SOIL SURVEY OF

Eaton County, Michigan

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Michigan Agricultural Experiment Station

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

Major fieldwork for this soil survey was completed in the period 1964–73. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the Michigan Agricultural Experiment Station. It is part of the technical assistance furnished to the Thornapple-Grand Soil Conservation District.

Preparation of this soil survey was partly financed by the Eaton County Board of Commissioners under provisions of agreements with the U.S. Department of Agriculture, Soil Conservation Service, and the Michigan Agricultural Experiment Station, and partly by an urban planning grant from the Department of Housing and Urban Development under provisions of section 701 of the Housing Act of 1954, as amended.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

All the soils of Eaton County are shown on the detailed map at the back of this survey. 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 it 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 Michigan soil management group of each. It also shows the page where each soil is described and the page for the capability unit. It lists the woody plant group and woodland suitability group 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 information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

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

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

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Community planners and others can read about soil properties that affect the choice of sites for recreation areas, dwellings, and nonindustrial buildings in the sections "Recreational Development" and "Community Development." They also can find help in selecting suitable trees and shrubs for environmental improvement and windbreaks in the section "Trees and Shrubs for Landscaping and Windbreaks."

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

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

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

Cover: Marlette-Capac association in foreground and Boyer-Bixby-Oshtemo association in background. Boyer and Oshtemo soils are well suited to community development.

Contents

Issued October 1978

Index to Soil Mapping Units

Summary of Tables

SOIL SURVEY OF EATON COUNTY, MICHIGAN

BY JAMES E. FEENSTRA, SOIL CONSERVATION SERVICE

FIELDWORK BY GILBERT R. LANDTISER, DONALD F. GIBBS, PAUL G. CORDER, ROBERT ROLLINS, ALAN W. IRVINE, ROBERT N. E. HICKS, E. SELDEN COWAN, AND GLENN P. BEDELL, SOIL CONSERVATION SERVICE, AND LYLE H. LINSEMIER, DONALD BUCHANAN, DAVID A. LIETZKE, DAN AMOS, AND ROBERT HUBBARD, MICHIGAN AGRICULTURAL EXPERIMENT STATION.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE MICHIGAN AGRICULTURAL EXPERIMENT STATION.

EATON COUNTY is in the south-central part of the lower peninsula of Michigan (fig. 1). The land area is about 567 square miles, or 362,880 acres. Charlotte, the county seat, is in the central part of the county. The population of the county according to the 1970 census is 668,892. Most of the people are employed by industries in nearby Lansing and in Eaton County, or they are engaged in farming.

About 73 percent of the county is used for cash crops, dairying, raising beef cattle, and other farm enterprises. The chief cash crop is corn. Small businesses and industries, including a large sawmill at Charlotte, contribute substantially to the economy of Eaton County. Woodland makes up about 15 percent of the county, and urban and idle land make up about 12 percent. Forest products (including maple syrup), nurseries (shrubs and ornamentals), small fruits, and truck crops are becoming more important to the economy of the county.

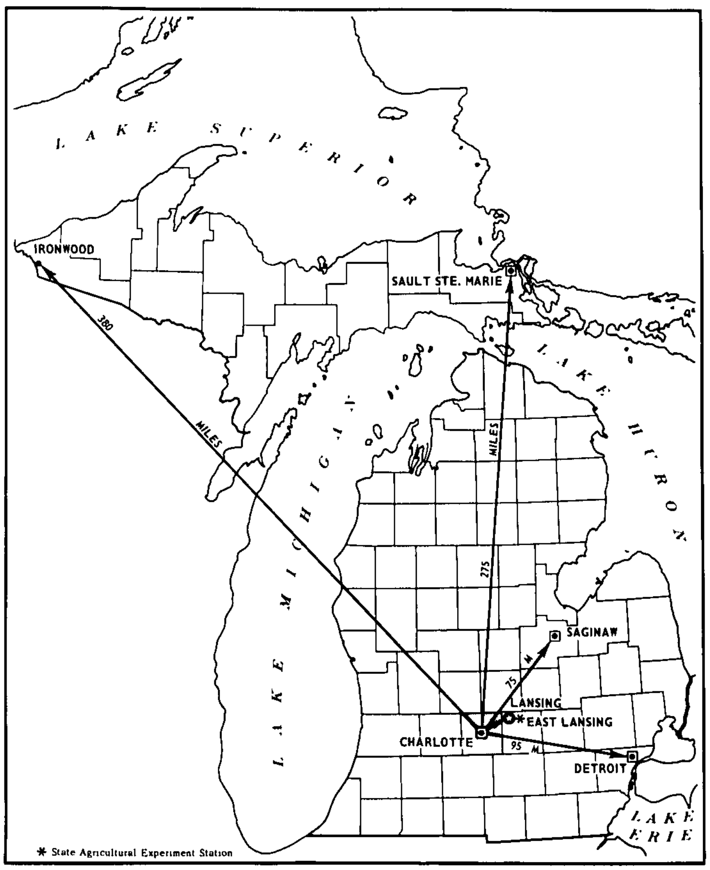

Figure 1.—**Location of Eaton County in Michigan.**

How This Survey Was Made

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

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

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Bixby and Marlette, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

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

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

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

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

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Capac-Marlette loams, 1 to 6 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so shallow or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Borrow land is a land type in this survey.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and range, and engineers.

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

General Soil Map

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

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

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

1. Boyer-Bixby-Oshtemo association

Nearly level to sloping, well drained, loamy soils in glacial drainageways and on outwash plains

This association consists dominantly of nearly level to gently undulating soils in glacial drainageways and on outwash plains.

This association makes up about 2 percent of the county, or about 6,400 acres. It is about 40 percent Boyer soils, 16 percent Bixby soils, 15 percent Oshtemo soils, and 29 percent minor soils.

Boyer soils are nearly level to gently undulating and are well drained. Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown, firm light sandy clay loam, the middle part is dark brown, very friable light sandy loam, and the lower part is dark brown, very friable loamy sand. The underlying material, beginning at a depth of about 38 inches, is brown, calcareous gravelly coarse sand.

Bixby soils are nearly level to very gently sloping and are well drained. Typically, the surface layer is dark brown loam about 9 inches thick. The subsurface layer is dark brown loam about 4 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown, firm heavy loam, the middle part is dark brown, firm sandy clay loam, and the lower part is dark brown, very friable sandy loam. The underlying material, beginning at a depth of about 39 inches, is dark brown, loose coarse sand banded with thin layers of loamy sand and gravelly sandy loam.

Oshtemo soils are nearly level to sloping and are well drained. Typically, the surface layer is dark brown sandy loam about 9 inches thick. The subsurface layer is brown sandy loam about 2 inches thick. The subsoil is about 40 inches thick. It is dark brown, friable sandy loam in the upper 35 inches and brown, loose sand banded with thin layers of dark brown loamy sand in the lower 5 inches. The underlying material, beginning at a depth of 51 inches, is calcareous, brown coarse sand.

Minor in this association are Spinks, Matherton, Wasepi, and Houghton soils. Spinks soils are well drained. They are in positions similar to those of Boyer soils. Matherton and Wasepi soils are somewhat poorly drained. They are lower on the landscape than Bixby, Boyer, and Oshtemo soils. Houghton soils are very poorly drained. They are in depressional areas.

Most areas of these soils are used for crops. Corn, alfalfa, and wheat are the main crops grown. Droughtiness and soil blowing are the main limitations in use and management. Near Charlotte, areas of these soils are slowly being changed to urban uses.

2. *Houghton-Gilford-Adrian association*

Nearly level, very poorly drained, mucky and loamy soils in glacial drainageways

This association consists of nearly level glacial drainageways.

This association makes up about 5 percent of the county, or about 18,000 acres. It is about 45 percent Houghton soils, 20 percent Gilford soils, 15 percent Adrian soils, and 20 percent minor soils.

Houghton soils are nearly level and are very poorly drained. Typically, the surface layer is black muck about 9 inches thick. Below this is 7 inches of black muck, 18 inches of dark reddish brown muck, and 15 inches of very dark gray muck. Dark reddish brown muck is below a depth of 49 inches.

Gilford soils are nearly level and are very poorly drained. Typically, the surface layer is black sandy loam about 11 inches thick. The subsurface layer is very dark gray sandy loam about 2 inches thick. The subsoil is about 20 inches thick. The upper part is gray, friable, mottled sandy loam, the middle part is gray, mottled, firm light sandy clay loam, and the lower part is gray, friable, mottled coarse sandy loam. The underlying material, beginning at a depth of about 33 inches, is gray, coarse, calcareous sand.

Adrian soils are nearly level and are very poorly drained. Typically, the surface layer is black muck about 9 inches thick. Below this is 13 inches of dark reddish brown muck and 7 inches of black muck. The underlying material, beginning at a depth of about 29 inches, is light gray and gray fine sand and sand that has strong effervescence.

Minor in this association are Colwood, Sebewa, Boyer, Oshtemo, Spinks, Wasepi, and Edwards soils. Colwood and Sebewa soils are poorly drained and very poorly drained. They are in positions similar to those of Gilford soils. Boyer, Oshtemo, and Spinks soils are well drained. They are in higher positions in the drainageways. Wasepi soils are slightly higher on the landscape than Gilford soils. Edwards soils are very poorly drained. They are in positions similar to those of Adrian soils.

These soils are used for farming, recreation, and wildlife habitat. Corn is the main cash crop. Sod, potatoes, and onions are the main specialty crops. Soil blowing, frost action, and wetness are the main limitations in use and management (fig. 2).

Figure 2.—Typical area of the Houghton-Gilford-Adrian association. Windbreaks are one method used to control soil blowing.

3. *Boyer-Cohoctah-Houghton association*

Nearly level to hilly, well drained, poorly drained, and very poorly drained, sandy and loamy soils and nearly level, very poorly drained, mucky soils; in and along glacial drainageways and on flood plains

This association consists of nearly level to hilly soils that are in and along glacial drainageways that dissect moraines and till plains, or they are on flood plains.

This association makes up about 12 percent of the county, or about 43,000 acres. It is about 30 percent Boyer soils, 15 percent Cohoctah soils, 15 percent Houghton soils, and 40 percent minor soils (fig. 3).

Boyer soils are on and along the glacial drainageways. They are nearly level to hilly and are well drained. Typically, the surface layer is dark grayish brown loamy sand about 9 inches thick. The subsoil is about 20 inches thick. The upper part is brown, very friable loamy sand about 8 inches thick. The middle part is dark brown, friable sandy loam about 7 inches thick. The lower part is very dark brown, very friable loamy sand about 5 inches thick. The underlying material, beginning at a depth of about 29 inches, is brown, very coarse sand that has strong effervescence.

Cohoctah soils are on flood plains. They are nearly level and are poorly drained and very poorly drained. Typically, the surface layer is very dark grayish brown fine sandy loam about 14 inches thick. Underlying the surface layer, to a depth of about 41 inches, is stratified dark gray, friable, mottled sandy loam; grayish brown, very friable, mottled loamy sand; and friable, mottled loam. Below this is stratified grayish brown and dark gray, loose, mottled sand.

Houghton soils are in depressions and low areas. They are nearly level and very poorly drained. Typically, the surface layer is black muck about 9 inches thick. Below this is 7 inches of black muck, 18 inches of dark reddish brown muck, and 15 inches of very dark gray muck. Dark reddish brown muck is below a depth of 49 inches.

Minor in this association are Matherton, Wasepi, Sebewa, Gilford, Marlette, Oshtemo, Spinks, and Owosso soils. Matherton and Wasepi soils are somewhat poorly drained, Sebewa soils are poorly drained and very poorly drained, and Gilford soils are very poorly drained. These soils are in positions intermediate between those of Boyer and Cohoctah soils. Oshtemo and Spinks soils are well drained. They are in positions similar to those of Boyer soils. Marlette soils are moderately well drained and well drained, and Owosso soils are well drained. They are on islands and peninsulas in the drainageways and on side slopes of the drainageways.

These soils are used for farming, recreation, wildlife, and urban development. Droughtiness of the well drained soils and wetness and flooding of the poorly drained and very poorly drained soils are limitations in use and management of the major soils. The higher lying well drained soils have a high potential for such fruit crops as apples, and the lower slopes have po-

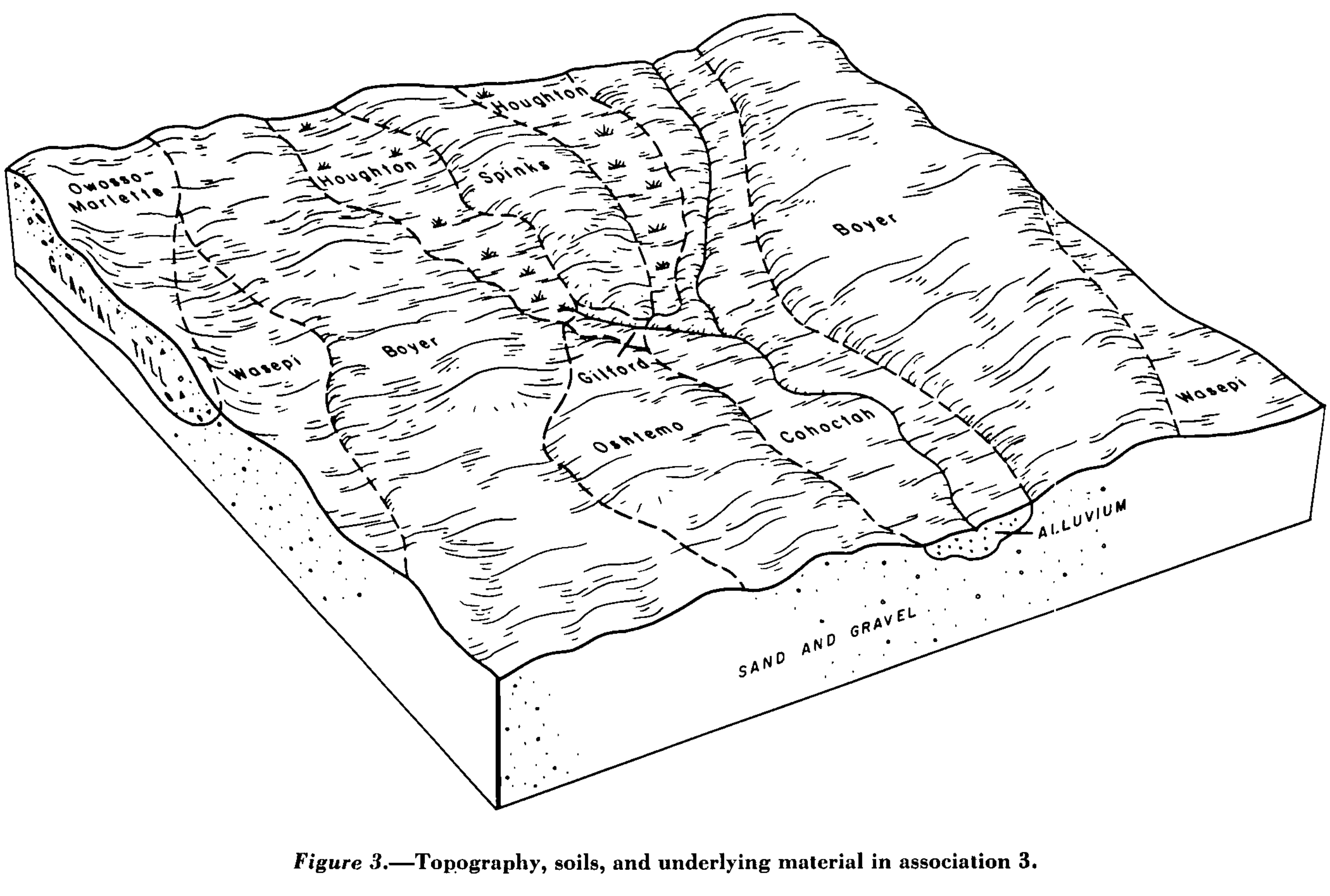

Figure 3.—Topography, soils, and underlying material in association 3.

tential for such small fruits as strawberries and raspberries. If the Houghton soils are drained and soil blowing is controlled, they are suited to vegetables and corn.

4. *Marlette-Capac association*

Nearly level to gently undulating, well drained to somewhat poorly drained, loamy soils on till plains

This association consists of nearly level to gently undulating soils on till plains.

This association makes up about 35 percent of the county, or about 127,000 acres. It is about 40 percent Marlette soils, 30 percent Capac soils, and 30 percent minor soils (fig. 4).

Marlette soils are gently sloping to gently undulating and are moderately well drained and well drained. Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is dark brown, firm clay loam about 29 inches thick. The underlying material, beginning at a depth of about 38 inches, is calcareous brown loam.

Capac soils are nearly level to very gently sloping and are somewhat poorly drained. Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 21 inches thick. The upper part is yellowish brown, firm, light clay loam. The middle part is dark yellowish brown, firm, mottled clay loam. The lower part is yellowish brown, friable, mottled heavy loam. The underlying material, beginning at a depth of 30 inches, is calcareous brown loam.

Minor in this association are Parkhill, Colwood, Sebewa, and Houghton soils. Parkhill, Sebewa, and Colwood soils are poorly drained and very poorly drained. They are slightly lower on the landscape than Capac soils. Houghton soils are in depressional areas.

Most areas of these soils are used for crops. The soils have high potential for all cultivated crops commonly grown in the county. They are some of the most productive soils in the county. Corn, soybeans, wheat, and navy beans are the main crops grown. The main enterprises are growing cash crops, dairying, and feeding beef cattle. Growing nursery stock is increasing. Erosion is the main limitation in use and management; also, wetness of the more poorly drained soils and low organic-matter content of the better drained soils are limitations. Some State and Federal highways cross this association (fig. 5).

5. *Capac-Parkhill association*

Nearly level to gently undulating, somewhat poorly drained, loamy soils and nearly level, poorly drained and very poorly drained, loamy soils; on till plains and low moraines

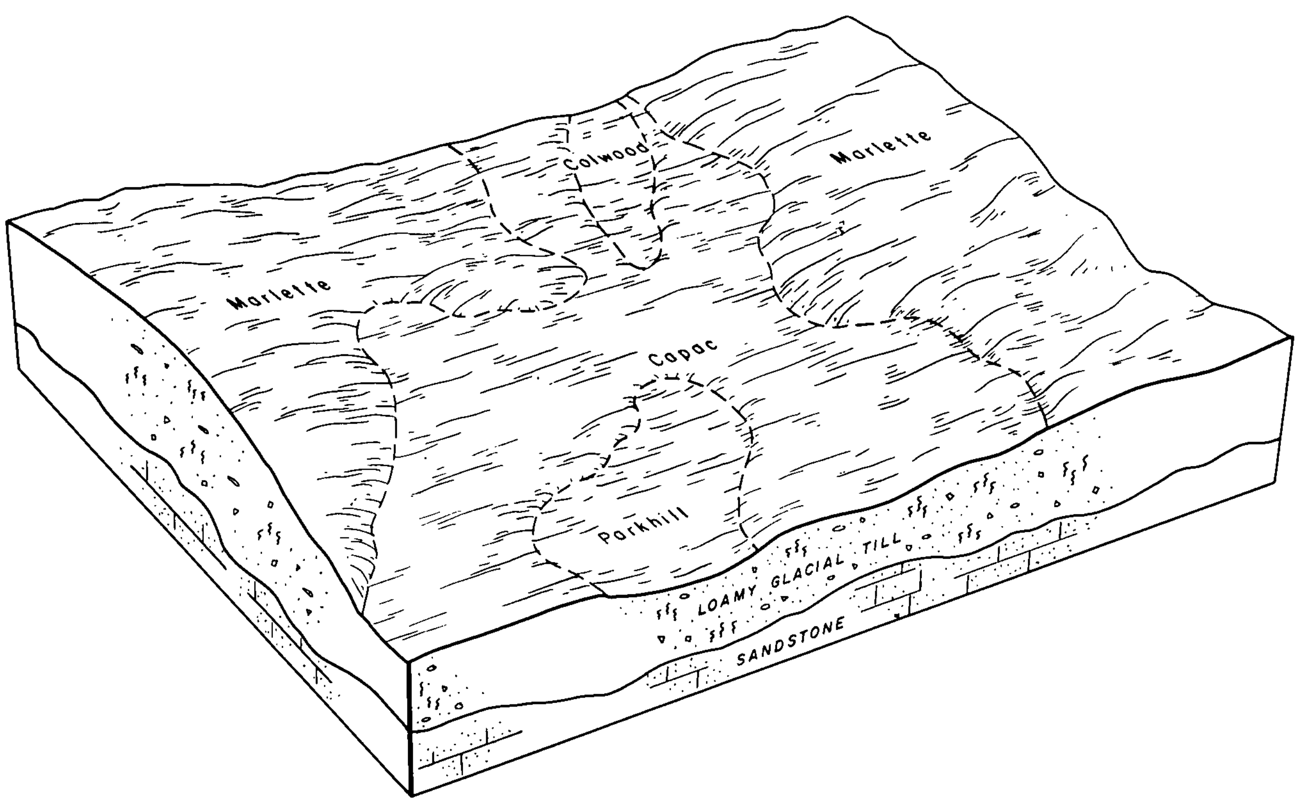

Figure 4.—Topography, soils, and underlying material in association 4.

