs–7

This unit consists of well drained and moderately well drained, nearly level and gently sloping soils that have a silt loam or silty clay loam surface layer and a very firm subsoil. These soils are on lacustrine plains.

These soils have moderately slow to very slow permeability and moderate to very high available water capacity. They have moderately low or low organic-matter content and high natural fertility. Maintaining good tilth is generally difficult on the soils in this unit that have a silty clay loam surface layer.

Corn is the main crop, but oats and alfalfa are also grown. These soils can produce good pasture.

Plowing down crop residue, manuring, and fertilizing help maintain the organic-matter content, fertility, and good tilth of the soil.

CAPABILITY UNIT IIIe–1

This unit consists of well drained, sloping soils that have a fine sandy loam or silt loam surface layer. These soils are on glacial till plains or in areas of the county where limestone is relatively near the surface.

These soils have low organic-matter content and medium or high natural fertility. They have moderate or moderately slow permeability and moderate or high available water capacity. The hazard of erosion is moderate.

These soils are suitable for crops commonly grown in the county. They are also suitable for pasture and hardwood timber production.

Minimum tillage, leaving crop residue on the soil, manuring, and fertilizing help maintain the organic-matter content, fertility, moisture, and structure of the soil. Contour stripcropping, terracing, crop rotation, and the use of grassed waterways help control runoff and erosion.

CAPABILITY UNIT IIIe–2

This unit consists of well drained and moderately well drained, sloping soils that have a loam or silt loam surface layer and a firm subsoil. These soils are on till plains that, in places, are relatively shallow to limestone bedrock.

These soils have low organic-matter content and medium natural fertility. They have low or high available water capacity and moderate to moderately slow or slow permeability. The hazard of erosion is moderate. The soil that is underlain by bedrock is slightly subject to drought. If properly managed, these soils are fairly easy to maintain in good tilth.

These soils are suitable for all crops commonly grown in the county. Corn, oats, and hay are the main crops. These soils are also suitable for pasture and hardwood timber.

Minimum tillage, leaving crop residue on the soil, manuring, and fertilizing help maintain the organic-matter content, fertility, moisture, and structure of the soil. Contour stripcropping, terracing, crop rotation, and the use of waterways help control runoff and erosion.

CAPABILITY UNIT IIIe–3

This unit consists of well drained and somewhat excessively drained, gently sloping soils that have a loam or silt loam surface layer. These soils are on outwash plains or glacial till plains in areas of the county where limestone bedrock is relatively close to the surface.

These soils have moderate permeability and low available water capacity. They have moderately low or low organic-matter content and low or medium natural fertility. Water erosion is a slight hazard, and drought is a moderate to severe hazard.

These soils are suited to the more drought-resistant hay crops and to crops, such as oats, that mature before the hot, dry part of the summer. Some corn is also grown. These soils are also suited to pasture and some hardwood timber.

Leaving crop residue on the soil, manuring, and fertilizing help maintain the organic-matter content, fertility, and moisture of the soil. Contour stripcropping, crop rotation, and the use of grassed waterways help control runoff and erosion.

CAPABILITY UNIT IIIe–4

This unit consists of well drained and moderately well drained, gently sloping soils that have a loamy fine sand or fine sandy loam surface layer. These soils are on glacial till plains.

These soils have rapid permeability in the upper sandy layer and moderate or slow permeability in the substratum. They have low organic-matter content and low natural fertility and moderate available water capacity. The hazard of erosion is slight. These soils are subject to blowing and are moderately droughty.

These soils are best suited to the more drought-resistant hay crops and to crops, such as oats, that mature before the hot, dry part of the summer. Some corn is also grown. These soils are well suited to pasture in early spring or late fall. Pines grow well on these soils.

Plowing under crop residue, manuring, and fertilizing help maintain the organic-matter content, fertility, and moisture of the soil. Stripcropping, crop rotations, the use of waterways, and shelterbelts reduce runoff and erosion and control soil blowing.

CAPABILITY UNIT IIIe–6

This unit consists of well drained and moderately well drained, sloping soils that have a silt loam or silty clay loam surface layer and a firm subsoil. These soils are on glacial till or lacustrine plains.

These soils have moderately slow to very slow permeability and moderate available water capacity. They have low or moderately low organic-matter content and high natural fertility. The hazard of erosion is moderate except if the soils are in pasture or woodland. Maintaining good tilth is difficult in some areas of these soils because of the high percentage of clay.

These soils are suited to all crops commonly grown in the county.

Plowing under crop residue, manuring, and fertilizing help maintain the tilth, organic-matter content, and fertility of the soil. Contour stripcropping, crop rotation, and the use of waterways control runoff and erosion.

CAPABILITY UNIT IIIe–7

This unit consists of well drained and somewhat excessively drained, sloping and moderately steep soils that have a fine sandy loam or loamy sand surface layer. These soils are on outwash plains or till plains where sandstone bedrock is relatively close to the surface.

These soils have moderate to moderately rapid

permeability and low or moderate available water capacity. They have low organic-matter content and low natural fertility. These soils are moderately droughty and are subject to blowing. The hazard of erosion is moderate.

These soils are suited to the more drought-resistant hay crops and to crops, such as oats, that mature before the hot, dry part of the summer. They are also suited to pasture. Pines grow very well on these soils.

Leaving crop residue on the soil, manuring, fertilizing, and minimum tillage help maintain the organic-matter content, fertility, and moisture of the soils. Contour stripcropping and crop rotation control runoff, water erosion, and soil blowing.

CAPABILITY UNIT IIIw–3

Keowns silt loam is the only soil in this unit. This nearly level soil is on lacustrine plains. It has 0 to 2 percent slopes.

This soil has moderate permeability and high available water capacity. It has high organic-matter content and high natural fertility. The hazard of flooding is severe. This soil has a high water table.

This soil is suited to all crops commonly grown in the county if adequate drainage and flood protection are provided. Cabbage, sweet corn, peas, snap beans, carrots, and table beets are the main crops; but some corn, oats, and hay crops are also grown. Unimproved areas are suited to pasture, wildlife habitat, or woodland.

Fertilizing and manuring help maintain the organic-matter content, fertility, and good tilth of the soil. Surface drainage removes excess water; dikes or diversions are used to provide protection from flooding.

CAPABILITY UNIT IIIw–6

Allendale loamy fine sand, 0 to 3 percent slopes, is the only soil in this unit. This soil is on lacustrine and glacial till plains.

This soil has rapid permeability in the upper part and slow permeability in the substratum. It has moderately low organic-matter content, low natural fertility, and moderate available water capacity. This soil has a high water table and is subject to occasional flooding.

This soil is suited to all crops commonly grown in the county if adequate drainage and flood protection are provided. Specialty crops, such as cabbage, sweet corn, peas, snap beans, carrots, and table beets, are sometimes grown. Unimproved areas are best suited to pasture, wildlife habitat, or woodland.

Fertilizing and manuring help maintain organic-matter content, fertility, and soil structure. Diversions are used to provide protection from flooding; surface drains or tile drains or both can be used to remove excess water. Where tiles are used, measures should be taken to prevent the tile from clogging after installation.

CAPABILITY UNIT IIIs–4

This unit consists of well drained and somewhat excessively drained, gently sloping soils that have a fine sandy loam or loamy sand surface layer. These soils are on outwash plains and till plains in areas where sandstone bedrock is relatively close to the surface.

These soils have moderately rapid permeability and low or moderate available water capacity. They have low organic-matter content and low natural fertility. The hazards of drought and soil blowing are moderate, and the hazard of erosion is slight.

These soils are suited to the more drought-resistant crops, such as oats, some hay, and pasture; but some corn is also grown. Pines grow very well on these soils.

Leaving crop residue on the soil, manuring, fertilizing, and minimum tillage help maintain the organic-matter content, fertility, and moisture of the soil. Stripcropping, crop rotation, and the use of waterways and shelterbelts control runoff and erosion, reduce soil blowing, and preserve soil moisture.

CAPABILITY UNIT IVe–2

This unit consists of well drained, moderately steep soils that have a loam or silt loam surface layer and a firm subsoil. These soils are on hillsides on glacial till plains.

These soils have moderate or high available water capacity and moderate to slow permeability. They have medium or high natural fertility and low organic-matter content. The erosion hazard is severe.

These soils are best suited, if intensively managed, to hay crops in rotation with some years of row crops. They are also suitable for pasture.

Minimum tillage, leaving crop residue on the soil, manuring, and fertilizing are practices that help maintain the organic-matter content, fertility, moisture, and tilth of the soil. Soil renovation and the use of waterways, crop rotation, and contour stripcropping help control runoff and erosion.

CAPABILITY UNIT IVe–3

Casco loam, 6 to 12 percent slopes, eroded, is the only soil in this unit. This soil is on hillsides on outwash plains.

This soil has low organic-matter content, low available water capacity, low fertility, and moderate permeability. The hazard of erosion is moderate. This soil is moderately droughty.

Intensive management is very important to obtain good yields. This soil is best suited to hay and drought-resistant crops. It is also suited to early summer and late fall pasture.

Minimum tillage, leaving crop residue on the soil, manuring, and fertilizing help maintain the organic-matter content, fertility, and moisture of the soil. Soil renovation, the use of waterways, crop rotation, and contour stripcropping help control runoff and erosion.

CAPABILITY UNIT IVe–4

This unit consists of well drained, sloping soils that have a loamy fine sand surface layer and a firm substratum. These soils are on lacustrine plains and old beach ridges.

These soils have low natural fertility and low organic-matter content. They have moderate available water capacity. Permeability is rapid in the upper part and moderate or slow in the substratum. The hazard of erosion is moderate. These soils are moderately droughty and require intensive management if they are cultivated.

These soils are best suited to the more drought-resistant crops, but some corn is also grown. They are

also well suited to early spring and fall pasture and to hardwoods. Pines grow very well on these soils.

Minimum tillage, fertilizing, and manuring help maintain the organic-matter content, fertility, and moisture of the soil. Mulching, contour stripcropping, crop rotation, and the use of waterways help reduce soil erosion and runoff. Soil renovation is important for good pasture.

CAPABILITY UNIT IVe-7

Boyer loamy sand, 12 to 20 percent slopes, eroded, is the only soil in this unit. This soil is on hillsides on outwash plains.

This soil has moderately rapid permeability and low organic-matter content, natural fertility, and available water capacity. Runoff is rapid. The hazard of erosion is severe. This soil is subject to blowing and is droughty.

This soil is best suited to permanent pasture or pines.

Minimum tillage, crop rotation, and stripcropping help reduce runoff and control erosion and soil blowing.

CAPABILITY UNIT IVw-5

This unit consists of somewhat poorly drained and poorly drained, nearly level and gently sloping soils that have a loamy fine sand surface layer. These soils are on outwash and lacustrine plains.

These soils have low natural fertility and high organic-matter content. They have low available water capacity and rapid permeability. These soils are subject to occasional flooding and the hazard of frost damage.

These soils are suitable for most crops commonly grown in the county if adequate drainage and flood protection are provided. They are also suitable for timber production or wildlife habitat.

Manuring, fertilizing, and plowing under crop residue help maintain the organic-matter content and fertility of the soils. Surface drainage removes excess water; diversions control runoff from adjacent slopes.

CAPABILITY UNIT IVw-7

This unit consists of very poorly drained, nearly level, organic soils that are underlain by sand or marl. These soils are in depressions on outwash plains and glacial till plains.

These soils have moderately slow to moderately rapid permeability and moderate or very high available water capacity. They have very high organic-matter content and low natural fertility. These soils have a high water table and a high frost potential. Flooding is a severe hazard. These soils are subject to subsidence and blowing if they are drained.

These soils are suitable for most crops commonly grown in the county if adequate drainage and flood protection are provided. Undrained areas are used for wildlife habitat and woodland.

Fertilizing and minimum tillage help maintain the organic-matter content and fertility of the soils. Surface drainage removes excess water; channeling, dikes, and diversions are used to provide protection from flooding.

CAPABILITY UNIT IVw-8

This unit consists of very poorly drained, nearly level, organic soils that are underlain by a clayey or loamy substratum. These soils are in old glacial lake basins and depressions.

These soils have moderately slow to moderately rapid permeability in the upper part and moderate to very low permeability in the substratum. They have low natural fertility, very high organic-matter content, and high or very high available water capacity. These soils have a high water table and a high frost potential. The hazard of flooding is severe. These soils are subject to subsidence and blowing if they are drained.

These soils are well suited to sod, mint, or truck crop production if adequate drainage and flood protection are provided. Undrained areas are suited to wetland pasture, wildlife habitat, or woodland.

Surface or tile drains or both can be used to remove excess water; diversions, dikes, and channels are used to protect against flooding. Fertilizing, mulching, and minimum tillage are important management practices.

CAPABILITY UNIT IVw-9

Carbondale muck is the only soil in this unit. This soil is in old glacial lake basins and depressions in stream valleys.

This soil has moderately slow to moderately rapid permeability and very high available water capacity. It has low natural fertility and very high organic-matter content. This soil has a high water table. The hazards of flooding and frost are severe. The soil is subject to subsidence and blowing if it is drained.

This soil is best suited to wetland pasture or wildlife habitat unless it is drained. With drainage and flood protection a continuous row cropping system is feasible. Sod, mint, or truck crops are grown where intensive management is used.

Fertilizing, mulching, and minimum tillage with drainage and protection from flooding are important management practices. Drainage is provided by deep ditching or tile drains. Diversions, dikes, and channels help control flooding and runoff from adjacent areas.

CAPABILITY UNIT IVs-3

Rousseau loamy fine sand, 2 to 6 percent slopes, is the only soil in this unit. This soil is on outwash plains.

This soil has rapid permeability and low natural fertility, available water capacity, and organic-matter content. This soil is droughty and is subject to blowing.

This soil is best suited to early-season crops, such as oats. It is also well suited to pines.

Manuring, fertilizing, and leaving crop residue on the soil help maintain the organic-matter content, fertility, and moisture of the soil. Mulch and shelterbelts provide protection from blowing. Because this soil is droughty, it is well suited to irrigation.

CAPABILITY UNIT Vw-14

Only Fluvaquents are in this unit. These soils are on bottom lands along streams and rivers.

These soils have a high water table and are subject to frequent flooding. Natural fertility, available water capacity, and permeability are variable.

These soils are used for wildlife areas and production of bottom-land timber. They are also suitable for marsh pasture.

The important management requirement is providing

a good grass cover, which helps prevent flood damage. It is also important to protect timber and wildlife areas from grazing.

CAPABILITY UNIT VIe–1

Hortonville silt loam, 20 to 30 percent slopes, is the only soil in this unit. This soil is on glacial till ridges and hillsides.

This soil has low organic-matter content and medium natural fertility. It has high available water capacity and moderate or moderately slow permeability. The hazard of erosion is severe. Soil renovation is beneficial to hay and pasture lands.

This soil is best suited to pasture or hay crops. Undisturbed areas are used for wildlife habitat.

CAPABILITY UNIT VIe–3

Casco loam, 12 to 20 percent slopes, eroded, is the only soil in this unit. This soil is on morainic ridges.

This soil has low natural fertility, low organic-matter content, and low available water capacity. It has moderate permeability in the subsoil and very rapid permeability in the underlying material. The hazard of erosion is severe. This soil is moderately droughty.

This soil is best suited to pasture. It is also suitable for wildlife habitat and woodland.

CAPABILITY UNIT VIs–5

Namur silt loam, 1 to 6 percent slopes, is the only soil in this unit. This soil is in areas of the county where limestone is very close to the surface.

This soil has low natural fertility and moderately low organic-matter content. It has low available water capacity and moderate permeability. This soil is very droughty.

This soil is best suited to wildlife habitat. Some areas are cultivated and used for small grain and pasture. Because of the droughtiness of this soil, crop yields are low and grazing is limited to early summer and fall.

CAPABILITY UNIT VIIe–6

Kewaunee soils, 20 to 45 percent slopes, severely eroded, are the only soils in this unit. These soils are on hillsides on glacial till plains or lacustrine plains.

These soils have moderately slow or slow permeability and low available water capacity. They have low organic-matter content and high natural fertility. In many areas, the subsoil has been exposed by erosion. Tillage is difficult, and surface crusting is a concern. Slippage is also a problem in many places.

These soils are best suited to permanent pasture or woodland. Undisturbed areas are used for wildlife habitat.

CAPABILITY UNIT VIIw–10

Lobo peat is the only soil in this unit. This is a nearly level soil in depressions in old glacial lake basins.

This soil has low natural fertility and very high available water capacity and organic-matter content. It has moderately rapid permeability. This soil has a high water table and is subject to subsidence if it is drained.

This soil is best suited to blueberry production or wildlife habitat. It needs to be protected from grazing.

CAPABILITY UNIT VIIs–9

This unit consists of excessively drained, rolling and hilly soils that have a fine sand surface layer and subsoil. These soils are on stabilized sand dunes and some active blowouts (fig. 8).

These soils have low natural fertility and very low organic-matter content. They have a low available water capacity and rapid permeability. These soils are subject to erosion and soil blowing if they are cultivated. They are also very droughty.

These soils are best suited to wildlife habitat or pines, but some areas are used for pasture.

Management consists of renovation of pasture areas. Protection from grazing is important for woodland and wildlife areas.

CAPABILITY UNIT VIIIs–10

Only Rock outcrop, a miscellaneous area, is in this unit. It consists of steep and very steep areas in which there are many outcrops of limestone bedrock.

Rock outcrop is not rated for available water capacity, permeability, natural fertility, or organic-matter content. The shallow soils that are in some areas have very low available water capacity and low natural fertility.

These areas are best suited to wildlife habitat and woodland. Because of the exposed bedrock, little management can be practiced. These areas also have a high esthetic value.

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 (*3*). 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 suited to the climate 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

Figure 8.—This area of Shawano fine sand, hilly, is in capability unit VIIs–9. The light-colored area in the background is an exposed blowout caused by cultivation and overgrazing.

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.

Crops other than those shown in table 2 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Woodland Management and Productivity[2]

Outagamie County was entirely forested before settlement took place. The northern part was mainly mixed conifer-northern hardwood forest and the southern part, as well as areas extending north in the center of the county, was a central hardwood forest. Scattered low areas of wet soils in the Angelica, Carbondale, Cathro, Keowns, Lobo, Markey, Pella, Rondeau, and Suamico series were covered with various sedges, grasses, willows, and tag alder (*4*).

A forest inventory taken in the county in 1968 classifies 69,100 acres, or about 17 percent of the land, as commercial forest. About 62,000 acres of this forest is in small tracts that are owned by farmers or other individuals. The remaining area is State, county, corporate, or Indian owned (fig. 9 and 10). The timber type of the commercial forest acreage is classified as follows: conifers, 5,300 acres; oak and hickory, 12,000 acres; elm, ash, and cottonwood, 21,800 acres; maple, beech and birch, 17,300 acres; aspen and paper birch, 8,800 acres; and nonstocked, 3,900 acres (*11*).

A small acreage of land that had once been farmed has been returned to forestry use. Red and white pine have been planted on Shawano and Rousseau soils. Continued reforestation is needed on these sandy soils. These plantings are a significant addition to the soil and water conservation program in Outagamie County because they reduce soil blowing, improve wildlife habitat, and beautify the landscape.

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 *w* indicates excessive water in or on the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; and *r*, steep slopes. The letter *o* indicates insignificant limitations or restrictions. If a soil has more than one limitation, priority in placing

[2] By GEORGE W. ALLEY, woodland conservationist, Soil Conservation Service, Madison, Wisconsin.

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 1974. Absence of a yield figure indicates that the soil is not suited to the crop or the crop is generally not grown on the soil. Only arable soils are listed]

Soil name and map symbol	Corn	Corn silage	Oats	Grass-legume hay	Kentucky bluegrass
	Bu	*Ton*	*Bu*	*Ton*	*AUM* [1]
Allendale: AdA	80	13	60	3.5	3.3
Angelica: Ax	105	17	75	3.0	3.5
Bellevue: Bc	100	16	70	4.5	3.0
Bonduel: BnA	80	13	70	3.5	3.5
Borth: BoA	85	15	75	4.5	3.0
Boyer:					
BrB	70	12	50	2.1	2.0
BrC2	65	11	45	2.1	1.6
BrD2	50	10	40	1.8	1.4
Briggsville:					
BtA	100	16	70	4.5	3.0
BtB	95	15	70	4.0	3.0
Carbondale: Ca	95	16	----	2.4	----
Casco:					
CcB	70	12	55	2.7	3.0
CcC2	65	11	50	2.5	2.5
CcD2	----	----	40	2.0	2.5
Cathro: Cm	50	12	55	2.5	----
Channahon: CnB	60	10	45	2.8	2.0
Deford: De	75	10	50	3.0	2.3
Eleva:					
ElB	70	11	50	3.0	2.3
ElC2	70	11	50	2.5	2.0
Fluvaquents: Fu	----	----	----	----	3.0
Grays:					
GrA	120	20	70	4.2	3.5
GrB	105	18	65	4.2	3.5
Hebron: HeB	90	15	70	3.5	3.0
Hortonville:					
HnB, HrB, HsB	110	17	70	4.5	3.5
HnC2, HrC2, HsC2	100	16	65	4.0	3.5
HrD2	85	14	55	3.5	3.0
HrE	----	----	----	3.0	2.5
HtB (both Hortonville and Symco parts)	104	17	68	4.3	2.5
Kaukauna: KaA	100	16	80	4.5	3.0
Keowns: Ke	90	15	60	3.5	3.5
Kewaunee:					
KhB	110	18	80	4.5	3.0
KhC2	100	17	75	4.5	2.7
KhD2	95	16	60	4.0	2.5
KkE3	----	----	----	2.7	1.5
KlB (both Kewaunee and Manawa parts)	100	17	75	4.5	3.5
Kolberg:					
KoB	80	13	65	3.7	3.0
KoC2	65	11	55	3.0	2.6
Manawa: McA	90	15	75	4.5	3.5

See footnote at end of table.

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Soil name and map symbol	Corn	Corn silage	Oats	Grass-legume hay	Kentucky bluegrass
	Bu	*Ton*	*Bu*	*Ton*	*AUM* [1]
Manistee:					
MeB, MfB	70	13	60	3.0	2.5
MeC2	65	12	55	2.7	2.4
Markey: Mk	75	12	60	2.5	----
Menominee:					
MsB	70	12	50	3.0	2.6
MsC2	60	10	45	2.7	2.3
Mosel: MtA	105	17	60	4.5	3.0
Mundelein: MuA	120	19	80	4.5	3.0
Namur: NaB	----	----	25	2.0	2.0
Nichols:					
NfA	95	16	70	4.0	3.0
NfB, NsA, NsB	90	15	65	4.0	3.0
Onaway:					
OhB	90	15	75	4.0	3.0
OhC2	80	14	65	3.8	2.7
OhD2	70	10	55	3.8	2.4
OlB (both Onaway and Solona parts.)	90	15	75	4.0	3.0
Pella: Pe	120	19	75	4.8	3.0
Poy: Pf	90	15	65	4.0	3.0
Poygan: Po	100	17	65	4.0	3.0
Rondeau: Rd	65	11	50	----	----
Rousseau: RoB	50	8	40	2.5	2.0
Shawano:					
SeC	----	----	30	1.5	2.0
SeD	----	----	----	----	1.7
Shiocton:					
ShA	100	16	55	3.0	3.0
SkA	110	18	65	4.0	3.0
SnB (both Shiocton and Nichols parts)	90	15	65	3.7	3.0
Solona: SoA	100	16	70	4.0	3.5
Suamico: Su	50	12	55	2.5	----
Symco: SyA	90	18	65	4.0	3.5
Symco variant: SzA	90	15	65	4.0	3.5
Udifluvents: Uf	60	10	60	3.5	3.3
Udorthents: Uo	----	----	----	----	2.3
Wainola: WaA	75	12	65	3.0	2.5
Will: Wb	105	17	65	4.5	3.0
Winneconne:					
WnA	90	15	80	5.0	3.5
WnB	85	14	75	5.0	3.5
WnC2	80	13	70	4.5	3.0
Zittau: ZtA	90	15	65	4.0	3.5

[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.

Figure 9.—**This stand of white pine is on Onaway soils in the northern part of the county.**

the soil into a limitation class is in the following order: w, d, c, s, 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 *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. Plant competition is not considered in the ratings. 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.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate,* that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe,* that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

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

Figure 10.—Tree growth is poor on Namur soils, which are shallow and very shallow to limestone bedrock.

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.

Windbreaks and Environmental Plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

TABLE 3.—*Woodland management and productivity*

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Important trees	Site index	
Allendale: AdA.	3w	Moderate	Severe	Slight	Slight	Quaking aspen White ash Swamp white oak Eastern white pine White spruce Paper birch Eastern white pine Balsam fir	60	White spruce, eastern white pine.
Angelica: Ax	4w	Severe	Severe	Severe	Slight	Balsam fir Quaking aspen Northern white-cedar. Black ash	45	White ash, northern white-cedar.
Bellevue: Bc	3o	Slight	Slight	Slight	Slight	Northern red oak Sugar maple	58	Eastern white pine, red pine, white spruce.
Bonduel: BnA	3o	Slight	Slight	Slight	Moderate	Northern white-cedar. Quaking aspen Paper birch	35	Poplars, white spruce.
Borth: BoA	3c	Slight	Slight	Moderate	Slight	White ash Sugar maple Northern pin oak American basswood	55	Red pine, eastern white pine.
Boyer: BrB, BrC2, BrD2.	2s	Slight	Slight	Slight	Moderate	Northern red oak White oak American basswood Northern pin oak	66	Eastern white pine, red pine.
Briggsville: BtA, BtB.	2c	Slight	Slight	Slight	Moderate	Sugar maple Northern red oak White oak American basswood	58	Eastern white pine, white spruce, black spruce.
Carbondale: Ca.	3w	Severe	Severe	Severe	Severe	Balsam fir Northern white-cedar. Tamarack	55 34 45	
Casco: CcB, CcC2	3s	Slight	Slight	Slight	Slight	Northern red oak Black oak White oak	55	Red pine, eastern red-cedar.
CcD2	3s	Moderate	Slight	Slight	Slight	Northern red oak Black oak White oak American basswood Sugar maple	55	Red pine, jack pine.
Cathro: Cm	3w	Severe	Severe	Severe	Severe	Balsam fir Tamarack Northern white-cedar. Red maple White ash	50	

TABLE 3.—*Woodland management and productivity*—Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Important trees	Site index	
Channahon: CnB.	3d	Slight	Slight	Moderate	Slight	Northern red oak Sugar maple American basswood Hickory	58	Eastern white pine, red pine.
Deford: De	5w	Severe	Severe	Severe	Severe	Quaking aspen Balsam fir Red maple Silver maple	45	Red maple, white ash.
Eleva: ElB, ElC2.	3o	Slight	Slight	Moderate	Slight	Jack pine Black oak Northern red oak Northern pin oak	57	Jack pine, red pine.
Fluvaquents: Fu.	4w	Severe	Moderate	Moderate	Severe	Red maple White ash	50	Red maple, white ash, poplars.
Grays: GrA, GrB.	1o	Slight	Slight	Slight	Slight	Northern red oak Sugar maple White ash	72	Eastern white pine, red pine, white spruce.
Hebron: HeB	2o	Slight	Slight	Slight	Moderate	Northern red oak White oak Bur oak American basswood Sugar maple	65	Red pine, eastern white pine, white spruce.
Hortonville: HnB, HnC2, HrB, HrC2, HsB, HsC2.	1o	Slight	Slight	Slight	Moderate	Northern red oak Sugar maple American basswood	70	Eastern white pine, red pine, white spruce.
HrD2, HrE	1r	Moderate	Slight	Slight	Moderate	Northern red oak Sugar maple American basswood	70 63	Eastern white pine, red pine, white spruce.
HtB: Hortonville part.	1o	Slight	Slight	Slight	Moderate	Northern red oak Sugar maple American basswood	70 63	Eastern white pine, red pine, white spruce.
Symco part.	1o	Slight	Slight	Slight	Moderate	White ash Northern red oak Sugar maple	79	Red maple, white ash, eastern white pine, white spruce.
Kaukauna: KaA.	2c	Slight	Severe	Severe	Moderate	Northern red oak Sugar maple White ash Red maple American basswood	58	Eastern white pine, red pine, white spruce.
Keowns: Ke	1w	Severe	Moderate	Moderate	Severe	Silver maple Red maple White ash	93 90 80	Silver maple, red maple, white ash.

TABLE 3.—*Woodland management and productivity*—Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Important trees	Site index	
Kewaunee: KhB, KhC2, KlB. For Manawa part of KlB, see Manawa series.	2c	Slight	Slight	Slight	Moderate	Northern red oak Sugar maple White ash American basswood	66	Eastern white pine, red pine, white spruce.
KhD2	2c	Moderate	Slight	Slight	Moderate	Northern red oak Sugar maple White ash American basswood	66	Eastern white pine, red pine, white spruce.
KkE3	2c	Severe	Severe	Slight	Moderate	Northern red oak Sugar maple White ash American basswood	66	Eastern white pine, red pine, white spruce.
Kolberg: KoB, KoC2.	2c	Slight	Moderate	Moderate	Moderate	Northern red oak Sugar maple White ash American basswood	66 67	Eastern white pine, red pine, white spruce.
Lobo: Lo	4w	Severe	Severe	Severe	Severe	Black spruce	23	
Manawa: McA.	2c	Slight	Slight	Slight	Moderate	Sugar maple American beech Green ash Red maple	58	Red maple, green ash, white ash, white spruce.
Manistee: MeB, MeC2, MfB.	2s	Slight	Moderate	Slight	Moderate	Sugar maple Eastern white pine Red maple Red pine American basswood Northern red oak White ash	61	Red pine.
Markey: Mk	3w	Severe	Severe	Severe	Severe	Balsam fir Tamarack Quaking aspen Northern white-cedar. Red maple	33	
Menominee: MsB, MsC2.	1s	Slight	Slight	Slight	Moderate	Northern red oak Sugar maple	74	Red pine, eastern white pine, white spruce.
Mosel: MtA	2o	Slight	Slight	Slight	Moderate	Northern red oak American basswood Red maple	65	Eastern white pine, red pine, white spruce.
Mundelein: MuA.	4o	Slight	Slight	Slight	Slight	Red maple White ash American basswood	45	White ash, eastern white pine, white spruce.
Namur: NaB	4d	Slight	Severe	Severe	Slight	Sugar maple White ash Eastern white pine Northern white-cedar.	49	Red pine, eastern white pine.

TABLE 3.—*Woodland management and productivity*—Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Important trees	Site index	
Nichols: NfA, NfB	1o	Slight	Slight	Slight	Moderate	Sugar maple Northern red oak American basswood White oak	66	Red pine, eastern white pine, white spruce.
NsA, NsB	1o	Slight	Slight	Slight	Moderate	Northern red oak Sugar maple White ash American basswood	70 65	Eastern white pine, red pine, white spruce.
Onaway: OhB, OhC2, OhD2, OlB. For Solona part of OlB, see Selona series.	2d	Slight	Slight	Slight	Moderate	Sugar maple Quaking aspen Yellow birch Northern red oak Red pine American basswood White ash	61	White spruce, eastern white pine.
Pella: Pe	3w	Moderate	Moderate	Moderate	Slight	Northern white-cedar. Black ash Tamarack Red maple	33	Black spruce, white spruce.
Poy: Pf	2w	Moderate	Moderate	Slight	Moderate	Red maple Silver maple American basswood American elm White ash Green ash	65	Red maple, silver maple, white ash, green ash.
Poygan: Po	2w	Severe	Severe	Moderate	Severe	White ash Red maple	65	White spruce, black spruce, red maple, white ash.
Rondeau: Rd	5w	Severe	Severe	Severe	Severe	Northern white-cedar. Tamarack	33	
Rousseau: RoB.	2s	Slight	Severe	Slight	Moderate	Sugar maple Red maple Balsam fir Northern red oak Eastern white pine Red pine Jack pine Black oak	61 70 65 65 55 66	Red pine, jack pine, white spruce.
Shawano: SeC	2s	Slight	Severe	Slight	Moderate	Northern red oak Red pine Eastern white pine Red maple Paper birch	66 62 66	Red pine, eastern white pine.
SeD	2s	Moderate	Severe	Slight	Moderate	Northern red oak Red pine Eastern white pine Red maple Paper birch	66 62 66	Red pine, eastern white pine.

TABLE 3.—*Woodland management and productivity*—Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Important trees	Site index	
Shiocton: ShA, SnB—For Nichols part of SnB, see NfA and NfB in Nichols series.	1o	Slight	Slight	Slight	Moderate	Red maple Sugar maple Northern red oak American basswood American beech	70	Eastern white pine, white spruce, silver maple, white ash.
SkA	1o	Slight	Slight	Slight	Moderate	Red maple Sugar maple Northern red oak American basswood American beech	70	Eastern white pine, white spruce, red maple, white ash.
Solona: SoA	2o	Slight	Slight	Slight	Moderate	Sugar maple Northern red oak White ash American basswood	63 68	Eastern white pine, red pine, white spruce.
Suamico: Su.	3w	Severe	Severe	Severe	Severe	Northern white-cedar. Tamarack Red maple White ash	35	
Symco: SyA	1o	Slight	Slight	Slight	Moderate	White ash Green ash Northern red oak Sugar maple American basswood	75	Red maple, silver maple, white ash, green ash, white spruce.
Symco variant: SzA.	2w	Moderate	Slight	Slight	Severe	Northern red oak Bitternut hickory White ash American basswood Sugar maple	66	White spruce, Norway spruce, eastern white pine, northern white-cedar.
Udifluvents: Uf.	3o	Slight	Slight	Slight	Slight	Northern red oak White ash Red maple	55	Eastern white pine, red pine, white spruce.
Udorthents: Uo.								Eastern white pine, red pine.
Wainola: WaA.	3w	Moderate	Severe	Slight	Slight	White ash Red maple Sugar maple Northern red oak	60	White spruce, Norway spruce, eastern white pine.
Will: Wb	4w	Moderate	Moderate	Moderate	Severe	Red maple White ash Swamp white oak	50	Black spruce, white spruce, white ash, red maple.
Winneconne: WnA, WnB, WnC2.	2c	Slight	Slight	Slight	Moderate	Northern red oak Sugar maple White ash	65	Eastern white pine, red pine.
Zittau: ZtA	3c	Slight	Slight	Moderate	Slight	Red maple White ash Eastern white pine	58	White spruce, eastern white pine.

TABLE 4.—*Windbreaks and environmental plantings*

[Gravel pits (Gp), Limestone quarries (Ln), and Rock outcrop (Ra) are not listed. Dashes indicate that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights of—				
	less than 8 feet	8 to 15 feet	16 to 25 feet	26 to 35 feet	More than 35 feet
Allendale: AdA		White spruce, American cranberry-bush, silky dogwood.	Black spruce, northern white-cedar, tall purple willow.		
Angelica: Ax		White spruce, silky dogwood.	Northern white-cedar, black spruce.		Carolina poplar.
Bellevue: Bc		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Bonduel: BnA		Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	
Borth: BoA	Silky dogwood	Common ninebark, northern white-cedar, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Boyer: BrB, BrC2, BrD2		Autumn-olive, Vanhoutte spirea, Tatarian honeysuckle, Amur privet.	Red pine	Eastern white pine, jack pine.	
Briggsville: BtA, BtB		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Carbondale: Ca		Black spruce, silky dogwood.	Austrian pine, nannyberry viburnum.	Northern white-cedar, Scotch pine.	
Casco: CcB, CcC2, CcD2		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Cathro: Cm		Tatarian honeysuckle, silky dogwood, white spruce.	Austrian pine, laurel willow.	Northern white-cedar, eastern white pine.	
Channahon: CnB		Autumn-olive, eastern red-cedar.	Russian-olive	Eastern white pine, red pine.	
Deford: De		Nannyberry viburnum, arrowwood.	Northern white-cedar, eastern white pine, black spruce.		
Eleva: ElB, ElC2	Manyflower cotoneaster.	Lilac	Norway spruce, Siberian peashrub.	Eastern white pine, red pine, jack pine.	

TABLE 4.—*Windbreaks and environmental plantings*—Continued

Soil name and map symbol	Trees having predicted 20-year average heights of—				
	less than 8 feet	8 to 15 feet	16 to 25 feet	26 to 35 feet	More than 35 feet
Fluvaquents: Fu		Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	
Grays: GrA, GrB		Silky dogwood, Amur maple, Amur honeysuckle, lilac.	Autumn-olive, Russian-olive, white spruce.	Eastern white pine, red pine, Douglas-fir.	Norway spruce.
Hebron: HeB		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Hortonville: HnB, HnC2, HrB, HrC2, HrD2, HrE, HsB, HsC2, HtB. For Symco part of HtB, see Symco series.		Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Kaukauna: KaA		Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Keowns: Ke		Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	
Kewaunee: KhB, KhC2, KhD2, KkE3, KlB For Manawa part of KlB, see Manawa series.		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Kolberg: KoB, KoC2		Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Lobo: Lo.					
Manawa: McA		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Manistee: MeB, MeC2, MfB			Red pine, American mountainash, Siberian crabapple, hawthorn.		
Markey: Mk		Silky dogwood	Austrian pine, laurel willow.	Eastern white pine, Scotch pine, northern white-cedar.	
Menominee: MsB, MsC2		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	

TABLE 4.—*Windbreaks and environmental plantings*—Continued

Soil name and map symbol	Trees having predicted 20-year average heights of—				
	less than 8 feet	8 to 15 feet	16 to 25 feet	26 to 35 feet	More than 35 feet
Mosel: MtA		Northern white-cedar, nannyberry viburnum, redosier dogwood.	White spruce, green ash.	Eastern white pine, jack pine, silver maple.	
Mundelein: MuA		Autumn-olive, Amur honeysuckle, lilac.	Russian-olive	Eastern white pine, Norway spruce, Douglas-fir, red pine.	
Namur: NaB	Manyflower cotoneaster.	Lilac	Norway spruce, Siberian peashrub.	Eastern white pine, red pine, jack pine.	
Nichols: NfA, NfB, NsA, NsB		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Onaway: OhB, OhC2, OhD2, OlB For Solona part of OlB, see Solona series.		White spruce, blue spruce, lilac.	Red pine, black spruce.		
Pella: Pe		Silky dogwood, forsythia, American cranberrybush.	Amur maple, laurel willow, northern white-cedar, Norway spruce, eastern white pine.		
Poy: Pf		Redosier dogwood, nannyberry viburnum.	Green ash, northern white-cedar.	Eastern white pine, jack pine, silver maple.	
Poygan: Po.					
Rondeau: Rd		Late lilac, nannyberry viburnum, common ninebark.	Japanese tree lilac.	Laurel willow	Carolina poplar, almondleaf willow.
Rousseau: RoB	Vanhoutte spirea.	White spruce, Tatarian honeysuckle, autumn-olive.	Eastern white pine, Austrian pine, Norway spruce.	Red pine, jack pine.	Carolina poplar.
Shawano: SeC, SeD	Manyflower cotoneaster.	Lilac	Norway spruce, Siberian peashrub.	Eastern white pine, red pine, jack pine.	
Shiocton: ShA, SnB For Nichols part of SnB, see Nichols series.		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	
SkA		Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	

TABLE 4.—*Windbreaks and environmental plantings*—Continued

Soil name and map symbol	Trees having predicted 20-year average heights of—				
	less than 8 feet	8 to 15 feet	16 to 25 feet	26 to 35 feet	More than 35 feet
Solona: SoA		Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	
Suamico: Su		Late lilac, nannyberry viburnum, common ninebark.	Japanese tree lilac.	Laurel willow	Carolina poplar, almondleaf willow.
Symco: SyA	Redosier dogwood, silky dogwood.	Northern white-cedar, American cranberrybush, lilac.	White spruce, black spruce.	Eastern white pine, red pine.	Red maple, white ash, green ash.
Symco variant: SzA		Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	
Udifluvents: Uf		Lilac	White spruce, green ash.	Eastern white pine, jack pine.	
Udorthents: Uo		Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Wainola: WaA		White spruce, silky dogwood, Tatarian honeysuckle.	Eastern white pine, northern white-cedar, Austrian pine.	Norway spruce, red pine, laurel willow.	Carolina poplar.
Will: Wb		Silky dogwood, American cranberrybush.	Green ash, Amur maple.	Black spruce	Eastern cottonwood.
Winneconne: WnA, WnB, WnC2		Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	
Zittau: ZtA	Redosier dogwood, silky dogwood.	Northern white-cedar, American cranberrybush, lilac.	White spruce, black spruce.	Eastern white pine, red pine.	Red maple, white ash, green ash.

Table 4 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 4, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Recreation

The soils of the survey area are rated in table 5 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

TABLE 5.—*Recreational development*

["Percs slowly" and other 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
Allendale: AdA	Severe: wetness	Moderate: wetness, too sandy.	Severe: wetness	Moderate: wetness, too sandy.
Angelica: Ax	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Bellevue: Bc	Severe: floods	Moderate: floods	Severe: floods	Moderate: floods.
Bonduel: BnA	Moderate: wetness	Moderate: wetness	Moderate: wetness, depth to rock.	Moderate: wetness.
Borth: BoA	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Boyer:				
BrB	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
BrC2	Moderate: too sandy	Moderate: too sandy	Severe: slope	Moderate: too sandy.
BrD2	Severe: slope	Severe: slope	Severe: slope	Moderate: too sandy.
Briggsville:				
BtA	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
BtB	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.
Carbondale: Ca	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.
Casco:				
CcB	Slight	Slight	Moderate: slope	Slight.
CcC2	Moderate: slope	Moderate: slope	Severe: slope	Slight.
CcD2	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Cathro: Cm	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.
Channahon: CnB	Slight	Slight	Severe: depth to rock.	Slight.
Deford: De	Severe: wetness, floods.	Severe: wetness	Severe: wetness, floods.	Severe: wetness.
Eleva:				
ElB	Slight	Slight	Moderate: depth to rock, slope.	Slight.
ElC2	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Fluvaquents: Fu	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Gravel pits: Gp. Not rated.				
Grays:				
GrA	Slight	Slight	Slight	Slight.
GrB	Slight	Slight	Moderate: slope	Slight.
Hebron: HeB	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.

See footnote at end of table.

TABLE 5.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Hortonville: HnB, HrB, HsB, [1] HtB — For Symco part of [1]HtB, see Symco series.	Slight	Slight	Moderate: slope	Slight.
HnC2, HrC2, HsC2	Moderate: slope	Moderate: slope	Severe: slope	Slight.
HrD2	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
HrE	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Kaukauna: KaA	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: percs slowly, too clayey.	Moderate: too clayey.
Keowns: Ke	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Kewaunee: KhB, [1] KlB — [1]For Manawa part of KlB, see Manawa series.	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
KhC2	Moderate: percs slowly.	Moderate: slope	Severe: slope	Slight.
KhD2	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
KkE3	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Kolberg: KoB	Moderate: percs slowly.	Slight	Moderate: slope, depth to rock, percs slowly.	Slight.
KoC2	Moderate: slope, percs slowly.	Moderate: slope	Severe: slope	Slight.
Limestone quarries: Ln. — Not rated.				
Lobo: Lo	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Manawa: [1]McA	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: floods, wetness.	Moderate: floods, wetness.
Manistee: MeB, MfB	Moderate: too sandy	Moderate: too sandy	Severe: too sandy	Moderate: too sandy.
MeC2	Moderate: too sandy	Moderate: too sandy	Severe: too sandy, slope.	Moderate: too sandy.
Markey: Mk	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.
Menominee: MsB	Moderate: too sandy	Moderate: too sandy	Severe: too sandy, soil blowing.	Moderate: too sandy.
MsC2	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope, too sandy, soil blowing.	Moderate: too sandy.
Mosel: MtA	Moderate: wetness, percs slowly.	Moderate: wetness	Moderate: wetness, percs slowly.	Moderate: wetness.
Mundelein: MuA	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Namur: NaB	Slight	Slight	Severe: depth to rock.	Slight.

See footnote at end of table.

TABLE 5.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Nichols:				
NfA, NsA	Slight	Slight	Slight	Slight.
NfB, NsB	Slight	Slight	Moderate: slope	Slight.
Onaway:				
OhB, [1] OlB For Solona part of OlB, see Solona series.	Slight	Slight	Moderate: slope	Slight.
OhC2	Moderate: slope	Moderate: slope	Severe: slope	Slight.
OhD2	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Pella: Pe	Severe: wetness, floods.	Severe: wetness	Severe: wetness, floods.	Severe: wetness.
Poy: Pf	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Poygan: Po	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Rock outcrop: Ra. Not rated.				
Rondeau: Rd	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.
Rousseau: RoB	Moderate: soil blowing, too sandy.	Moderate: soil blowing, too sandy.	Severe: soil blowing, too sandy.	Severe: soil blowing, too sandy.
Shawano:				
SeC	Moderate: too sandy, soil blowing, slope.	Moderate: too sandy, soil blowing, slope.	Severe: too sandy, slope.	Severe: too sandy, soil blowing.
SeD	Severe: slope	Severe: slope	Severe: too sandy, slope.	Severe: too sandy, soil blowing.
Shiocton:				
ShA, SkA, [1] SnB For Nichols part of SnB, see NfB in Nichols series.	Severe: floods	Moderate: wetness, floods.	Severe: floods	Moderate: wetness.
Solona: SoA	Moderate: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness.
Suamico: Su	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.
Symco: SyA	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Symco variant: SzA	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Udifluvents: Uf	Severe: floods	Moderate: floods	Severe: floods	Moderate: floods.
Udorthents: Uo	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: too clayey, percs slowly, slope.	Moderate: too clayey.
Wainola: WaA	Severe: wetness	Moderate: wetness, too sandy.	Severe: too sandy, wetness.	Severe: too sandy.
Will: Wb	Severe: wetness, floods.	Severe: wetness	Severe: wetness, floods.	Severe: wetness.
Winneconne: WnA, WnB, WnC2.	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: percs slowly, too clayey.	Moderate: too clayey.