This association consists of nearly level to very gently sloping till plains and low moraines.

This association makes up about 10 percent of the county, or about 35,200 acres. It is about 45 percent Capac soils, 35 percent Parkhill soils, and 20 percent minor soils.

Capac soils are nearly level to gently undulating and are somewhat poorly drained. Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 21 inches thick. The upper part is yellowish brown, firm light clay loam. The middle part is dark yellowish brown, firm, mottled clay loam. The lower part is yellowish brown, friable, mottled heavy loam. The underlying material, beginning at a depth of about 30 inches, is calcareous brown loam.

Parkhill soils are nearly level and are poorly drained and very poorly drained. Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil is a light brownish gray, firm, mottled clay loam about 25 inches thick. The underlying material, beginning at a depth of about 34 inches, is calcareous light brownish gray heavy loam and yellowish brown loam.

Minor in this association are Kibbie, Colwood, Marlette, and Palms soils. Kibbie soils are somewhat poorly drained. They are in positions similar to those of Capac soils. Colwood soils are nearly level and are poorly drained and very poorly drained. They are on flats and in slightly concave areas. Marlette soils are very gently sloping to gently undulating and are well drained and moderately well drained. They occur as individual areas or in intricate patterns with the Capac soils. Palms soils are very poorly drained, mucky soils. They are in depressional areas.

Most areas of these soils are used for crops. The soils have a high potential for all cultivated crops commonly grown in the county. They are some of the most productive soils in the county. Corn, soybeans, wheat, and field beans are the main crops grown. The main enterprises are growing cash crops, dairying, and feeding beef cattle. Wetness is a limitation in use and management.

6. *Marlette-Capac-Owosso association*

Nearly level to hilly, well drained to somewhat poorly drained, loamy soils on moraines and till plains

This association consists of nearly level to hilly soils on moraines and till plains that have been dissected by streams and rivers.

The association makes up about 36 percent of the county, or about 133,280 acres. It is about 42 percent Marlette soils, 13 percent Capac soils, 10 percent Owosso soils, and 35 percent minor soils (fig. 6).

Marlette soils are gently sloping to hilly and are well drained and moderately well drained. Typically, the surface layer is dark grayish brown loam about 9

***Figure 5.*—Interstate highway interchange in an area that was once farmland; Marlette-Capac association.**

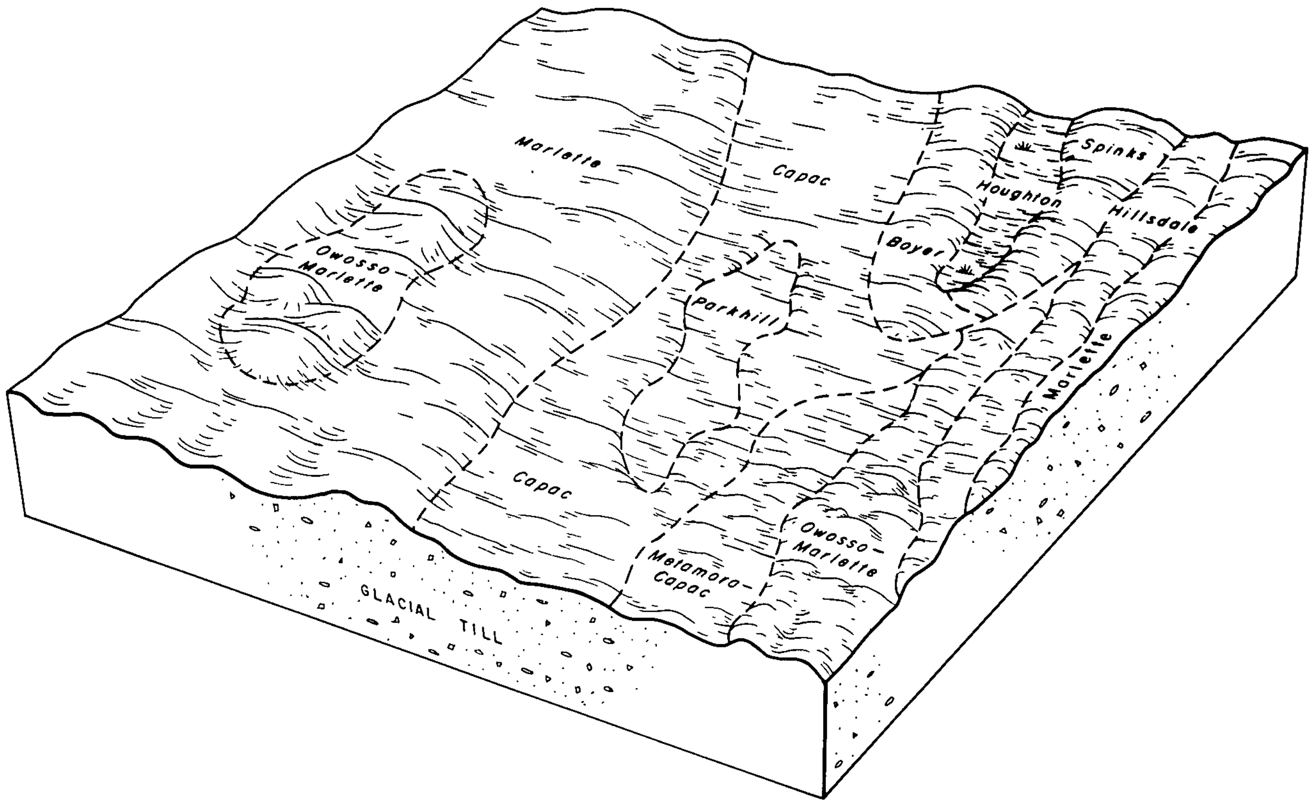

Figure 6.—**Topography, soils, and underlying material in association 6.**

inches thick. The subsoil is dark brown, firm clay loam about 29 inches thick. The underlying material, beginning at a depth of 38 inches, is calcareous brown loam.

Capac soils are nearly level to gently undulating and are somewhat poorly drained. Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 21 inches thick. The upper part is yellowish brown, firm light clay loam. The middle part is dark yellowish brown, firm, mottled clay loam. The lower part is yellowish brown, friable, mottled heavy loam. The underlying material, beginning at a depth of 30 inches, is calcareous brown loam.

Owosso soils are gently undulating to hilly and are well drained. Typically, the surface layer is dark grayish brown sandy loam about 9 inches thick. The subsoil is about 32 inches thick. The upper part is brown, friable sandy loam. The middle part is dark yellowish brown, friable heavy sandy loam. The lower part is dark yellowish brown, firm clay loam. The underlying material, beginning at a depth of 41 inches, is calcareous brown loam.

Minor in this association are Boyer, Hillsdale, Spinks, Bixby, Houghton, Shoals, Sloan, Parkhill, and Metamora soils. Boyer, Bixby, and Spinks soils are well drained. They are on terraces and side slopes of small drainageways. Hillsdale soils are well drained. They are on side slopes and knolls, or they occur as a series of low hills. Houghton soils are very poorly drained organic soils. They are in depressions. Shoals soils are somewhat poorly drained, and Sloan soils are very poorly drained. These soils are on flood plains. Parkhill soils are poorly drained and very poorly drained. They are in slightly lower depressional areas. Metamora soils are somewhat poorly drained. They are in intricate patterns with Capac soils.

Most areas of these soils are used for crops. The soils on lower slopes have a high potential for all cultivated crops grown in the county. Wheat, corn, and alfalfa are the main crops. The soils in steeper areas are well suited to forage crops, woodland, and recreation. The main enterprises are growing cash crops, dairying, and feeding beef cattle (fig. 7). Erosion is the main hazard in use and management of these soils.

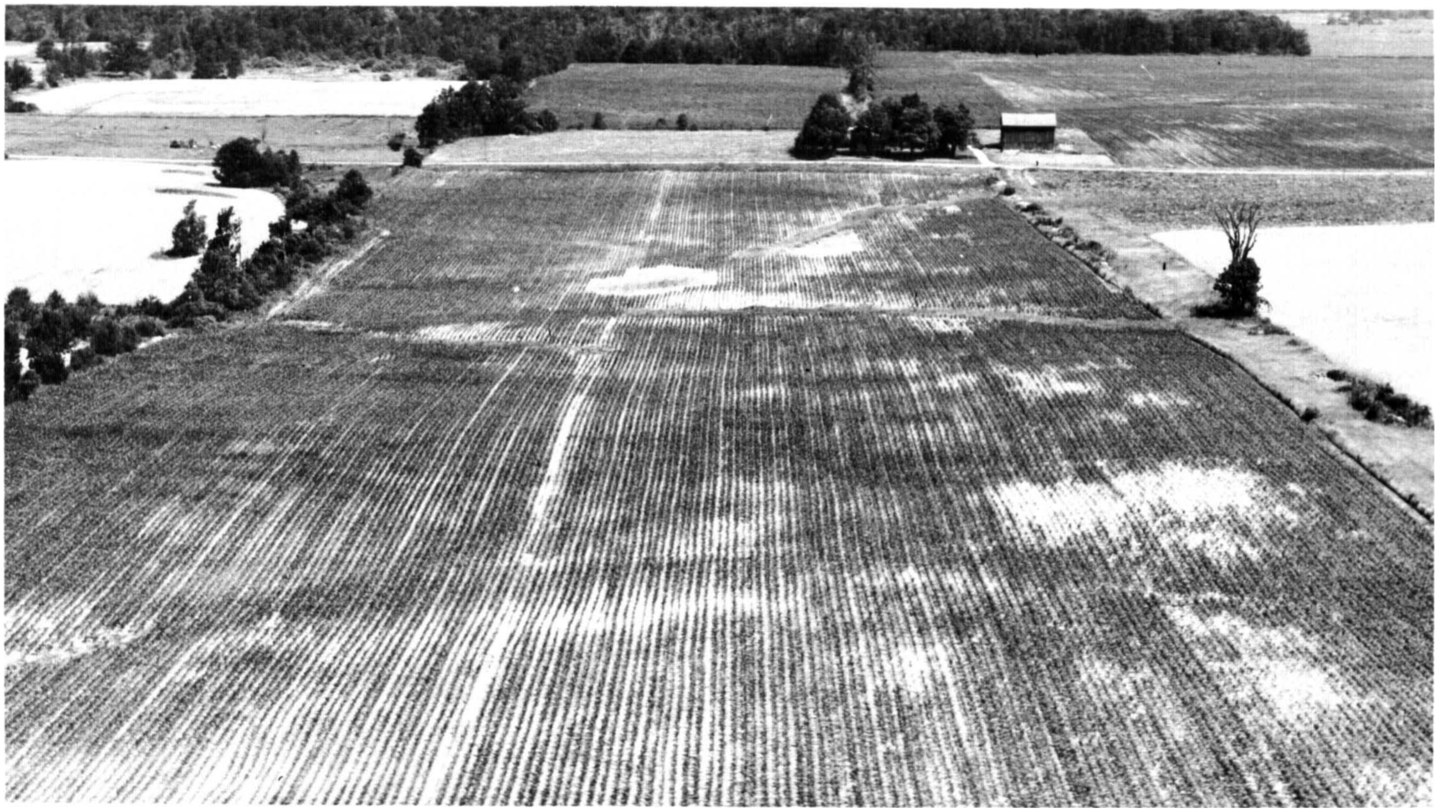

Figure 7.—**Dairy enterprise on Marlette, Owosso, and Capac soils. Contour stripcropping system in the background controls erosion and conserves moisture.**

Descriptions of the Soils

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

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

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Borrow land, for example, does not belong to a soil series, but nevertheless, it is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, the Michigan soil management group in parentheses, the woodland suitability group, and the woody plant group in which the mapping unit has been placed. The Michigan soil management group is made up of Arabic numerals and small or capital letters. The soil management groups for soil complexes are listed in the same order as the named soil series. This management group is part of a statewide system used in Michigan for making recommendations about applications of lime and fertilizer, about artificial drainage, and about other practices. For an explanation of this classification, refer to "Fertilizer Recommendations for Michigan Vegetable and Field Crops" (*5*).[1] The page for the description of each capability unit, woodland suitability group, and woody plant group and the symbol for the Michigan soil management group, can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*7*).

The names, descriptions, and delineations of soils in

[1] Italic numbers in parentheses refer to References, p. 88.

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

Soil	Area	Extent
	Acres	*Percent*
Adrian muck	3,795	1.0
Bixby loam, 0 to 3 percent slopes	1,410	.4
Borrow land	630	.2
Boyer loamy sand, 0 to 6 percent slopes	7,280	2.1
Boyer loamy sand, 6 to 12 percent slopes	3,425	.9
Boyer sandy loam, 0 to 6 percent slopes	5,635	1.5
Boyer sandy loam, 6 to 12 percent slopes	1,765	.5
Boyer-Spinks loamy sands, 12 to 18 percent slopes	2,145	.6
Brady-Bronson sandy loams, 0 to 3 percent slopes	4,235	1.1
Capac loam, 0 to 3 percent slopes	55,515	15.2
Capac-Marlette loams, 1 to 6 percent slopes	30,775	8.3
Cohoctah fine sandy loam, frequently flooded	6,680	1.8
Colwood loam	8,765	2.4
Colwood loam, depressional	990	.3
Edwards muck	2,140	.6
Gilford sandy loam	4,980	1.4
Hillsdale sandy loam, 2 to 6 percent slopes	3,570	1.0
Hillsdale sandy loam, 6 to 12 percent slopes	3,105	.8
Houghton muck	16,490	4.6
Kibbie fine sandy loam, 0 to 3 percent slopes	2,955	.8
Lenawee silty clay loam, depressional	965	.3
Marlette loam, 2 to 6 percent slopes	72,615	20.0
Marlette loam, 6 to 12 percent slopes	22,960	6.2
Marlette loam, 12 to 18 percent slopes	3,415	.9
Marlette loam, 18 to 25 percent slopes	1,375	.4
Marlette clay loam, 6 to 12 percent slopes, severely eroded	1,480	.5
Matherton loam, 0 to 3 percent slopes	4,885	1.4
Metamora-Capac sandy loams, 0 to 4 percent slopes	6,580	1.9
Oshtemo sandy loam, 0 to 6 percent slopes	3,320	.9
Oshtemo sandy loam, 6 to 12 percent slopes	565	.2
Owosso-Marlette sandy loams, 1 to 6 percent slopes	13,600	3.8
Owosso-Marlette sandy loams, 6 to 12 percent slopes	3,925	1.1
Owosso-Marlette sandy loams, 12 to 18 percent slopes	1,580	.4
Palms muck	4,445	1.2
Parkhill loam	24,595	6.8
Sebewa loam	9,605	2.6
Shoals-Sloan loams	2,080	.6
Spinks loamy sand, 0 to 6 percent slopes	3,440	1.0
Spinks loamy sand, 6 to 12 percent slopes	1,350	.4
Spinks-Metea loamy sands, 0 to 6 percent slopes	1,105	.3
Spinks-Metea loamy sands, 6 to 12 percent slopes	630	.2
Tuscola fine sandy loam, 0 to 4 percent slopes	1,410	.4
Wasepi sandy loam, 0 to 3 percent slopes	6,085	1.7
Wasepi sandy loam, bedrock variant, 0 to 3 percent slopes	695	.2
Winneshiek silt loam, 0 to 3 percent slopes	725	.2
Miscellaneous acreage shown by special symbols	1,470	.4
Water	1,695	.5
Total	362,880	100.0

this published soil survey do not always agree with soils on maps of adjoining counties published at an earlier date. Differences are brought about by better knowledge about soils or modifications and refinements in soil series concepts, including recognition of new soil series. In addition, the correlation of a recognized soil is based upon the acreage of that soil and the dissimilarity to adjacent soils within the survey area. Frequently, it is more feasible to include soils that are small in extent with similar soils that have much the same management and response, rather than to set them apart as individual soils. The soil descriptions reflect these inclusions. Other differences are brought about by the predominance of different soils in taxonomic units made up of two or three series. Still another difference can be caused by the range in slope allowed within the mapping unit for each survey.

Adrian Series

The Adrian series consists of very poorly drained, nearly level organic soils. These soils are in swamps, along waterways, and in depressions on till plains and moraines. They are underlain by sandy material.

In a representative profile the surface layer is black muck about 9 inches thick. Below this is 13 inches of dark reddish brown, friable muck and 7 inches of black, friable muck. The underlying material, between depths of 29 and 47 inches, is light gray fine sand. Below this, to a depth of 60 inches, is gray stratified sand and fine sand.

Runoff is very slow; the soils are ponded most of the time. Permeability is rapid. Available water capacity is high in the muck and very low in the underlying sand.

Because of slow runoff, a high water table, and low supply of phosphorus and potassium, Adrian soils are generally poorly suited to farming. If these soils are drained and cultivated, soil blowing and frost are hazards. A few areas are used for row crops. Some areas, because of their small size or because they lack an adequate drainage outlet, are idle or are used for pasture.

Representative profile of Adrian muck, in a cultivated field, 500 feet south and 400 feet east of northwest corner sec. 22, T. 2 N., R. 3 W.:

Oa1—0 to 9 inches; black (5YR 2/1, broken face and rubbed) sapric material; about 5 percent fiber, trace rubbed; moderate medium granular structure; very friable; mainly herbaceous fibers, few woody fibers; slightly acid; abrupt smooth boundary.

Oa2—9 to 22 inches; dark reddish brown (5YR 2/2, broken face and rubbed) sapric material; about 15 percent fiber, 5 percent rubbed; massive separating to weak medium granular structure; friable; mainly woody fibers, about 5 percent herbaceous; 8 percent coarse woody fragments; mildly alkaline; clear wavy boundary.

Oa3—22 to 29 inches; black (5YR 2/1, broken face) sapric material, dark reddish brown (5YR 2/2, rubbed and pressed); about 10 percent fiber, trace rubbed; massive; friable; mainly herbaceous fibers; mildly alkaline; abrupt wavy boundary.

IIC1g—29 to 47 inches; light gray (10YR 6/1) fine sand; common medium distinct strong brown (7.5YR 5/6) mottles; single grained; loose; mildly alkaline; clear wavy boundary.

IIC2g—47 to 60 inches; gray (10YR 5/1) strata of sand and fine sand; single grained; loose; strong effervescence; moderately alkaline.

Depth to the sandy IICg horizon ranges from 16 to 50 inches. The fibers in the organic part of the profile are mainly from herbaceous plants. Thin layers of hemic material are in some places, but they have a combined thickness of less than 10 inches in the bottom tiers. Coarse woody fragments in the form of twigs, branches, and pieces of roots or logs, 1 inch to 8 inches in diameter, are mixed throughout the Oa horizon, and they make up as much as 15 percent, by volume, of this horizon. Reaction throughout the organic material typically is mildly alkaline but ranges from slightly acid to mildly alkaline. In some places the lower part of the organic material commonly has a high mineral content, ranging to as much as 50 percent, by volume.

The Oa1 horizon is black (5YR 2/1, 10YR 2/1, or N 2/0) on broken faces and when rubbed. It is typically less than 5 percent fiber when rubbed.

The Oa2 and Oa3 horizons have hue of 5YR, 10YR, or 7.5YR, value of 2, and chroma of 1 or 2 on broken faces and when rubbed.

The IICg horizon has hue of 10YR, 2.5YR, or 5Y, value of 5 to 7, and chroma of 1 or 2. Reaction is mildly alkaline or moderately alkaline. In many places the sandy IICg material effervesces at the point of contact. This horizon is sand, fine sand, or loamy sand, and in many places it is stratified with thin to thick layers of these textures.

Adrian soils formed in similar organic deposits as Edwards, Houghton, and Palms soils. Adrian soils have sand and loamy sand below the organic material, whereas Edwards soils have marl and Palms soils have loamy material. They have a thinner organic layer than Houghton soils.

Ad—Adrian muck. This soil is in depressional areas and in broad, low-lying areas. Slopes are 0 to 2 percent. Areas are irregular in shape. They range from 2 acres to more than 100 acres in size.

Included with this soil in mapping, at slightly higher elevations and along the boundaries of the mapped areas, are small areas of somewhat poorly drained Wasepi sandy loam, Brady sandy loam, and very poorly drained Gilford sandy loam. Also included are a few areas of Palms muck, Houghton muck, and Edwards muck; areas of soils in which the depth to sand is less than 16 inches; and some areas that have as much as 6 inches of sedimentary peat over the sandy material.

Runoff is very slow or ponded. Permeability is rapid. The hazard of soil blowing is severe.

Some areas of this soil are used for crops. Other areas are idle or are in woodland. If adequately drained and protected from soil blowing, this soil is suited to corn, potatoes, onions, radishes, and commercial sod. The main concerns in management are removing excess water and controlling soil blowing. Capability unit IVw–1 (M/4c); woodland suitability group 4w2; woody plant group 1.