See footnote at end of table.

TABLE 5.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Zittau: ZtA	Moderate: wetness, percs slowly.	Moderate: wetness	Moderate: wetness, percs slowly.	Moderate: wetness.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

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 the 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 5 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 8, and interpretations for dwellings without basements and for local roads and streets, given in table 7.

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 sites 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.

Wildlife Areas[3]

Outagamie County soils range widely in physical and chemical properties that affect natural drainage and fertility. Most of the soils formed in glacial till or in lacustrine deposits. Most of the county is in farms, and about 17 percent is in small woodlots. Before settlement, a large proportion of Outagamie County was wetlands; at present, approximately 22 percent is wetlands.

The habitat elements needed by a species of wildlife generally are produced on several kinds of soil and require a combination of land uses. For this reason wildlife interpretations are best related to the soil associations described in the section "General Soil Map." In the following paragraphs, the soil associations of Outagamie County are grouped according to their potential for wildlife (mainly game species) and their environmental factors.

WILDLIFE AREA 1

This wildlife area is on the Hortonville-Symco, Winneconne-Manawa, and Onaway-Solona associations, mainly in the eastern half of the county. This wildlife area consists mainly of nearly level to moderately steep, moderately coarse textured to moderately fine textured soils. Although much of it is cultivated, many areas of the steeper soils and wet soils in drainageways and depressions are in woodland or are used for wetland wildlife habitat. Manawa and Symco soils are especially favorable for pond development. Most farms are used for dairy cattle. The principal crops are corn, small grain, and hay. The diversity of crops and land use makes this area suitable for many wildlife species.

Wildlife in this area are white-tailed deer, cottontail rabbit, squirrels, red fox, and limited numbers of ringneck pheasants and Hungarian partridge.

WILDLIFE AREA 2

This wildlife area is on the Carbondale-Keowns-Cathro association. This association is mostly in the western half of the county. It consists of nearly level organic soils and medium textured mineral soils and includes most of the wetlands in the county. An accu-

[3] By DAVID J. FRISQUE, biological technician, wildlife, Soil Conservation Service, Madison, Wisconsin.

Figure 11.—**Wooded swamp wetlands on Markey soils. Uprooted trees are evidence of severe windthrow hazard.**

rate wetlands inventory is not available, but the most common wetland type is the wooded swamp (*6*). The wet meadow and shrub swamp types are also common. Estimated acres in the various wetland types in Outagamie County are 15,100 acres of wooded swamp, 14,900 acres of wet meadow, 3,900 acres of shrub swamp, and 3,100 acres in other types of wetlands (fig. 11, 12, 13).

This association is in small areas scattered throughout other soil associations that are better suited to crops. Together with the cultivated soils of the surrounding associations, it provides the wide diversity of soil and land use that is vital to many wildlife species.

Wildlife in this area include white-tailed deer, ruffed grouse, cottontail rabbit, muskrat, woodcock, ringneck pheasants, and many species of waterfowl. Mallards, blue-winged teal, and wood duck are the most common ducks.

Most public hunting and fishing grounds in Outagamie County are located in this wildlife area.

WILDLIFE AREA 3

This wildlife area is on the Shiocton-Nichols association. It is mostly in the western half of the county. It consists of nearly level and gently sloping, medium textured and moderately coarse textured soils This association is in small areas contiguous to wildlife area 2, which contains most of the wetlands in the county. Soils in this wildlife area are used mostly for dairy farming and cash crops. The less extensive soils are wet and are used for woodland or wildlife habitat. Because of its diversity of land use and soil conditions, this wildlife area provides the habitat elements that are vital to many wildlife species.

Wildlife in this area include white-tailed deer, ringneck pheasants, cottontail rabbit, ruffed grouse, squirrel, and some waterfowl.

WILDLIFE AREA 4

This wildlife area is on the Wainola-Deford-Rousseau and Menominee-Grays-Rousseau associations. It is mostly in small areas scattered throughout the county. The soils are nearly level to sloping and are dominantly coarse textured. Many parts of this wildlife area are next to the major wetlands in wildlife area 2 in the western part of the county. The better drained soils are used for general farming, but many areas remain wooded. The wetter soils are mostly in woodland and wildlife habitat, but some are cultivated. Because of the diversity of land use, this wildlife area provides

cover and feed for such wildlife species as white-tailed deer and pheasants.

Wildlife in this area are white-tailed deer, pheasants, waterfowl, cottontail rabbit, squirrel, ruffed grouse, and predators such as red fox and raccoon.

Wildlife Habitat

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, is inadequate, or is 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 6, 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.

***Figure 12.*—Wet meadow wetlands on Cathro, Deford, and Keowns soils. Flooding early in spring and late in fall provides suitable habitat for waterfowl.**

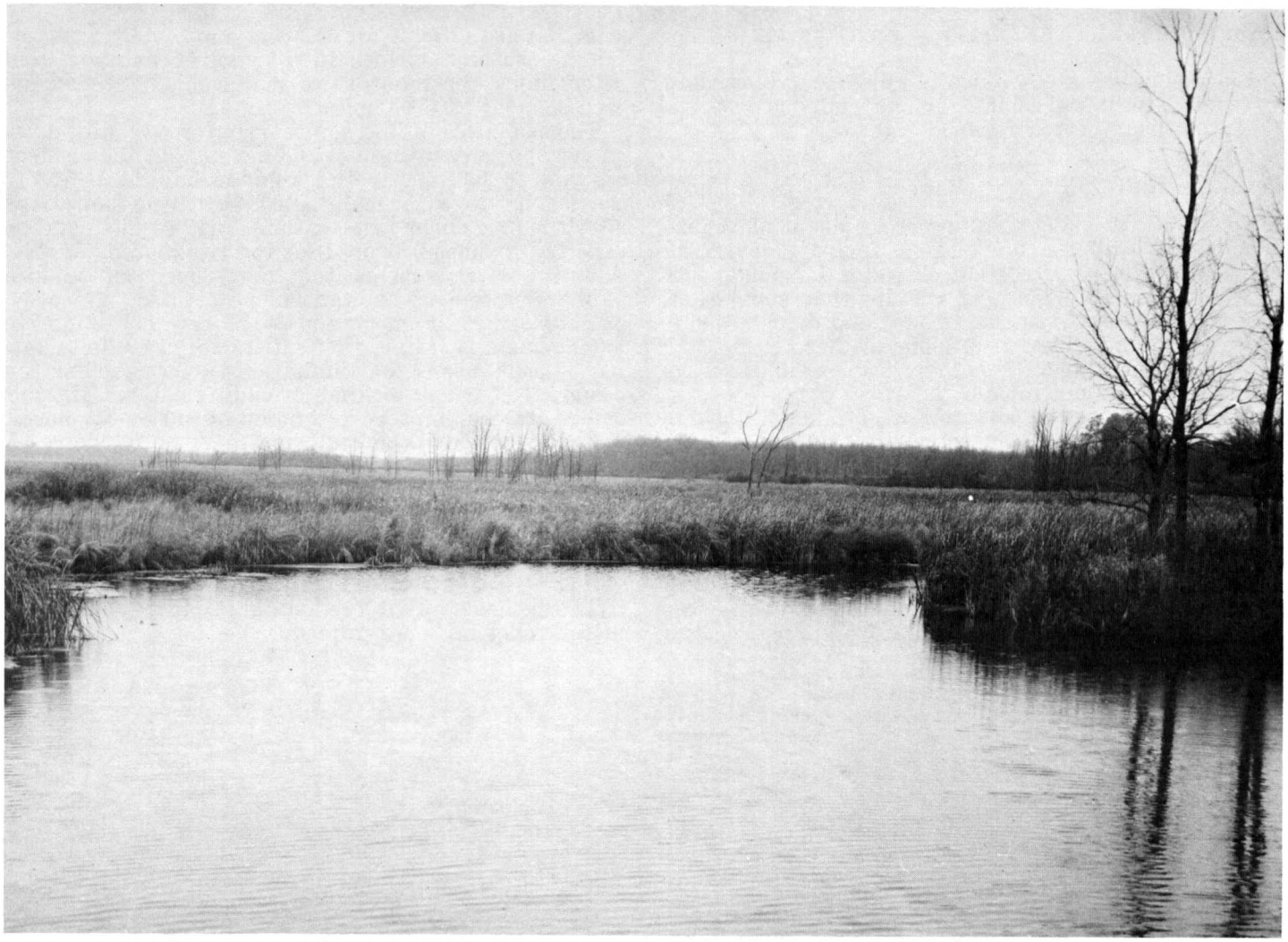

Figure 13.—**Wetlands of the Rat River Conservation Area on Carbondale soils provide good habitat for waterfowl and wetland animals.**

Grain and seed crops are seed-producing annuals used by wildlife. 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. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. 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. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. 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. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

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. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are oak, poplar, cherry, 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.

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. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, cedar, and juniper.

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. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, and cordgrass and rushes, sedges, and reeds.

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 structures in marshes or streams. 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. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland wildlife includes birds and mammals that use 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, and red fox.

Woodland wildlife includes birds and mammals that use areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Wetland wildlife includes birds and mammals that use 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.

Engineering[4]

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, 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 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 uses; (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 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 7 shows, for each kind of soil, the degree and kind of limitations for building site development; table 8, for sanitary facilities; and table 10, for water management. Table 9 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

[4] MICHAEL J. TIRY, civil engineer, Soil Conservation Service, Green Bay, helped prepare this section.

TABLE 6.—*Wildlife*

[See text for definitions of "good," "fair," "poor," and "very

Soil name and map symbol	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
Allendale: AdA	Fair	Fair	Good	Fair
Angelica: Ax	Good	Fair	Good	Good
Bellevue: Bc	Poor	Fair	Fair	Good
Bonduel: BnA	Fair	Good	Good	Good
Borth: BoA	Good	Good	Good	Good
Boyer: BrB, BrC2, BrD2	Poor	Fair	Good	Good
Briggsville: BtA, BtB	Good	Good	Good	Good
Carbondale: Ca	Good	Fair	Good	Fair
Casco:				
CcB, CcC2	Fair	Fair	Fair	Fair
CcD2	Poor	Fair	Fair	Fair
Cathro: Cm	Fair	Fair	Fair	Fair
Channahon: CnB	Poor	Poor	Fair	Fair
Deford: De	Fair	Fair	Good	Good
Eleva: ElB, ElC2	Fair	Good	Good	Good
Fluvaquents: Fu	Poor	Poor	Fair	Fair
Gravel pits: Gp.				
Grays: GrA, GrB	Good	Good	Good	Good
Hebron: HeB	Good	Good	Good	Good
Hortonville: HnB, HrB, HsB, HsC2, [1] HtB— For Symco part of HtB, see Symco series.	Good	Good	Good	Good
HnC2, HrC2	Good	Good	Good	Good
HrD2	Poor	Good	Good	Good
HrE	Very poor	Fair	Good	Good
Kaukauna: KaA	Good	Good	Good	Good
Keowns: Ke	Good	Good	Good	Fair
Kewaunee: KhB, [1] KlB — For Manawa part of KlB, see Manawa series.	Good	Good	Good	Good
KhC2	Fair	Good	Good	Good
KhD2	Poor	Fair	Good	Good
KkE3	Very poor	Poor	Good	Good
Kolberg: KoB, KoC2	Good	Good	Good	Good
Limestone quarries: Ln.				
Lobo: Lo	Very poor	Very poor	Very poor	Very poor

See footnote at end of table.

habitat potentials

poor." Absence of an entry indicates 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
Fair	Fair	Fair	Fair	Fair	Poor.
Fair	Good	Good	Good	Good	Good.
Good	Poor	Poor	Fair	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Good	Good	Good	Good	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Good	Good	Fair	Good	Good.
Fair	Poor	Very poor	Poor	Fair	Very poor.
Fair	Good	Good	Fair	Good	Good.
Good	Very poor	Very poor	Good	Good	Very poor.
Fair	Good	Fair	Poor	Fair	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Poor	Good	Good	Good	Fair	Good.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Poor	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Very poor	Good	Good	Very poor	Very poor	Fair.

TABLE 6.—*Wildlife habitat*

Soil name and map symbol	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
Manawa: McA	Good	Good	Good	Good
Manistee:				
MeB	Poor	Fair	Good	Good
MeC2	Poor	Fair	Good	Good
MfB	Good	Good	Good	Good
Markey: Mk	Fair	Fair	Good	Good
Menominee: MsB, MsC2	Poor	Fair	Good	Fair
Mosel: MtA	Good	Good	Good	Good
Mundelein: MuA	Good	Good	Good	Good
Namur: NaB	Poor	Poor	Fair	Poor
Nichols: NfA, NfB, NsA, NsB	Good	Good	Good	Good
Nichols part of SnB	Good	Good	Good	Good
Onaway:				
OhB, [1] OlB For Solona part of OlB, see Solona series.	Good	Good	Good	Good
OhC2	Fair	Good	Good	Good
OhD2	Poor	Fair	Good	Good
Pella: Pe	Good	Good	Good	Good
Poy: Pf	Good	Good	Good	Good
Poygan: Po	Good	Good	Good	Good
Rock outcrop: Ra.				
Rondeau: Rd	Fair	Fair	Fair	Fair
Rousseau: RoB	Poor	Poor	Good	Fair
Shawano:				
SeC	Poor	Poor	Fair	Poor
SeD	Very poor	Very poor	Fair	Poor
Shiocton: ShA, SkA, [1] SnB For Nichols part of SnB, see Nichols series.	Good	Good	Good	Good
Solona:				
SoA	Good	Good	Good	Good
Solona part of OlB	Good	Good	Good	Good
Suamico: Su	Fair	Fair	Fair	Fair
Symco: SyA	Good	Good	Good	Good
Symco variant: SzA	Good	Good	Good	Good
Udifluvents: Uf	Fair	Good	Good	Good
Udorthents: Uo. Not rated.				
Wainola: WaA	Fair	Good	Good	Good

See footnote at end of table.

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—		
Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Good	Good	Good	Good	Good	Good.
Good	Poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Very poor	Fair	Good	Very poor.
Good	Good	Good	Fair	Good	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Good	Good	Good	Good	Good.
Good	Good	Good	Good	Good	Good.
Poor	Very poor	Very poor	Poor	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Fair	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.
Good	Good	Good	Good	Good	Good.
Good	Good	Good	Fair	Fair	Good.
Fair	Poor	Very poor	Fair	Fair	Poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Poor	Good	Good	Poor.
Good	Good	Good	Fair	Fair	Good.
Good	Good	Good	Good	Good	Good.
Good	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.

TABLE 6.—*Wildlife habitat*

Soil name and map symbol	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
Will: Wb	Good	Good	Good	Good
Winneconne: WnA, WnB, WnC2	Good	Good	Good	Good
Zittau: ZtA	Good	Good	Good	Good

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

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 7. A *slight* limitation indicates that soil properties generally 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 that 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 made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high 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 5 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, 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 7 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 of the structure 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 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 hazard.

Local roads and streets referred to in table 7 have an all-weather surface that can carry light to medium traffic all year. They consist of a 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 5 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 affect stability and ease of excavation (fig. 14).

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, 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 8 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. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean

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	Fair	Fair	Good	Good	Fair.
Good	Poor	Poor	Good	Good	Poor.
Good	Good	Good	Good	Good	Good.

behavior characteristics of the mapping unit.

***Figure 14.*—Frost damage is severe on this road constructed on Keowns and Shiocton soils. Wet soils that have a high content of silt and very fine sand are particularly susceptible to frost action.**

about the same as the terms *slight, moderate,* and *severe.*

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 60 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 can 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

TABLE 7.—*Building site development*

["Shrink-swell" and other 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	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Allendale: AdA	Severe: wetness, cutbanks cave.	Severe: wetness, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, low strength, shrink-swell.	Severe: low strength, shrink-swell.
Angelica: Ax	Severe: wetness, floods.	Severe: wetness, floods, frost action.	Severe: wetness, floods.	Severe: wetness, floods, frost action.	Severe: wetness, frost action, floods.
Bellevue: Bc	Severe: floods.	Severe: floods.	Severe: floods, wetness.	Severe: floods.	Severe: floods.
Bonduel: BnA	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness, depth to rock.	Moderate: wetness, shrink-swell.	Severe: frost action.
Borth: BoA	Severe: too clayey, cutbanks cave.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.	Severe: low strength.
Boyer:					
BrB	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
BrC2	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope	Moderate: slope.
BrD2	Severe: cutbanks cave.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Briggsville: BtA, BtB	Slight	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: low strength.
Carbondale: Ca	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.
Casco:					
CcB	Severe: cutbanks cave, small stones.	Slight	Slight	Moderate: slope.	Moderate: low strength.
CcC2	Severe: cutbanks cave, small stones.	Moderate: slope.	Moderate: slope.	Severe: slope	Moderate: slope, low strength.
CcD2	Severe: cutbanks cave, small stones.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Cathro: Cm	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods, frost action.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, low strength, frost action.
Channahon: CnB	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Deford: De	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Eleva:					
ElB	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength, frost action.

TABLE 7.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
ElC2	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope	Moderate: slope, low strength, frost action.
Fluvaquents: Fu	Severe: floods, wetness.	Severe: floods, frost action, wetness.	Severe: floods, wetness.	Severe: floods, frost action, wetness.	Severe: floods, frost action, wetness.
Gravel pits: Gp. Not rated.					
Grays: GrA	Slight	Moderate: shrink-swell, low strength, frost action.	Slight	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
GrB	Slight	Moderate: shrink-swell, low strength, frost action.	Slight	Moderate: shrink-swell, low strength, slope.	Severe: frost action, low strength.
Hebron: HeB	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Moderate: shrink-swell.
Hortonville: HnB, HrB, [1] HtB For Symco part of HtB, see Symco series.	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell, slope.	Severe: low strength.
HnC2, HrC2	Moderate: slope.	Moderate: low strength, shrink-swell, slope.	Moderate: low strength, shrink-swell, slope.	Severe: slope	Severe: low strength.
HrD2, HrE	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: low strength, slope.
HsB	Moderate: too clayey.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, slope, shrink-swell.	Severe: low strength.
HsC2	Moderate: too clayey, slope.	Moderate: low strength, slope, shrink-swell.	Moderate: low strength, slope, shrink-swell.	Severe: slope	Severe: low strength.
Kaukauna: KaA	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Keowns: Ke	Severe: wetness, floods.	Severe: wetness, floods, frost action.	Severe: wetness, floods, frost action.	Severe: wetness, floods, frost action.	Severe: wetness, floods, frost action.
Kewaunee: KhB, [1] KlB For Manawa part of KlB, see Manawa series.	Severe: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength, slope.	Severe: low strength.

See footnote at end of table.

TABLE 7.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
KhC2	Severe: too clayey.	Moderate: shrink-swell, low strength, slope.	Moderate: shrink-swell, low strength, slope.	Severe: slope	Severe: low strength.
KhD2, KkE3	Severe: slope, too clayey.	Severe: slope	Severe: slope	Severe: slope	Severe: low strength, slope.
Kolberg:					
KoB	Severe: too clayey.	Moderate: low strength, shrink-swell.	Moderate: depth to rock, shrink-swell, low strength.	Moderate: low strength, shrink-swell.	Severe: low strength.
KoC2	Severe: too clayey.	Moderate: low strength, shrink-swell, slope.	Moderate: depth to rock, shrink-swell, low strength.	Severe: slope	Severe: low strength.
Limestone quarries: Ln. Not rated.					
Lobo: Lo	Severe: wetness, excess humus.	Severe: wetness, frost action, low strength.	Severe: wetness, low strength.	Severe: wetness, frost action, low strength.	Severe: wetness, low strength, frost action.
Manawa: McA	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: floods, low strength.
Manistee:					
MeB, MfB	Moderate: cutbanks cave.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Slight.
MeC2	Moderate: cutbanks cave.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: slope, low strength, shrink-swell.	Moderate: slope.
Markey: Mk	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods, frost action.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, low strength.
Menominee:					
MsB	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: frost action, low strength, shrink-swell.
MsC2	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope	Moderate: slope, frost action, low strength.
Mosel: MtA	Severe: wetness.	Severe: wetness, floods, frost action.	Severe: wetness, floods.	Severe: wetness, floods, frost action.	Severe: frost action, low strength.
Mundelein: MuA	Severe: wetness.	Moderate: wetness, low strength.	Severe: wetness.	Moderate: wetness, low strength.	Severe: frost action, low strength.
Namur: NaB	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Nichols:					
NfA	Slight	Slight	Slight	Slight	Severe: frost action.

TABLE 7.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
NfB	Slight	Slight	Slight	Moderate: slope.	Severe: frost action.
NsA	Severe: too clayey.	Moderate: low strength, frost action.	Severe: low strength.	Moderate: low strength, frost action.	Moderate: low strength.
NsB	Severe: too clayey.	Moderate: low strength, frost action.	Severe: low strength.	Moderate: low strength, slope, frost action.	Moderate: low strength.
Onaway:					
OhB, [1] OlB For Solona part of OlB, see Solona series.	Slight	Moderate: frost action.	Slight	Moderate: slope, frost action.	Moderate: frost action, shrink-swell.
OhC2	Moderate: slope.	Moderate: frost action, slope.	Moderate: slope.	Severe: slope	Moderate: slope, frost action, shrink-swell.
OhD2	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Pella: Pe	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, frost action.
Poy: Pf	Severe: floods, wetness, cutbanks cave.	Severe: wetness, floods, low strength.	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, frost action, low strength.
Poygan: Po	Severe: wetness, floods, too clayey.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
Rock outcrop: Ra. Not rated.					
Rondeau: Rd	Severe: wetness, excess humus.	Severe: floods, frost action, low strength.	Severe: floods, low strength, wetness.	Severe: floods, low strength, wetness.	Severe: frost action, low strength, wetness.
Rousseau: RoB	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Shawano:					
SeC	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope	Moderate: slope.
SeD	Severe: cutbanks cave, slope.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Shiocton: ShA, SkA, [1] SnB For Nichols part of SnB, see NfB in Nichols series.	Severe: wetness, floods.	Severe: frost action, wetness, floods.	Severe: wetness, floods.	Severe: frost action, wetness, floods.	Severe: frost action, floods.
Solona: SoA	Severe: wetness, floods.	Severe: floods, wetness, frost action.	Severe: wetness, floods, frost action.	Severe: floods, wetness, frost action.	Severe: frost action, floods.
Suamico: Su	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.

See footnote at end of table.

TABLE 7.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Symco: SyA	Severe: wetness.	Moderate: shrink-swell, low strength.	Severe: wetness.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
Symco variant: SzA	Severe: wetness, cutbanks cave, floods.	Severe: floods, wetness, frost action.	Severe: wetness, floods.	Severe: floods, wetness, frost action.	Severe: frost action, floods.
Udifluvents: Uf	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action.
Udorthents: Uo	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength, frost action.
Wainola: WaA	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
Will: Wb	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action.
Winneconne: WnA, WnB	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
WnC2	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength, slope.	Severe: shrink-swell, low strength.
Zittau: ZtA	Severe: wetness, too clayey, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

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 can be installed or the size of the absorption field can 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 content of 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 soil material 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 a thin layer of soil material. 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 moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding.

TABLE 8.—*Sanitary facilities*

["Percs slowly" and other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoons	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Allendale: AdA	Severe: wetness, percs slowly.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor: too sandy, thin layer.
Angelica: Ax	Severe: wetness, floods, percs slowly.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Bellevue: Bc	Severe: floods.	Moderate: seepage, wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Good.
Bonduel: BnA	Severe: wetness, depth to rock.	Severe: wetness, depth to rock.	Severe: depth to rock, wetness.	Severe: wetness.	Poor: thin layer.
Borth: BoA	Severe: percs slowly.	Severe: seepage.	Severe: seepage.	Slight	Poor: thin layer.
Boyer:					
BrB	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: thin layer.
BrC2	Moderate: slope.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: thin layer.
BrD2	Severe: slope	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: slope.
Briggsville:					
BtA	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Poor: area reclaim.
BtB	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Poor: area reclaim.
Carbondale: Ca	Severe: wetness, floods.	Severe: wetness, excess humus, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: excess humus, hard to pack, wetness.
Casco:					
CcB	Slight	Severe: seepage.	Severe: seepage, small stones.	Severe: seepage.	Poor: thin layer.
CcC2	Moderate: slope.	Severe: seepage.	Severe: seepage, small stones.	Severe: seepage.	Poor: thin layer.
CcD2	Severe: slope	Severe: seepage.	Severe: seepage, small stones.	Severe: seepage.	Poor: thin layer.
Cathro: Cm	Severe: wetness, floods.	Severe: wetness, excess humus, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: excess humus, hard to pack.
Channahon: CnB	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: thin layer.
Deford: De	Severe: wetness, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, seepage, floods.	Poor: seepage, too sandy, wetness.
Eleva:					
ElB	Slight	Severe: seepage, depth to rock.	Severe: depth to rock, seepage.	Severe: slope	Poor: thin layer.

TABLE 8.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoons	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
EIC2	Moderate: slope.	Severe: slope	Severe: depth to rock, seepage.	Severe: slope	Poor: thin layer.
Fluvaquents: Fu	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Gravel pits: Gp. Not rated.					
Grays: GrA	Moderate: wetness.	Slight	Severe: seepage.	Slight	Good.
GrB	Moderate: wetness.	Moderate: slope.	Severe: seepage.	Slight	Good.
Hebron: HeB	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Hortonville: HnB, HrB, [1] HtB	Moderate: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
For Symco part of HtB, see Symco series.					
HnC2, HrC2	Moderate: percs slowly, slope.	Severe: slope	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
HrD2	Severe: percs slowly, slope.	Severe: slope	Moderate: too clayey, slope.	Severe: slope	Poor: too clayey, slope.
HrE	Severe: percs slowly, slope.	Severe: slope	Severe: too clayey, slope.	Severe: slope	Poor: too clayey, slope.
HsB	Severe: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock.	Slight	Fair: too clayey, slope.
HsC2	Severe: depth to rock.	Severe: slope	Moderate: depth to rock.	Moderate: slope.	Fair: too clayey, slope.
Kaukauna: KaA	Severe: percs slowly.	Moderate: seepage, wetness.	Slight	Slight	Poor: too clayey.
Keowns: Ke	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Kewaunee: KhB, [1] KlB	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
For Manawa part of KlB, see Manawa series.					
KhC2	Severe: percs slowly.	Severe: slope	Severe: too clayey.	Moderate: slope.	Poor: too clayey.
KhD2	Severe: percs slowly, slope.	Severe: slope	Severe: too clayey.	Severe: slope	Poor: too clayey, slope.
KkE3	Severe: percs slowly, slope.	Severe: slope	Severe: slope, too clayey.	Severe: slope	Poor: too clayey, slope.
Kolberg: KoB	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Slight	Poor: thin layer, area reclaim.

See footnote at end of table.

TABLE 8.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoons	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
KoC2	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Moderate: slope.	Poor: thin layer, area reclaim.
Limestone quarries: Ln. Not rated.					
Lobo: Lo	Severe: wetness.	Severe: excess humus, wetness.	Severe: wetness, excess humus.	Severe: wetness.	Poor: wetness, excess humus.
Manawa: McA	Severe: wetness, percs slowly, floods.	Moderate: slope.	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Poor: too clayey.
Manistee:					
MeB, MfB	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too sandy.
MeC2	Severe: percs slowly.	Severe: slope	Severe: too clayey.	Moderate: slope.	Poor: too sandy.
Markey: Mk	Severe: wetness, floods.	Severe: wetness, excess humus, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: excess humus, hard to pack.
Menominee:					
MsB	Slight	Moderate: slope, seepage.	Slight	Slight	Poor: too sandy.
MsC2	Moderate: slope.	Severe: slope	Slight	Moderate: slope.	Poor: too sandy.
Mosel: MtA	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Moderate: wetness, floods.	Fair: thin layer.
Mundelein: MuA	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Namur: NaB	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: seepage.	Poor: thin layer, small stones, area reclaim.
Nichols:					
NfA, NfB	Slight	Moderate: seepage.	Slight	Slight	Good.
NsA	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Good.
NsB	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Good.
Onaway:					
OhB, [1] O1B	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Good.
For Solona part of O1B, see Solona series.					
OhC2	Severe: percs slowly.	Severe: slope	Slight	Moderate: slope.	Fair: slope.
OhD2	Severe: slope, percs slowly.	Severe: slope	Moderate: slope.	Severe: slope	Poor: slope.
Pella: Pe	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.

See footnote at end of table.

TABLE 8.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoons	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Poy: Pf	Severe: wetness, floods, percs slowly.	Severe: wetness, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods.	Poor: wetness, thin layer.
Poygan: Po	Severe: wetness, percs slowly, floods.	Severe: floods.	Severe: wetness, floods, too clayey.	Severe: wetness, floods.	Poor: wetness, too clayey.
Rock outcrop: Ro. Not rated.					
Rondeau: Rd	Severe: wetness, floods.	Severe: floods, seepage, wetness.	Severe: wetness, floods, excess humus.	Severe: wetness, floods.	Poor: excess humus, wetness.
Rousseau: RoB	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: too sandy.
Shawano: SeC	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: too sandy, seepage.
SeD	Severe: slope	Severe: seepage, slope.	Severe: seepage.	Severe: seepage, slope.	Poor: too sandy, seepage, slope.
Shiocton: ShA, [1] SnB	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: floods, wetness.	Good.
For Nichols part of SnB, see NfB in Nichols series.					
SkA	Severe: wetness, floods.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Good.
Solona: SoA	Severe: wetness, floods.	Severe: wetness, floods.	Severe: floods, wetness.	Severe: floods, wetness.	Good.
Suamico: Su	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, excess humus.
Symco: SyA	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Fair: thin layer.
Symco variant: SzA	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: seepage, wetness, floods.	Severe: seepage, wetness, floods.	Fair: thin layer, area reclaim.
Udifluvents: Uf	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
Udorthents: Uo	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Fair: too clayey.
Wainola: WaA	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor: seepage, too sandy.
Will: Wb	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods.	Poor: wetness, area reclaim.
Winneconne: WnA	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
WnB	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.

See footnote at end of table.

TABLE 8.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoons	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
WnC2	Severe: percs slowly.	Severe: slope	Severe: too clayey.	Slight	Poor: too clayey.
Zittau: ZtA	Severe: wetness, percs slowly.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor: thin layer, too clayey.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

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 can 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.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 8 apply only to the soil material within a depth of about 5 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 periods. 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 9 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 5 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 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 11 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 9 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizeable quantities of sand or gravel (fig. 15). 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 11.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected

TABLE 9.—*Construction materials*

["Shrink-swell" and other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor"]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Allendale: AdA	Poor: low strength, shrink-swell.	Poor: thin layer	Unsuited	Poor: too sandy.
Angelica: Ax	Poor: wetness, frost action.	Unsuited	Unsuited	Poor: wetness.
Bellevue: Bc	Fair: frost action, low strength.	Unsuited	Unsuited	Good.
Bonduel: BnA	Poor: frost action	Unsuited	Unsuited	Fair: thin layer.
Borth: BoA	Poor: low strength	Fair: excess fines	Unsuited	Fair: thin layer.
Boyer:				
BrB, BrC2	Good	Good	Good	Poor: too sandy.
BrD2	Fair: slope	Good	Good	Poor: too sandy, slope.
Briggsville: BtA, BtB	Poor: low strength	Unsuited	Unsuited	Fair: thin layer.
Carbondale: Ca	Poor: excess humus, frost action, low strength.	Unsuited	Unsuited	Poor: wetness.
Casco:				
CcB, CcC2	Good	Good	Good	Fair: thin layer.
CcD2	Fair: slope	Good	Good	Poor: slope.
Cathro: Cm	Poor: excess humus, wetness, frost action.	Unsuited	Unsuited	Poor: wetness.
Channahon: CnB	Poor: thin layer	Unsuited	Unsuited	Poor: thin layer.
Deford: De	Poor: wetness	Good	Unsuited	Poor: too sandy, wetness.
Eleva:				
ElB	Fair: low strength, frost action.	Poor: excess fines	Unsuited	Good.
ElC2	Fair: low strength, frost action.	Poor: excess fines	Unsuited	Fair: slope.
Fluvaquents: Fu	Poor: frost action, wetness.	Unsuited	Unsuited	Poor: wetness.
Gravel pits: Gp. Not rated.				
Grays: GrA, GrB	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer.
Hebron: HeB	Poor: low strength	Unsuited	Unsuited	Good.
Hortonville:				
HnB, HrB, [1] HtB For Symco part of HtB, see Symco series.	Fair: low strength, shrink-swell, frost action.	Unsuited	Unsuited	Fair: thin layer.
HnC2, HrC2	Fair: low strength, shrink-swell, frost action.	Unsuited	Unsuited	Fair: thin layer, slope.
HrD2	Fair: low strength, shrink-swell, slope.	Unsuited	Unsuited	Poor: slope.

See footnote at end of table.

TABLE 9.—*Construction materials*—Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
HrE	Poor: low strength, shrink-swell, slope.	Unsuited	Unsuited	Poor: slope.
HsB	Poor: low strength	Unsuited	Unsuited	Fair: thin layer.
HsC2	Poor: low strength	Unsuited	Unsuited	Fair: thin layer, slope.
Kaukauna: KaA	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer, too clayey.
Keowns: Ke	Poor: wetness, frost action.	Unsuited	Unsuited	Poor: wetness.
Kewaunee: KhB, [1] KlB	Poor: low strength	Unsuited	Unsuited	Fair: thin layer.
For Manawa part of KlB, see Manawa series.				
KhC2	Poor: low strength	Unsuited	Unsuited	Fair: thin layer, slope.
KhD2	Poor: low strength	Unsuited	Unsuited	Poor: slope.
KkE3	Poor: low strength, slope.	Unsuited	Unsuited	Poor: slope.
Kolberg: KoB	Poor: low strength, area reclaim.	Unsuited	Unsuited	Fair: thin layer.
KoC2	Poor: low strength, area reclaim.	Unsuited	Unsuited	Fair: thin layer, slope.
Limestone quarries: Ln. Not rated.				
Lobo: Lo	Poor: wetness, excess humus, low strength.	Unsuited	Unsuited	Poor: wetness.
Manawa: McA	Poor: low strength	Unsuited	Unsuited	Fair: too clayey.
Manistee: MeB, MeC2	Fair: thin layer, area reclaim.	Poor: excess fines	Unsuited	Poor: too sandy.
MfB	Fair: thin layer, area reclaim.	Poor: excess fines	Unsuited	Poor: area reclaim.
Markey: Mk	Poor: excess humus, wetness.	Poor: excess fines	Unsuited	Poor: wetness.
Menominee: MsB, MsC2	Fair: frost action, low strength.	Unsuited: thin layer	Unsuited	Poor: too sandy.
Mosel: MtA	Poor: frost action, low strength.	Unsuited	Unsuited	Good.
Mundelein: MuA	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer.
Namur: NaB	Poor: thin layer, area reclaim.	Unsuited	Unsuited	Poor: thin layer, area reclaim.
Nichols: NfA, NfB	Poor: frost action	Poor: excess fines	Unsuited	Good.
NsA, NsB	Poor: low strength	Unsuited	Unsuited	Good.

See footnote at end of table.

TABLE 9.—*Construction materials*—Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Onaway: OhB, [1] OIB — For Solona part of OIB, see Solona series.	Fair: frost action	Unsuited	Unsuited	Fair: thin layer.
OhC2	Fair: frost action	Unsuited	Unsuited	Fair: slope, thin layer.
OhD2	Fair: slope, frost action.	Unsuited	Unsuited	Poor: slope.
Pella: Pe	Poor: frost action, wetness.	Unsuited	Unsuited	Poor: wetness, area reclaim.
Poy: Pf	Poor: low strength, wetness, frost action.	Good	Unsuited	Poor: wetness.
Poygan: Po	Poor: wetness, low strength.	Unsuited	Unsuited	Poor: wetness.
Rock outcrop: Ra. Not rated.				
Rondeau: Rd	Poor: excess humus, wetness.	Unsuited	Unsuited	Poor: wetness.
Rousseau: RoB	Good	Good	Unsuited	Poor: too sandy.
Shawano: SeC	Good	Good	Unsuited	Poor: too sandy.
SeD	Fair: slope	Good	Unsuited	Poor: too sandy, slope.
Shiocton: ShA, [1] SnB — For Nichols part of SnB, see NfB in Nichols series.	Poor: frost action	Unsuited	Unsuited	Good.
SkA	Poor: frost action	Unsuited	Unsuited	Fair: thin layer.
Solona: SoA	Poor: frost action	Unsuited	Unsuited	Good.
Suamico: Su	Poor: wetness, low strength, excess humus.	Unsuited	Unsuited	Poor: wetness.
Symco: SyA	Poor: low strength, frost action.	Unsuited	Unsuited	Fair: thin layer.
Symco variant: SzA	Poor: frost action	Good	Good	Fair: thin layer.
Udifluvents: Uf	Poor: frost action	Unsuited	Unsuited	Good.
Udorthents: Uo	Fair: shrink-swell, frost action, low strength.	Unsuited	Unsuited	Poor: too clayey.
Wainola: WaA	Fair: wetness	Good	Unsuited	Poor: too sandy.
Will: Wb	Poor: frost action, wetness.	Good	Good	Poor: wetness, area reclaim.
Winneconne: WnA, WnB, WnC2.	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer.
Zittau: ZtA	Poor: frost action, wetness, shrink-swell.	Good	Unsuited: excess fines.	Fair: too clayey, thin layer.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

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, slope, 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.

Soils 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 8 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 10, 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.

Aquifer-fed excavated ponds are bodies of water made by excavating a pit or dugout into a groundwater aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 10 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer quality of the water, and ease of excavation.

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; alkalinity; and availability of outlets for drainage.

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.

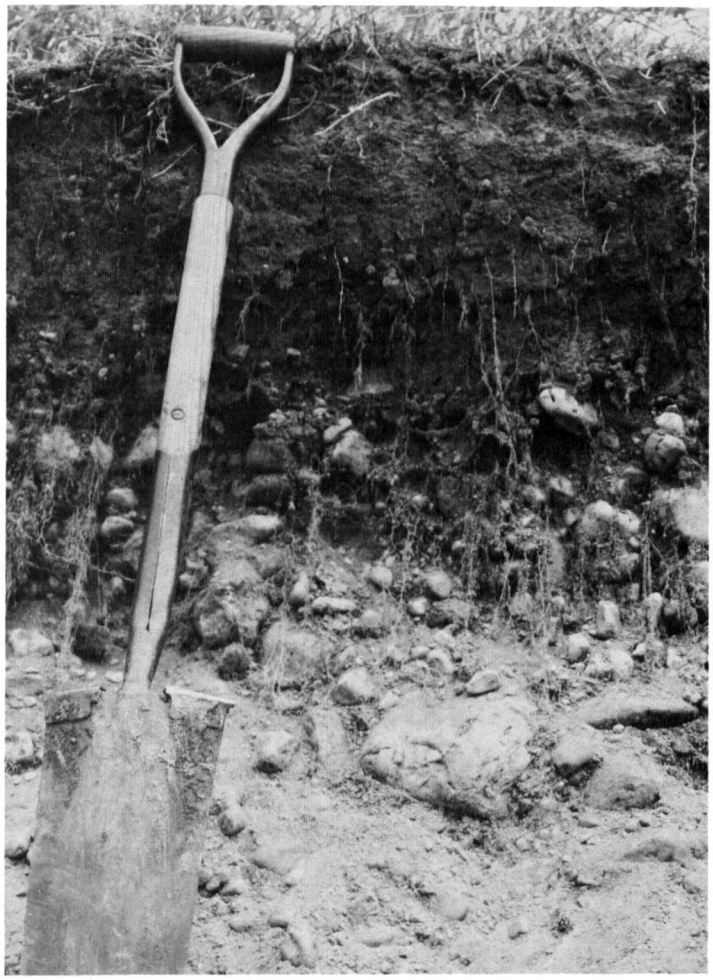

Figure 15.—The underlying sand and gravel in Casco soils are a good source of construction material.

TABLE 10.—*Water management*

["Seepage" and other terms that describe restrictive soil features are defined in the Glossary]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Allendale: AdA	Seepage	Thin layer	Slow refill	Cutbanks cave	Not needed	Not needed.
Angelica: Ax	Favorable	Piping, low strength.	Favorable	Poor outlets, floods.	Not needed	Wetness.
Bellevue: Bc	Seepage	Low strength, piping.	Deep to water	Floods	Erodes easily	Erodes easily.
Bonduel: BnA	Depth to rock, seepage.	Low strength, piping, thin layer.	Deep to water	Depth to rock, frost action, wetness.	Wetness, depth to rock.	Wetness, rooting depth.
Borth: BoA	Seepage	Compressible, shrink-swell, low strength.	Deep to water	Not needed	Percs slowly	Percs slowly.
Boyer: BrB, BrC2, BrD2	Seepage, slope	Seepage	No water	Not needed	Complex slope, soil blowing.	Slope.
Briggsville: BtA, BtB	Favorable	Shrink-swell, low strength.	Deep to water	Not needed	Percs slowly	Percs slowly.
Carbondale: Ca	Seepage	Excess humus	Favorable	Floods, wetness, cutbanks cave.	Not needed	Not needed.
Casco: CcB, CcC2, CcD2	Seepage	Seepage	No water	Not needed	Rooting depth	Droughty, rooting depth.
Cathro: Cm	Seepage	Compressible, hard to pack, low strength.	Favorable	Wetness, floods, cutbanks cave.	Not needed	Not needed.
Channahon: CnB	Depth to rock	Thin layer	No water	Not needed	Depth to rock	Rooting depth.
Deford: De	Seepage	Piping, seepage.	Favorable	Cutbanks cave	Not needed	Not needed.
Eleva: ElB, ElC2	Depth to rock, seepage.	Piping, thin layer.	No water	Not needed	Depth to rock, slope.	Droughty, rooting depth, slope.
Fluvaquents: Fu	Seepage	Low strength, piping, seepage.	Favorable	Floods, wetness.	Not needed	Wetness.
Gravel pits: Gp. Not rated.						
Grays: GrA	Seepage	Low strength, piping.	Deep to water	Not needed	Favorable	Favorable.
GrB	Seepage	Low strength, piping.	Deep to water	Not needed	Favorable	Slope, erodes easily.
Hebron: HeB	Favorable	Shrink-swell, low strength.	No water	Not needed	Percs slowly	Percs slowly.
Hortonville: HnB, HnC2, HrB, HrC2, HrD2, HrE, HsB, HsC2, [1] HtB. For Symco part of HtB, see Symco series.	Seepage, slope	Low strength, shrink-swell.	No water	Not needed	Complex slope, percs slowly.	Percs slowly, slope.
Kaukauna: KaA	Favorable	Low strength, shrink-swell.	Deep to water	Not needed	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Keowns: Ke	Seepage	Low strength, piping.	Deep to water	Wetness, floods, frost action.	Wetness, piping.	Wetness.

See footnote at end of table.

TABLE 10.—*Water management*—Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Kewaunee: KhB, KhC2, KhD2, KkE3, [1] KlB. For Manawa part of KlB, see Manawa series.	Favorable	Shrink-swell, low strength.	No water	Not needed	Erodes easily, percs slowly.	Erodes easily, percs slowly
Kolberg: KoB, KoC2	Depth to rock, seepage.	Low strength, thin layer, shrink-swell.	No water	Not needed	Depth to rock, erodes easily, percs slowly.	Erodes easily, percs slowly, rooting depth.
Limestone quarries: Ln. Not rated.						
Lobo: Lo	Seepage	Compressible, seepage, low strength.	Favorable	Favorable	Not needed	Not needed.
Manawa: McA	Favorable	Shrink-swell, low strength.	Deep to water	Percs slowly, floods.	Wetness, percs slowly, rooting depth.	Wetness, percs slowly, rooting depth.
Manistee: MeB, MfB	Favorable	Unstable fill, seepage.	No water	Not needed	Soil blowing, complex slope.	Droughty, soil blowing.
MeC2	Slope	Unstable fill, seepage.	No water	Not needed	Soil blowing, complex slope.	Droughty, soil blowing.
Markey: Mk	Seepage	Compressible, seepage, hard to pack.	Favorable	Floods, wetness, cutbanks cave.	Not needed	Not needed.
Menominee: MsB, MsC2	Seepage, slope	Low strength, piping, shrink-swell.	No water	Not needed	Too sandy, soil blowing, droughty.	Slope, droughty.
Mosel: MtA	Favorable	Low strength, piping, shrink-swell.	Deep to water	Percs slowly, frost action.	Wetness, percs slowly, piping.	Wetness.
Mundelein: MuA	Seepage	Low strength, piping.	Slow refill	Favorable	Not needed	Favorable.
Namur: NaB	Depth to rock, seepage.	Thin layer	No water	Not needed	Depth to rock, seepage, piping.	Droughty, rooting depth.
Nichols: NfA, NfB	Seepage	Low strength, piping.	Deep to water	Not needed	Piping, erodes easily.	Erodes easily.
NsA, NsB	Seepage	Low strength, hard to pack, shrink-swell.	Deep to water	Not needed	Piping	Favorable.
Onaway: OhB, [1] OlB For Solona part of OlB, see Solona series.	Favorable	Erodes easily	No water	Percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.
OhC2, OhD2	Slope	Erodes easily	No water	Percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Pella: Pe	Favorable	Low strength	Favorable	Favorable	Not needed	Not needed.
Poy: Pf	Seepage	Low strength	Slow refill	Percs slowly, cutbanks cave, floods.	Wetness, percs slowly.	Wetness, percs slowly.
Poygan: Po	Favorable	Shrink-swell, low strength.	Slow refill	Percs slowly, wetness, floods.	Wetness, percs slowly, rooting depth.	Wetness, percs slowly, rooting depth.