Bixby Series

The Bixby series consists of well drained, nearly level to very gently sloping soils on outwash plains. These soils formed in loamy material less than 40 inches thick, dominantly over sandy material that generally becomes gravelly as depth increases. These soils have been deeply leached.

In a representative profile the surface layer is dark brown loam about 9 inches thick. The subsurface layer is dark brown loam 4 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown, firm heavy loam. The middle part is dark brown, firm sandy clay loam. The lower part is dark brown, very friable sandy loam. The underlying material, at a depth of 39 inches, is dark brown, loose coarse sand banded with thin layers of loamy sand and gravelly sandy loam.

Runoff is slow. Permeability is moderate, and available water capacity is moderate.

These soils are well suited to farming. Most areas are in crops. During extreme dry weather, droughtiness is sometimes a hazard.

Representative profile of Bixby loam, 0 to 3 percent slopes, in a cultivated field, 500 feet east and 100 feet north of southwest corner sec. 28, T. 2 N., R. 5 W.:

Ap—0 to 9 inches; dark brown (10YR 3/3) loam; moderate medium granular structure; friable; 1 to 3 percent pebbles; slightly acid; abrupt smooth boundary.

A2—9 to 13 inches; dark brown (10YR 4/3) loam; moderate medium platy structure; friable; 1 to 3 percent pebbles; medium acid; abrupt wavy and broken boundary.

B21t—13 to 22 inches; dark brown (7.5YR 4/4) heavy loam; moderate medium subangular blocky structure; firm; 1 to 3 percent pebbles; thin continuous dark brown (10YR 4/3) clay films; strongly acid; clear wavy boundary.

B22t—22 to 31 inches; dark brown (7.5YR 4/4) sandy clay loam; weak coarse subangular blocky structure; firm; 12 to 15 percent pebbles; thin continuous dark brown (7.5YR 4/4) clay films; strongly acid; abrupt wavy boundary.

IIB3—31 to 39 inches; dark brown (7.5YR 4/4) sandy loam; weak moderate subangular blocky structure; very friable; 12 to 15 percent pebbles; medium acid; abrupt irregular boundary.

IIC—39 to 60 inches; dark brown (7.5YR 4/4) coarse sand, single grained, loose; and dark brown (7.5YR 4/4) loamy sand and gravelly sandy loam, massive, friable; 3 to 5 percent pebbles; neutral; abrupt wavy boundary.

The depth to the IIC horizon ranges from 24 to 40 inches. Reaction of the solum is very strongly acid to neutral. The solum is 2 to 15 percent pebbles and 1 to 5 percent cobbles.

The A horizon is loam, silt loam, or fine sandy loam. The Ap horizon is very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), or dark brown (10YR 3/3). The A2 horizon is dark brown (10YR 4/3), brown (10YR 5/3), or pale brown (10YR 6/3).

The B21t horizon is brown (10YR 5/3), dark yellowish brown (10YR 4/4), or dark brown (7.5YR 4/4) heavy loam, sandy clay loam, or clay loam. The B22t horizon is dark brown (7.5YR 4/4), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4) sandy clay loam, clay loam, heavy sandy loam, or heavy loam, or it is gravelly phases of these textures.

The IIB3 horizon is dark brown (7.5YR 4/4), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4) coarse sandy loam, heavy loamy sand, or sandy loam.

The IIC horizon is dark brown (7.5YR 4/4) or dark yellowish brown (10YR 5/4) sand and has thin discontinuous layers of loamy sand or gravelly sandy loam. It is coarse sand or sand or is gravelly analogs of these textures.

These Bixby soils have sandy loam more than 6 inches thick in the lower part of the solum and thus lack the contrasting textures defined in the range for the series. This difference, however, does not affect their use and management.

Bixby soils are mostly near Boyer soils. They have finer textures in the B horizon and a thicker and more acid solum than Boyer soils. They are in a toposequence with Matherton soils. They lack the grayish brown colors below the Ap horizon typical of Matherton soils.

BbA—Bixby loam, 0 to 3 percent slopes. This soil is on plains. Most areas are irregular in shape. They range from 5 to 80 acres in size.

Included with this soil in mapping are small areas of well drained Oshtemo sandy loam in positions similar to those of this Bixby soil, and some small slightly depressional areas of moderately well drained soils that are similar to Bixby loam, except for drainage. Also included are gently undulating areas of well drained Boyer sandy loam and areas of somewhat poorly drained Brady sandy loam and Matherton loam.

Runoff is slow. The hazard of erosion is slight.

Most areas of this soil are used for crops. Some areas are in woodland. The main concern in management is possible dryness during extended periods of low rainfall. Capability unit IIs-1 (3a); woodland suitability group 2o2; woody plant group 4.

Borrow Land

Bh—Borrow land. This land type consists of areas where soil material has been excavated. The areas are on plains and moraines, mostly near major highways and urban areas. The soil material is sandy and loamy. The areas are generally well drained, but some are somewhat poorly drained or poorly drained. Included in mapping are areas of open water.

Removal of the soil material has destroyed the original soil profile. In most areas the textures are variable and onsite investigation is needed. Generally, borrow land that is sandy is associated with coarse textured or moderately coarse textured soils, and borrow land that is loamy is associated with medium textured to moderately fine textured soils.

Trees or grasses are needed to stabilize the soil and to reduce the severe hazard of erosion. Capability unit VIIs-1; not placed in a woodland suitability group, Michigan soil management group, or woody plant group.

Boyer Series

The Boyer series consists of well drained, nearly level to hilly soils on outwash plains, moraines, and glacial drainage terraces. These soils formed in sandy loam and loamy sand underlain at a depth of 24 to 40 inches by calcareous gravelly coarse sand.

In a representative profile the surface layer is dark brown sandy loam about 8 inches thick. The subsurface layer is brown sandy loam 4 inches thick. The subsoil is 26 inches thick. The upper part is dark brown, firm light sandy clay loam, the middle part is dark brown, friable light sandy loam, and the lower part is dark brown, very friable loamy sand. The underlying material, beginning at a depth of 38 inches, is brown, calcareous gravelly coarse sand.

Runoff is slow to rapid. Permeability is moderately rapid, and available water capacity is low.

Boyer soils are moderately suited to farming. They are a source of gravel.

Representative profile of Boyer sandy loam, 0 to 6 percent slopes, on the side of a gravel pit, 1,625 feet south and 2,000 feet west of northeast corner sec. 20, T. 1 N., R. 6 W.:

Ap—0 to 8 inches; dark brown (10YR 3/3) sandy loam; weak medium granular structure; very friable; 2 to 5 percent pebbles; slightly acid; abrupt smooth boundary.

A2—8 to 12 inches; brown (10YR 5/3) sandy loam; weak medium platy structure; friable; 2 to 5 percent pebbles; strongly acid; clear wavy boundary.

B21t—12 to 21 inches; dark brown (7.5YR 4/4) light sandy clay loam; moderate medium to coarse subangular blocky structure; firm; continuous thin dark reddish brown (5YR 3/4) clay films on surface of peds; 10 percent pebbles; strongly acid; clear wavy boundary.

B22t—21 to 28 inches; dark brown (7.5YR 4/4) light sandy loam; weak coarse subangular blocky structure; friable; discontinuous thin patchy reddish brown (5YR 4/4) clay films on surfaces of peds and bridging sand grains; 10 percent pebbles; medium acid; gradual wavy boundary.

B3—28 to 38 inches; dark brown (7.5YR 4/4) loamy sand; weak coarse to very coarse subangular blocky structure; very friable; thin dark reddish brown (5YR 3/4) clay films on sand grains and some bridging; about 5 percent pebbles; slightly acid; abrupt irregular boundary.

IIC—38 to 60 inches; brown (10YR 5/3) gravelly coarse sand; single grained; loose; 30 percent pebbles; strong effervescence; moderately alkaline.

The solum is commonly 25 to 38 inches in thickness, but it ranges from 24 to 40 inches; in most profiles thickness coincides with the depth to free carbonates. It is 1 to 20 percent pebbles or is gravelly. It is strongly acid to slightly acid.

The Ap horizon is dark grayish brown (10YR 4/2), dark brown (10YR 3/3), or brown (10YR 4/3). The A2 horizon, where present, is loamy sand, light sandy loam, or sandy loam.

The B2t horizon is dark brown (7.5YR 4/4) or reddish brown (5YR 4/4) light sandy loam, sandy loam, heavy sandy loam, light sandy clay loam, and gravelly sandy loam. The B horizon averages less than 18 percent clay. The B3 horizon, where present, is dark brown (7.5YR 4/4) or strong brown (7.5YR 5/6) loamy sand or light sandy loam, or it is a gravelly or coarse sandy analog of these textures.

The IIC horizon is sand or coarse sand, or it is a gravelly analog of these textures. The sandy strata are commonly 1 to 35 percent pebbles.

Boyer soils are mostly near Bixby, Oshtemo, and Spinks soils. They have a coarser textured B horizon and a thinner, less acid solum than Bixby soils. They are shallower to the C horizon than Oshtemo soils. They have a finer textured B horizon than Spinks soils and are shallower to the C horizon.

BnB—Boyer loamy sand, 0 to 6 percent slopes. This soil is on convex mounds, on low ridges, and in broad undulating areas. Areas are round, long and narrow, or irregular in shape. They are 2 acres to about 100 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer, subsurface layer, and upper part of the subsoil are loamy sand.

Included with this soil in mapping are small areas of somewhat poorly drained Wasepi sandy loam and Brady sandy loam. These soils are in the lowest parts of small depressions and entrenched drainageways and are in narrow bands along the boundaries where this Boyer soil borders wet soils. Also included are a few small areas of Boyer sandy loam, Spinks loamy sand, and Oshtemo sandy loam; small areas of soils that are underlain at a depth of 40 to 60 inches by loamy material; and small areas of soils that are similar to the Boyer soils but are underlain by very fine sand and silt.

Runoff is slow. The hazard of soil blowing is moderate or severe.

Many areas of this soil are idle. This soil is moderately suited to farming. The main concerns in management are conserving moisture, controlling soil blowing, and increasing organic-matter content to reduce droughtiness. Capability unit IIIs–1 (4a); woodland suitability group 2s5; woody plant group 3.

BnC—Boyer loamy sand, 6 to 12 percent slopes. This soil is on rolling plains. It is in areas that have plane slopes, or it is on narrow-topped, convex ridges, knoblike knolls, or clusters of rolling hills. Areas range from long and narrow to round or oval, or they are irregular in shape. They are commonly 2 to 10 acres in size but range to as much as 80 acres. This soil has a profile similar to the one described as representative of the series, but the surface layer and upper part of the subsoil are loamy sand and the surface layer commonly is lighter in color.

Included with this soil in mapping are small areas of well drained Spinks loamy sand, mostly on the upper side slopes of the knolls, ridges, and hills or in the basinlike depressions of the rolling areas; small areas of Boyer sandy loam and Oshtemo sandy loam; and small areas of soils that are similar to the Boyer soils but are underlain by very fine sand. Also included are a few small areas and long narrow strips of soils on the tops of hills and along the crests of ridges where the depth to the limy underlying gravelly sand or sand is less than 24 inches; some small areas of nearly level to gently sloping soils on the tops of knolls, hills, and ridges; and a few eroded spots and spots where the subsoil is exposed at the surface.

Runoff is medium, and the hazard of erosion is severe.

Most areas of this soil are idle or are being reforested. The main concerns in management are controlling erosion and increasing organic-matter content to reduce droughtiness. Capability unit IIIe–3 (4a); woodland suitability group 2s5; woody plant group 3.

BoB—Boyer sandy loam, 0 to 6 percent slopes. This soil is on plains. Areas range from long and narrow to round or oval, or they are irregular in shape. They are commonly 5 to 40 acres in size but range from 2 acres to about 100 acres. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of well drained Oshtemo sandy loam in positions similar to those of this Boyer soil. Also included are small areas of Boyer and Oshtemo soils that have a surface layer of loamy sand; small areas of somewhat poorly drained Wasepi, Matherton, and Kibbie soils; and small areas of soils that are similar to Boyer soils but have a medium textured to moderately fine textured subsoil.

Runoff is slow, and the hazard of erosion is slight to moderate.

Most areas of this soil have been cultivated; some areas are idle. The main concerns in management are conserving moisture, controlling erosion, and maintaining organic-matter content. Capability unit IIIs–1 (4a); woodland suitability group 2s5; woody plant group 3.

BoC—Boyer sandy loam, 6 to 12 percent slopes. This soil is on side slopes, knolls, and hills. Areas range from long and narrow to round or oval, or they are irregular in shape. They are commonly 5 to 20 acres in size, but they range from 2 acres to about 60 acres. This soil has a profile similar to the one described as representative of the series, but the surface layer and upper part of the subsoil are thinner and contain more gravel.

Included with this soil in mapping are small areas of well drained Marlette loam and Oshtemo sandy loam and small areas of Boyer and Oshtemo soils. Also included are some small spots and long narrow strips of soils on the tops of knolls, ridges, and crests of slopes where the depth to the calcareous underlying sand and gravel is less than 24 inches and small areas of soils that are similar to this Boyer soil but have a medium textured to moderately fine textured subsoil.

Surface runoff is medium, and the hazard of erosion is moderate.

Most areas of this soil have been cultivated. Some areas are used for pasture, and some are idle. A few areas are wooded. The main concerns in management are conserving moisture, controlling erosion, and maintaining organic-matter content. Capability unit IIIe–3 (4a); woodland suitability group 2s5; woody plant group 3.

BpD—Boyer-Spinks loamy sands, 12 to 18 percent slopes. This complex is in areas that have plane slopes or is on narrow-topped ridges, knoblike knolls, or clusters of hills. Areas range from long and narrow to round or oval, or they are irregular in shape. They are generally 2 acres to more than 100 acres in size.

Boyer loamy sand makes up about 55 percent of the acreage of this complex. It has a profile similar to the one described as representative of the series, but the surface layer and upper part of the subsoil contain more gravel. It is mostly on the upper side slopes and tops of the mapped areas.

Spinks loamy sand makes up about 30 percent of the acreage. It has a profile similar to the one described as representative of the series, but the subsoil has more coarse sand. It is on the lower side slopes and foot slopes of the mapped areas and is the major soil in the small basinlike depressions in the large rolling areas.

Included with these soils in mapping are small areas of well drained Boyer and Oshtemo sandy loams on the upper side slopes of the hills and ridges and in the small basinlike depressions of the rolling areas. Also included are a few small spots and long narrow strips of soils on the tops of hills and along the crests of ridges, where the depth to the limy underlying gravelly sand or coarse sand is less than 24 inches, and some small, nearly level to gently sloping areas on the tops of hills and ridges and on the bottoms of small depressions and drainageways.

Runoff is rapid, and the erosion hazard is severe.

Most areas of these soils are in woodland or are idle. The main concerns in management are controlling erosion and conserving moisture. Increasing and maintaining organic-matter content are also important. Capability unit IVe–2 (4a); woodland suitability group 2s5; woody plant group 3.

Brady Series

The Brady series consists of somewhat poorly drained, nearly level to very gently sloping soils on outwash plains and along glacial drainage channels. These soils formed in sandy loam and loamy sand over calcareous coarse sand.

In a representative profile the surface layer is very dark grayish brown sandy loam 9 inches thick. The subsurface layer is grayish brown, mottled heavy loamy sand 4 inches thick. The subsoil is about 43 inches thick. The upper 10 inches is brown, friable, mottled sandy loam. The next 14 inches is dark yellowish brown, friable, mottled heavy sandy loam. The lower 19 inches is dark brown, very friable, mottled loamy sand. The underlying material, beginning at a depth of 56 inches, is dark brown, mottled, calcareous sand.

Runoff is slow. Permeability is moderately rapid, and the available water capacity is moderate.

Brady soils are moderately suited to farming. Most of the larger areas are cultivated or are in pasture. Many of the smaller areas are idle or are in woodland.

Representative profile of Brady sandy loam, in an area of Brady-Bronson sandy loams, 0 to 3 percent slopes, in a cultivated field, 800 feet east and 500 feet north of center sec. 13, T. 2 N., R. 5 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; slightly acid; abrupt smooth boundary.

A2—9 to 13 inches; grayish brown (10YR 5/2) heavy loamy sand; few fine distinct yellowish brown (10YR 5/6) mottles; weak coarse granular structure; friable; slightly acid; clear wavy boundary.

B21—13 to 23 inches; brown (10YR 5/3) sandy loam; many medium distinct gray (10YR 5/1) mottles; weak coarse subangular blocky structure; friable; many roots; medium acid; clear wavy boundary.

B22t—23 to 37 inches; dark yellowish brown (10YR 4/4) heavy sandy loam; many medium distinct gray (10YR 5/1), dark brown (7.5YR 4/4), and yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; friable; few patchy clay films on faces of peds and bridging sand grains; very dark grayish brown (10YR 3/2) sandy loam worm casts and fillings in root channels; 2 to 6 percent pebbles; medium acid; abrupt irregular boundary.

B3—37 to 56 inches; dark brown (7.5YR 4/4) loamy sand; few medium distinct gray (10YR 5/1) and yellowish brown (10YR 5/8) mottles; massive separating to very weak coarse subangular blocky structure; very friable; few thin 1/8- to 2-inch thick discontinuous dark brown (7.5YR 4/4) sandy loam layers; neutral; abrupt irregular boundary.

IIC—56 to 60 inches; brown (10YR 5/3) coarse sand; common medium distinct gray (10YR 5/1) mottles; structureless, single grained; loose; 15 percent pebbles; slight effervescence; mildly alkaline.

The solum is dominantly 45 to 60 inches in thickness, but it ranges from 40 to 66 inches. It is 1 to 20 percent pebbles throughout and is less than 1 percent to 5 percent cobbles.

The A horizon is dominantly sandy loam, but it ranges from fine sandy loam to loamy sand. The Ap horizon is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1). The A2 horizon is grayish brown (10YR 5/2) or light brownish gray (10YR 6/2).

The B horizon is medium acid in the upper part to neutral in the lower part. The B21 horizon is brown (10YR 5/3), yellowish brown (10YR 5/4), or pale brown (10YR 6/3) sandy loam, heavy loamy sand, or loamy sand. The B22t horizon is dark yellowish brown (10YR 4/4), dark brown (7.5YR 4/4), or strong brown (7.5YR 5/6 or 5/8) heavy sandy loam or light sandy clay loam, or it is gravelly phases of these textures. The B3 horizon is dark brown (7.5YR 4/4), brown (10YR 5/3), pale brown (10YR 6/3), or grayish brown (10YR 5/2) heavy loamy sand or loamy sand, and it has thin discontinuous bands of sandy loam or light sandy clay loam.

The IIC horizon is sand, coarse sand, or gravelly coarse sand.

Brady soils are similar to Bronson, Matherton, and Wasepi soils. They have gray mottles in the upper part of the B horizon, which Bronson soils lack. They have coarser texture in the B horizon and a greater depth to the C horizon than Matherton soils. They are deeper to the C horizon than Wasepi soils.

BrA—Brady-Bronson sandy loams, 0 to 3 percent slopes. This complex is in areas that are long and range from narrow to wide or that are irregular in shape. Areas range from 3 acres to about 200 acres in size.

Brady sandy loam makes up about 50 percent of this complex, and Bronson sandy loam makes up about 35 percent. Both of these soils occupy similar elevations and positions in the mapped areas, but the Brady soil is more commonly on the lower parts.

Included with these soils in mapping are small areas of somewhat poorly drained Wasepi sandy loam, Matherton loam, and Kibbie fine sandy loam, and areas of a soil that is similar to this Brady soil but is underlain at a depth of 24 to 40 inches by loamy material. Also included are small areas of very poorly drained Gilford sandy loam and poorly drained and very poorly drained Sebewa loam in small depressions and long narrow drainageways. There are also small spots of well drained Oshtemo, Boyer, or Bixby soils on the tops of low knolls and mounds, and on crests of slopes bordering entrenched drainageways, and on flood plains of streams.

Runoff is very slow to slow, and the hazard of erosion is slight.

Most areas of these soils are used for crops. Some areas are idle, and some are in woodland. These soils are moderately suited to farming if excess water is removed. The main concern in management is removing excess water. Capability unit IIw–4 (4b, 4a); Brady soil in woodland suitability group 3s3, woody plant group 2; Bronson soil in woodland suitability group 2s5, woody plant group 3.

Bronson Series

The Bronson series consists of moderately well drained, nearly level to very gently sloping soils on outwash plains and along glacial drainage channels. These soils formed in sandy and loamy material over calcareous coarse sand. Bronson soils are mapped only in a complex with Brady soils.

In a representative profile the surface layer is dark brown sandy loam about 8 inches thick. The subsoil extends to a depth of 60 inches. In sequence from the top, it is 30 inches of dark brown, friable, mottled sandy loam, 9 inches of dark brown, very friable, mottled heavy loamy sand, and 13 inches of yellowish brown, mottled loose sand.

Runoff is slow. Permeability is moderately rapid, and available water capacity is moderate.

Bronson soils are moderately suited to farming. Most of the larger areas are cultivated or are in pasture. Many smaller areas are idle or are in woodland.

Representative profile of Bronson sandy loam, in an area of Brady-Bronson sandy loams, 0 to 3 percent slopes, in an idle cultivated field, 1,000 feet west and 1,640 feet south of northeast corner sec. 33, T. 2 N., R. 5 W.:

Ap—0 to 8 inches; dark brown (10YR 3/3) sandy loam, dark grayish brown (10YR 4/2) rubbed, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; about 1 percent pebbles; many fine roots; medium acid; abrupt smooth boundary.

B21t—8 to 23 inches; brown (10YR 4/3) sandy loam; common fine distinct yellowish brown (10YR 5/4, 5/6) mottles; weak coarse subangular blocky structure; friable; many fine roots grading to common as depth increases; about 2 percent pebbles; many thin patchy dark brown (7.5YR 4/4) clay films on surfaces of peds; medium acid; gradual wavy boundary.

B22t—23 to 38 inches; dark brown (10YR 4/3) heavy sandy loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6, 5/8) mottles; weak coarse subangular blocky structure; friable; thin dark brown (7.5YR 4/2) and dark reddish brown (5YR 3/4) discontinuous clay films on surfaces of peds, also clay bridging sand grains; 15 percent pebbles; few fine roots; medium acid; clear wavy boundary.

B23—38 to 47 inches; dark brown (7.5YR 4/4) heavy loamy sand; few, fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; massive; very friable; less than 1 percent pebbles; many thin discontinuous dark brown (7.5YR 4/2) clay bridging sand grains; many discontinuous lenses and patches of dark yellowish brown (10YR 4/4) sand; single grained; loose; medium acid; clear wavy boundary.

IIB3—47 to 60 inches; yellowish brown (10YR 5/4) sand; few fine distinct grayish brown (10YR 5/2) mottles; single grained; loose; few thin dark yellowish brown (10YR 4/4), discontinuous loamy sand lenses; neutral.

The solum is typically 44 to 66 inches in thickness, but it ranges from 40 to 80 inches. It is strongly acid to slightly acid in the upper part and medium acid to neutral in the lower part.

The Ap horizon is dark brown (10YR 3/3), dark grayish brown (10YR 4/2), or very dark grayish brown (10YR 3/2) sandy loam, fine sandy loam, or loamy sand.

The Bt horizon is brown (10YR 4/3 or 5/3), dark yellowish brown (10YR 4/4), or dark brown (7.5YR 4/4) sandy loam, heavy sandy loam, or light sandy clay loam, or it is gravelly analogs of these textures. The upper part of the Bt horizon is loamy sand in some profiles.

The B23 and IIB3 horizons are dark brown (7.5YR 4/4), yellowish brown (10YR 5/4), brown (10YR 5/3), or light yellowish brown (10YR 6/4) light loamy sand, loamy sand, or sand. These horizons have thin, discontinuous layers of loamy sand, light sandy loam, or sandy loam as much as 3 inches thick.

The IIC horizon, where present, is coarse sand, sand, or gravelly coarse sand.

Bronson soils are similar to Brady, Tuscola, and Wasepi soils. They lack gray mottles in the upper part of the B horizon, which Brady soils have. They have coarser textures in the B and C horizons than Tuscola soils. They are deeper to the calcareous C horizon than Wasepi soils, and they lack grayish brown mottles in the upper part of the B horizon, which Wasepi soils have.

Capac Series

The Capac series consists of somewhat poorly drained, nearly level to gently undulating soils on till plains and low moraines. These soils formed in calcareous glacial loam till.

In a representative profile the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 21 inches thick. The upper 4 inches is yellowish brown, firm light clay loam, the next 6 inches is dark yellowish brown, firm, mottled clay loam, and the lower 11 inches is yellowish brown, friable, mottled heavy loam. The underlying material, beginning at a depth of 30 inches, is calcareous brown loam.

Runoff is slow to medium. Permeability is moderately slow, and available water capacity is high.

If Capac soils are artificially drained, they are well suited to farming. Most areas are cultivated.

Representative profile of Capac loam, 0 to 3 percent slopes, in a cultivated field, 1,150 feet east and 1,000 feet south of northwest corner sec. 20, T. 4 N., R. 5 W.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam, gray (10YR 6/1) dry; cloddy to moderate fine and medium granular structure; friable; common fine roots; 6 percent pebbles and cobbles; slightly acid; abrupt smooth boundary.

B&A—9 to 13 inches; yellowish brown (10YR 5/4) light clay loam (B part); brown (10YR 5/3) fine sandy loam (A part), white (10YR 8/2) dry; coatings (A part) approximately 2 millimeters thick on vertical faces and surrounding some peds; few fine faint strong brown (7.5YR 5/6) and dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; firm; common fine roots; thin dark brown (7.5YR 4/4) and dark grayish brown (10YR 4/2) clay films on faces of peds and in root channels; about 1 percent cobbles and 6 percent pebbles; slightly acid; clear wavy boundary.

B21t—13 to 19 inches; dark yellowish brown (10YR 4/4) clay loam; few fine faint brown (7.5YR 5/2, 5/4) and common medium distinct grayish brown (10YR 5/2) mottles; moderate medium prismatic structure separating to moderate fine and medium angular blocky; firm; few fine roots; thin dark brown (7.5YR 4/2) and dark reddish gray (5YR 4/2) clay films on faces of peds; 1 percent cobbles and about 6 percent pebbles; slightly acid; clear wavy boundary.

B22t—19 to 24 inches; yellowish brown (10YR 5/8) heavy loam; common fine faint brown (7.5YR 5/4) and strong brown (7.5YR 5/8) mottles and common fine distinct light brownish gray (10YR 6/2) mottles; moderate medium prismatic structure separating to strong fine and medium angular blocky; friable; common fine roots; thin dark brown (7.5YR 4/2) and greenish gray (5GY 5/1) clay films on faces of peds; 1 percent cobbles and 5 percent pebbles; slightly acid; gradual wavy boundary.

B3—24 to 30 inches; yellowish brown (10YR 5/6) heavy loam; few fine distinct dark brown (7.5YR 4/4) mottles and many medium distinct grayish brown (10YR 5/2) mottles; weak coarse prismatic structure separating to moderate fine and medium angular blocky; friable; thin patchy dark brown (10YR 4/2) clay films on faces of peds; 1 percent cobbles and 5 percent pebbles; neutral; clear wavy boundary.

C—30 to 60 inches; brown (10YR 5/3) loam; common medium distinct light gray (N 7/0), light brownish gray (10YR 6/2), and yellowish brown (10YR 5/6 and 5/8) mottles; weak medium subangular blocky structure to massive; friable; 1 percent cobbles and 5 percent pebbles; slight effervescence; mildly alkaline.

The solum typically is 24 to 34 inches in thickness, but it ranges from 24 to 40 inches. It is medium acid to neutral. The profile is 1 to 15 percent pebbles and less than 1 percent to about 5 percent cobbles.

The A horizon is loam, sandy loam, fine sandy loam, or light loam. The Ap horizon is dark grayish brown (10YR 4/2) or dark brown (10YR 3/3); when dry it is light grayish brown (10YR 6/2), gray (10YR 6/1), or pale brown (10YR 6/3). The A2 horizon, where present, is 2 to 6 inches thick. Its matrix color is grayish brown (10YR 5/2) or brown (10YR 5/3). The A part of the B&A horizon is 1 millimeter to 5 millimeters thick on vertical faces.

The B horizon is yellowish brown (10YR 5/4 or 5/6) or dark yellowish brown (10YR 4/4) light clay loam, clay loam, or heavy loam. The B3 horizon is yellowish brown (10YR 5/6 or 5/4), light yellowish brown (10YR 6/4), and pale brown (10YR 6/3).

The C horizon is yellowish brown (10YR 5/4) or brown (10YR 5/3). A few thin streaks and patches of soft lime accretions are light gray (10YR 7/1). This horizon has weak or strong effervescence.

Capac soils are mostly near Marlette and Metamora soils. They have grayish brown mottles in the upper part of the B horizon, which Marlette soils lack. They have finer textures in the A and B horizons than Metamora soils.

CaA—Capac loam, 0 to 3 percent slopes. This soil is on plains and low knolls. It is on small, very slightly convex mounds; on large domelike rises on broad plains, or in narrow, concave drainageways and depressions on gently undulating uplands. Areas are round, long and narrow, or irregular in shape. They 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 a few small areas of poorly drained and very poorly drained Parkhill loam and Colwood loam on the bottoms of depressions and entrenched drainageways; a few small areas of better drained Marlette loam on the tops of knoblike mounds, sharp rises, and short gentle slopes bordering drainageways; and a few areas of somewhat poorly drained Metamora sandy loam on small, moundlike knolls. Also included are a few small areas of soils where the subsoil is clayey and depth to the limy underlying loam is less than 24 inches and some small areas of somewhat poorly drained, stratified Kibbie fine sandy loam, mostly along the boundaries of mapped areas adjacent to old glacial lakes.

Runoff is slow, and the hazard of erosion is slight.

Most areas of this soil are used for crops. A few areas are in second-growth hardwoods. If adequately drained, this soil is well suited to farming. The main concern in management is removing excess water. Capability unit IIw–1 (2.5b); woodland suitability group 2o4; woody plant group 2.

CbB—Capac-Marlette loams, 1 to 6 percent slopes. This complex is in areas that range from round to irregular in shape and from 2 to 400 acres in size.

Capac loam makes up about 45 percent of this complex. It is on the side slopes and foot slopes of mounds, knolls, ridges, and gentle rises and is in the small depressions and drainageways.

Marlette loam makes up about 40 percent of the complex. It has a profile similar to the one described as representative of the series, but it generally has mottles in the lower part of the subsoil. It is on the highest parts of mapped areas.

Included with these soils in mapping are a few small areas of poorly drained and very poorly drained Parkhill loam and Colwood loam on the bottoms of the deepest depressions and entrenched drainageways; a few small areas of the well drained Owosso sandy loam, generally on the tops of knolls and crests of ridges and in small spots on slightly steeper slopes; and small, caplike mounds of somewhat poorly drained Metamora sandy loam. Also included are a few small areas of a moderately well drained sandy loam that has a profile similar to that of the Metamora soil; small eroded areas in a few places where the surface layer of these soils is lighter colored and mostly consists of material from the subsoil; and small areas, mainly a few miles northeast of Bellevue, where the subsoil is clayey.

Runoff is slow to medium, and the hazard of erosion is moderate.

Most areas of these soils are used for crops. A few areas have second growth hardwoods. These soils are well suited to farming if they are adequately drained and erosion is controlled. The main concerns in management are controlling erosion and, in some areas, removing excess water. Capability unit IIw–6 (2.5b, 2.5a); Capac soil in woodland suitability group 2o4, woody plant group 2; Marlette soil in woodland suitability group 2o1, woody plant group 4.

Cohoctah Series

The Cohoctah series consists of poorly drained and very poorly drained, nearly level soils on flood plains of streams and rivers. These soils formed in sandy and loamy material that was deposited by floodwaters.

In a representative profile the surface layer is very dark grayish brown fine sandy loam about 14 inches thick. The underlying material, to a depth of 41 inches, is stratified, dark gray, friable, mottled sandy loam; grayish brown, very friable, mottled loamy sand; and gray, friable, mottled loam. Below this, to a depth of 60 inches, the underlying material is stratified grayish brown and dark gray, loose, mottled sand.

Runoff is very slow or ponded. Permeability is moderately rapid, and available water capacity is moderate.

Cohoctah soils are poorly suited to farming. Crops are subject to frost damage because the soils are low on the landscape. Artificial drainage is difficult because the soils lack adequate outlets. These soils are mostly in woodland or are used for wetland wildlife habitat.

Representative profile of Cohoctah fine sandy loam, frequently flooded, in idle field, 2,240 feet north and 100 feet west of southeast corner sec. 12, T. 3 N., R. 5 W.:

A1—0 to 14 inches; very dark grayish brown (10YR 3/2) fine sandy loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; many roots; mildly alkaline; abrupt smooth boundary.

C1g—14 to 30 inches; dark gray (10YR 4/1) sandy loam; common medium distinct grayish brown (10YR 5/2) mottles and few medium distinct strong brown (7.5YR 5/8) mottles; weak coarse subangular blocky structure; friable; many fine roots; mildly alkaline; abrupt smooth boundary.

IIC2g—30 to 37 inches; grayish brown (10YR 5/2) loamy sand; common medium distinct yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; few ⅛- to ½-inch thick very dark grayish brown (10YR 3/2) loam layers; massive; friable; mildly alkaline; abrupt wavy boundary.

IIIC3g—37 to 41 inches; gray (10YR 5/1) loam; common medium distinct yellowish brown (10YR 5/8) mottles; weak moderate subangular blocky structure; few thin bands and pockets of very dark grayish brown (10YR 3/2) loam; massive; friable; mildly alkaline; abrupt wavy boundary.

IVC4g—41 to 52 inches; grayish brown (10YR 5/2) sand; few medium distinct yellowish red (5YR 4/6) mottles; single grained; loose; few thin bands of very dark grayish brown (10YR 3/2) sandy loam; massive; friable; mildly alkaline; abrupt irregular boundary.

IVC5g—52 to 60 inches; dark gray (10YR 4/1) coarse sand; common medium distinct grayish brown (10YR 5/2) mottles; single grained; loose; thin very dark gray (10YR 3/1) sandy loam layers or bands; massive; friable; few dead roots and branches; about 2 to 4 percent pebbles; slight effervescence; mildly alkaline.

Reaction is neutral to mildly alkaline between depths of 10 and 40 inches.

The A1 horizon is very dark grayish brown (10YR 3/2), very dark brown (10YR 2/2), black (10YR 2/1), or very dark gray (10YR 3/1) fine sandy loam, sandy loam, silt loam, or loam. It is 10 to 15 inches in thickness.

The C1g horizon is very dark gray (10YR 4/1) or gray (10YR 5/1) fine sandy loam or sandy loam.

The IIC2g and IIIC3g horizons are gray (10YR 5/1 or 6/1) or grayish brown (10YR 5/2) loamy sand, sandy loam, or loam. They contain thin strata, ⅛ inch to 3 inches thick, of very dark grayish brown (10YR 3/2), very dark brown (10YR 2/2), or very dark gray (10YR 3/1) loam or sandy loam. The IVC4g and IVC5g horizons are grayish brown (10YR 5/2), gray (10YR 5/1 or 6/1), or dark gray (10YR 41) sand, coarse sand, or fine sand, or they are gravelly analogs of these textures. They contain thin strata of very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), or very dark brown (10YR 2/2) sandy loam or loam.

Cohoctah soils are similar to Gilford and Sloan soils. They have less gravel in the profile than Gilford soils, and organic-matter content decreases irregularly as depth increases. They have coarser textures in the upper part of the C horizon than Sloan soils. Cohoctah soils are mostly near Houghton soils. They have mineral horizons, whereas Houghton soils have organic horizons.

Ch—Cohoctah fine sandy loam, frequently flooded. This soil is on flood plains, on the first and second bottoms of the major rivers and streams. Slopes are 0 to 2 percent. Areas are generally elongated in shape. They range from 2 acres to more than 100 acres in size.

Included with this soil in mapping are small areas of well drained to somewhat poorly drained, coarse textured and moderately coarse textured, stratified soils on small islandlike knolls, long narrow mounds, and benchlike terraces and small areas of very poorly drained Houghton, Adrian, Palms, and Edwards soils. Also included are small areas of the very poorly drained Sloan soils and somewhat poorly drained Shoals soils. These finer textured soils occur as small spots scattered throughout the large flood plains of Battle Creek and Thornapple River and their tributaries.

Runoff is very slow or ponded, and the hazard of erosion is slight. Most areas of this soil are in woodland. Few areas are cultivated. The main concerns in management are flooding and excess wetness. Capability unit Vw-1 (L-2c); woodland suitability group 2w1; woody plant group 5.

Colwood Series

The Colwood series consists of poorly drained and very poorly drained, nearly level soils in depressions and on broad flats on the lake plains, in glacial drainageways, and on till plains. These soils formed in stratified sandy to silty material.

In a representative profile the surface layer is very dark gray loam about 11 inches thick. The subsoil is about 22 inches thick. The upper 4 inches is gray, friable, mottled loam, the next 9 inches is light brownish gray, friable, mottled silt loam, and the lower 9 inches is gray, firm, mottled light silty clay loam. The underlying material, beginning at a depth of 33 inches, is calcareous gray silt loam.

Runoff is very slow or ponded. Permeability is moderate, and available water capacity is high.

If artificially drained, these soils are well suited to farming.

Representative profile of Colwood loam, in a cultivated field, 2,240 feet west and 200 feet south of northeast corner sec. 6, T. 1 N., R. 4 W.:

Ap—0 to 11 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; slightly acid; abrupt smooth boundary.

B11g—11 to 15 inches; gray (10YR 6/1) loam that has few fine faint yellowish brown (10YR 5/8) mottles; moderate medium granular structure; friable; slightly acid; clear wavy boundary.

B12g—15 to 24 inches; light brownish gray (10YR 6/2) silt loam; common coarse distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; friable; very dark gray (10YR 3/1) root channel fillings; few fine roots; slightly acid; clear wavy boundary.

IIB2g—24 to 33 inches; gray (10YR 5/1) light silty clay loam and thin strata of silt and very fine sand; common coarse distinct yellowish brown (10YR 5/8) mottles and few fine faint yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; firm; few fine roots; neutral; abrupt wavy boundary.

IIIC1g—33 to 54 inches; gray (10YR 5/1) silt loam and thin strata of fine sand and silt; common medium distinct yellowish brown (10YR 5/8) mottles and few fine faint yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; firm; slight effervescence; mildly alkaline; abrupt irregular boundary.

IIIC2g—54 to 60 inches; gray (5YR 5/1) silt and very fine sand that has strata of fine sand; massive; friable; strong effervescence; mildly alkaline.

The solum is dominantly 28 to 40 inches in thickness, but it ranges from 24 to 50 inches; thickness coincides with depth to effervescent material. The solum is less than 5 percent coarse fragments throughout. It is slightly acid to mildly alkaline.

The Ap horizon is very dark gray (10YR 3/1), very dark brown (10YR 2/2), black (10YR 2/1), or very dark grayish brown (10YR 3/2), and it is 10 to 14 inches thick.

The B11g horizon is gray (10YR 6/1 or 5/1) or dark gray (10YR 4/1) loam, silt loam, or fine sandy loam. The B12g horizon is light brownish gray (10YR 6/2), gray (10YR 5/1 or 5Y 5/1), or grayish brown (10YR 5/2) heavy sandy loam, heavy fine sandy loam, silt loam, or light silty clay loam.

The IIB2g horizon is gray (10YR 5/1 or 5Y 5/1) or grayish brown (10YR 5/2 or 2.5Y 5/2) light silty clay loam or silt loam and has thin strata 1/8 to 1/2 inch thick of silt, very fine sand, or fine sand.

The IIICg horizon is gray (10YR 5/1, 5Y 5/1, or N 5/0), light brownish gray (10YR 6/2), or brownish gray (10YR 5/2) silt loam and has thin strata of silt, very fine sand, or fine sand, or stratified silt and very fine sand. In some places thin strata of silt loam, silty clay loam, or very fine sandy loam are present.

Colwood soils are mostly near Kibbie soils. They have more predominant gray colors in the B horizon than Kibbie soils. Colwood soils are similar to the Parkhill and Lenawee soils. They have coarser textured material in the C horizon than Parkhill soils, and they have stratified material throughout the solum. They have a coarser textured and thicker A horizon than Lenawee soils.

Co—Colwood loam. This stratified soil is in depressions and narrow drainageways. Slopes are 0 to 2 percent. Areas are round, oval, or long and narrow, or they are irregular in shape. They are commonly about 5 to 40 acres in size, but they range from 2 to 200 acres. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of poorly drained and very poorly drained Parkhill loam and small areas of soils that are similar to Metamora soils but are poorly drained. These soils are low, islandlike mounds or are narrow strips along boundaries where this soil is adjacent to till plains. Also included are a few small areas of very poorly drained Gilford sandy loam and poorly drained and very poorly drained Sebewa loam; a few small areas where the soil is calcareous at or near the surface; and some small areas that have a surface layer of mucky fine sandy loam or muck 10 to 16 inches thick.

Runoff is very slow or ponded, and the hazard of erosion is slight.

Most areas of this soil are used for crops. This soil is well suited to farming if excess water is removed. The main concern in management is removing excess water. Capability unit IIw-2 (2.5c-s); woodland suitability group 3w1; woody plant group 5.