See footnote at end of table.

TABLE 10.—*Water management*—Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Rock outcrop: Ra. Not rated.						
Rondeau: Rd	Seepage	Compressible, seepage, low strength.	Favorable	Floods, cutbanks cave, wetness.	Not needed	Not needed.
Rousseau: RoB	Seepage	Seepage, piping.	No water	Not needed	Too sandy, soil blowing.	Droughty.
Shawano: SeC, SeD	Seepage	Seepage, piping, erodes easily.	No water	Not needed	Complex slope, too sandy, soil blowing.	Droughty, erodes easily, slope.
Shiocton: ShA, [1] SnB	Seepage	Low strength, piping, hard to pack.	Deep to water	Floods, wetness.	Piping, wetness, erodes easily.	Erodes easily, wetness.
For Nichols part of SnB, see NfB in Nichols series.						
SkA	Seepage	Low strength, piping.	Deep to water	Wetness, floods.	Wetness, erodes easily.	Wetness, erodes easily.
Solona: SoA	Seepage	Low strength, piping.	Deep to water	Floods, wetness.	Wetness	Wetness.
Suamico: Su	Favorable	Excess humus, seepage, low strength.	Favorable	Percs slowly, wetness, floods.	Wetness, percs slowly.	Wetness, percs slowly.
Symco: SyA	Favorable	Low strength, compressible.	Favorable	Percs slowly	Not needed	Not needed.
Symco variant: SzA	Seepage	Low strength	Favorable	Wetness, cutbanks cave.	Wetness	Wetness.
Udifluvents: Uf	Seepage	Low strength, piping. seepage.	Deep to water	Floods, frost action.	Not needed	Favorable.
Udorthents: Uo	Favorable	Low strength, shrink-swell.	No water	Not needed	Percs slowly	Percs slowly.
Wainola: WaA	Seepage	Piping, seepage.	Deep to water	Cutbanks cave	Not needed	Not needed.
Will: Wb	Favorable	Seepage	Favorable	Favorable	Not needed	Not needed.
Winneconne: WnA, WnB WnC2.	Favorable	Low strength, shrink-swell.	Deep to water	Percs slowly	Percs slowly	Percs slowly.
Zittau: ZtA	Seepage	Low strength	Favorable	Percs slowly	Not needed	Not needed.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

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 classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering Properties

Table 11 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 11 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 "Descriptions of the Soils."

Texture is described in table 11 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 classifiying 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, indentified 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 14. The estimated classification, without group index numbers, is given in table 11. Also in table 11 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. Range 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.

Physical and Chemical Properties

Table 12 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

TABLE 11.—*Engineering*

[The symbol< means less than and > means more than. Absence of an

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Allendale: AdA	0–11	Loamy fine sand	SM	A–2–4
	11–39	Sand, loamy sand, loamy fine sand	SP, SM	A–2–4, A–3
	39–60	Silty clay, clay	CH, MH	A–7
Angelica: Ax	0–8	Silt loam	ML, CL, CL–ML	A–4
	8–29	Loam, sandy loam, clay loam	SM, ML, SC, CL	A–4, A–6
	29–60	Loam, sandy loam, gravelly loam	ML, SM, CL, SC	A–2–4, A–4
Bellevue: Bc	0–35	Silt loam	ML, CL–ML	A–4
	35–60	Loam, sandy loam, silt loam	SC, SM–SC, CL, CL–ML	A–4, A–6, A–2
Bonduel: BnA	0–10	Silt loam	ML, CL, CL–ML	A–4
	10–20	Sandy clay loam, clay loam, loam	CL, SC	A–4, A–6
	20–24	Loam	CL, CL–ML	A–4, A–6
	24–60	Unweathered bedrock.		
Borth: BoA	0–14	Silt loam	CL, CL–ML	A–4, A–6
	14–18	Silt loam, silty clay loam, clay loam	CL	A–6
	18–33	Silty clay, clay	CH	A–7
	33–60	Sand, loamy sand, gravel	SP–SM, SM	A–2, A–3
Boyer: BrB, BrC2, BrD2	0–14	Loamy sand	SM, SM–SC	A–2
	14–28	Sandy loam, sandy clay loam, loamy sand.	SM, SC, SM–SC	A–2, A–4, A–6
	28–60	Stratified sand to gravel	SP, SP–SM, GP, GP–GM	A–1, A–3, A–2–4
Briggsville: BtA, BtB	0–11	Silt loam	CL–ML, CL, ML	A–4, A–6
	11–27	Silty clay, silty clay loam	CH, CL	A–6, A–7
	27–60	Silty clay loam	CL, CH	A–6, A–7
Carbondale: Ca	0–34	Sapric material	Pt	A–8
	34–60	Hemic material	Pt	A–8
Casco: CcB, CcC2, CcD2	0–7	Loam	ML, CL–ML	A–4
	7–19	Clay loam, loam, sandy clay loam	SC, CL	A–6, A–7
	19–60	Sand and gravel	GP, SP, GP–GM, SP–SM	A–1, A–3, A–2
Cathro: Cm	0–33	Sapric material	Pt	A–8
	33–60	Sandy loam, loam, silt loam	SM, ML, SC, CL	A–4
Channahon: CnB	0–11	Silt loam	CL	A–6, A–4
	11–18	Loam, clay loam, silty clay loam	CL	A–6, A–7
	18–60	Unweathered bedrock.		
Deford: De	0–5	Loamy fine sand	SM	A–2–4
	5–60	Fine sand, very fine sand, loamy fine sand.	SM	A–2–4
Eleva: ElB, ElC2	0–8	Fine sandy loam	SM	A–2
	8–23	Sandy loam, loam	SM, SM–SC	A–4
	23–29	Sand, loamy sand, sandy loam	SP–SM, SM	A–3, A–2
	29–60	Weathered bedrock.		
Fluvaquents: Fu	0–60	Variable		
Gravel pits: Gp. Not rated.				
Grays: GrA, GrB	0–9	Silt loam	CL	A–4, A–6
	9–25	Silty clay loam	CL	A–6, A–7
	25–60	Stratified silt loam to very fine sand	ML, CL, SM, SC	A–4, A–2, A–6

properties and classifications

entry indicates that data were not estimated. NP means nonplastic]

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	95–100	50–75	10–25		NP
0	100	95–100	50–70	0–20		NP
0	100	90–100	90–100	75–95	50–70	20–40
0–10	90–100	85–100	55–100	55–90	25–40	2–9
0–10	90–100	85–100	50–90	36–70	12–40	2–20
0–15	85–95	80–100	50–90	30–70	20–40	NP–16
0	100	100	85–100	60–90	20–30	1–7
0	100	100	60–100	30–90	20–30	5–15
0	100	100	85–100	60–90	20–30	3–10
0–5	95–100	95–100	80–90	35–80	25–40	7–20
0–5	80–95	80–95	75–85	50–65	20–30	5–12
0	100	100	85–100	60–90	20–40	5–15
0	100	100	90–100	70–95	30–40	13–22
0	80–100	100	90–100	90–100	65–80	40–50
0	65–100	65–100	65–80	5–30		NP
0–5	95–100	65–95	45–75	15–30	<20	NP–6
0–5	80–100	65–95	55–85	10–45	10–35	NP–16
0–10	40–100	35–100	30–70	0–10		NP
0	100	100	85–100	60–90	30–40	5–15
0	100	100	95–100	95–100	30–65	15–40
0	100	100	95–100	90–100	30–60	10–35
0						
0						
0	80–100	80–100	80–100	50–70	20–30	1–7
0–5	75–100	75–100	70–100	45–70	25–45	11–25
0–10	30–100	30–90	10–90	3–10		NP
0						
0	100	95–100	60–100	35–90	15–26	3–10
0–20	95–100	95–100	85–100	65–90	21–38	7–18
0–20	95–100	90–100	85–100	50–85	24–46	15–20
0	100	95–100	65–80	20–35		NP
0	100	95–100	50–80	15–35		NP
0	100	100	75–85	25–35	<20	2–4
0	100	100	65–75	40–50	<20	2–6
0	100	100	50–75	5–35	<20	NP–4
0	100	95–100	90–100	80–95	25–40	8–20
0	100	95–100	90–100	60–90	30–45	15–25
0	90–100	80–100	70–100	30–70	15–40	NP–20

TABLE 11.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Hebron: HeB	0–18	Loam	ML, CL–ML	A–4
	18–28	Clay loam, loam	CL–ML, CL	A–4, A–6
	28–32	Silty clay loam	CL	A–7
	32–60	Stratified silty clay to fine sand	CL	A–6, A–7
Hortonville:				
HnB, HnC2	0–8	Fine sandy loam	SM, ML	A–4
	8–27	Silty clay loam, clay loam, loam	CL, CH	A–7, A–6
	27–60	Silty clay loam, clay loam, loam	CL, SC	A–4, A–6
HrB, HrC2, HrD2, HrE, [1] HtB	0–8	Silt loam	ML, CL	A–4
For Symco part of HtB, see Symco series.	8–27	Silty clay loam, clay loam, loam	CL, CH	A–7, A–6
	27–60	Silty clay loam, clay loam, loam	CL, SC	A–4, A–6
HsB, HsC2	0–10	Silt loam	ML, CL, CL–ML	A–4
	10–30	Silty clay loam	CL, CH	A–7, A–6
	30–45	Clay loam	CL	A–6, A–4
	45–60	Weathered bedrock.		
Kaukauna: KaA	0–9	Silty clay loam	CL	A–6
	9–27	Clay, silty clay	CH	A–7
	27–34	Silt loam, loam, very fine sandy loam	CL, CL–ML	A–4, A–6
	34–60	Stratified silt to very fine sand	CL, CL–ML, SC, SM–SC	A–4
Keowns: Ke	0–8	Silt loam	ML, CL, CL–ML	A–4
	8–21	Silt loam, very fine sandy loam, sandy loam.	ML, CL, SM, SC	A–4, A–2
	21–60	Stratified silt to fine sand	ML, SM	A–2, A–4
Kewaunee:				
KhB, KhC2, KhD2, [1] KlB	0–6	Silt loam	ML, CL, CL–ML	A–4
For Manawa part of KlB, see Manawa series.	6–27	Clay, silty clay, silty clay loam	CL, CH	A–7
	27–60	Clay, silty clay, silty clay loam	CL, CH	A–6, A–7
KkE3	0–6	Silty clay loam	CL, CH	A–7
	6–27	Clay, silty clay, silty clay loam	CL, CH	A–7
	27–60	Clay, silty clay, silty clay loam	CL, CH	A–6, A–7
Kolberg: KoB, KoC2	0–9	Silt loam	ML, CL, CL–ML	A–4
	9–22	Silty clay loam, silty clay, clay	CL, CH	A–6, A–7
	22–27	Loam, clay loam, gravelly loam	CL, CL–ML	A–4, A–6
	27–60	Weathered bedrock.		
Limestone quarries: Ln. Not rated.				
Lobo: Lo	0–40	Fibric material	Pt	A–8
	40–60	Hemic material	Pt	A–8
Manawa: McA	0–11	Silty clay loam	CL	A–6
	11–30	Silty clay, silty clay loam, clay	CH, CL	A–7
	30–60	Silty clay, silty clay loam, clay	CH, CL	A–6, A–7
Manistee:				
MeB, MeC2	0–14	Loamy fine sand	SM	A–2–4
	14–31	Sand, loamy sand	SP–SM, SM	A–2–4
	31–60	Clay, silty clay	CH	A–7
MfB	0–14	Fine sandy loam	SM	A–2–4, A–4
	14–31	Sand, loamy sand	SP–SM, SM	A–2–4
	31–60	Clay, silty clay	CH	A–7
Markey: Mk	0–25	Sapric material	Pt	A–8
	25–60	Sand, loamy sand	SP, SM	A–2, A–3

See footnote at end of table.

and classifications—Continued

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	95–100	95–100	85–100	50–70	20–30	NP–7
0	85–100	85–100	85–95	80–90	25–40	6–15
0	100	100	85–95	80–90	40–50	20–30
0	100	100	85–100	85–100	25–50	11–30
0	95–100	95–100	70–85	40–55	10–19	1–4
0	85–100	85–100	80–100	70–85	35–60	20–37
0–5	75–100	75–95	60–90	45–80	24–30	8–14
0	95–100	95–100	85–100	60–90	20–30	3–10
0	85–100	85–100	80–100	70–85	35–60	20–37
0–5	75–100	75–95	60–90	45–80	24–30	8–14
0	95–100	95–100	85–95	80–90	20–30	3–10
0	95–100	95–100	85–95	85–90	35–60	20–37
0–3	95–100	90–95	85–95	75–85	24–30	8–14
0	100	100	95–100	85–95	25–40	10–20
0	100	100	95–100	85–95	70–80	45–50
0	100	100	85–100	55–85	20–30	5–15
0	100	100	85–100	45–100	<20	4–10
0	100	100	85–100	60–90	20–30	3–10
0	100	100	60–100	30–85	<20	NP–10
0	100	100	70–95	30–95	<20	NP–4
0	95–100	95–100	85–100	50–70	20–30	2–10
0	90–100	90–100	90–100	75–95	45–70	30–45
0	90–100	90–100	90–100	65–95	30–60	15–35
0	95–100	95–100	90–100	75–95	45–55	25–35
0	90–100	90–100	90–100	75–95	45–70	30–45
0	90–100	90–100	90–100	65–95	30–60	15–35
0	100	100	85–100	60–90	20–30	3–10
0	95–100	95–100	90–100	75–95	35–65	20–35
0	80–100	80–100	75–90	65–75	20–35	5–15
0						
0						
0	100	100	100	80–90	25–40	11–20
0	90–100	90–100	90–100	65–95	45–70	30–45
0–5	90–100	90–100	90–100	65–95	30–60	15–35
0–2	95–100	95–100	50–75	15–30		NP
0–2	95–100	95–100	50–75	10–25		NP
0	100	100	90–100	80–95	50–80	25–45
0–2	95–100	95–100	95–100	30–45	<25	NP–5
0–2	95–100	95–100	50–75	10–25		NP
0	100	100	90–100	80–95	50–80	25–45
0	100	90–100	60–75	0–20		NP

TABLE 11.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Menominee: MsB, MsC2	0–4	Loamy fine sand	SM	A–2, A–4
	4–27	Fine sand, very fine sand	SM, ML	A–2, A–4
	27–44	Clay loam, loam, sandy clay loam	SC, SM–SC, CL, CL–ML	A–4, A–6
	44–60	Sandy loam, loam	SC, SM–SC, CL, CL–ML	A–4, A–6, A–2
Mosel: MtA	0–9	Silt loam	ML, CL–ML	A–4
	9–21	Loam, sandy loam, sandy clay loam	SM–SC, SC, CL, CL–ML	A–4, A–6
	21–27	Silty clay loam, silty clay, clay	CL	A–7
	27–60	Stratified silty clay to fine sand	CL	A–7, A–6
Mundelein: MuA	0–10	Silt loam	ML, CL, OL	A–4, A–6
	10–27	Silty clay loam	CL	A–7, A–6
	27–60	Stratified silt loam to sand	SC, SM, ML, CL	A–2, A–3, A–4, A–6
Namur: NaB	0–5	Silt loam	ML	A–4
	5–60	Weathered bedrock.		
Nichols:				
NfA, NfB	0–26	Very fine sandy loam	ML, CL–ML, SM, SM–SC	A–4
	26–60	Stratified very fine sand to silt	ML, CL–ML, SM, SM–SC	A–4
NsA, NsB	0–26	Very fine sandy loam	ML, CL–ML	A–4
	26–40	Stratified very fine sand to silt	ML, CL–ML, SM, SM–SC	A–4
	40–60	Clay	CH	A–7
Onaway: OhB, OhC2, OhD2, [1] OlB — For Solona part of OlB, see Solona series.	0–4	Loam	ML, CL–ML, CL	A–4
	4–15	Fine sandy loam, loam	SM, SM–SC	A–2, A–4
	15–27	Loam, clay loam, silty clay loam	CL, CL–ML	A–4, A–6
	27–60	Silt loam, loam, sandy loam	CL–ML, SC, CL, SM–SC	A–4
Pella: Pe	0–14	Silt loam	CL, CL–ML	A–4
	14–29	Silty clay loam	CL	A–6, A–7
	29–60	Stratified sandy loam to silty clay loam.	SM–SC, SC, CL, CL–ML	A–2, A–4, A–6
Poy: Pf	0–8	Silty clay loam	CL	A–6
	8–24	Clay, silty clay loam, silty clay	CH	A–7
	24–60	Sand, gravelly sand	SP	A–3
Poygan: Po	0–8	Silty clay loam	CL, CH	A–7
	8–24	Silty clay, silty clay loam, clay	CL, CH	A–7
	24–60	Clay, silty clay	CL, CH	A–7, A–6
Rock outcrop: Ra. Not rated.				
Rondeau: Rd	0–22	Sapric material	Pt	A–8
	22–60	Marl	OH, MH	A–8, A–5
Rousseau: RoB	0–3	Loamy fine sand	SM	A–2–4, A–4
	3–21	Fine sand	SP, SP–SM	A–3, A–2–4
	21–60	Fine sand	SP, SP–SM	A–3
Shawano: SeC, SeD	0–5	Fine sand	SP, SM	A–2
	5–28	Fine sand, very fine sand	SP, SM	A–2
	28–60	Fine sand	SP, SM	A–2
Shiocton:				
ShA	0–10	Silt loam	ML, CL–ML, CL	A–4
	10–26	Silt loam, very fine sandy loam	ML, CL–ML	A–4
	26–60	Stratified silt to very fine sand	ML, SM	A–4

See footnote at end of table.

and classifications—Continued

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	60–80	30–40		NP
0	100	100	65–80	20–60		NP
0	95–100	95–100	80–100	35–80	20–30	5–15
0	95–100	95–100	60–95	30–75	15–30	5–12
0	95–100	95–100	85–100	50–70	20–30	NP–5
0	90–100	90–100	45–70	40–65	20–40	5–25
0	100	100	85–100	85–95	40–50	20–30
0	100	100	85–100	85–100	25–50	10–30
0	95–100	95–100	95–100	85–95	30–50	5–20
0	95–100	95–100	95–100	75–95	35–50	15–25
0	90–100	90–100	60–90	10–75	<35	NP–20
0–5	90–100	90–100	85–100	60–90	20–30	NP–5
0	100	100	75–95	45–60	<20	2–6
0	100	95–100	85–100	75–100	<20	NP–6
0	100	100	85–95	50–65	<20	NP–5
0	100	95–100	75–95	35–95	<20	NP–6
0	100	100	100	95–100	65–75	40–50
0–30	90–100	90–100	75–90	60–70	<25	NP–10
0–30	90–100	85–95	55–80	25–50	<20	NP–10
0–20	95–100	95–100	80–95	65–90	25–35	7–15
0–20	90–95	85–95	60–95	36–80	15–25	4–10
0	100	100	90–100	70–90	20–30	5–10
0	100	95–100	85–100	70–95	30–50	20–30
0–5	90–100	80–100	50–100	30–85	20–35	7–20
0	100	100	95–100	80–90	30–40	10–20
0	100	100	95–100	80–95	60–90	40–60
0	65–100	65–100	50–60	1–5		NP
0	100	100	90–100	75–95	45–55	25–35
0	90–100	90–100	90–100	75–95	45–70	30–45
0–5	90–100	90–100	90–100	80–100	30–55	20–45
0						NP
0	100	95–100	80–90	60–80	50–90	NP–10
0	100	100	75–95	25–45		NP
0	100	100	90–100	5–25		NP
0	100	100	85–100	0–10		NP
0	100	100	75–100	5–35		NP
0	95–100	95–100	70–100	3–35		NP
0	95–100	95–100	70–100	2–25		NP
0	100	100	85–100	65–95	20–30	3–8
0	100	100	85–100	50–90	<30	NP–6
0	100	100	80–100	40–95	<30	NP

TABLE 11.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
SkA	0–8	Silt loam	ML, CL, CL–ML	A–4
	8–16	Loamy very fine sand, very fine sandy loam.	ML, CL–ML, SM, SM–SC	A–4
	16–50	Very fine sand, very fine sandy loam	ML, CL–ML, SM, SM–SC	A–4
	50–60	Silty clay, clay	CL, CH	A–7
[1] SnB	0–10	Silt loam	ML, CL–ML, CL	A–4
For Nichols part, see NfB in Nichols series.	10–26	Silt loam, very fine sandy loam	ML, CL–ML	A–4
	26–60	Stratified silt to very fine sand	ML	A–4
Solona: SoA	0–11	Silt loam	ML, CL, CL–ML	A–4
	11–24	Clay loam, loam, sandy loam	CL, SC	A–6
	24–60	Loam, sandy loam	ML, CL, SM, SC	A–2, A–4, A–6
Suamico: Su	0–26	Sapric material	Pt	A–8
	26–60	Silty clay, clay, clay loam	CL, CH	A–7
Symco: SyA	0–11	Silt loam	ML	A–4
	11–25	Clay loam, silt loam, silty clay loam	CL	A–6
	25–60	Loam, clay loam, silty clay loam	CL	A–6
Symco variant: SzA	0–12	Silt loam	ML, CL	A–4
	12–22	Silty clay loam, clay loam	CL	A–6, A–4
	22–26	Sandy loam	SM, SM–SC	A–2, A–4
	26–60	Sand and gravel	GP, SP, SP–SM, GP–GM	A–1, A–3
Udifluvents: Uf	0–60	Variable		
Udorthents: Uo	0–60	Variable		
Wainola: WaA	0–9	Loamy fine sand	SM	A–2–4
	9–33	Fine sand, loamy fine sand	SM	A–2–4
	33–60	Fine sand, loamy fine sand	SM	A–2–4
Will: Wb	0–10	Silt loam	CL, ML	A–7, A–6
	10–26	Loam, clay loam, silty clay loam	CL, CH	A–7
	26–60	Stratified sand to gravelly loamy sand	GP, GP–GM, SP, SP–SM	A–1
Winneconne: WnA, WnB, WnC2	0–9	Silty clay loam	CH	A–7
	9–31	Clay, silty clay	CH	A–7
	31–60	Clay	CH	A–7
Zittau: ZtA	0–11	Silty clay loam	CL	A–6, A–7
	11–32	Silty clay, clay	CH	A–7
	32–60	Sand, loamy sand, sand and gravel	SP, SM	A–3, A–2

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

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.