Cp—Colwood loam, depressional. This soil is in depressional areas. The areas are generally small in size and irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is 5 to 10 inches thicker.

Included with this soil in mapping are small areas where the loam surface layer is underlain by organic material and many small areas of Parkhill, Sebewa, and Kibbie soils. Also included are small areas of soils that are similar to the Houghton soils but have a loamy surface layer and subsoil that extends to a depth of as much as 30 inches.

Runoff is ponded; it is from the surrounding uplands.

Most areas of this soil are idle. Some areas are wooded or brushy. Some areas are suitable for pond sites. The main concern in management is removing excess water; many areas do not have natural outlets. Capability unit Vw-1 (L-2c); woodland suitability group 3w1; woody plant group 5.

Edwards Series

The Edwards series consists of very poorly drained, nearly level organic soils. These soils are in swamps, along waterways, and in depressions on the till plains and moraines. The organic layers are about 35 inches thick and are underlain by marl.

In a representative profile the surface layer is black muck about 8 inches thick. Below this is 8 inches of dark reddish brown muck and 19 inches of very dark gray, very friable muck. The underlying material, at a depth of 35 inches, is calcareous light brownish gray marl.

Runoff is very slow or ponded. Permeability is rapid in the muck and variable in the marl. Available water capacity is very high.

Edwards soils are generally poorly suited to farming. If these soils are cultivated, soil blowing and frost are hazards. Most areas are idle, are in pasture, or are in native vegetation. Some areas are used for crops or for commercial sod production.

Representative profile of Edwards muck, in a cultivated field, 1,450 feet south and 50 feet west of the center sec. 31, T. 4 N., R. 3 W.:

Oa1—0 to 8 inches; black (5YR 2/1, broken face and rubbed) sapric material; less than 5 percent fiber, trace rubbed; weak fine granular structure; very friable, mainly herbaceous fibers; neutral; abrupt smooth boundary.

Oa2—8 to 16 inches; dark reddish brown (5YR 2/2, broken face and rubbed) sapric material; about 10 percent fiber, less than 5 percent rubbed; massive; mainly herbaceous fibers; neutral; abrupt smooth boundary.

Oa3—16 to 35 inches; very dark gray (5YR 3/1, broken face) and black (5YR 2/1, rubbed) sapric material; about 10 percent fiber, less than 5 percent rubbed; weak thin platy structure; very friable; mainly herbaceous fibers, few woody fibers and coarse woody fragments; mildly alkaline; abrupt smooth boundary.

IILca—35 to 60 inches; light brownish gray (10YR 6/2) marl; massive; slightly sticky; high ash content; many shells; very low density; strong effervescence; moderately alkaline.

Depth to the IILca horizon is typically 19 to 43 inches, but it ranges from 16 to 49 inches. The fiber in the organic part of the profile is mainly from well decomposed, herbaceous plants. Thin layers of hemic material are in some places, but they have a combined thickness of less than 10 inches in the bottom tiers. Coarse woody fragments 1 inch to 8 inches in diameter make up as much as 20 percent, by volume, of the organic material. Reaction throughout the organic material is typically neutral or mildly alkaline. Snail shells and free carbonates commonly are in the organic layers immediately above the marl, and in some places they are throughout the profile.

The surface tier has hue of 10YR, 5YR, or N, value of 2, and chroma of 0, 1, or 2 on broken faces and when rubbed. It is typically less than 8 percent fiber when rubbed.

The organic part of the subsurface and bottom tiers has hue of 5YR or 10YR, value of 2 or 3, and chroma of 1 or 2 on broken faces and when rubbed.

The IILca horizon has hue of 10YR, 5YR, or 5Y, value of 5 to 7, and chroma of 1 or 2. Some layers in the upper part of the marl are 10 to 20 percent snail shells and 5 to 20 percent silt and clay. Reaction is mildly alkaline or moderately alkaline.

Edwards soils formed in similar organic deposits as Adrian, Palms, and Houghton soils. Edwards soils have marl below the organic material, whereas Adrian soils have sand and loamy sand and Palms soils have loamy material. They have a thinner organic layer than Houghton soils.

Ed—Edwards muck. This soil is in depressional areas on plains and in hilly areas. Slopes are 0 to 2 percent. Areas are irregular in shape. They range from 2 to 100 acres in size.

Included with this soil in mapping are areas of very poorly drained Palms muck and Adrian muck; a few small areas of very poorly drained Gilford sandy loam and poorly drained and very poorly drained Colwood loam; and, where this soil is adjacent to areas of mineral soils, small areas of very poorly drained Houghton muck. Also included are a few small areas of soils in which the depth to marl is less than 16 inches.

Some areas of this soil are used for crops. Other areas are idle or are in woodland. If adequately drained, fertilized, and protected from wind, this soil is suited to corn, potatoes, onions, radishes, and commercial sod production. The main concerns in management are removing excess water and controlling soil blowing. Capability unit IVw-2 (M/mc); woodland suitability group 4w2; woody plant group 1.

Gilford Series

The Gilford series consists of very poorly drained, nearly level soils in depressions on outwash plains and along glacial drainage channels. These soils formed in loamy material underlain by calcareous coarse sand.

In a representative profile the surface layer is black sandy loam about 11 inches thick. The subsurface layer is a very dark gray sandy loam about 2 inches thick. The subsoil is about 20 inches thick. The upper 8 inches is gray, friable, mottled sandy loam, the next 5 inches is gray, firm, mottled light sandy clay loam, and the lower 7 inches is gray, friable, mottled coarse sandy loam. The underlying material, at a depth of 33 inches, is gray calcareous coarse sand.

Runoff is very slow or ponded. Permeability is moderately rapid, and available water capacity is low.

Gilford soils are moderately well suited to farming. The smaller areas are in pasture or are idle. These soils have a high water table, so artificial drainage is needed.

Representative profile of Gilford sandy loam, in an idle cultivated field, 300 feet north and 2,440 feet west of southeast corner sec. 9, T. 3 N., R. 3 W.:

Ap—0 to 11 inches; black (10YR 2/1) sandy loam; moderate medium granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

A12—11 to 13 inches; very dark gray (10YR 3/1) sandy loam; moderate medium granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

B21g—13 to 21 inches, gray (10YR 5/1) sandy loam; common fine and medium distinct dark gray (10YR 4/1), light olive brown (2.5YR 5/6), and olive brown (2.5YR 4/4) mottles; weak medium subangular blocky structure; friable; very dark grayish brown (10YR 3/2) worm casts and fillings in old root channels; common roots; 1 percent pebbles; slightly acid; clear wavy boundary.

B22g—21 to 26 inches; gray (10YR 5/1) light sandy clay loam; common medium distinct light olive brown (2.5YR 5/6) mottles and few fine distinct olive brown (2.5YR 4/4) and yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; firm; few thin discontinuous clay films on a few faces of peds; 6 percent pebbles; slightly acid; clear wavy boundary.

B23g—26 to 33 inches; gray (10YR 5/1) coarse sandy loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; friable; few fine roots; about 10 percent pebbles and less than 1 percent cobbles; neutral; abrupt irregular boundary.

IICg—33 to 60 inches; gray (10YR 5/1) coarse sand; few fine distinct yellowish brown (10YR 5/6) and olive brown (2.5YR 4/4) mottles; single grained; loose; about 15 percent pebbles and 1 percent cobbles; strong effervescence; mildly alkaline.

The solum is dominantly 28 to 40 inches in thickness, but it ranges from 24 to 44 inches.

The A horizon is sandy loam, heavy loamy sand, or fine sandy loam. The Ap horizon is black (10YR 2/1), very dark brown (10YR 2/2), or very dark gray (10YR 3/1). The A12 horizon, where present, is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2).

The Bg horizon is gray (10YR 5/1) or grayish brown (10YR 5/2) sandy loam, light sandy clay loam, or coarse sandy loam. It averages less than 18 percent clay.

The IICg horizon is gray (10YR 5/1 or 6/1) or grayish brown (10YR 5/2).

Gilford soils are similar to Colwood and Cohoctah soils. They have calcareous coarse sand below the B horizon, whereas Colwood soils have stratified layers of silt loam, fine sand, and very fine sand. They have more gravel in the profile than Cohoctah soils, and the organic-matter content decreases regularly as depth increases.

Gf—Gilford sandy loam. This soil is on plains and in drainageways. Areas are round, oval, or long and narrow, or they are irregular in shape. They are commonly 5 to 30 acres in size, but range from 2 acres to about 80 acres.

Included with this soil in mapping are some small areas of poorly drained and very poorly drained Colwood loam and Sebewa loam in some lower depressional areas or randomly on positions and elevations similar to those of this Gilford soil. Also included are small areas of somewhat poorly drained Wasepi sandy loam and Brady sandy loam, mostly along the soil boundaries where these areas join uplands. Along the soil boundaries where this soil joins areas of organic soils, there are a few small spots and narrow strips of soils that have a surface layer of mucky sandy loam or muck.

Runoff is very slow or ponded, and the hazard of erosion is slight.

Many areas of this soil are used for crops. Other areas are in woodland or are idle. If adequately drained and fertilized, this soil is moderately suited to farming. The main concerns in management are removing excess water and improving fertility. Capability unit IIIw-2 (4c); woodland suitability group 3w1; woody plant group 5.

Hillsdale Series

The Hillsdale series consists of well drained, gently sloping to gently rolling soils on till plains and moraines. These soils formed in sandy loam that has been deeply leached.

In a representative profile the surface layer is dark grayish brown sandy loam about 9 inches thick. The subsoil extends to a depth of 60 inches. The upper 4 inches is yellowish brown, very friable sandy loam, and the next 9 inches is strong brown, friable sandy loam. Below this, the subsoil is brown and dark brown, friable fine sandy loam.

Runoff is slow to rapid, depending on the slope. Permeability is moderate, and available water capacity is moderate.

Hillsdale soils are well suited to farming in the gently sloping areas and moderately well suited in the strongly sloping areas. Erosion is the main hazard. Rapid runoff impedes infiltration and causes a surface crust to form. These soils tend to be droughty during dry weather. Most of the less sloping areas are in crops or pasture. Many of the steeper areas are wooded.

Representative profile of Hillsdale sandy loam, 6 to 12 percent slopes, in a cultivated field, 1,300 feet north and 700 feet east of southwest corner sec. 34, T. 1 N., R. 5 W.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; cloddy to moderate medium and coarse granular structure; friable; many fine and medium roots; 6 percent pebbles and cobbles; strongly acid; abrupt smooth boundary.

A&B—9 to 13 inches; yellowish brown (10YR 5/6) sandy loam (B part); yellowish brown (10YR 5/4) loamy sand (A part), white (10YR 8/2) dry; coatings (A part) on surfaces of peds and along root and worm channels and extending through the horizon; coatings make up more than 15 percent, by volume, of the horizon and are typically more than 2 millimeters thick on vertical faces between abutting peds; moderate fine and medium subangular blocky structure (A and B parts); very friable (A and B parts); common fine and medium roots; few dark brown (7.5YR 4/4) clay films on surfaces of blocky peds; 6 percent pebbles and cobbles; medium acid; clear wavy boundary.

B&A—13 to 22 inches; strong brown (7.5YR 5/6) sandy loam (B part) and white (10YR 8/2) dry loamy sand (A part) coatings on surface of peds and along root and worm channels; blocky peds have white (10YR 8/2) dry material that is typically more than 2 millimeters thick (more than 15 percent by volume) on vertical faces between abutting peds; vertical extension is through the horizon; moderate fine and medium angular and subangular blocky structure (A and B parts); friable (A and B parts); common fine and medium roots; many, reddish brown (5YR 4/3) clay films on surfaces of peds; 6 percent pebbles and cobbles; very strongly acid; clear broken boundary.

B21t—22 to 33 inches; brown (7.5YR 5/4) fine sandy loam; moderate fine and medium angular and subangular blocky structure; friable; common to few fine and medium roots; many reddish brown (5YR 4/3) clay films on surfaces of peds; 6 percent pebbles and cobbles; very strongly acid; diffuse smooth boundary.

B22t—33 to 50 inches; dark brown (7.5YR 4/4) fine sandy loam; moderate fine to very coarse subangular blocky structure; friable; many dark brown (7.5YR 4/4) clay films on surface of peds and pinkish white (7.5YR 8/2) dry skeletans less than 2 millimeters thick; 6 percent pebbles and cobbles; very strongly acid; diffuse smooth boundary.

B23t—50 to 60 inches; brown (7.5YR 5/4) fine sandy loam; weak fine to very coarse subangular blocky structure; friable; many dark brown (7.5YR 4/4) clay films on surfaces of peds; 6 percent pebbles and cobbles; strongly acid.

The solum is 40 inches to more than 80 inches in thickness. It is very strongly acid to slightly acid in the upper part and medium acid or slightly acid in the lower part. It is about 1 to 15 percent pebbles and less than 1 percent to about 4 percent cobbles. In a few places it is about 1 percent stones.

The Ap horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3) sandy loam, fine sandy loam, or heavy loamy sand.

The A&B and the B&A horizons occur in most profiles. Where they are present, the A part is brown (10YR 5/3) or yellowish brown (10YR 5/4) when moist and white (10YR 8/2) when dry loamy fine sand or light sandy loam, and the B part is yellowish brown (10YR 5/6) or strong brown (7.5YR 5/6) fine sandy loam or sandy loam.

The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. The B23t horizon is absent in some profiles. The Bt horizon averages less than 18 percent clay, but in some profiles the clay content in a single subhorizon is as high as 21 percent. The B horizon ranges from sandy loam to light sandy clay loam, but the B3 horizon, where present, is light sandy loam or loamy sand.

The C horizon, where present, is sandy loam, fine sandy loam, and light sandy loam.

These soils are more acid than defined in the range for the series, and they have interfingering of the A horizon into the B horizon, which is not defined in the range for the series. These differences do not affect use and management.

Hillsdale soils are similar to Marlette and Oshtemo soils. They have coarser textures in the B and C horizons than Marlette soils. They have fine sandy loam in the C horizon, whereas Oshtemo soils have coarse sand.

HaB—Hillsdale sandy loam, 2 to 6 percent slopes. This soil is on plains and low knolls. Areas are mostly elongated, or they are irregular in shape. They range from about 5 to 160 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thicker.

Included with this soil in mapping are a few areas of moderately well drained and somewhat poorly drained sandy loam soils that are similar to Hillsdale soils. These wetter soils are in slight depressions, in drainageways, and along the foot slopes or lower elevations of the mapped areas. Also included are small areas of well drained Owosso sandy loam, Oshtemo sandy loam, Spinks loamy sand, and Marlette loam; a few small areas that have short, steeper slopes and are shown on the map by a spot symbol; and small areas of soils that are similar to this Hillsdale soil but have more clay in the lower part of the subsoil.

Runoff is slow, and the hazard of erosion is moderate. During prolonged periods of dry weather this soil tends to be droughty.

Most areas of this soil are used for crops. A few areas are in woodland. The main concern in management is controlling erosion. Capability unit IIe-2 (3a); woodland suitability group 2o2; woody plant group 4.

HaC—Hillsdale sandy loam, 6 to 12 percent slopes. This soil is on side slopes and on knolls or low hills. Areas are mostly elongated, or they are irregular in shape. They range from 3 acres to about 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping, mostly along the boundaries of mapped areas where this soil joins large plains, are a few small areas of well drained Spinks loamy sand and small areas of well drained Owosso sandy loam and Marlette loam. Also included are some small, flatter areas on the tops of knolls or ridges; a few small areas at several elevations from the top to the bottom of slopes in Walton Township where this Hillsdale soil is interbedded with strata of heavy silty clay loam 2 to 3 feet thick; and small areas of soils that are similar to this Hillsdale soil but have more clay in the lower part of the subsoil.

Runoff is medium to rapid, and the hazard of erosion is moderate to severe. During prolonged periods of dry weather, this soil tends to be droughty.

Most areas of this soil are used for crops. Some areas are idle; some are in pasture, and some are in woodland. This soil is moderately suited to farming if erosion is controlled. The main concern in management is controlling erosion. Capability unit IIIe-2 (3a); woodland suitability group 2o2; woody plant group 4.

Houghton Series

The Houghton series consists of very poorly drained, nearly level organic soils. These soils are in swamps, along waterways, and in depressions on the flood plains, outwash plains, till plains, and moraines. The organic material extends to a depth of more than 49 inches.

In a representative profile the surface layer is black muck about 9 inches thick. Below this is 7 inches of black muck, 18 inches of dark reddish brown muck, 15 inches of very dark gray muck, and 11 inches of dark reddish brown muck.

Runoff is very slow, and the soils are ponded most of the time. Permeability is rapid, and available water capacity is very high.

Houghton soils are generally poorly suited to farming because of ponding, the high water table, and the low supply of phosphorus and potassium. If these soils are artificially drained and left with no plant cover, soil blowing is a hazard. Crops are often damaged by frost because these soils are on the lowest positions in the landscape. Some areas, because of their small size or because they lack adequate drainage outlets, are in permanent pasture or are idle.

Representative profile of Houghton muck, in a commercial sod field, 600 feet south and 200 feet west of northeast corner sec. 1, T. 3 N., R. 4 W.:

Oa1—0 to 9 inches; black (10YR 2/1) sapric material, black (5YR 2/1) rubbed and pressed; about 2 percent fiber; moderate medium granular structure; very friable; about 70 percent herbaceous fibers, and 30 percent woody; about 2 percent coarse woody fragments; neutral; abrupt smooth boundary.

Oa2—9 to 16 inches; black (5YR 2/1, broken face, rubbed, and pressed) sapric material; about 5 percent fiber; weak thick platy structure; friable; few fine live roots; about 70 percent herbaceous fibers and 30 percent woody; about 10 percent coarse woody fragments; neutral; abrupt smooth boundary.

Oa3—16 to 21 inches; dark reddish brown (5YR 3/2) sapric material, dark reddish brown (5YR 2/2) rubbed and pressed; about 12 percent fiber, 5 percent rubbed; weak thick platy structure; very friable; about 80 percent herbaceous fibers and 20 percent woody; about 2 percent coarse woody fragments; neutral; abrupt smooth boundary.

Oa4—21 to 34 inches; dark reddish brown (5YR 3/2) sapric material, dark reddish brown (5YR 2/2) rubbed and pressed; about 25 percent fiber, 8 percent rubbed; massive; nonsticky; mainly herbaceous fibers and less than 20 percent woody; neutral; abrupt smooth boundary.

Oa5—34 to 49 inches; very dark gray (5YR 3/1) sapric material, black (5YR 2/1) rubbed, and dark reddish brown (5YR 2/2) pressed; about 18 percent fiber, 5 percent rubbed; massive; nonsticky; mainly herbaceous fibers and some woody; neutral; abrupt smooth boundary.

Oa6—49 to 60 inches; dark reddish brown (5YR 3/3) sapric material, dark reddish brown (5YR 2/2) rubbed and pressed; about 10 percent fibers, less than 5 percent herbaceous fibers and some woody; neutral.

The organic material is more than 50 inches in thickness. Typically, it ranges from 5 to 20 feet in thickness, but a few deposits are as much as 48 feet or more. The organic material is mainly herbaceous and is sapric. In some places coarse woody fragments 1 inch to 8 inches in diameter are mixed throughout the upper 51 inches of the profile; they make up as much as 20 percent, by volume, of the organic material. Thin layers of hemic material are in some places, but they have a combined thickness of less than 10 inches in the bottom tiers. The organic material is medium acid to neutral throughout, but it ranges to mildly alkaline in the bottom tier.

The surface tier has hue of 10YR, 5YR, or N, value of 2, and chroma of 0, 1, or 2 on broken faces and when rubbed. It is less than 5 percent fiber when rubbed.

The subsurface and bottom tiers have hue of 5YR or 10YR, value of 2 or 3, and chroma of 1 to 4 on broken faces and when rubbed.

Houghton soils formed in similar organic deposits as Adrian, Edwards, and Palms soils. Houghton soils have thicker organic deposits than these soils. The Houghton soils are mostly near Cohoctah soils. They have organic horizons, whereas Cohoctah soils have mineral horizons.

Ho—Houghton muck. This nearly level, organic soil is in small, slightly concave depressions in hilly areas and in large areas at lower elevations on plains. The smaller areas are commonly rounded or oval, and the larger areas are long and narrow, rounded, oval, or irregular in shape. The areas range from 2 acres to about 300 acres in size.

Included with this soil in mapping are small areas of Palms, Adrian, and Edwards soils and a few small areas of Parkhill, Colwood, Cohoctah, Gilford, and Sebewa soils in small islandlike spots and narrow strips along the boundaries of the mapped areas. Also included are small areas that have mineral material on the surface. These areas are most commonly where Houghton soils are on flood plains or in depressions and receive runoff from sloping upland mineral soils.

Runoff is ponded. The hazard of soil blowing is severe. Frost is a hazard, and this soil has a low content of phosphorus, potassium, and some micronutrients.

Some areas of this soil are used for crops, and many are either idle or are in natural vegetation. If adequately drained and fertilized, and if soil blowing is controlled, this soil is suited to corn, soybeans, onions, potatoes, and commercial sod. The main concerns in management are removing excess water and controlling soil blowing. Capability unit IIIw-4 (Mc) ; woodland suitability group 4w2; woody plant group 1.

Kibbie Series

The Kibbie series consists of somewhat poorly drained, nearly level to very gently sloping soils on lake plains and glacial drainageways. These soils formed in loamy material and in water laid deposits of fine sand, very fine sand, and silt.

In a representative profile the surface layer is very dark grayish brown fine sandy loam about 9 inches thick. The subsoil is about 21 inches thick. The upper part is brown, firm, mottled heavy loam, and the lower part is dark yellowish brown, firm, mottled loam. The underlying material, at a depth of 30 inches, is yellowish brown stratified silt loam that has thin lenses of loamy fine sand and very fine sand.

Runoff is slow. Permeability is moderate, and available water capacity is high.

If Kibbie soils are drained, they are well suited to farming. The main limitation is the seasonal high water table. Most of the larger areas are in crops, and many of the smaller areas are in permanent pasture or are idle.

Representative profile of Kibbie fine sandy loam, 0 to 3 percent slopes, in a cultivated field, 1,100 feet south and 300 feet east of northwest corner sec. 32, T. 1 N., R. 3 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) fine sandy loam, gray (10YR 5/1) dry; moderate medium granular structure; very friable; many roots; slightly acid; abrupt smooth boundary.

B21t—9 to 19 inches; brown (10YR 5/3) heavy loam; common medium distinct gray (10YR 5/1), grayish brown (10YR 5/2), and yellowish brown (10YR 5/4 and 5/6) mottles; moderate medium subangular blocky structure; firm; common roots; thin discontinuous dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) clay films on faces of peds; few very dark grayish brown (10YR 3/2) worm casts and fillings in vertical cracks; neutral; clear wavy boundary.

B22t—19 to 30 inches; dark yellowish brown (10YR 4/4) loam; common medium distinct gray (10YR 5/1) and yellowish brown (10YR 5/6 and 5/8) mottles and few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin discontinuous dark grayish brown (10YR 4/2) clay films on faces of peds; few roots; about 1 percent gravel; few very dark grayish brown (10YR 3/2) worm casts; neutral; abrupt wavy boundary.

IIC—30 to 60 inches; yellowish brown (10YR 5/4) stratified silt loam alternating with thin lenses of loamy fine sand and very fine sand; common medium distinct grayish brown (10YR 5/2) mottles and few fine distinct gray (10YR 5/1) and yellowish brown (10YR 5/6 and 5/8) mottles; massive; very friable; strong effervescence; mildly alkaline.

The solum is typically 24 to 42 inches in thickness, but it is as much as 48 inches thick in a few profiles. It is slightly acid to neutral.

The Ap horizon is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1) silt loam, loam, fine sandy loam, or very fine sandy loam. When dry, it is dominantly gray (10YR 5/1) or grayish brown (10YR 5/2).

The B2t horizon is brown (10YR 5/3), dark yellowish brown (10YR 4/4), or pale brown (10YR 6/3) heavy loam, heavy silt loam, loam, silt loam, or light silty clay loam.

The IIC horizon is yellowish brown (10YR 5/4), brown (10YR 5/3), or grayish brown (10YR 5/2).

Kibbie soils are mostly near Colwood and Tuscola soils. They lack the predominant gray colors in the B horizon typical of Colwood soils. They have more predominant dark grayish brown colors on faces of peds immediately below the Ap horizon than Tuscola soils.

KbA—Kibbie fine sandy loam, 0 to 3 percent slopes. This soil is on plains. It occurs on small convex mounds, in slightly concave depressions, and on very gently sloping, benchlike terraces on old glacial channels and lakebeds. Areas are generally round, oval, or irregular in shape. They range from 2 acres to about 60 acres in size.

Included with this soil in mapping are a few small areas of somewhat poorly drained stratified soils that have a coarser textured subsoil than this Kibbie soil; small areas where this soil is underlain at a depth of 30 to 45 inches by sandy material and gravel; and small areas of poorly drained Colwood loam, generally in small depressions and narrow drainageways. Also included are some small areas of somewhat poorly drained Matherton loam, Capac loam, and Metamora sandy loam and areas of moderately well drained Tuscola fine sandy loam.

Runoff is slow, and the hazard of erosion is slight.

Most areas of this soil are used for farming. A few areas are in woodland. If this soil is adequately drained, it is well suited to farming. The main concern in management is removing excess water. Capability unit IIw-2 (2.5b-s); woodland suitability group 2o4; woody plant group 2.

Lenawee Series

The Lenawee series consists of poorly drained and very poorly drained soils on lake plains and on till plains that were inundated by shallow lake waters. These soils formed in loamy material containing thin lenses of silt loam, silt, and fine sand.

In a representative profile the surface layer is very dark gray silty clay loam about 9 inches thick. The subsoil is about 21 inches thick. The upper 7 inches is dark gray very firm, mottled heavy silty clay loam, the next 9 inches is gray, very firm, mottled heavy silty clay loam, and the lower 5 inches is gray, firm, mottled silty clay loam. The underlying material, at a depth of 30 inches, is calcareous, gray silty clay loam that has thin lenses of fine sand and very fine sand.

Runoff is very slow or ponded. Permeability is moderately slow, and available water capacity is high.

Lenawee soils are poorly suited to farming because they have a high water table, and they are difficult to drain and to keep in good tilth. Most areas are idle because they are small or lack adequate drainage outlets.

Representative profile of Lenawee silty clay loam, depressional, in a cultivated field, 100 feet south and 100 feet east of center sec. 33, T. 2 N., R. 6 W.:

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate fine angular blocky structure; friable; many roots; slightly acid; abrupt smooth boundary.

B21g—9 to 16 inches; dark gray (5Y 4/1) heavy silty clay loam; few coarse distinct dark yellowish brown (10YR 4/4) mottles; moderate coarse angular blocky structure; very firm; common roots; neutral; clear wavy boundary.

B22g—16 to 25 inches; gray (5Y 5/1) heavy silty clay loam; many medium distinct light olive brown (2.5Y 5/4) mottles and common coarse distinct yellowish brown (10YR 5/8) mottles; moderate coarse angular blocky structure; very firm; few roots; neutral; gradual wavy boundary.

B23g—25 to 30 inches; gray (5Y 6/1) silty clay loam; many coarse distinct dark yellowish brown (10YR 4/4) mottles; moderate coarse angular blocky structure; firm; few roots; mildly alkaline; gradual wavy boundary.

Cg—30 to 60 inches; gray (5Y 6/1) silty clay loam; thin lenses of very fine sand and fine sand; many medium distinct olive (5Y 5/3) and olive brown (2.5Y 4/4) mottles; massive; strong effervescence; mildly alkaline.

The solum is typically 26 to 36 inches in thickness, but it ranges from 25 to 42 inches. It is slightly acid to mildly alkaline, and it becomes less acid as depth increases.

The Ap horizon is very dark gray (10YR 3/1), black (10YR 2/1), or very dark brown (10YR 2/2) light silty clay loam or silty clay loam.

The B horizon is gray (10YR 5/1, 5Y 6/1, or 5Y 5/1), dark yellowish brown (10YR 4/4), or dark gray (5Y 4/1) silty clay loam, heavy silty clay loam, and light silty clay that has thin strata of silt, very fine sand, or clay. Between depths of 10 and 40 inches it is about 35 to 42 percent clay.

The C horizon is grayish brown (10YR 5/2) or gray (10YR 5/1, 5Y 6/1, or 5Y 5/1) stratified silty clay loam and thin lenses and layers of silt, silt loam, fine sand, very fine sand, or silty clay.

Lenawee soils are similar to Parkhill and Colwood soils. They are finer textured throughout the profile than Parkhill or Colwood soils and have a thinner A horizon than Colwood soils.

Le—Lenawee silty clay loam, depressional. This soil is in slightly concave depressional areas. Slopes are 0 to 2 percent. Areas are generally round or irregular in shape, and are 5 to 40 acres in size.

Included with this soil in mapping are small areas where the subsoil is dominantly clay and silty clay and a few small areas of poorly drained and very poorly drained Colwood loam.

Runoff is very slow to ponded, and the hazard of erosion is slight. Many areas of the soil are subject to flooding by runoff from the adjoining uplands. Drainage is hindered by the lack of good drainage outlets.

Most areas of this soil have been cleared for farming, but most are idle. The main concern in management is removing excess water. Capability unit Vw-1 (1.5c); woodland suitability group 2w1; woody plant group 5.

Marlette Series

The Marlette series consists of well drained and moderately well drained, gently sloping to steep soils on till plains and moraines. These soils formed in calcareous loam glacial till.

In a representative profile the surface layer is dark grayish brown loam about 9 inches thick. The subsoil, about 29 inches thick, is dark brown, firm clay loam. The underlying material, beginning at a depth of 38 inches, is calcareous brown loam.

Runoff is medium in the less sloping areas and rapid and very rapid in the more steeply sloping areas. Permeability is moderate or moderately slow, and available water capacity is high.

The less sloping areas of Marlette soils are well suited or moderately well suited to farming, and most of these areas are in crops. The more steeply sloping areas are poorly suited to farming, because rapid runoff and erosion are hazards. Some of these areas are wooded or are in permanent pasture.

Representative profile of Marlette loam, 2 to 6 percent slopes, in an idle field, 382 feet north and 250 feet east of center sec. 15, T. 3 N., R. 5 W.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam; weak medium granular structure; friable; many roots; 5 percent pebbles and cobbles; neutral; abrupt smooth boundary.

B&A—9 to 17 inches; dark brown (7.5YR 4/4) clay loam (B part); brown (10YR 5/3) loam (A part), light gray (10YR 7/1) dry coatings (A part) on surfaces of peds and along root and worm channels and extending through the horizon; coatings make up more than 15 percent, by volume, of the horizon and are typically more than 2 millimeters thick and some are 5 to 10 millimeters thick on vertical faces between abutting peds; weak medium prismatic structure separating to weak medium angular blocky (A and B parts); firm (B part); very friable (A part); common fine roots; continuous thin dark brown (7.5YR 4/2) clay films on surfaces of blocky peds; 5 percent pebbles and cobbles; slightly acid; clear wavy boundary.

B21t—17 to 26 inches; dark brown (7.5YR 4/4) clay loam; weak medium prismatic structure separating to moderate coarse angular blocky; firm; common fine roots; many discontinuous moderately thick reddish brown (5YR 4/3) clay films on surfaces of prismatic and blocky peds; 5 percent pebbles and cobbles; medium acid; gradual wavy boundary.

B22t—26 to 34 inches; dark brown (7.5YR 4/4) clay loam; weak coarse angular blocky structure; firm; few very fine roots; continuous moderately thick reddish brown (5YR 4/3) clay films on all surfaces of blocky peds; 5 percent pebbles and cobbles; medium acid; gradual wavy boundary.

B23t—34 to 38 inches; dark brown (7.5YR 4/4) clay loam; weak coarse angular blocky structure; firm; few very fine roots; few discontinuous moderately thick and thin reddish brown (5YR 4/3) clay films on surfaces of peds and on surfaces of root channels and vertical cracks; 5 percent pebbles and cobbles; slightly acid; clear wavy boundary.

C—38 to 60 inches; brown (10YR 5/3) loam; massive; friable; 10 percent pebbles and cobbles; slight effervescence; mildly alkaline.

The solum is typically 30 to 38 inches in thickness, but it ranges from 24 to 42 inches. It is dominantly medium acid or slightly acid in the upper part and slightly acid or neutral in the lower part. The solum and C horizon are 0 to about 8 percent coarse fragments throughout.

The Ap horizon is dark grayish brown (10YR 4/2) or dark brown (10YR 4/3) loam or fine sandy loam. The A2 horizon, where present, is brown (10YR 5/3), pale brown (10YR 6/3), or yellowish brown (10YR 5/4) loam.

The B&A horizon is brown (10YR 5/3) or yellowish brown (10YR 5/4) loam in the A part and dark yellowish brown (10YR 4/4), dark brown (10YR 4/3 or 7.5YR 4/4) heavy loam or clay loam in the B part. The B2t horizon is brown (7.5YR 5/4), dark brown (10YR 3/3 or 7.5YR 4/4), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4) heavy loam, light clay loam, or clay loam. The lower part of the B horizon is mottled in some places, but mottles of low chroma are lacking within the upper 10 inches of the B2t horizon.

The C horizon is loam, light clay loam, or heavy loam. It is mildly alkaline or moderately alkaline.

Marlette soils are mostly near Capac and Owosso soils. They lack the grayish brown mottles in the upper part of the B horizon typical of Capac soils. They have finer textured A and B horizons than Owosso soils. Marlette soils are similar to Hillsdale and Winnesheik soils. They have finer textures in the B and C horizons than Hillsdale soils. They lack the limestone bedrock at a depth of 20 to 40 inches of the Winneshiek soils.

MaB—Marlette loam, 2 to 6 percent slopes. This soil is on plains and low knolls. Areas are round or irregular in shape. Commonly, they are 3 acres to about 200 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of well drained Owosso sandy loam in places where there are deposits of sandy loam less than 40 inches thick; small areas of soils that are similar to Tuscola soils but are well drained; and some areas of somewhat poorly drained Capac soils in small depressions and narrow entrenched drainageways. Also included are a few small eroded spots of this Marlette soil where the surface layer is lighter colored and is largely material from the subsoil and small areas that have a fine textured subsoil, mainly in the northeast corner of Bellevue Township.

Runoff is medium, and the hazard of erosion is moderate.

Most areas of this soil are used for crops. A few areas are in woodland. If erosion is controlled, this soil is well suited to farming. The main concern in management is controlling erosion. Capability unit IIe–1 (2.5a); woodland suitability group 2o1; woody plant group 4.

MaC—Marlette loam, 6 to 12 percent slopes. This soil is on side slopes, knolls, and low hills. Areas are round, long and narrow, or irregular in shape. Commonly, they are 5 to 30 acres in size, but they range from 2 acres to about 120 acres. This soil has a profile similar to the one described as representative of the series, but the depth to the limy underlying loam is generally between 25 and 35 inches.

Included with this soil in mapping are small areas of well drained Owosso sandy loam, Hillsdale sandy loam, and Metea loamy sand; a few small areas that are wet; a few small areas that are strongly sloping and are shown on the soil map by a spot symbol; and, in cultivated areas, small severely eroded spots on steeper slopes on the upper parts and crests of knolls and hills. Also included are small areas of soils that are similar to Tuscola soils, but are well drained; a few small areas that have flatter slopes on the tops of knolls and hills, in the drainageways, and in the narrow valley in the rolling areas; and small areas, mainly in the northeast corner of Bellevue Township, where the subsoil is fine textured.

Runoff is medium to rapid, and the hazard of erosion is moderate to severe.

Most areas of this soil are used for crops. A few areas are in woodland. If erosion is controlled, this soil is moderately suited to farming. The main concern in management is controlling erosion. Capability unit IIIe–1 (2.5a); woodland suitability group 2o1; woody plant group 4.

MaD—Marlette loam, 12 to 18 percent slopes. This soil is on side slopes and hills. Areas are generally elongated. They range from 3 acres to about 80 acres in size. This soil has a profile similar to the one described as representative of the series, but depth to the limy underlying loam material is between 25 and 35 inches.

Included with this soil in mapping are small areas of well drained Hillsdale sandy loam and Owosso sandy loam; a few areas where this soil is underlain by sandy material, generally on the lower part of slopes where mapped areas border entrenched glacial drainage channels; and small areas of soils that are severely eroded. Also included are some small, less strongly sloping areas; a few areas that have steeper slopes and that are shown on the soil map by a spot symbol; and some areas of wetter soils in small depressions and drainageways.

Runoff is rapid, and the hazard of erosion is severe.

Some areas of this soil are used for crops, mainly small grain, hay, and pasture. Most other areas are in woodland or are idle. The main concern in management is controlling erosion. Capability unit IVe–1 (2.5a); woodland suitability group 2o1; woody plant group 4.

MaE—Marlette loam, 18 to 25 percent slopes. This soil is on side slopes. Areas range from 2 acres to about 10 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and the depth to the calcareous underlying material is less.

Included with this soil in mapping are areas of well drained Hillsdale sandy loam and Owosso sandy loam and small areas of well drained Boyer sandy loam and Oshtemo sandy loam that are underlain by gravelly sand. Also included are some areas of soils that are severely eroded or are gullied and have a very severe hazard of erosion and some areas where slopes are less than 18 percent.

Runoff is very rapid, and the hazard of erosion is very severe.

Most areas of this soil are idle or are in woodland or pasture. The main concerns in management are controlling erosion, improving soil tilth, and operating equipment on the steep slopes. Capability unit VIe-1 (2.5a); woodland suitability group 2r1; woody plant group 4.

MbC3—Marlette clay loam, 6 to 12 percent slopes, severely eroded. This soil is on side slopes in areas that have mostly plane slopes. Areas range from rounded to long and narrow, or they are irregular in shape. Commonly they are 2 acres to about 40 acres in size. This soil has a profile similar to the one described as representative of the series, but because of erosion the present surface layer is mainly material from the subsoil, and the depth to the limy underlying material is generally much less.

Included with this soil in mapping are small areas of well drained Hillsdale loam or Owosso loam. Also included are a few areas of gently sloping Marlette loam on the tops of knolls and along the lower parts of long slopes.

Runoff is medium to rapid, and the hazard of erosion is severe.

Almost all areas of these soils have been used for crops. Some areas are idle, and some are in pasture. The main concerns in management are improving soil tilth and controlling erosion. Capability unit IVe-3 (2.5a); woodland suitability group 2o1; woody plant group 4.

Matherton Series

The Matherton series consists of somewhat poorly drained, nearly level to very gently sloping soils on broad outwash plains and along glacial drainage channels. These soils formed in loamy material over calcareous sand.

In a representative profile the surface layer is very dark grayish brown loam about 9 inches thick. The subsurface layer is grayish brown loam about 2 inches thick. The subsoil is about 27 inches thick. The upper 13 inches is dark brown, firm, mottled light clay loam, the next 11 inches is dark brown, firm, mottled clay loam, and the lower 3 inches is brown, friable, mottled sandy loam. The underlying material, at a depth of 38 inches, is calcareous gray coarse sand.

Runoff is slow. Permeability is moderate, and available water capacity is moderate.

Matherton soils are well suited to farming if they are artificially drained. Many of the larger areas have been cleared and cultivated. Some of the smaller areas are in pasture or are idle.

Representative profile of Matherton loam, 0 to 3 percent slopes, in a cultivated field, 750 feet west and 100 feet south of center sec. 9, T. 2 N., R. 5 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; many roots; about 5 percent pebbles; slightly acid; abrupt smooth boundary.

A2—9 to 11 inches; grayish brown (10YR 5/2) loam; moderate medium granular structure; friable; common roots; about 1 percent pebbles; slightly acid; clear wavy boundary.

B21t—11 to 24 inches; dark brown (7.5YR 4/4) light clay loam; common fine and medium distinct, grayish brown (10YR 5/2) and yellowish brown (10YR 5/6 and 5/8) mottles; moderate medium subangular blocky structure; firm; common roots; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; about 4 percent pebbles; slightly acid; gradual wavy boundary.

B22t—24 to 35 inches; dark brown (7.5YR 4/4) clay loam; many medium distinct grayish brown (10YR 5/2) mottles and common fine and medium faint yellowish brown (10YR 5/6 and 5/8) mottles; moderate medium subangular blocky structure; firm; few fine roots; thin discontinuous dark grayish brown (10YR 4/2) clay films on face of peds; about 8 percent pebbles; neutral; clear wavy boundary.

B23—35 to 38 inches; brown (10YR 5/3) sandy loam; common medium distinct gray (10YR 5/1) and yellowish brown (10YR 5/6 and 5/8) mottles; weak coarse subangular blocky structure; friable; about 10 percent pebbles; neutral; abrupt wavy boundary.

IICg—38 to 60 inches; gray (10YR 5/1) coarse sand; single grained; loose; about 10 to 15 percent pebbles; strong effervescence; moderately alkaline.

The solum is typically 32 to 40 inches in thickness, but it ranges from 25 to 40 inches. It ranges from less than 1 percent to about 35 percent coarse fragments. It is medium acid to neutral.

The A horizon is loam, heavy sandy loam, or sandy loam. The Ap horizon is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1). The A2 horizon, where present, is grayish brown (10YR 5/2) or brown (10YR 5/3).

The B2t horizon is yellowish brown (10YR 5/4), dark brown (7.5YR 4/4 or 4/2 or 10YR 4/3), or dark yellowish brown (10YR 4/4) loam, heavy loam, light clay loam, clay loam, or sandy clay loam. The Bt horizon, where present, is brown (10YR 5/3 or 7.5YR 5/4), yellowish brown (10YR 5/6 or 5/8), or dark brown (10YR 4/3) sandy loam, heavy loamy sand, or light sandy clay loam.