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 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

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	90–100	70–90	20–30	3–8
0	100	100	85–95	40–65	<30	NP–6
0	100	100	75–95	35–65	<30	NP–6
0	100	100	95–100	90–95	45–55	25–32
0	100	100	85–100	65–95	20–30	3–8
0	100	100	85–100	50–90	<30	NP–6
0	100	100	80–100	40–95	<30	NP
0	90–100	85–100	75–85	60–80	20–30	1–10
0–3	90–100	85–100	75–95	40–65	25–35	10–20
0–5	85–95	80–90	70–85	30–60	<24	NP–12
0						
0	100	100	90–100	70–95	40–60	25–35
0	100	100	90–95	70–80	20–30	NP–5
0–5	95–100	90–95	85–95	75–85	25–40	11–20
0–5	95–100	90–95	85–95	75–85	25–40	11–20
0	100	100	90–100	70–90	20–30	3–10
0–5	95–100	90–100	90–100	70–95	25–40	10–20
0–5	95–100	90–100	60–70	30–40	10–19	2–6
0–10	40–80	35–70	30–55	0–10		NP
0	100	95–100	55–80	20–35		NP
0	100	95–100	50–80	15–35		NP
0	100	95–100	50–80	15–35		NP
0	95–100	95–100	90–100	60–90	35–50	15–25
0–5	90–100	90–100	80–100	60–90	40–60	20–35
1–10	40–80	40–70	40–50	0–10		NP
0	100	100	95–100	85–95	70–80	40–45
0	100	100	90–100	70–95	70–80	45–50
0	100	100	90–100	75–100	70–80	45–50
0	100	100	95–100	85–95	25–45	11–20
0	100	100	100	85–95	60–70	30–40
0	85–100	65–100	60–85	1–20		NP

behavior characteristics of the mapping unit.

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 to 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

TABLE 12.—*Physical and chemical properties of soils*

[The symbol < means less than and > means more than. The erosion tolerance factor (T) and wind erodibility group are for the entire profile. Absence of an entry indicates that data were not estimated. Dashes indicate that data were not available]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
						Uncoated steel	Concrete	K	T	
	In	*In per hr*	*In per in*	*pH*						
Allendale: AdA	0–11	2.0–20	0.07–0.12	5.1–7.3	Low	Low	Moderate	0.15	4	2
	11–39	6.0–20	0.06–0.10	5.1–7.3	Low	Low	Moderate	0.15		
	39–60	0.06–0.2	0.08–0.12	6.1–8.4	High	High	Low	0.32		
Angelica: Ax	0–8	0.6–2.0	0.18–0.22	6.1–7.3	Low	High	Low			5
	8–29	0.6–2.0	0.10–0.18	6.1–7.3	Low	High	Low			
	29–60	0.2–0.6	0.10–0.20	7.9–8.4	Low	High	Low			
Bellevue: Bc	0–35	0.6–2.0	0.20–0.24	6.1–8.4	Low	Low	Low	0.32	5	5
	35–60	0.6–2.0	0.12–0.19	6.1–8.4	Low	Low	Low	0.32		
Bonduel: BnA	0–10	0.6–2.0	0.20–0.24	6.6–7.8	Low	Moderate	Low	0.28	4–3	5
	10–20	0.6–2.0	0.15–0.19	5.6–7.8	Moderate	Moderate	Low	0.28		
	20–24	0.6–2.0	0.17–0.19	6.6–8.4	Low	Moderate	Low	0.28		
	24–60									
Borth: BoA	0–14	0.6–2.0	0.20–0.24	5.6–8.4	Low	High	Low	0.43	3–2	6
	14–18	0.2–0.6	0.15–0.22	5.6–8.4	Moderate	High	Low	0.43		
	18–33	0.06–0.2	0.09–0.13	5.6–8.4	Moderate	High	Low	0.32		
	33–60	6.0–20	0.05–0.10	6.6–8.4	Low	Low	Low	0.15		
Boyer: BrB, BrC2, BrD2.	0–14	6.0–20	0.10–0.12	5.6–7.3	Low	Low	Moderate	0.17	4–3	2
	14–28	2.0–6.0	0.12–0.18	5.6–7.3	Low	Low	Moderate	0.24		
	28–60	>20	0.02–0.04	6.1–7.3	Low	Low	Low	0.10		
Briggsville: BtA, BtB.	0–11	0.6–2.0	0.20–0.24	5.1–6.0	Low	Moderate	Moderate	0.37	5–4	5
	11–27	0.2–0.6	0.11–0.20	6.1–8.4	Moderate	High	Low	0.37		
	27–60	0.2–0.6	0.18–0.20	7.4–8.4	Moderate	High	Low	0.37		
Carbondale: Ca.	0–34	0.2–6.0	0.35–0.45	5.6–7.8		High	Moderate			3
	34–60	0.6–6.0	0.45–0.55	5.6–7.8		High	Moderate			
Casco: CcB, CcC2, CcD2.	0–7	0.6–2.0	0.20–0.24	5.6–7.3	Low	Low	Low	0.32	3	5
	7–19	0.6–2.0	0.15–0.19	5.6–7.8	Moderate	Low	Low	0.32		
	19–60	>20	0.02–0.04	7.4–8.4	Very low	Low	Low	0.10		
Cathro: Cm	0–33	0.2–6.0	0.45–0.55	5.6–7.8		High	Low			8
	33–60	0.2–2.0	0.11–0.22	6.6–8.4	Low	High	Low			
Channahon: CnB.	0–11	0.6–2.0	0.20–0.24	6.1–8.4	Low	Low	Low	0.37	2–1	6
	11–18	0.6–2.0	0.15–0.22	6.1–8.4	Moderate	Moderate	Low	0.37		
	18–60									
Deford: De	0–5	6.0–20	0.07–0.09	5.6–6.5	Very low	Low	Moderate			2
	5–60	6.0–20	0.05–0.07	5.6–8.4	Very low	Low	Low			
Eleva: ElB, ElC2.	0–8	2.0–6.0	0.13–0.18	5.1–6.5	Low	Low	Moderate	0.24	4–3	3
	8–23	0.6–6.0	0.12–0.19	5.1–6.5	Low	Low	Moderate	0.24		
	23–29	2.0–6.0	0.06–0.14	5.1–6.0	Low	Low	Moderate	0.15		
	29–60									
Fluvaquents: Fu.	0–60									5
Gravel pits: Gp. Not rated.										
Grays: GrA, GrB.	0–9	0.6–2.0	0.22–0.24	5.6–6.5	Low	Moderate	Moderate	0.32	5–4	6
	9–25	0.6–2.0	0.18–0.20	5.6–6.5	Moderate	Moderate	Moderate	0.43		
	25–60	0.6–6.0	0.14–0.22	7.4–8.4	Low	Moderate	Low	0.43		

TABLE 12.—*Physical and chemical properties of soils*—Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
						Uncoated steel	Concrete	K	T	
	In	*In per hr*	*In per in*	*pH*						
Hebron: HeB	0–18	0.6–2.0	0.20–0.22	5.6–6.5	Low	Low	Low	0.32	5–4	6
	18–28	0.6–2.0	0.15–0.19	5.6–6.5	Moderate	Moderate	Low	0.32		
	28–32	0.2–0.6	0.18–0.20	6.6–8.4	Moderate	Moderate	Low	0.32		
	32–60	0.2–0.6	0.18–0.20	7.4–8.4	Moderate	Moderate	Low	0.43		
Hortonville:										
HnB, HnC2	0–8	0.6–2.0	0.16–0.18	5.6–7.3	Low	Low	Moderate	0.24	5–4	3
	8–27	0.2–2.0	0.15–0.20	5.6–7.8	Moderate	Moderate	Moderate	0.37		
	27–60	0.2–2.0	0.15–0.20	7.4–8.4	Low	Moderate	Moderate	0.37		
HrB, HrC2, HrD2, HrE, [1] HtB. For Symco part of HtB, see Symco series.	0–8	0.6–2.0	0.20–0.24	5.6–7.3	Low	Low	Moderate	0.37	5–4	5
	8–27	0.2–2.0	0.15–0.20	5.6–7.8	Moderate	Moderate	Moderate	0.37		
	27–60	0.2–2.0	0.15–0.20	7.4–8.4	Low	Moderate	Moderate	0.37		
HsB, HsC2	0–10	0.6–2.0	0.22–0.24	5.1–7.3	Low	Low	Moderate	0.37	5–4	5
	10–30	0.2–2.0	0.18–0.20	5.1–7.8	Moderate	Moderate	Moderate	0.37		
	30–45	0.2–2.0	0.14–0.16	5.1–7.8	Moderate	Moderate	Moderate	0.37		
	45–60									
Kaukauna:										
KaA.	0–9	0.6–2.0	0.21–0.23	5.6–7.8	Low	Moderate	Moderate	0.37	3	4
	9–27	>0.2	0.09–0.13	6.6–8.4	High	Moderate	Low	0.37		
	27–34	0.2–2.0	0.17–0.22	6.6–8.4	Low	Moderate	Low	0.37		
	34–60	0.2–2.0	0.17–0.22	7.4–8.4	Low	Moderate	Low	0.37		
Keowns: Ke	0–8	0.6–2.0	0.20–0.24	6.6–8.4	Low	High	Low			5
	8–21	0.6–2.0	0.12–0.22	6.6–8.4	Low	High	Low			
	21–60	0.6–2.0	0.11–0.22	7.4–8.4	Low	High	Low			
Kewaunee:										
KhB, KhC2, KhD2, [1] KlB. For Manawa part of KlB, see Manawa series.	0–6	0.6–2.0	0.20–0.24	5.6–7.3	Low	Low	Low	0.37	3	5
	6–27	0.06–0.6	0.09–0.13	5.6–7.8	Moderate	Moderate	Low	0.37		
	27–60	0.2–0.6	0.08–0.20	7.4–8.4	Moderate	Moderate	Low	0.37		
KkE3	0–6	0.2–0.6	0.21–0.23	5.6–7.3	Moderate	Moderate	Low	0.37	3	4
	6–27	0.06–0.6	0.09–0.13	5.6–7.8	Moderate	Moderate	Low	0.37		
	27–60	0.2–0.6	0.08–0.20	7.4–8.4	Moderate	Moderate	Low	0.37		
Kolberg: KoB, KoC2.	0–9	0.6–2.0	0.20–0.24	5.6–7.3	Low	Moderate	Moderate	0.43	3–2	5
	9–22	0.06–0.6	0.09–0.20	6.6–7.8	Moderate	Moderate	Low	0.32		
	22–27	0.2–2.0	0.15–0.19	6.6–7.8	Moderate	Moderate	Low	0.32		
	27–60									
Limestone quarries: Ln. Not rated.										
Lobo: Lo	0–40	>6.0	0.55–0.65	3.6–4.4		High	High			8
	40–60	0.6–6.0	0.45–0.55	3.6–5.0		High	High			
Manawa: McA	0–11	0.2–0.6	0.21–0.23	6.6–7.8	Moderate	Low	Low	0.37	3–2	7
	11–30	0.06–0.2	0.09–0.20	6.1–8.4	Moderate	High	Low	0.37		
	30–60	0.06–0.2	0.08–0.20	7.9–8.4	Moderate	High	Low	0.37		
Manistee:										
MeB, MeC2	0–14	6.0–20	0.10–0.12	5.1–6.5	Very low	Low	Moderate	0.17	4–3	2
	14–31	6.0–20	0.06–0.10	5.6–7.3	Very low	Low	Moderate	0.17		
	31–60	0.06–0.2	0.08–0.12	7.4–8.4	High	High	Low	0.32		

See footnote at end of table.

TABLE 12.—*Physical and chemical properties of soils*—Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
						Uncoated steel	Concrete	K	T	
	In	*In per hr*	*In per in*	*pH*						
MfB	0–14	2.0–6.0	0.13–0.15	5.1–6.5	Very low	Low	Moderate	0.24	4–3	3
	14–31	6.0–20	0.06–0.10	5.6–7.3	Very low	Low	Moderate	0.17		
	31–60	0.06–0.2	0.08–0.12	7.4–8.4	High	High	Low	0.32		
Markey: Mk	0–25	0.2–6.0	0.35–0.45	5.6–7.8		High	Low			8
	25–60	6.0–20	0.03–0.08	6.1–8.4	Low	High	Low			
Menominee:										
MsB, MsC2	0–4	6.0–20	0.10–0.12	5.1–6.5	Very low	Low	Moderate	0.24	4	2
	4–27	6.0–20	0.06–0.08	5.1–6.5	Very low	Low	Moderate	0.24		
	27–44	0.6–2.0	0.15–0.20	5.6–8.4	Moderate	Moderate	Low	0.32		
	44–60	0.6–2.0	0.11–0.19	5.6–8.4	Low	Moderate	Low	0.32		
Mosel: MtA	0–9	0.6–2.0	0.20–0.24	5.6–7.8	Low	High	Low	0.28	5	5
	9–21	0.6–2.0	0.12–0.19	5.6–7.8	Low	High	Low	0.28		
	21–27	0.2–0.6	0.18–0.20	7.4–8.4	Moderate	High	Low	0.28		
	27–60	0.2–0.6	0.18–0.20	7.4–8.4	Moderate	High	Low	0.28		
Mundelein:										
MuA.	0–10	0.6–2.0	0.22–0.24	5.6–7.3	Low	High	Moderate	0.28	5	6
	10–27	0.2–2.0	0.18–0.20	5.6–7.3	Moderate	High	Moderate	0.43		
	27–60	0.2–2.0	0.05–0.22	6.1–8.4	Low	High	Low	0.43		
Namur: NaB	0–5	0.6–2.0	0.20–0.24	6.1–7.8	Low	Moderate	Low	0.37	1	5
	5–60									
Nichols:										
NfA, NfB	0–26	0.6–2.0	0.15–0.22	6.1–7.8	Low	Low	Low	0.37	5–4	3
	26–60	0.6–2.0	0.10–0.14	7.9–8.4	Low	Low	Low	0.37		
NsA, NsB	0–26	0.6–2.0	0.20–0.22	6.1–7.8	Low	Low	Low	0.32	4–3	3
	26–40	0.6–2.0	0.10–0.14	7.9–8.4	Low	Low	Low	0.43		
	40–60	0.06–0.2	0.08–0.10	7.9–8.4	Moderate	Moderate	Low	0.32		
Onaway: OhB, OhC2, OhD2, [1] OlB. For Solona part of OlB, see Solona series.	0–4	0.6–2.0	0.14–0.20	5.6–7.3	Low	Moderate	Low	0.32	5–4	5
	4–15	0.6–2.0	0.16–0.22	5.6–7.3	Low	Moderate	Low	0.32		
	15–27	0.2–2.0	0.12–0.18	5.6–7.8	Moderate	Moderate	Low	0.32		
	27–60	0.2–2.0	0.10–0.20	7.4–8.4	Low	Moderate	Low	0.32		
Pella: Pe	0–14	0.6–2.0	0.22–0.24	6.1–7.3	Moderate	High	Moderate			6
	14–29	0.6–2.0	0.21–0.24	6.1–7.3	Moderate	High	Moderate			
	29–60	0.6–2.0	0.10–0.19	7.4–8.4	Low	High	Low			
Poy: Pf	0–8	0.6–2.0	0.21–0.23	6.1–8.4	Moderate	High	Low			7
	8–24	<0.2	0.09–0.20	6.6–8.4	Moderate	High	Low			
	24–60	6.0–20	0.05–0.07	7.4–8.4	Low	High	Low			
Poygan: Po	0–8	0.2–0.6	0.14–0.21	7.4–7.8	Moderate	High	Low	0.37	3–2	7
	8–24	0.06–0.2	0.09–0.18	6.6–7.8	Moderate	High	Low	0.37		
	24–60	0.06–0.2	0.08–0.12	7.4–7.8	Moderate	High	Low	0.37		
Rock outcrop. Ro. Not rated.										
Rondeau: Rd	0–22	0.2–6.0	0.35–0.48	7.4–7.8		High	Low			8
	22–60	<0.2	0.20–0.22	7.4–7.8		High	Low			
Rousseau:										
RoB.	0–3	2.0–6.0	0.10–0.12	5.1–6.0	Very low	Low	High	0.15	5	2
	3–21	6.0–20	0.06–0.08	5.1–6.0	Very low	Low	Moderate	0.15		
	21–60	6.0–20	0.05–0.07	5.6–6.5	Very low	Low	Moderate	0.15		

See footnote at end of table.

TABLE 12.—*Physical and chemical properties of soils*—Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
						Uncoated steel	Concrete	K	T	
	In	*In per hr*	*In per in*	*pH*						
Shawano: SeC, SeD.	0–5	6.0–20	0.07–0.09	5.6–6.5	Low	Low	Moderate	0.15	5	1
	5–28	6.0–20	0.06–0.08	5.6–6.5	Low	Low	Moderate	0.15		
	28–60	6.0–20	0.05–0.07	5.6–7.8	Low	Low	Moderate	0.15		
Shiocton:										
ShA, [1] SnB	0–10	0.6–2.0	0.20–0.24	6.1–7.8	Low	Moderate	Low	0.32	5	5
For Nichols Part of SnB, see NfB in Nichols series.	10–26	0.6–2.0	0.17–0.22	6.6–8.4	Low	Moderate	Low	0.43		
	26–60	0.6–2.0	0.14–0.16	6.6–8.4	Low	Moderate	Low	0.43		
SkA	0–8	0.6–2.0	0.22–0.24	7.4–7.8	Low	Moderate	Low	0.32	5	5
	8–16	0.6–2.0	0.09–0.19	7.4–7.8	Low	Moderate	Low	0.43		
	16–50	0.6–2.0	0.09–0.19	7.4–8.4	Low	Moderate	Low	0.43		
	50–60	<0.06	0.08–0.12	7.4–8.4	Moderate	High	Low	0.32		
Solona: SoA	0–11	0.6–2.0	0.20–0.24	6.6–7.8	Low	High	Low	0.28	5	5
	11–24	0.6–2.0	0.12–0.19	6.6–7.8	Low	High	Low	0.28		
	24–60	0.6–2.0	0.11–0.19	7.4–8.4	Low	High	Low	0.37		
Suamico: Su	0–26	2.0–6.0	0.35–0.45	6.1–7.3		Moderate	Moderate			8
	26–60	<0.06	0.08–0.20	6.6–8.4	Moderate	Moderate	Low			
Symco: SyA	0–11	0.6–2.0	0.22–0.24	7.4–8.4	Low	High	Low	0.32	5–4	6
	11–25	0.2–0.6	0.15–0.17	7.9–8.4	Moderate	High	Low	0.32		
	25–60	0.2–0.6	0.16–0.18	7.9–8.4	Low	High	Low	0.32		
Symco variant: SzA.	0–12	0.6–2.0	0.22–0.24	6.6–7.3	Low	High	Low			5
	12–22	0.6–2.0	0.15–0.20	6.6–7.3	Low	High	Low			
	22–26	0.6–2.0	0.12–0.14	7.4–7.8	Low	High	Low			
	26–60	6.0–20	0.02–0.04	7.9–8.4	Low	High	Low			
Udifluvents: Uf.	0–60									5
Udorthents: Uo.	0–60									4
Wainola: WaA	0–9	6.0–20	0.10–0.12	5.1–6.5	Low	Low	Moderate	0.15	5	2
	9–33	6.0–20	0.06–0.11	5.1–6.5	Low	Low	Moderate	0.15		
	33–60	6.0–20	0.05–0.07	5.6–6.5	Low	Low	Moderate	0.15		
Will: Wb	0–10	0.6–2.0	0.15–0.20	6.1–8.4	Moderate	High	Low			6
	10–26	0.6–2.0	0.15–0.20	6.1–7.3	Moderate	High	Low			
	26–60	6.0–20	0.02–0.04	7.9–8.4	Low	High	Low			
Winneconne: WnA, WnB, WnC2.	0–9	0.2–0.6	0.12–0.23	6.1–7.8	High	Moderate	Low	0.43	3–2	4
	9–31	<0.2	0.09–0.13	6.1–7.8	High	Moderate	Low	0.32		
	31–60	<0.2	0.08–0.10	7.4–8.4	High	Moderate	Low	0.32		
Zittau: ZtA	0–11	0.2–2.0	0.20–0.22	5.6–7.3	Moderate	Moderate	Low	0.37	4	7
	11–32	0.06–0.2	0.08–0.12	5.6–7.3	High	Moderate	Low	0.37		
	32–60	6.0–20	0.02–0.04	6.6–8.4	Very low	Low	Low	0.15		

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

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 of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. 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.
2. 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.
3. 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.

4L. 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.

4. 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.
5. 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.
6. 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.
7. 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.
8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

Table 13 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 been 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 or deep, moderately well drained or 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 rains or after snow melts is not considered flooding, nor is water in swamps and marshes. 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 on 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 in table 13 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 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 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 mapping of the soils. 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.

Subsidence is the settlement of organic soils or of soils containing semifluid layers. Initial subsidence generally results from drainage. Total subsidence is initial subsidence plus the slow sinking that occurs over a period of several years as a result of the oxidation or compression of organic material.

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 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

The results of analyses of engineering properties of several typical soils of the survey area are given in table 14.

The data presented are for soil samples that were collected from carefully selected sites. The soil profiles sampled are typical of the series discussed in the section "Descriptions of the Soils." The soil samples were analyzed by the Wisconsin Department of Transportation, Division of Highways.

The methods used in obtaining the data are listed by code in the next paragraph. Most of the codes, in parentheses, refer to the methods assigned by the American Association of State Highway and Transportation Officials. The codes for shrinkage and Unified classification are those assigned by the American Society for Testing and Materials.

The methods and codes are AASHTO classification (M–145–66); Unified classification (D–2487–66T); mechanical analysis (T88–57); liquid limit (T89–60); plasticity index (T90–56); and moisture-density, method A (T99–57).

Formation and Classification of the Soils

In this section, the factors of soil formation are discussed, the current system of classifying soils is explained, and the soils in the survey area are classified according to that system.

Factors of Soil Formation

Soil is produced by soil-forming processes that act on geologic deposits. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks, and they slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into soil. It may be much or little, but some time is always required for differentiation of soil horizons. Usually a long time is needed for the development of distinct horizons. It is now thought that a combination of basic processes continues in all soils and is responsible for horizon differentiation. All of these processes are at least potentially in every soil. These basic processes, which are called *gains, losses, transfers,* and *transformations,* either promote horizon differentiation or retard or offset it. Their interaction determines the nature of the soil at any given spot.

Climate

Climate has a great influence on the formation of soils because it not only affects the weathering processes, but also determines the kinds of plants and animals in an area and controls the rate of plant growth. Outagamie County has a cool, humid, continental type climate in which temperatures vary greatly from summer to winter. During winter, the soil-forming processes are largely inactive, although some alternate freezing and thawing continues.

Plants and animals

Plants and animals affect the formation of soils by providing organic matter and by transferring plant nutrients from the lower layers of the soil to the upper layers. They also affect changes in soil structure and porosity.

Forest trees were the original vegetation in Outagamie County. Many of the soils in the northern and western parts formed under coniferous forest. These soils are classified as Spodosols. Some of these are Manistee, Menominee, Onaway, Rousseau soils, and others. Other soils in the county formed under deciduous forest in young calcareous parent material. These soils are classified as Alfisols. Some of these are Kaukauna, Kewaunee, Kolberg soils, and others.

Topography

The effects of climate and plant and animal life are conditioned by relief. The topography of Outagamie County ranges from nearly level in large depressions

TABLE 13.—*Soil and*

[The definitions of "flooding" and "water table" in the Glossary explain the terms "brief," "apparent," and "perched."