The IIC horizon is gray (10YR 5/1), grayish brown (10YR 5/2), light brownish gray (10YR 6/2), or brown (10YR 5/3) sand, coarse sand, gravelly sand, gravelly coarse sand, or stratified combinations of these textures.

Matherton soils are in a toposequence with Bixby soils. They have grayish brown colors below the Ap horizon, which Bixby soils lack. Matherton soils are similar to Brady, Sebewa, and Shoals soils. They have finer textures in the B horizon than Brady soils, and they are shallower to the C horizon. They have a thinner A1 horizon than Sebewa soils, and they lack the predominant gray colors in the B horizon. Unlike Shoal soils, they have an organic-matter content that decreases regularly as depth increases.

MdA—Matherton loam, 0 to 3 percent slopes. This soil is on plains and in glacial drainage channels. Areas are generally elongated, or they are irregular in shape. Commonly, they are 10 to 60 acres in size, but they range from 4 acres to about 120 acres.

Included with this soil in mapping are small areas of somewhat poorly drained Wasepi sandy loam, Metamora sandy loam, Brady sandy loam, and Kibbie fine sandy loam, small areas of poorly drained and very poorly drained Sebewa loam and Colwood loam, and small areas of very poorly drained Gilford sandy loam. Also included are small areas of moderately well drained soils on the tops of rises, mounds, and gentle slopes bordering slightly entrenched drainageways.

Runoff is slow, and the hazard of erosion is slight.

Most areas of this soil have been used for crops. Many areas that have not been drained are in pasture or are idle. Some areas are in woodland. If adequately drained, this soil is well suited to farming. The main concern in management is removing excess water. Capability unit IIw-2 (3/5b); woodland suitability group 2o4; woody plant group 2.

Metamora Series

The Metamora series consists of somewhat poorly drained, nearly level to gently sloping soils on till plains and river terraces. These soils formed in 20 to 40 inches of loamy material and the underlying calcareous loam or clay loam glacial till. Metamora soils are mapped only in complex with Capac soils.

In a representative profile the surface layer is very dark grayish brown sandy loam about 9 inches thick. The subsurface layer is brown, mottled sandy loam 4 inches thick. The subsoil is about 30 inches thick. The upper 16 inches is dark yellowish brown, friable, mottled sandy loam, the next 6 inches is dark yellowish brown, firm, mottled light sandy clay loam, and the lower 8 inches is dark yellowish brown, firm, mottled clay loam. The underlying material, at a depth of 43 inches, is calcareous, firm brown loam.

Runoff is slow. Permeability is moderately rapid in the surface layer and upper part of the subsoil and moderately slow in the lower part of the subsoil and in the underlying material. Available water capacity is moderate.

Metamora soils are well suited to farming. A high water table, especially in spring, is the main limitation. If artificially drained, most areas can be used for crops. Some smaller areas that cannot be drained are in pasture or are idle.

Representative profile of Metamora sandy loam, in an area of Metamora-Capac sandy loams, 0 to 4 percent slopes, in a cultivated field, 300 feet west and 50 feet south of northeast corner sec. 3, T. 1 N., R. 6 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; many roots; about 1 percent pebbles; slightly acid; abrupt smooth boundary.

A2—9 to 13 inches; brown (10YR 5/3) sandy loam; common medium distinct grayish brown (10YR 5/2) mottles; weak medium granular strucure; friable; many roots; common very dark grayish brown (10YR 3/2) worm casts and fillings in old root channels; about 1 percent pebbles; slightly acid; clear wavy boundary.

B1—13 to 29 inches; dark yellowish brown (10YR 4/4) sandy loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles and few fine distinct gray (10YR 5/1) mottles; weak coarse subangular blocky structure; friable; many roots to a depth of 17 inches, few below; few very dark grayish brown (10YR 3/2) worm casts and fillings in old root channels; about 2 percent pebbles; slightly acid; clear wavy boundary.

IIB21t—29 to 35 inches; dark yellowish brown (10YR 4/4) light sandy clay loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; common thin discontinuous dark brown (7.5YR 4/2) clay films on surfaces of peds; about 7 percent pebbles; slightly acid; abrupt wavy boundary.

IIB22t—35 to 43 inches; dark yellowish brown (10YR 4/4) clay loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; few thin discontinuous dark grayish brown (10YR 4/2) clay films on surfaces of peds; about 2 percent pebbles and 1 percent cobbles; mildly alkaline; clear wavy boundary.

IIC—43 to 60 inches; brown (10YR 5/3) loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; massive; firm; about 2 percent pebbles and 1 percent cobbles; strong effervescence; mildly alkaline.

The solum is typically 24 to 38 inches in thickness, but it ranges from 20 to 45 inches. It is slightly acid to mildly alkaline.

The A horizon is sandy loam or fine sandy loam. The Ap horizon is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1). The A2 horizon is brown (10YR 5/3), grayish brown (10YR 5/2), or pale brown (10YR 6/3).

The B1 horizon is dark yellowish brown (10YR 4/4), dark brown (10YR 4/3), or brown (10YR 5/3) sandy loam or fine sandy loam.

The IIB2t horizon is dark yellowish brown (10YR 4/4) or dark brown (10YR 4/3) loam, light sandy clay loam, light clay loam, or clay loam.

The IIC horizon is brown (10YR 5/3) or grayish brown (10YR 5/2) loam or clay loam.

These soils lack the dominant gray colors in the upper part of the Bt horizon that are defined in the range for the series. This difference does not significantly influence use and management.

Metamora soils are mostly near Capac soils. They have coarser textures in the A and B horizons than Capac soils. Metamora soils are similar to the Owosso and Wasepi soils. They have mottles in the B horizon which Owosso soils lack. They have loamy material in the C horizon, which Wasepi soils lack.

MeA—Metamora-Capac sandy loams, 0 to 4 percent slopes. This complex is on plains. Areas are generally irregular in shape. They range from 3 acres to about 70 acres in size.

Metamora sandy loam makes up about 50 percent of this complex. It has the profile described as representative of the series. It is in the higher parts of the mapped areas.

Capac sandy loam makes up about 30 percent of the complex. It has a profile similar to the one described as representative of the series, but the surface layer is sandy loam instead of loam. It is in the lower parts of the mapped areas.

Included with this soil in mapping are a few small areas of poorly drained and very poorly drained Colwood loam and Parkhill loam in slight depressions and narrow drainageways and a few small areas of moderately well drained soils that have textures similar to those of Metamora and Capac soils on the tops of rises, on mounds, and on gentle slopes bordering drainageways or adjacent to the wetter soils. Also included are some small areas of soils that have loamy sand or sand layers in the surface layer and subsoil.

The hazard of erosion is slight.

Most areas of these soils are used for crops. A few areas are in woodland. If adequately drained, these soils are well suited to farming. The main concern in management is removing excess water. Capability unit IIw-3 (3/2b, 2.5b); woodland suitability group 2o4; woody plant group 2.

Metea Series

The Metea series consists of well drained, nearly level to sloping soils on moraines and plains. These soils formed in 20 to 40 inches of sandy glaciofluvial material and the underlying loamy glacial till. Metea soils are mapped only in complexes with Spinks soils.

In a representative profile the surface layer is dark grayish brown loamy sand about 9 inches thick. The subsurface layer is brown loamy sand 4 inches thick. The subsoil is about 30 inches thick. The upper 18 inches is light yellowish brown, very friable loamy sand, the next 4 inches is dark yellowish brown, firm loam, and the lower 8 inches is yellowish brown, firm light clay loam. The underlying material, at a depth of 43 inches, is calcareous yellowish brown loam.

Runoff is slow to rapid. Permeability is very rapid in the sandy upper part and moderately slow in the loamy lower part. Available water capacity is moderate.

Metea soils are moderately suited to farming. Most areas are idle, in permanent vegetation, or in woodland. A few areas are in crops. Droughtiness and erosion are the main concerns in management. Erosion is a hazard on the steeper slopes.

Representative profile of Metea loamy sand, in an area of Spinks-Metea loamy sands, 0 to 6 percent slopes, in a cultivated field, 1,270 feet west and 660 feet north of southeast corner sec. 25, T. 1 N., R. 6 W.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loamy sand; weak fine and medium granular structure; very friable; neutral; abrupt smooth boundary.

A2—9 to 13 inches; brown (10YR 5/3) loamy sand; weak fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.

B1—13 to 31 inches; light yellowish brown (10YR 6/4) loamy sand; weak fine subangular blocky structure; very friable; slightly acid; gradual wavy boundary.

IIB21t—31 to 35 inches; dark yellowish brown (10YR 4/4) loam; many brown (10YR 5/3) coatings on surfaces of peds, white (10YR 8/2) dry; weak fine and medium subangular blocky structure; firm; neutral; clear wavy boundary.

IIB22t—35 to 43 inches; yellowish brown (10YR 5/4) light clay loam; few brown (10YR 5/3) coatings on surfaces of peds, white (10YR 8/2) dry; moderate medium subangular blocky structure; firm; neutral; abrupt wavy boundary.

IIC—43 to 60 inches; yellowish brown (10YR 5/4) loam; massive; friable; strong effervescence; mildly alkaline.

The solum is 20 to 40 inches in thickness. It is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part.

The Ap horizon is dark grayish brown (10YR 4/2) or dark brown (10YR 3/3 and 4/3). The A2 horizon, where present, is brown (10YR 5/3) or pale brown (10YR 6/3) loamy sand or sand.

The B1 horizon is yellowish brown (10YR 5/4), pale brown (10YR 6/3), or light yellowish brown (10YR 6/4) loamy sand or sand.

The IIB21t horizon is yellowish brown (10YR 5/4), dark yellowish brown (10YR 4/4), or dark brown (10YR 4/3) heavy sandy loam, sandy loam, or loam. The IIB22t horizon is dark yellowish brown (10YR 4/4), dark brown (10YR 4/3), or yellowish brown (10YR 5/4) loam, light clay loam, silt loam, or light silty clay loam.

The IIC horizon is loam or silt loam.

Metea soils are similar to Owosso and Spinks soils. They have coarser textures in the A and B horizons than Owosso soils. They have loamy material below a depth of 20 to 40 inches, which Spinks soils lack.

Oshtemo Series

The Oshtemo series consists of well drained, nearly level to sloping soils on outwash plains, moraines, and glacial drainage channels. These soils formed in sandy loam underlain by calcareous coarse sand below a depth of 40 inches.

In a representative profile the surface layer is dark brown sandy loam about 9 inches thick. The subsurface layer is brown sandy loam 2 inches thick. The subsoil is about 40 inches thick. It is dark brown, friable sandy loam in the upper 35 inches and brown loose sand and thin bands of loamy sand in the lower 5 inches. The underlying material, at a depth of 51 inches, is calcareous brown coarse sand.

Runoff is slow to rapid. Permeability is moderately rapid, and available water capacity is moderate.

Oshtemo soils are moderately suited to farming. Some areas are in crops, but many areas are idle. Erosion on the steeper slopes and droughtiness are the main concerns in management.

Representative profile of Oshtemo sandy loam, 0 to 6 percent slopes, in a cultivated field, 200 feet east and 200 feet south of center sec. 15, T. 2 N., R. 4 W.:

Ap—0 to 9 inches; dark brown (10YR 3/3) sandy loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; very friable; few fine roots; about 2 percent pebbles and less than 1 percent cobbles; slightly acid; abrupt smooth boundary.

A2—9 to 11 inches; brown (10YR 5/3) sandy loam; moderate medium granular structure; very friable; few dark brown (10YR 3/3) worm casts; about 2 percent pebbles and less than 1 percent cobbles; slightly acid; clear wavy boundary.

B21t—11 to 17 inches; dark brown (7.5YR 4/4) sandy loam; weak coarse subangular blocky structure; friable; few thin discontinuous dark brown (7.5YR 4/2) and dark reddish brown (5YR 3/4) clay films on faces of peds and bridging sand grains; about 5 percent pebbles and less than 1 percent cobbles; medium acid; gradual wavy boundary.

B22t—17 to 38 inches; dark brown (7.5YR 4/4) sandy loam; weak coarse subangular blocky structure; friable; few thin patchy dark brown (7.5YR 4/2) clay films on faces of peds and bridging sand grains; about 3 percent pebbles and less than 1 percent cobbles; medium acid; gradual wavy boundary.

B23t—38 to 46 inches; dark brown (7.5YR 4/4) heavy sandy loam; moderate medium subangular blocky structure; friable; few thin discontinuous dark brown (7.5YR 4/4) and dark reddish brown (5YR 3/4) clay films on surfaces of peds and bridging sand grains; about 7 percent pebbles and less than 1 percent cobbles; slightly acid; abrupt wavy boundary.

IIB3—46 to 51 inches; brown (10YR 5/3) sand; single grained; loose; dark brown (7.5YR 4/4) loamy sand bands 1/4 to 1 inch thick and 12 to 36 inches long; massive; very friable; less than 1 percent pebbles and cobbles; neutral; abrupt irregular boundary.

IIC—51 to 60 inches; brown (10YR 5/3) coarse sand; single grained; loose; about 12 percent pebbles and less than 1 percent cobbles; strong effervescence; mildly alkaline.

The solum is typically more than 50 inches in thickness, but it ranges from 40 inches to more than 80 inches; thickness coincides with depth to carbonates. The solum is about 1 percent to 35 percent pebbles and 0 to 3 percent cobbles. It is strongly acid to slightly acid in the upper part and slightly acid or neutral in the lower part.

The A horizon is loamy sand or sandy loam. The Ap horizon is dark grayish brown (10YR 4/2) and dark brown (10YR 4/3 and 10YR 3/3). The A2 horizon is brown (10YR 5/3) and yellowish brown (10YR 5/4).

The Bt horizon is heavy loamy sand, sandy loam, heavy sandy loam, light sandy clay loam, or gravelly analogs of these textures. It averages less than 18 percent clay. The B2t horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5, and chroma of 4 to 6. The B23t horizon, where present, is dark brown (7.5YR 4/4) or reddish brown (5YR 5/4 or 4/4).

The IIB3 horizon consists of discontinuous alternating bands or lenses of brown (10YR 5/3) sand or coarse sand and dark brown (7.5YR 4/4) loamy sand or sandy loam. Typically, the sand bands range from ¼ inch to 8 inches in thickness. The loamy sand or sandy loam bands range from 1/16 inch to about 2 inches in thickness.

The IIC horizon is stratified fine sand, sand, coarse sand, gravelly sand, and gravelly coarse sand.

Oshtemo soils are mostly near Boyer and Spinks soils. They are deeper to the C horizon than Boyer soils. They have a finer texture throughout the solum than Spinks soils. Oshtemo soils are similar to the Hillsdale soils. They have coarse sand in the C horizon, whereas Hillsdale soils have fine sandy loam.

OsB—Oshtemo sandy loam, 0 to 6 percent slopes. This soil is on plains and low, beachlike terraces along glacial drainage channels. Areas are round to long and narrow, or they are irregular in shape. They are commonly 5 to 200 acres in size, but they range from 2 acres to about 600 acres. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of well drained Bixby loam and Boyer sandy loam and a few areas of moderately well drained Bronson sandy loam, in slightly concave depressions and narrow strips along the boundaries where the mapped areas adjoin lower areas of wetter soils. Also included in places are small areas of somewhat poorly drained Wasepi sandy loam and Brady sandy loam, mostly in the bottoms of the deeper, basinlike depressions and narrow drainageways of the larger, gently undulating areas.

Runoff is slow, and the hazard of erosion is slight.

Most areas of this soil are used for crops. A few areas are idle or are in pasture. The main concerns in management are conserving moisture, improving organic-matter content and fertility, and controlling erosion. Capability unit IIIs-1 (4a); woodland suitability group 2s5; woody plant group 3.

OsC—Oshtemo sandy loam, 6 to 12 percent slopes. This soil is on side slopes and low hills. Areas are round to long and narrow, or they are irregular in shape. Most areas are 2 acres to about 40 acres in size. This soil has a profile similar to the one described as representative of the series, but the subsoil generally is slightly coarser textured.

Included with this soil in mapping are a few small areas of Boyer sandy loam, mostly on the tops of ridges and knolls and the crests of single slopes, and many small areas of Spinks loamy sand. Also included in some areas is a soil that is similar to this Oshtemo soil but is underlain by very fine sand and small areas that have flatter slopes.

Runoff is medium to rapid, and the hazard of erosion is moderate to severe. Permeability is moderately rapid.

Most areas of this soil have been used for crops, but many areas are in pasture or are idle. If erosion is controlled, this soil is moderately suited to farming. The main concern in management is controlling erosion; improving organic-matter content and fertility are also concerns. Capability unit IIIe-3 (4a); woodland suitability group 2s5; woody plant group 3.

Owosso Series

The Owosso series consists of well drained, gently undulating to hilly soils on till plains and moraines. These soils formed in 20 to 40 inches of sandy loam and the underlying calcareous loamy till. Owosso soils are mapped only in complexes with Marlette soils.

In a representative profile the surface layer is dark grayish brown sandy loam about 9 inches thick. The subsoil is about 32 inches thick. The upper 17 inches is brown, friable sandy loam, the next 5 inches is dark yellowish brown, friable heavy sandy loam, and the lower 10 inches is dark yellowish brown, firm clay loam. The underlying material, beginning at a depth of 41 inches, is calcareous brown loam.

Runoff is slow to rapid. Permeability is moderately rapid in the surface layer and upper part of the subsoil and moderately slow in the lower part of the subsoil and in the underlying material. Available water capacity is moderate.

The more gently sloping areas of Owosso soils are well suited to farming, and the more strongly sloping areas are moderately suited to farming. Most areas have been cleared and are cultivated. The smaller, more sloping areas are used for hay or pasture, or they are idle.

Representative profile of Owosso sandy loam, in an area of Owosso-Marlette sandy loams, 1 to 6 percent slopes, in a cultivated field, 950 feet east and 200 feet north of center sec. 8, T. 4 N., R. 6 W.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) sandy loam; moderate fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

B1—9 to 26 inches; brown (10YR 4/3) sandy loam; weak medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

B21t—26 to 31 inches; dark yellowish brown (10YR 4/4) heavy sandy loam; moderate medium subangular blocky structure; friable; neutral; clear wavy boundary.

IIB22t—31 to 41 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; common thin discontinuous reddish brown (5YR 4/3) clay films on ped surfaces; about 5 percent pebbles; neutral; clear wavy boundary.

IIC—41 to 60 inches; brown (10YR 5/3) loam; massive; friable; 5 percent pebbles; slight effervescence; mildly alkaline.

The solum is typically 27 to 38 inches in thickness, but it ranges from 24 to 50 inches; thickness coincides with depth to the free calcium carbonates. The solum is about 1 to 12 percent pebbles and 1 to 3 percent cobbles. It is strongly acid to slightly acid in the upper part and is neutral or mildly alkaline in the lower part.

The A horizon is sandy loam, fine sandy loam, or loamy sand. The Ap horizon is dark grayish brown (10YR 4/2), dark yellowish brown (10YR 4/4), or dark brown (10YR 4/3). The A2 horizon, where present, is brown (10YR 5/3 or 7.5YR 5/4), yellowish brown (10YR 5/4 or 5/6), or pale brown (10YR 6/3).

The B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. The B21t horizon is sandy loam, heavy sandy loam, loam, or light sandy clay loam.

The IIB22t horizon is heavy loam, light clay loam, or clay loam.

The IIC horizon is loam, heavy loam, or light clay loam. It has a slight or strong effervescence.

Owosso soils are mostly near Marlette soils. They have coarser textures in the A and B horizons than Marlette soils. Owosso soils are similar to Metamora and Metea soils. Unlike Metamora soils, they lack mottles in the B horizon. They have a finer texture in the A and B horizons than Metea soils.

OwB—Owosso-Marlette sandy loams, 1 to 6 percent slopes. This complex is generally on the highest upland parts of till plains and moraines. Areas are round or irregular in shape. They are generally 5 to 60 acres in size, but they range from 2 acres to about 200 acres.

Owosso sandy loam makes up about 45 percent of the acreage of this complex. It has the profile described as representative of the series. It is generally on the tops of rises, mounds, knolls, and undulating areas.

Marlette sandy loam makes up about 30 percent of the acreage. It has a profile similar to the one described as representative of the series, but the surface layer and subsurface layer are sandy loam or fine sandy loam instead of loam. It is mostly on the lower side slopes of the mounds and knolls and in the slightly concave depressions of the undulating areas.

Included with these soils in mapping are a few small areas of well drained Hillsdale sandy loam; some soils in a few places that are similar to this Owosso soil but are moderately well drained; and a few small spots of somewhat poorly drained Metamora sandy loam and Capac loam, generally in slightly depressional areas and narrow drainageways. Also included are small, caplike mounds of Metea loamy sand on the tops of the higher knolls, on the crests of slopes bordering drainageways, and along the boundaries where the mapped areas are adjacent to areas of lower elevation.