Soil name and map symbol	Hydrologic group	Flooding		
		Frequency	Duration	Months
Allendale: AdA	B	Rare		
Angelica: Ax	B/D	Frequent	Long	Nov. to May
Bellevue: Bc	B	Frequent	Brief	Sept. to May
Bonduel: BnA	C	None		
Borth: BoA	C	None		
Boyer: BrB, BrC2, BrD2	B	None		
Briggsville: BtA, BtB	C	None		
Carbondale: Ca	D	Frequent	Long	Nov. to May
Casco: CcB, CcC2, CcD2	B	None		
Cathro: Cm	D	Frequent	Long	Nov. to May
Channahon: CnB	D	None		
Deford: De	A/D	Frequent	Brief	Mar. to Apr.
Eleva: ElB, ElC2	B	None		
Fluvaquents: Fu	D	Frequent	Very long	Mar. to Nov.
Gravel pits: Gp. Not rated.				
Grays: GrA, GrB	B	None		
Hebron: HeB	C	None		
Hortonville: HnB, HnC2, HrB, [1] HtB, HrC2, HrD2, HrE. For Symco part of HtB, see Symco series.	B	None		
HsB, HsC2	B	None		
Kaukauna: KaA	C	None		
Keowns: Ke	B/D	Frequent	Brief	Mar. to Apr.
Kewaunee: KhB, KhC2, KhD2, KhE3, [1] KlB. For Manawa part of KlB, see Manawa series.	C	None		
Kolberg: KoB, KoC2	B	None		
Limestone quarries: Ln. Not rated.				
Lobo: Lo	D	None		
Manawa: McA	C	Occasional	Brief	Nov. to May
Manistee: MeB, MeC2, MfB	A	None		
Markey: Mk	D	Frequent	Long	Nov. to May
Menominee: MsB, MsC2	B	None		

See footnote at end of table.

water features

The symbol < means less than and > means more than. Absence of an entry indicates that the feature is not a concern]

High water table			Bedrock		Subsidence (total)	Potential frost action
Depth	Kind	Months	Depth	Hardness		
Ft			*In*		*In*	
0.5–1.5	Apparent	Nov. to May	>60			Moderate.
0–1.0	Apparent	Oct. to June	>60			High.
3.0–6.0	Apparent	Sept. to May	>60			Moderate.
1.0–3.0	Apparent	Sept. to June	20–40	Rippable		High.
3.0–6.0	Apparent	Nov. to May	>60			Moderate.
>6.0			>60			Low.
3.0–6.0	Apparent	Mar. to May	>60			High.
0–1.0	Apparent	Sept. to May	>60			High.
>6.0			>60			Low.
0–1.0	Apparent	Nov. to June	>60		19–22	High.
>6.0			10–20	Hard		Moderate.
0–1.0	Apparent	Jan. to May	>60			Moderate.
>6.0			20–40	Rippable		Moderate.
0–1.0	Apparent	Jan. to Dec.	>60			High.
4.0–6.0	Apparent	Feb. to Mar.	>60			High.
3.0–6.0	Apparent	Mar. to May	>60			Moderate.
>6.0			>60			Moderate.
>6.0			40–60	Rippable		Moderate.
3.0–6.0	Apparent	Nov. to May	>60			Moderate.
0–1.0	Apparent	Oct. to May	>60			High.
>3.0	Perched	Nov. to May	>60			Moderate.
>6.0			20–40	Rippable		Moderate.
0–2.0	Apparent	Jan. to Dec.	>60		55–50	High.
1.0–3.0	Perched	Nov. to June	>60			High.
>6.0			>60			Low.
0–1.0	Apparent	Nov. to June	>60		25–30	High.
>6.0			>60			Moderate.

TABLE 13.—*Soil and*

Soil name and map symbol	Hydrologic group	Flooding		
		Frequency	Duration	Months
Mosel: MtA	C	Rare		
Mundelein: MuA	B	None		
Namur: NaB	D	None		
Nichols: NfA, NfB	B	None		
NsA, NsB	B	None		
Onaway: OhB, OhC2, OhD2, [1] OlB For Solona part of OlB, see Solona series.	B	None		
Pella: Pe	B/D	Occasional	Brief	Mar. to June
Poy: Pf	D	Frequent	Long	Nov. to May
Poygan: Po	D	Frequent	Long	Nov. to June
Rock outcrop: Ra. Not rated.				
Rondeau: Rd	D	Frequent	Long	Nov. to May
Rousseau: RoB	A	None		
Shawano: SeC, SeD	A	None		
Shiocton: ShA, [1] SnB For Nichols part of SnB, see NfB in Nichols series.	B	Occasional	Long	Mar. to May
SkA	C	Frequent	Long	Mar. to June
Solona: SoA	B	Occasional	Brief	Apr. to June
Suamico: Su	D	Frequent	Very long	Nov. to May
Symco: SyA	B	Rare		
Symco variant: SzA	B	Occasional	Brief	Apr. to May
Udifluvents: Uf	C	Occasional	Brief	Apr. to Nov.
Udorthents: Uo	C	None		
Wainola: WaA	A	Rare		
Will: Wb	B/D	Occasional	Brief	Apr. to June
Winneconne: WnA, WnB, WnC2	C	None		
Zittau: ZtA	C	Occasional	Long	Nov. to May

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

to steep on morainal uplands. In depressions, runoff is slow and internal drainage generally is slow. Because soils in these areas remain wet and cool, they develop mottles throughout their profile; and because they are covered by slowly decomposing surface litter, they develop a thick surface layer that is high in organic-matter content. Example of these soils are in the Angelica, Poygan, and Solona series.

Soils that formed in alluvium are along streams. They receive fresh deposits of silt, clay, and sand at a rate faster than their horizons can develop; thus their profiles do not exhibit specific horizonation as

water features—Continued

High water table			Bedrock		Subsidence (total)	Potential frost action
Depth	Kind	Months	Depth	Hardness		
Ft			*In*		*In*	
1.0–3.0	Apparent	Nov. to May	>60			High.
1.0–3.0	Apparent	Mar. to June	>60			High.
>6.0			5–12	Hard		Moderate.
3.0–6.0	Apparent	Nov. to May	>60			High.
3.0–6.0	Apparent	Nov. to May	>60			Moderate.
>2.0	Apparent	Mar. to May	>60			Moderate.
0–2.0	Apparent	Mar. to June	>60			High.
0–1.0	Perched	Nov. to May	>60			High.
0–1.0	Perched	Nov. to July	>60			High.
0–1.0	Apparent	Jan. to Dec.	>60		35	High.
>2.5	Apparent	Mar. to May	>60			Low.
>6.0			>60			Low.
1.0–3.0	Apparent	Sept. to July	>60			High.
1.0–3.0	Perched	Nov. to July	>60			High.
1.0–3.0	Apparent	Mar. to July	>60			High.
0–1.0	Apparent	Nov. to May	>60		25–30	High.
1.0–3.0	Apparent	Nov. to May	>60			High.
1.0–3.0	Apparent	Nov. to June	>60			High.
1.0–6.0	Apparent	Apr. to June	>60			High.
>6.0			>60			Moderate.
1.0–2.0	Apparent	Nov. to May	>60			Moderate.
0–2.0	Apparent	Mar. to June	>60			High.
3.0–6.0	Apparent	Nov. to May	>60			Moderate.
1.0–2.5	Apparent	Nov. to May	>60			High.

behavior characteristics of the mapping unit.

do those of older soils. Fluvaquents is an example of a soil that formed in alluvium.

Typical soils on uplands are in the Casco, Hebron, Hortonville, Kewaunee, and Winneconne series. Their profiles show distinct horizonation throughout. On some of the steep soils, however, erosion has removed one or two of the upper horizons and altered the physical nature of the soils.

Parent material

Most soils in Outagamie County were derived either from material deposited by glaciers or from material

TABLE 14.—*Engineering*

[Tests performed by Wisconsin Department of Transportation, Division of

Soil name and location	Parent material	SCS report no.	Depth	Moisture density[1]	
				Maximum	Optimum
			In	*lb/cu-ft*	*Pct*
Angelica silt loam: NW¼, NE¼, NE¼, sec. 4, T. 24 N., R. 18 E. (Modal.)	Loamy deposits underlain by loamy glacial till.	S72WI–44–7			
		7–1	8–16		
		7–2	29–60		
Borth silt loam: SE¼, SW¼, SW¼, sec. 1, T. 22 N., R. 16 E. (Modal.)	Loamy and clayey lacustrine deposits underlain by sand.	S70WI–44–1			
		1–1	20–24		
		1–2	27–60	118.4	10.8
Grays silt loam: NW¼, NE¼, NE¼, sec. 34, T. 22 N., R. 16 E. (Modal.)	Loamy lacustrine deposits	S71WI–44–2			
		2–1	12–21	112.4	15.7
		2–2	24–60	109.2	15.8
Hortonville silt loam: SW¼, SE¼, SE¼, sec. 28, T. 21 N., R. 16 E. (Modal.)	Loamy and clayey deposits underlain by loamy glacial till.	S70WI–44–2			
		2–1	11–25		
		2–2	25–60	123.2	10.8
Keowns silt loam: NW¼, SW¼, sec. 21, T. 23 N., R. 16 E. (Modal.)	Loamy lacustrine deposits	S72WI–44–6			
		6–1	24–60		
Kolberg silt loam: NE¼, NW¼, SE¼, sec. 2, T. 21 N., R. 16 E. (Modal.)	Loamy deposits underlain by limestone bedrock.	S74WI–44–1			
		1–1	10–32		
		1–2	32–36		
Menominee loamy fine sand: NE¼, SE¼, SW¼, sec. 16, T. 22 N., R. 15 E. (Modal.)	Sandy and loamy deposits over loamy glacial till.	S74WI–44–2			
		2–1	5–23		
		2–2	46–60	121.2	12.4
Mundelein silt loam: NE¼, NE¼, NE¼, sec. 21, T. 21 N., R. 17 E. (Modal.)	Loamy lacustrine deposits	S70WI–44–3			
		3–1	9–23		
		3–2	48–60	113.2	13.4
Nichols very fine sandy loam: SE¼, SE¼, SE¼, sec. 19, T. 22 N., R. 17 E. (Modal.)	Loamy lacustrine deposits	S71WI–44–1			
		1–1	9–18		
		1–2	18–60	108.8	16.4
Onaway loam: NE¼, NE¼, sec. 26, T. 24 N., R. 17 E. (Modal.)	Loamy deposits over loamy glacial till.	S72WI–44–1			
		1–1	22–27		
		1–2	29–54		
Poy silty clay loam: NW¼, NE¼, SW¼, sec. 31, T. 21 N., R. 16 E. (Modal.)	Loamy and clayey lacustrine deposits underlain by sand.	S73WI–44–2			
		2–1	10–14		
		2–2	24–60		
Shawano fine sand: NW¼, NW¼, SW¼, sec. 6, T. 24 N., R. 17 E. (Modal.)	Loamy deposits over loamy glacial till.	S73WI–44–1			
		1–1	6–22		
		1–2	32–60	99.7	15.2
Shiocton silt loam: SE¼, SE¼, NE¼, sec. 21, T. 22 N., R. 17 E. (Modal.)	Loamy lacustrine deposits	S72WI–44–8			
		8–1	15–23		
		8–2	23–60		

See footnotes at end of table.

test data

Highways. Absence of an entry indicates that no determination was made]

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			
100	97	57	51	36	19	13	32.1	13.5	A–6(6)	CL
100	95	51	44	30	16	11	21.8	6.6	A–4(3)	CL–ML
———										
———	100	97	97	96	91	77	74.7	48.3	A–7–6(20)	CH
100	94	30	20	9	7	5	———	[5]NP	A–2–4(0)	SM
———	100	85	79	56	29	23	33.6	14.2	A–6(10)	CL
———	———	98	92	53	13	9	24.1	NP	A–4(8)	ML
100	98	78	75	63	47	36	41.7	22.4	A–7–6(13)	CL
79	72	54	50	39	23	14	24.2	9.3	A–4(4)	CL
———	———	30	22	14	9	8	———	NP	A–2–4(0)	SM
100	98	84	82	76	62	51	60.0	35.4	A–7–6(20)	CH
88	86	70	64	47	29	21	31.6	12.0	A–6(8)	CL
100	98	61	47	20	8	5	———	NP	A–4(5)	ML
86	78	48	43	33	22	16	27.6	12.0	A–6(4)	SC
———	100	87	78	42	18	13	25.4	3.5	A–4(8)	ML
———	———	90	82	30	8	4	19.5	NP	A–4(8)	ML
100	99	94	92	73	29	20	32.8	11.0	A–6(8)	CL
100	99	98	95	70	19	10	22.9	1.8	A–4(8)	ML
100	93	57	52	44	31	25	32	19	A–6(8)	CL
89	83	56	52	44	30	21	24	12	A–6(5)	CL
100	99	70	65	56	45	40	53	35	A–7–6(17)	CH
100	98	45	27	13	6	4	———	NP	A–4(2)	SM
———	100	22	8	4	3	2	———	NP	A–2–4(0)	SM
———	100	16	5	2	2	1	———	NP	A–2–4(0)	SM
———	100	94	86	43	14	10	———	NP	A–4(8)	ML
100	99	96	89	56	14	9	———	NP	A–4(8)	ML

TABLE 14.—*Engineering*

Soil name and location	Parent material	SCS report no.	Depth	Moisture density [1]	
				Maximum	Optimum
			In	*lb/cu-ft*	*Pct*
Symco silt loam: NE¼, NE¼, NW¼, sec. 35, T. 21 N., R. 16 E. (Modal.)	Loamy deposits over loamy glacial till.	S73WI–44–3			
		3–1	18–23		
		3–2	23–60		
Will silt loam: NW¼, NW¼, SW¼, sec. 20, T. 21 N., R. 15 E. (Modal.)	Loamy deposits over outwash sand and gravel.	S74WI–44–3			
		3–1	10–20		
		3–2	24–60		
Winneconne silty clay loam: NE¼, SE¼, SE¼, sec. 7, T. 22 N., R. 15 E. (Modal.)	Silty and clayey lacustrine deposits.	S74WI–44–4			
		4–1	13–27		
		4–2	31–60	95.2	26.0
Zittau silty clay loam: NE¼, NE¼, SW¼, sec. 9, T. 24 N., R. 15 E. (Modal.)	Loamy and clayey lacustrine deposits underlain by sand.	S74WI–44–5			
		5–1	18–28		
		5–2	32–60	114.3	12.5

[1] Based on AASHTO Designation T99–57, Method A (*1*).

[2] Mechanical analysis according to the AASHTO Designation T88–57 (*1*). Results by this procedure may differ somewhat from the results obtained by the soil survey procedure of the 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 all material up to and including that 3 inches in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculation of grain-size fraction. The mechanical analysis data used in this table are not suitable for use in naming textural classes of soil.

deposited as lacustrine sediment. The lacustrine sediment is mainly silt and fine sand. It is mostly along major river systems of the Wolf, Embarrass, Shioc, Black, Bear, and Rat Rivers. Most of these deposits are within 3 miles of the river channels on the first or second terrace above the river. Examples of soils that formed in lacustrine sediment are the Grays, Keowns, Nichols, and Shiocton soils.

An area about 10 miles wide covered with reddish loam to clay loam glacial drift extends from the northeast corner of the county to the southwest corner. Soils in this area are gently sloping to moderately steep. Examples of soils that formed from this drift are the Hortonville, Onaway, Pella, and Solona soils.

The southeastern part of the county is covered with reddish clayey lacustrine sediment that was deposited in Glacial Lake Oshkosh. This area is nearly level except for the steep sides of eroded gullies. The sediment is parent material of the Manawa, Poygan, Winneconne, and other soils.

Some soils in the survey area formed in organic material that accumulated in depressions and in old stream channels. Soils of the Carbondale, Cathro, and Suamico series formed in this kind of material.

Drainage characteristics of soils are determined mainly by relief or by position on the landscape. A drainage sequence is made up of soils that formed in one kind of parent material but have different characteristics because of the degree of wetness. For example, Angelica, Onaway, and Solona soils are members of a drainage sequence. The well drained or moderately well drained Onaway soils are at the higher elevations on the landscape and are gently sloping to moderately steep. They have distinct horizons of clay accumulation. The somewhat poorly drained Solona soils generally occupy foot slopes, borders of wet areas, and drainageways. These soils have red, yellow, and gray mottles, which indicate poor aeration and excess moisture. Their subsoil has some accumulation of clay. The poorly drained Angelica soils are nearly level and are in broad drainageways and depressional areas. In most places these soils have a water table near the surface at some time during the year. The surface layer is dark and distinct, but none of the subsoil horizons have clay accumulations.

Time

Time is needed for changing parent material into soil. It may be much or little, but time is always required for horizon differentiation. Soils can have a profile that is well developed, that is poorly developed, or that is somewhere in between, depending on the length of time the soil-forming factors have been active. Hortonville and Kewaunee soils, for example, have moderately distinct horizons and are considered fairly mature. But soils that formed in recently deposited alluvium, such as Fluvaquents, show little or no profile development.

The five factors of soil formation are so closely

test data—Continued

Percentage passing sieve—[3]			Percentage smaller than—[3]				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			
100	99	76	70	55	40	32	46.1	26.9	A–7–6(16)	CL
91	84	64	58	46	30	21	33.8	18.0	A–6(9)	CL
93	90	45	36	25	14	11	----------	NP	A–4(2)	SM
88	82	32	25	14	6	4	----------	NP	A–2–4(0)	SM
----------	100	93	93	93	88	66	69.1	43.2	A–7–6(20)	CH
100	99	97	97	96	92	75	73.0	45.8	A–7–6(20)	CH
----------	100	98	97	96	94	76	85.2	57.6	A–7–6(20)	CH
98	97	51	33	12	6	4	----------	NP	A–4(3)	ML

[3] Based on AASHTO Designation M145–49 (*1*).

[4] Based on MIL–STD–619B (*2*).

[5] NP means nonplastic.

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 development are still unknown.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (*7, 10*).

The system of classification 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 15, 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 Entisol.

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 Aquent (*Aqu,* meaning water, plus *ent* from Entisol).

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 Haplaquents (*Hapl,* meaning simple horizons, plus *aquent,* the suborder of Entisols 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 Haplaquents.

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

TABLE 15.—*Classification of the soils*

Soil name	Family or higher taxonomic class
Allendale	Sandy over clayey, mixed, frigid Aqualfic Haplorthods.
Angelica	Fine-loamy, mixed, nonacid, frigid Aeric Haplaquepts.
Bellevue	Fine-loamy, mixed, mesic Fluventic Hapludolls.
Bonduel	Fine-loamy, mixed Aquic Eutroboralfs.
Borth	Clayey over sandy or sandy-skeletal, mixed, mesic Mollic Hapludalfs.
Boyer[1]	Coarse-loamy, mixed, mesic Typic Hapludalfs.
Briggsville	Fine, mixed, mesic Typic Hapludalfs.
Carbondale	Euic Hemic Borosaprists.
Casco	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludalfs.
Cathro	Loamy, mixed, euic Terric Borosaprists.
Channahon	Loamy, mixed, mesic Lithic Argiudolls.
Deford	Mixed, frigid Typic Psammaquents.
Eleva	Coarse-loamy, mixed, mesic Typic Hapludalfs.
Fluvaquents	Loamy, mixed, mesic Typic Fluvaquents.
Grays	Fine-silty, mixed, mesic Mollic Hapludalfs.
Hebron	Fine-loamy, mixed, mesic Typic Hapludalfs.
Hortonville	Fine-loamy, mixed, mesic Glossoboric Hapludalfs.
Kaukauna	Clayey over loamy, mixed, mesic Mollic Hapludalfs.
Keowns	Coarse-loamy, mixed, nonacid, mesic Mollic Haplaquepts.
Kewaunee	Fine, mixed, mesic Typic Hapludalfs.
Kolberg	Fine, mixed Glossic Eutroboralfs.
Lobo	Dysic, frigid Hemic Sphagnofibrists.
Manawa	Fine, mixed, mesic Aquollic Hapludalfs.
Manistee	Sandy over clayey, mixed, frigid Alfic Haplorthods.
Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists.
Menominee	Sandy over loamy, mixed, frigid Alfic Haplorthods.
Mosel	Fine-loamy, mixed, mesic Aquollic Hapludalfs.
Mundelein	Fine-silty, mixed, mesic Aquic Argiudolls.
Namur	Loamy, mixed Lithic Haploborolls.
Nichols	Coarse-silty, mixed, frigid Typic Eutrochrepts.
Onaway	Fine-loamy, mixed, frigid Alfic Haplorthods.
Pella	Fine-silty, mixed, mesic Typic Haplaquolls.
Poy	Clayey over sandy or sandy-skeletal, mixed, mesic Typic Halplaquolls.
Poygan	Fine, mixed, mesic Typic Haplaquolls.
Rondeau	Marly, euic Limnic Borosaprists.
Rousseau	Sandy, mixed, frigid Entic Haplorthods.
Shawano	Mixed, frigid Typic Udipsamments.
Shiocton	Coarse-silty, mixed Aquic Haploborolls.
Solona	Fine-loamy, mixed Aquic Eutroboralfs.
Suamico[2]	Clayey, mixed, euic Terric Borosaprists.
Symco	Fine-loamy, mixed, mesic Aquollic Hapludalfs.
Symco variant	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquollic Hapludalfs.
Udifluvents	Loamy, mixed, mesic Typic Udifluvents.
Udorthents	Loamy and clayey, mixed, mesic Udorthents.
Wainola	Sandy, mixed, frigid Entic Haplaquods.
Will	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls.
Winneconne	Very-fine, mixed, mesic Mollic Hapludalfs.
Zittau	Clayey over sandy or sandy-skeletal, mixed, mesic Aquollic Hapludalfs.

[1] Boyer soils in the survey areas are taxadjuncts. See text for characteristics.
[2] Suamico soils are now classified within the range of the Cathro series.

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 soil properties used as family differentiae. An example is fine-loamy, mixed, nonacid, mesic, Typic Haplaquents.

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.

Environmental Factors Affecting Soil Use

This section gives information about the chief natural and cultural features that affect the use and management of the soils of Outagamie County. It is not intended to be a full description of the survey area, but it does explain briefly those features that affect the actual use and the potential use of soils for farming and other purposes.

Natural Features

In this section, several natural features are discussed that affect land use in Outagamie County.

These are relief and drainage, geology, climate, water supply, and vegetation.

Relief and drainage

The relief of Outagamie County was formed mostly by recent glaciation. The southeastern corner of the county is mostly gently sloping and has a thick mantle of clayey glacial till. The northwestern corner of the county is mostly nearly level and is covered with lacustrine sediment that typically has a loamy texture. The remainder of the county consists of a strip about 10 miles wide running from the northeast corner to the southwest corner. It is mostly gently sloping and sloping and has a thick mantle of loamy glacial till. The county is about 75 percent soils that formed wholly or partly in glacial till and 25 percent soils that formed in lacustrine sediment.

Most of the county, except for the land drained by Duck Creek, is within the Fox River drainage basin. The Wolf River, a slow moving, meandering stream, drains the flat, mostly poorly drained northwestern quarter of the county. From the northern boundary of the county, near Leeman, it flows parallel to the escarpment formed by the Prairie du Chien Group, then southward through Shiocton to a point about 3 miles northeast of Hortonville where it turns abruptly west and flows through New London. The Wolf River is joined at Shiocton by the Shioc River, which drains the north-central part of the county. The drainage basin of the Wolf River above New London covers about 2,240 square miles, about 400 square miles in Outagamie County. From New London the river flows southwestward through Waupaca County and into Winnebago County where it joins the Fox River.

The remainder of the county is drained by Duck Creek, which flows generally south from Seymour. About 6.5 miles north of Little Chute, it turns abruptly to the northeast and flows between two prominent ridges and out of the county. It flows into Green Bay, 17 or 18 miles farther northeast.

Geology

The survey area may be divided into three topographic units. The flat northwestern quarter, which is bounded on the south and east by escarpments of a cuesta, was formed by rocks of the Prairie du Chien Group. Because this area is covered by glacial-lake deposits and recent flood-plain deposits, most of the soils are somewhat poorly drained and loamy. Along both sides of the Fox River are relatively flat but well drained soils that formed in clayey glacial till. The remainder of the survey area is mostly gently sloping, loamy glacial till in areas where typical landforms are drumlins and ground moraines, but where some small scarps and cliffs of bedrock are exposed through glacial drift.

Climate [5]

Outagamie County has a continental climate. Winters are long, cold, and snowy; summers are warm and occasionally humid. Spring and fall are sometimes of short duration; they are periods of transition between summer and winter. In many years, the change from spring to summer is gradual, but the change from summer to fall is usually abrupt.

Storms accompany changes from one air mass to another in all seasons, but particularly from late fall to the middle of spring when a change occurs every 2 or 3 days. Nearby Lake Winnebago slightly modifies temperatures during the time of the year that it is not frozen, usually from mid-April to mid-November. Table 16 gives temperature and precipitation data. Table 17 shows the probability of the last freezing temperatures in spring and the first in fall.

The data in tables 16 and 17 were recorded at Appleton and are fairly representative of the entire county. The minimum temperatures throughout the survey area may vary considerably because of such local factors as calm, clear nights; topography; or soil type. Frost can occur in summer on organic soils because they are in low positions on the landscape and cool air drains onto them from the surrounding uplands.

The average date of the last 32-degree freeze in spring is May 3, and the first in fall is October 14. The growing season, defined as the number of days between the last 32-degree freeze in spring and the first in fall, averages 164 days; however, this figure is merely an approximation, because different crops have different temperatures at which growth is affected.

There is considerable temperature range, not only from season to season but also from year to year. Between 1930 and 1959, the number of days when the temperature reached 90° F or higher ranged from 27 in 1936 to none in 1951. The number of days when the temperature was zero or lower ranged from 39 in 1936 to four in 1931.

Approximately 55 percent of the total annual precipitation falls between May and September, when crops are in active growth. It is probable that 1 inch or more of rain will fall in a 7-day period in 3 out of 10 years in June but in fewer than 2 out of 10 years at the end of August. A 7-day dry period in which precipitation is a trace or less, is likely to occur about once in 10 years in June and more than twice in 10 years at the end of August. Intensities of about 1.20 inches of precipitation in 1 hour, 1.90 inches in 6 hours, and 2.60 inches in 24 hours can be expected about once in 2 years. The greatest amount of rain to be officially measured in 24 hours was 3.34 inches on July 23, 1912. Thunderstorms occur on an average of 25 days per year.

The amount of snowfall varies greatly from year to year, from only 22 inches of snow in 1958 to 90 inches in 1959. Snowfall was 3 inches or more deep on an average of five times a year, but ranged from 1 to 11 times. Snowfall was 4 inches or more on an average of three times a year, but ranged from 1 to 8 times.

Prevailing winds are from the northwest in winter and from the southwest in summer. In April and November, the windiest months, the windspeed averages 13 miles per hour; in August, the least windy month, it averages 10 miles per hour. The strongest winds are from the southwest, south, and west.

Sunshine observations are not available for Outagamie County, but the following data from Green Bay

[5] By MARVIN W. BURLEY, former State climatologist, National Weather Service, U. S. Department of Commerce.

TABLE 16.—*Temperature and precipitation*

[Data recorded at Appleton, Wisconsin from 1930 to 1959]

Month	Temperature						Precipitation		
	Average daily maximum	Average daily minimum	Maximum		Minimum		Average monthly total	Average snow and sleet	0.1 inch or more
			90° F and above	32° F and below	32° F to 0° F	0° F and below			
	°F	°F	Days	Days	Days	Days	In	In	Days
January	26.1	9.8	0	21	31	8	1.31	10.6	4
February	28.4	11.1	0	18	28	6	1.27	9.1	4
March	37.5	22.0	0	9	27	1	1.77	9.7	5
April	53.4	34.8	0	1	13	0	2.60	1.6	6
May	66.8	46.2	(1)	0	1	0	3.00	0.2	7
June	77.0	56.9	2	0	0	0	3.98	0.0	7
July	82.6	61.9	5	0	0	0	3.00	0.0	6
August	80.4	60.2	4	0	0	0	2.86	0.0	6
September	71.2	51.8	1	0	(1)	0	3.18	(2)	6
October	59.2	41.2	0	0	5	0	1.95	0.2	5
November	41.8	27.8	0	6	21	(1)	2.14	3.7	5
December	29.9	15.9	0	17	29	4	1.39	8.3	4
Year	54.5	36.6	12	72	155	19	28.45	43.4	65

[1] Less than one-half day.

[2] Trace.

should be similar. Possible sunshine averaged about 40 percent for November and December, 60 percent or more for May through September, and between 50 and 60 percent for the remaining months.

Water supply

The major sources of ground water in Outagamie County are the St. Peter Sandstone of Ordovician age and the sandstones of the Upper Cambrian series (*5*). Where they are sufficiently thick, glacial sand and gravel are an important source of ground water.

Ground water in the survey area is under water table and artesian conditions. The source of the ground water is precipitation that falls on the surface and percolates downward into the underlying materials. Regional movement of the ground water in the eastern third of the survey area is controlled by the bedrock structure, and the discharge is toward the east and south. Throughout the rest of the survey area the movement of water is controlled mainly by bedrock and surface topography, and the water moves toward streams and bedrock valleys.

The ground water level is usually not far below the surface, generally less than 100 feet. In the north-

TABLE 17.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data recorded at Appleton from 1930 to 1959]

Probability	Dates for given probability and temperature of—				
	16° F or below	20° F or below	24° F or below	28° F or below	32° F or below
Spring:					
2 years in 10 later than	Mar. 31	Apr. 8	Apr. 16	Apr. 29	May 13
4 years in 10 later than	Mar. 24	Apr. 1	Apr. 9	Apr. 22	May 6
6 years in 10 later than	Mar. 17	Mar. 25	Apr.2	Apr. 16	Apr. 30
8 years in 10 later than	Mar. 10	Mar. 17	Mar. 25	Apr. 8	Apr. 23
Fall:					
2 years in 10 earlier than	Nov. 11	Nov. 3	Oct. 25	Oct. 12	Oct. 3
4 years in 10 earlier than	Nov. 18	Nov. 10	Nov. 1	Oct. 20	Oct. 10
6 years in 10 earlier than	Nov. 25	Nov. 17	Nov. 8	Oct. 26	Oct. 17
8 years in 10 earlier than	Dec. 3	Nov. 24	Nov. 16	Nov. 3	Oct. 24

western quarter of the survey area, ground water is mostly within 20 feet of the surface.

Natural vegetation

Most of the northern part of Outagamie County was a mixed conifer and hardwood forest; the southern and north-central parts were hardwood forest. Approximately 69,000 acres, or 17 percent of the county, remains in woodland.

The wetlands of the county support various sedges, grasses, and such water-tolerant trees and shrubs as American elm, tamarack, white-cedar, willow, tag alder, and dogwood. Approximately 38,000 acres, or 22 percent of the wetlands, remain in their natural condition.

Cultural Features

In this section the history, transportation and schools, industrial activity, and trends in land use in Outagamie County are discussed.

History

Before the first permanent settlers arrived, Outagamie County was the fishing and hunting grounds of the Winnebago and Menominee Indian tribes. The Outagamie tribe moved into the Fox Valley after 1650. The tribe clashed with the early French traders; a series of wars followed, and the Outagamie tribe eventually broke up.

Most of the early French explorers, fur traders, and missionaries who came to eastern Wisconsin passed through Outagamie County. The earliest of these was Jean Nicolet who passed through in 1624 on his way to visit the Indians at Lake Winnebago.

The first settler was Dominique DuCharme, who established a trading post on the bank of the Fox River between 1760 and 1793. The first permanent settlement, however, is credited to Augustin Grignon. He formed a settlement at Grand Kaukaulin in 1813 that included the DuCharme trading post. The settlement is now known as Kaukauna.

In the early 1830's, the government brought the Stockbridge Indians to Wisconsin. The Stockbridge and Munsee Indians occupied the south side of the river opposite Kaukauna. They raised corn, potatoes, and small grain. This is the earliest farming reported in the area.

The early settlers came from diverse backgrounds. They were from France, Germany, Holland, Ireland, and New England. Between 1840 and 1860, many new immigrants came to form new settlements and open up farming areas.

By 1860, the population of the county was 9,587. This number had almost doubled by 1870, when the population was 18,430. The county population was 119,357 in 1970.

Much of the county away from the Fox River was opened up by the logging industry. Although lumbering began earlier, the larger logging operations began around 1862 and 1863. The accessibility of rivers and streams, such as the Wolf and Embarrass Rivers and Bear and Black Creeks, was very important to the industry. These water resources were used both for floating logs and for operating sawmills.

The arrival of Louis Perrot in 1855 was important to the agricultural development of the county. He was the father of the cheese-making industry, which, in turn, was a forerunner of the dairy industry that is prevalent in the county today.

Industry developed at the same time as agriculture and logging. The Fox River drops 170 feet from Lake Winnebago to Green Bay, 150 feet of this drop in Outagamie County. This water power made the area a natural place for industrial development.

There were three distinct phases in the development of industry in the area. The original lumbering was succeeded by flour milling, which was in turn eclipsed by the paper industry. These phases overlapped. A sawmill and a flour mill often were side by side on the river. The lumber business and the flour business began at approximately the same time. Augustin Grignon built both a sawmill and grist mill in 1818. In 1828 a flour mill was built in Kaukauna, across the river from Grignon's mills, but it was not until the 1850's that the flour industry began to flourish. The flour mills moved to Minneapolis, and the local mills were converted to pulp and paper mills. The earliest paper mill in Outagamie County was located at Appleton in about 1853.

Other industrial enterprises in the county included tanning houses, wire works, watch-making shops, woolen mills, machine shops, blast furnaces, nail factories, farm implement factories, and even a cracker factory. Many of these enterprises exist today. The older enterprises together with many new ones make for much diversity of industry in the county.

The earliest school on record was located in Kaukauna in 1823. It was followed by other schools throughout the area. In addition to the normal subjects, farming and trades were taught to both settlers and Indians. Lawrence University opened in 1840 and had 35 pupils. In 1853 the school began operating on a college level. The first graduation took place in 1857.

Transportation and schools

The county is served by three railroads: the Soo Line, the Green Bay and Western, and the Chicago and Northwestern. The Soo Line goes through the towns of Dale, Nichols, Black Creek, Binghamton, Center Valley, and Appleton. The Green Bay and Western goes through New London, Shiocton, Black Creek, Seymour, and Oneida. The Chicago and Northwestern goes through Bear Creek, Sugar Bush, New London, Hortonville, Greenville, Appleton, Little Chute, Combined Locks, and Kaukauna.

The county has three Federal highways and nine State highways. The county highways are all paved, and most are on the section lines. Scheduled flights are available at the Appleton airport or at nearby Green Bay.

There are nine high schools in Outagamie County. Lawrence University, a liberal arts college, is in the county, as is the Institute of Paper Chemistry, a research and graduate education center supported by the paper industry and affiliated with Lawrence University.

Industry

Outagamie County in the Fox River Valley is one of the more important manufacturing and agricultural counties in Wisconsin. Paper making is the main industry. Also important are metal-working and printing and the production of food and beverages, textiles, leather goods, wood products, and chemicals. Manufacturing has made gains since the early postwar period. Relative statewide gains in employment, payroll, and value added by manufacturing, were recorded during the period 1947 to 1958. Growth has recently been less rapid, probably because the paper industry has a slower growth trend. For each thousand residents, the county has 123 manufacturing jobs, whereas the statewide average is only 118.

Trends in land use

The number of farms in Outagamie County is decreasing, and the average size per farm is increasing. This is generally true throughout the United States. In 1964 there were 2,494 farms in Outagamie County with an average size of 130.3 acres. In 1969 there were 2,140 farms with an average size of 139.2 acres. Some areas of sandy soil and soils with low available water capacity that were once farmed are now in pine trees. An increasing amount of land is used for nonagricultural uses, such as rural nonfarm homes, summer cottages, and camping and recreational areas. The county has attractive lakes, streams, and wetlands and is accessible to the Fox River Valley, southeastern Wisconsin, and northern Illinois. These factors make it appeal to urban residents seeking a rural retreat. Areas near the many lakes and streams are increasingly important for homesites and recreation. Wooded tracts throughout the county are also in demand for these uses.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

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.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

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

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

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.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

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.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

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.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

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."

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

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.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. None means that flooding is not probable; rare that it is unlikely but possible under unusual weather conditions; occasional that it occurs on an average of once or less in 2 years; and frequent that it occurs on an average of more than once in 2 years. Duration is expressed as very brief if less than 2 days, brief if 2 to 7 days, and long if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered 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.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

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.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

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).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Organic matter. A general term for plant and animal material in or on the soil in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition. Terms used to define organic-matter content are *very low*, less than 0.5 percent; *low*, 0.5 to 1.0 percent; *moderately low*, 1.0 to 2.0 percent; *medium*, 2.0 to 4.0 percent; *high*, 4.0 to 8.0 percent; and *very high*, more than 8 percent.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

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).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

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

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant 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.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure,

reaction, consistence, and mineralogical and chemical composition.

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.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey the letters A through F are used in some mapping unit symbols to indicate slope. The percent and description of the slope indicated by the letters are as follows:

Letters	*Percent*	*Description*
A	0 to 2	Nearly level
B	2 to 6	Gently sloping
C	6 to 12	Sloping
D	12 to 20	Moderately steep
E	20 to 30	Steep
F	30 and greater	Very steep

Slow intake. The slow movement of water into the soil.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: very coarse sand (2.0 millimeters to 1.0 millimeter); coarse sand (1.0 to 0.5 millimeter); medium sand (0.5 to 0.25 millimeter); fine sand (0.25 to 0.10 millimeter); very fine sand (0.10 to 0.05 millimeter); silt (0.005 to 0.002 millimeter); and clay (less than 0.002 millimeter).

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.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

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.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

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."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

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.

Till plain. An extensive flat to undulating area underlain by glacial till.

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.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

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.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. Capability units are described on pages 47 to 53. Woodland group symbols are described on page 54.

Map symbol	Mapping unit	Page	Capability unit	Woodland group
			Symbol	Symbol
AdA	Allendale loamy fine sand, 0 to 3 percent slopes	8	IIIw-6	3w
Ax	Angelica silt loam	10	IIw-1	4w
Bc	Bellevue silt loam	11	IIw-11	3o
BnA	Bonduel silt loam, 0 to 3 percent slopes	12	IIw-2	3o
BoA	Borth silt loam, 0 to 3 percent slopes	12	IIs-7	3c
BrB	Boyer loamy sand, 2 to 6 percent slopes	13	IIIs-4	2s
BrC2	Boyer loamy sand, 6 to 12 percent slopes, eroded	13	IIIe-7	2s
BrD2	Boyer loamy sand, 12 to 20 percent slopes, eroded	13	IVe-7	2s
BtA	Briggsville silt loam, 0 to 2 percent slopes	14	IIs-7	2c
BtB	Briggsville silt loam, 2 to 6 percent slopes	14	IIe-6	2c
Ca	Carbondale muck	15	IVw-9	3w
CcB	Casco loam, 2 to 6 percent slopes	15	IIIe-3	3s
CcC2	Casco loam, 6 to 12 percent slopes, eroded	15	IVe-3	3s
CcD2	Casco loam, 12 to 20 percent slopes, eroded	16	VIe-3	3s
Cm	Cathro muck	16	IVw-8	3w
CnB	Channahon silt loam, 2 to 6 percent slopes	17	IIIe-3	3d
De	Deford loamy fine sand	17	IVw-5	5w
ElB	Eleva fine sandy loam, 2 to 6 percent slopes	18	IIIs-4	3o
ElC2	Eleva fine sandy loam, 6 to 15 percent slopes, eroded	18	IIIe-7	3o
Fu	Fluvaquents	18	Vw-14	4w
Gp	Gravel pits	18	------	--
GrA	Grays silt loam, 0 to 2 percent slopes	19	I-1	1o
GrB	Grays silt loam, 2 to 6 percent slopes	19	IIe-1	1o
HeB	Hebron loam, 2 to 6 percent slopes	20	IIe-6	2o
HnB	Hortonville fine sandy loam, 2 to 6 percent slopes	20	IIe-1	1o
HnC2	Hortonville fine sandy loam, 6 to 12 percent slopes, eroded	21	IIIe-1	1o
HrB	Hortonville silt loam, 2 to 6 percent slopes	21	IIe-1	1o
HrC2	Hortonville silt loam, 6 to 12 percent slopes, eroded	21	IIIe-1	1o
HrD2	Hortonville silt loam, 12 to 20 percent slopes, eroded	21	IVe-2	1r
HrE	Hortonville silt loam, 20 to 30 percent slopes	21	VIe-1	1r
HsB	Hortonville silt loam, limestone substratum, 2 to 6 percent slopes	21	IIe-1	1o
HsC2	Hortonville silt loam, limestone substratum, 6 to 12 percent slopes, eroded	21	IIIe-1	1o
HtB	Hortonville-Symco silt loams, 2 to 6 percent slopes	22	IIe-1	1o
KaA	Kaukauna silty clay loam, 0 to 3 percent slopes	23	IIs-7	2c
Ke	Keowns silt loam	23	IIIw-3	1w
KhB	Kewaunee silt loam, 2 to 6 percent slopes	24	IIe-6	2c
KhC2	Kewaunee silt loam, 6 to 12 percent slopes, eroded	24	IIIe-6	2c
KhD2	Kewaunee silt loam, 12 to 20 percent slopes, eroded	24	IVe-2	2c
KkE3	Kewaunee soils, 20 to 45 percent slopes, severely eroded	25	VIIe-6	2c
KlB	Kewaunee-Manawa complex, 2 to 6 percent slopes	25	IIw-2	2c
KoB	Kolberg silt loam, 1 to 6 percent slopes	25	IIe-2	2c
KoC2	Kolberg silt loam, 6 to 12 percent slopes, eroded	26	IIIe-2	2c
Ln	Limestone quarries	26	------	--
Lo	Lobo peat	26	VIIw-10	4w
McA	Manawa silty clay loam, 1 to 3 percent slopes	27	IIw-2	2c
MeB	Manistee loamy fine sand, 2 to 6 percent slopes	28	IIIe-4	2s
MeC2	Manistee loamy fine sand, 6 to 12 percent slopes, eroded	28	IVe-4	2s
MfB	Manistee fine sandy loam, 2 to 6 percent slopes	28	IIIe-4	2s
Mk	Markey muck	29	IVw-7	3w
MsB	Menominee loamy fine sand, loamy substratum, 2 to 6 percent slopes	29	IIIe-4	1s
MsC2	Menominee loamy fine sand, loamy substratum, 6 to 12 percent slopes, eroded	30	IVe-4	1s
MtA	Mosel silt loam, 0 to 3 percent slopes	30	IIw-2	2o
MuA	Mundelein silt loam, 0 to 3 percent slopes	31	IIw-4	4o
NaB	Namur silt loam, 1 to 6 percent slopes	31	VIs-5	4d

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit	Woodland group
			Symbol	Symbol
NfA	Nichols very fine sandy loam, 0 to 2 percent slopes	32	I-1	1o
NfB	Nichols very fine sandy loam, 2 to 6 percent slopes	32	IIe-1	1o
NsA	Nichols very fine sandy loam, clayey substratum, 0 to 2 percent slopes-	32	I-1	1o
NsB	Nichols very fine sandy loam, clayey substratum, 2 to 6 percent slopes-	32	IIe-1	1o
OhB	Onaway loam, 2 to 6 percent slopes	33	IIe-2	2d
OhC2	Onaway loam, 6 to 12 percent slopes, eroded	33	IIIe-2	2d
OhD2	Onaway loam, 12 to 20 percent slopes, eroded	33	IVe-2	2d
OlB	Onaway-Solona complex, 2 to 6 percent slopes	33	IIe-2	--
	Onaway part	--	--------	2d
	Solona part	--	--------	2o
Pe	Pella silt loam	34	IIw-1	3w
Pf	Poy silty clay loam	35	IIw-5	2w
Po	Poygan silty clay loam	36	IIw-1	2w
Ra	Rock outcrop	36	VIIIs-10	--
Rd	Rondeau muck	36	IVw-7	5w
RoB	Rousseau loamy fine sand, 2 to 6 percent slopes	37	IVs-3	2s
SeC	Shawano fine sand, rolling	38	VIIs-9	2s
SeD	Shawano fine sand, hilly	38	VIIs-9	2s
ShA	Shiocton silt loam, 0 to 3 percent slopes	39	IIw-4	1o
SkA	Shiocton silt loam, clayey substratum, 0 to 3 percent slopes	39	IIw-4	1o
SnB	Shiocton-Nichols complex, 2 to 6 percent slopes	39	IIe-1	1o
SoA	Solona silt loam, 1 to 3 percent slopes	40	IIw-2	2o
Su	Suamico muck	40	IVw-8	3w
SyA	Symco silt loam, 1 to 3 percent slopes	41	IIw-2	1o
SzA	Symco variant, 0 to 3 percent slopes	41	IIw-5	2w
Uf	Udifluvents	42	IIw-11	3o
Uo	Udorthents	42	--------	--
WaA	Wainola loamy fine sand, 0 to 3 percent slopes	42	IVw-5	3w
Wb	Will silt loam	43	IIw-5	4w
WnA	Winneconne silty clay loam, 0 to 2 percent slopes	44	IIs-7	2c
WnB	Winneconne silty clay loam, 2 to 6 percent slopes	44	IIe-6	2c
WnC2	Winneconne silty clay loam, 6 to 12 percent slopes, eroded	44	IIIe-6	2c
ZtA	Zittau silty clay loam, 0 to 3 percent slopes	45	IIw-5	3c

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