Runoff is slow to medium, and the hazard of erosion is moderate.

Most areas of these soils are used for crops. A few areas are in woodland. If erosion is controlled, these soils are well suited to farming. The main concern in management is controlling erosion. Capability unit IIe–2 (3/2a, 2.5a); Owosso soil in woodland suitability group 1o1, Marlette soil in woodland suitability group 2o1; woody plant group 4.

OwC—Owosso-Marlette sandy loams, 6 to 12 percent slopes. This complex is on side slopes and low hills. Areas are round, oval, or long and narrow, or they are irregular in shape. They are generally 3 to 40 acres in size, but they range to as much as 80 acres.

Owosso sandy loam makes up about 40 percent of the acreage of this complex. It has a profile similar to the one described as representative of the series, but the surface layer is thinner. It is mostly on the tops of knolls, along the crests of slopes, and at the foot of long slopes.

Marlette sandy loam makes up about 40 percent of the acreage. It is mostly on the upper and middle parts of the side slopes. Also, it is on tops and crests of slopes and knolls, on concave slopes, and on bottoms of slightly depressional areas.

Included with these soils in mapping are many small areas of well drained Hillsdale sandy loam and a few areas of somewhat poorly drained Capac loam and poorly drained and very poorly drained Parkhill loam. These Capac and Parkhill soils are in basinlike depressions in valleys of the gently rolling areas, on bottoms of deeper depressions, and in narrow drainageways. Also included are a few small areas of Metea loamy sand and Spinks loamy sand that are caplike mounds on the upper parts of side slopes or are outcrops of underlying sandy material exposed at the base of long slopes.

Runoff is medium to rapid, and the hazard of erosion is severe.

Most areas of these soils are used for crops. Some areas are used for pasture, or they are idle. Other areas are in woodland. If erosion is controlled, these soils are moderately suited to farming. The main concern in management is controlling erosion. Capability unit IIIe-2 (3/2a, 2.5a); Owosso soil in woodland suitability group 1o1, Marlette soil in woodland suitability group 2o1; woody plant group 4.

OwD—Owosso-Marlette sandy loams, 12 to 18 percent slopes. This complex is on side slopes and hills. Areas are mainly long and narrow or are irregular in shape. They range from 2 acres to about 30 acres in size.

Owosso sandy loam makes up about 40 percent of the acreage of this complex. It has a profile similar to the one described as representative of the series, but the surface layer is lighter in color and is thinner. It is on the flatter parts of hilltops and the middle and lower side slopes.

Marlette sandy loam makes up about 35 percent of the acreage. It has a profile similar to the one described as representative of the series, but the surface layer and subsurface layer are sandy loam instead of loam. It is on the upper side slopes of the knobby hills and plane slopes. It is also on the upper parts of the slightly concave valley slopes.

Included with these soils in mapping are many small areas of well drained Hillsdale sandy loam; small areas of somewhat poorly drained Capac loam and poorly drained Parkhill loam on the bottoms of the basinlike depressional valleys and narrow drainageways; and, in a few areas, small spots of Spinks, Boyer, Oshtemo, and Metea loamy sands that are caplike mounds on the tops of hills, crests of slopes, and along the upper parts of side slopes. The Spinks soils are also at the base of slopes or in foot slope positions of the mapped areas. Also included are a few severely eroded areas.

Runoff is rapid, and the hazard of erosion is very severe.

Many areas of these soils that have been used for crops are now in pasture or are idle. Some areas are in woodland. These soils are moderately suited to small grains and legume hay. The main concerns in management are controlling erosion and operating equipment on slopes. Capability unit IVe–1 (3/2a, 2.5a); Owosso soil in woodland suitability group 1o1; Marlette soil in woodland suitability group 2o1; woody plant group 4.

Palms Series

The Palms series consists of very poorly drained, nearly level or slightly depressional organic soils. These soils are in swamps, along waterways, and in depressions on till plains and moraines. The organic layers are about 34 inches thick and are over loamy material.

In a representative profile the surface layer is black muck about 9 inches thick. Below this is 17 inches of dark reddish brown, very friable muck and 8 inches of very dark gray muck. The underlying material, beginning at a depth of 34 inches, is gray heavy silt loam.

Runoff is very slow, and the soils are ponded most of the time. Permeability is rapid in the muck and moderate in the underlying loamy material. Available water capacity is very high.

Palms soils are moderately well suited to farming, but they must be artificially drained because of a high water table and runoff from adjacent upland soils. Soil blowing is a hazard if these soils are cultivated. Some areas are idle or in pasture because they are small or lack adequate drainage outlets.

Representative profile of Palms muck, in an idle field, 1,125 feet west and 100 feet south of northeast corner sec. 6, T. 3 N., R. 3 W.:

Oa1—0 to 9 inches; black (5YR 2/1, on broken face and rubbed) sapric material; less than 5 percent fiber before and after rubbing; weak fine granular structure; very friable; mainly herbaceous fibers; neutral; abrupt smooth boundary.

Oa2—9 to 26 inches; dark reddish brown (5YR 2/2, broken face) and black (5YR 2/1, rubbed) sapric material; less than 5 percent fiber, trace rubbed; weak coarse subangular blocky structure to massive; very friable; herbaceous fibers; mildly alkaline; clear smooth boundary.

Oa3—26 to 34 inches; very dark gray (5YR 3/1, broken face) and dark reddish brown (5YR 2/2, rubbed) sapric material; about 15 percent fiber, 5 percent rubbed; massive; fibers are herbaceous; mildly alkaline; clear smooth boundary.

IICg—34 to 60 inches; gray (10YR 5/1) heavy silt loam that has dark yellowish brown (10YR 4/4) mottles; massive; friable; strong effervescence; moderately alkaline.

Depth to the loamy IICg horizon ranges from 16 to 49 inches. The fiber in the organic part of the profile is mainly from herbaceous plants. In some places coarse woody fragments 1 inch to 8 inches in diameter make up as much as 15 percent, by volume, of the organic material. Reaction throughout the organic material ranges from slightly acid to mildly alkaline.

The surface tier is very dark brown (10YR 2/2) or black (10YR 2/1, 5YR 2/1, or N 2/0) on broken faces and when rubbed. It is typically less than 5 percent fiber when rubbed.

The organic part of the subsurface and bottom tiers has hue of 10YR, 5YR, 5Y, or N, value of 2 or 3, and chroma of 0 to 3 on broken faces or when rubbed. In some places the organic material directly above the IIC horizon is as much as 50 percent, by volume, mineral material.

The IICg horizon has hue of 10YR or 2.5Y, value of 4, 5, or 6, and chroma of 1 or 2. It ranges from fine sandy loam to light silty clay loam and averages less than 35 percent clay. It is typically mildly alkaline or moderately alkaline but is neutral in the upper part in some places.

Palms soils formed in similar organic deposits as Adrian, Houghton, and Edwards soils. They have loamy material below the organic material, whereas Adrian soils have sand and loamy sand, and Edwards soils have marl. They have a thinner organic layer than Houghton soils.

Pa—Palms muck. This soil is in depressional areas and on broad flats. Slopes are 0 to 2 percent. Areas are irregular in shape. They range from 2 to 160 acres in size.

Included with this soil in mapping are areas of very poorly drained Adrian muck, Edwards muck, and Houghton muck. Houghton muck is generally at the center of the mapped areas. Also included are small areas of poorly drained and very poorly drained Parkhill loam and Colwood loam and a few areas where the muck is less than 16 inches in thickness.

Runoff is very slow to ponded. The hazard of soil blowing is severe.

Some areas of this soil are used for crops, and other areas are idle. If it is adequately drained and protected from soil blowing, this soil is suited to corn, potatoes, commercial sod, radishes, and onions. The main concerns in management are removing excess water, protecting from frost damage, and controlling soil blowing. Capability unit IIw–5 (M/3c); woodland suitability group 4w2; woody plant group 1.

Parkhill Series

The Parkhill series consists of poorly drained and very poorly drained, nearly level soils on till plains and low moraines. These soils formed in loamy material underlain by calcareous glacial loam till.

In a representative profile the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil is light brownish gray, firm, mottled clay loam 25 inches thick. The underlying material, beginning at a depth of 34 inches, is calcareous light brownish gray heavy loam and yellowish brown loam.

Runoff is very slow or ponded. Permeability is moderately slow, and available water capacity is high.

Parkhill soils are well suited to farming if they are artificially drained. Most larger areas are cultivated. Many smaller areas that lack adequate drainage outlets are in permanent pasture or woodland.

Representative profile of Parkhill loam, in a cultivated field, 950 feet east and 200 feet south of northwest corner sec. 17, T. 4 N., R. 4 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

B21g—9 to 18 inches; light brownish gray (2.5Y 6/2) clay loam; common medium distinct yellowish brown (10YR 5/8) and brownish yellow (10YR 6/2) mottles; moderate medium subangular blocky structure; firm; very dark grayish brown (10YR 3/2) worm casts and old root channel fillings; slightly acid; clear wavy boundary.

B22g—18 to 34 inches; light brownish gray (2.5Y 6/2) clay loam; common medium distinct strong brown (7.5YR 5/8), yellowish brown (10YR 5/8), and brownish yellow (10YR 6/6) mottles; moderate coarse angular blocky structure separating to moderate medium subangular blocky; firm; very dark grayish brown (10YR 3/2) worm casts and old root channel fillings; 5 percent pebbles; neutral; abrupt wavy boundary.

C1g—34 to 42 inches; light brownish gray (10YR 6/2) heavy loam; common medium distinct gray (10YR 5/1) mottles; massive; friable; few pebbles and cobbles; one 2-inch dark gray (10YR 4/1) krotovina extending from the surface to the upper part of the C1g horizon; few white (2.5Y 8/2) limy streaks; few fine roots; 6 percent pebbles; slight effervescence; mildly alkaline; abrupt wavy boundary.

C2—42 to 60 inches; yellowish brown (10YR 5/4) loam; common medium faint grayish brown (10YR 5/2) mottles; massive; friable; 5 percent pebbles and cobbles; slight effervescence; moderately alkaline.

The solum ranges from 29 to 50 inches in thickness. It is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part. The solum and substratum are 3 to 7 percent pebbles and 1 to 3 percent cobbles.

The A horizon is very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2) loam or fine sandy loam.

The B horizon is 20 to 35 percent clay. The B21g horizon is gray (10YR 5/1), grayish brown (10YR 5/2), or light brownish gray (2.5Y 6/2) clay loam, light clay loam, or loam. The B22g horizon is gray (10YR 5/1 or 6/1 or 5Y 6/1) and light brownish gray (2.5Y 6/2) clay loam, light clay loam, and heavy loam.

The C horizon is gray (10YR 5/1 or 6/1), yellowish brown (10YR 5/4), light brownish gray (10YR 6/2), or grayish brown (10YR 5/2) loam, heavy loam, or light clay loam. It is mildly alkaline or moderately alkaline and has slight to strong effervescence.

Parkhill soils are similar to Colwood, Lenawee, and Sebewa soils. They lack the stratified material throughout the solum and coarse textured material in the C horizon characteristic of Colwood soils. They are coarser textured throughout the profile than Lenawee soils. Unlike Sebewa soils, they have a loamy C horizon.

Pr—Parkhill loam. This soil is in narrow drainageways, on broad flats, and in depressional areas on plains. Areas are round to long and narrow, or they are irregular in shape. They are 2 to 150 acres in size.

Included with this soil in mapping are small areas of somewhat poorly drained Capac loam in small islandlike mounds or narrow strips along boundaries of the mapped areas and a few small areas of poorly drained and very poorly drained Colwood loam and Lenawee silty clay loam and somewhat poorly drained Metamora sandy loam. Also included are some small areas where depth to the limy underlying loamy material is less than 24 inches; some small spots in depressions that have a surface layer of mucky loam; a few small areas of poorly drained Sebewa loam in depressions; and some small areas of soils that have a fine textured subsoil.

Runoff is very slow or ponded, and the hazard of erosion is slight.

Most areas of this soil are used for crops. A few areas are wooded. If adequately drained, this soil is well suited to farming. The main concern in management is removing excess water. Capability unit IIw-1 (2.5c); woodland suitability group 2w1; woody plant group 5.

Sebewa Series

The Sebewa series consists of poorly drained and very poorly drained, nearly level soils in depressions on broad outwash plains and glacial drainage channels. These soils formed in loamy material over calcareous sand.

In a representative profile the surface layer is about 14 inches thick. The upper 11 inches is very dark gray loam, and the lower 3 inches is dark gray loam. The subsoil is about 22 inches thick. The upper 5 inches is gray, firm, mottled sandy clay loam, the next 12 inches is gray, firm, mottled clay loam, and the lower 5 inches is gray, firm, mottled gravelly clay loam. The underlying material, at a depth of 36 inches, is calcareous, gray gravelly sand.

Runoff is very slow, and the soils are often ponded. Permeability and available water capacity are moderate.

Sebewa soils are well suited to farming. Areas that are too small or lack adequate drainage outlets are idle or are in pasture.

Representative profile of Sebewa loam, in a cultivated field, 700 feet west and 100 feet south of northeast corner sec. 9, T. 2 N., R. 5 W.:

Ap—0 to 11 inches; very dark gray (10YR 3/1) loam; dark grayish brown (10YR 4/2) dry; moderate medium granular structure; friable; neutral; abrupt smooth boundary.

A12g—11 to 14 inches; dark gray (10YR 4/1) loam; few fine distinct gray (10YR 5/1) mottles; moderate medium granular structure; friable; very dark grayish brown (10YR 3/2) root channel fillings; neutral; clear wavy boundary.

B21tg—14 to 19 inches; gray (10YR 5/1) sandy clay loam; common medium distinct yellowish brown (10YR 5/6) mottles and few medium distinct olive brown (2.5Y 4/4) mottles; moderate medium subangular blocky structure; firm; few dark gray (10YR 4/1) thin discontinuous clay films on faces of peds; few fine roots; mildly alkaline; gradual wavy boundary.

B22tg—19 to 31 inches; gray (10YR 5/1) clay loam; common medium distinct strong brown (7.5YR 5/6) mottles and few fine distinct light olive brown (2.5Y 5/4) mottles; moderate medium subangular blocky structure; firm; few dark gray (10YR 4/1) thin discontinuous clay films on faces of peds; mildly alkaline; abrupt wavy boundary.

B23tg—31 to 36 inches; gray (10YR 5/1) gravelly clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; 20 percent ½- to 3-inch water-rounded pebbles; mildly alkaline; abrupt irregular boundary.

IICg—36 to 60 inches; gray (10YR 5/1) gravelly sand; single grained; loose; about 35 percent pebbles; strong effervescence; mildly alkaline.

The solum typically is 27 to 36 inches in thickness, but it ranges from 25 to 40 inches. It is 5 to 15 percent coarse fragments.

The A horizon is slightly acid or neutral. The Ap horizon is very dark grayish brown (10YR 3/2), very dark gray (10YR 3/1), or very dark brown (10YR 2/2). It is 10 to 12 inches thick. Some places have a very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1) A11g horizon 2 to 4 inches thick. The A12g horizon is light brownish gray (10YR 6/2), gray (10YR 6/1 and 5/1), grayish brown (10YR 5/2), or dark gray (10YR 4/1).

The B21tg horizon is dominantly gray (10YR 5/1) or grayish brown (10YR 5/2) sandy clay loam, clay loam, or heavy loam. It averages 18 to 33 percent clay. It is typically slightly acid to mildly alkaline. The B22tg horizon is dominantly gray (10YR 6/1 or 5/1) and is dominantly gravelly clay loam or clay loam. It averages 18 to 35 percent clay. Generally, if the B22tg horizon is clay loam, there is a layer of gravelly clay loam 3 to 6 inches thick between the B22tg and the IICg horizons. Thin, patchy, discontinuous clay films are on vertical faces of peds. The B22tg horizon is neutral or mildly alkaline.

The IICg horizon is sand, fine sand, and coarse sand that is 0 to 20 percent coarse fragments, or it is gravelly analogs of these textures.

Sebewa soils are similar to Matherton and Parkhill soils. They have a thicker Ap horizon than Matherton soils and are predominantly gray in the B horizon. They lack a loamy C horizon, which Parkhill soils have.

Sb—Sebewa loam. This soil is on broad plains and glacial drainage channels. Areas are round, oval, or long and narrow, or they are irregular in shape. Most commonly they are 5 to 60 acres in size, but they range from 2 acres to about 200 acres.

Included with this soil in mapping in a few areas are small spots of Gilford sandy loam; a few spots of stratified Colwood loam in slightly depressional areas and along boundaries of the mapped areas of organic soils; and a few areas where this soil has a surface layer of muck less than 16 inches thick. Also included in some areas are somewhat poorly drained Wasepi sandy loam and Matherton loam that are on slightly higher positions on the landscape than the Sebewa soil.

Most larger areas of this soil are used for crops. The smaller areas are idle, or they are in pasture or woodland. If adequately drained, this soil is well suited to farming. The main concern in management is removing excess water. Capability unit IIw-2 (3/5c); woodland suitability group 2w1; woody plant group 5.

Shoals Series

The Shoals series consists of somewhat poorly drained, nearly level soils on flood plains. These soils formed in loamy material deposited by floodwater. Shoals soils are mapped only in a complex with Sloan soils.

In a representative profile the surface layer is very dark grayish brown loam 9 inches thick. The underlying material, to a depth of 52 inches, is grayish brown and brown, friable, mottled silt loam. Below this, it is calcareous, brown fine and very fine sand.

Runoff is slow. Permeability is moderate, and available water capacity is high.

Shoals soils are poorly suited to farming because of the high water table and seasonal flooding. These soils are generally in permanent vegetation, in pasture, or in woodland. A few areas are used for crops.

Representative profile of Shoals loam, in an area of Shoals-Sloan loams, in an idle field, 1,300 feet east and 60 feet south of northwest corner sec. 24, T. 2 N., R. 3 W.:

A1—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; friable; neutral; abrupt wavy boundary.

C1g—9 to 26 inches; grayish brown (10YR 5/2) silt loam; many fine faint brown (10YR 5/3) mottles; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.

C2—26 to 37 inches; brown (10YR 5/3) silt loam; few fine distinct light olive brown (2.5Y 5/4) mottles and common medium faint grayish brown (10YR 5/2) mottles; thin streaks of black (10YR 2/1) organic matter; weak medium subangular blocky structure; friable; small spots of very dark brown (10YR 2/2) manganese concretions; mildly alkaline; clear wavy boundary.

C3—37 to 45 inches; brown (10YR 5/3) silt loam; few medium distinct light olive brown (2.5Y 5/4) mottles and many medium faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; many very dark brown (10YR 2/2) manganese concretions; mildly alkaline; clear wavy boundary.

C4g—45 to 52 inches; grayish brown (10YR 5/2) silt loam; many medium distinct yellowish brown (10YR 5/4) mottles, common medium distinct light olive brown (2.5Y 5/4) mottles, and few fine faint gray (10YR 5/1) mottles; massive; friable; mildly alkaline; abrupt wavy boundary.

IIC5—52 to 60 inches; brown (10YR 5/3) fine and very fine sand; single grained; loose; strong effervescence; mildly alkaline.

Depth to the IIC horizon ranges from 38 to 55 inches. The part of the profile between depths of 10 and 40 inches is slightly acid to mildly alkaline, and it becomes less acid as depth increases.

The A1 horizon or Ap horizon, where present, is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1) loam, silt loam, or very fine sandy loam.

The C horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 4. It is silt loam, loam, light silty clay loam, silty clay loam, clay loam, or heavy silt loam. The C3 and C4g horizons are fine sandy loam, heavy loamy sand, or sandy loam in some pedons. In many places there are one or more horizons, 1 to 6 inches thick, that are very dark grayish brown (10YR 3/2), very dark gray (10YR 3/1), or very dark brown (10YR 2/2).

The IIC horizon is sand, fine and very fine sand, or gravelly sand.

Shoals soils are similar to Matherton and Sloan soils. Unlike Matherton soils, they have an organic-matter content that decreases irregularly as depth increases. They lack predominant gray colors below the A horizon, which Sloan soils have.

Sh—Shoals-Sloan loams. This complex is mainly on first bottoms. Slopes are 0 to 2 percent. Areas are generally elongated. They range from 10 to 200 acres in size.

Shoals loam makes up about 60 percent of the acreage of this complex. This soil is on the better drained, slightly higher positions along old stream channels and islandlike knolls.

Sloan loam makes up about 30 percent of the acreage.

Included with these soils in mapping are small areas of well drained and moderately well drained, moderately fine textured and moderately coarse textured, stratified soils on small islandlike knolls, long narrow mounds, and benchlike terraces and some small spots of Cohoctah soils throughout the large flood plains of the Grand River and some tributaries of the Thornapple River. Also included are small areas of coarse textured, somewhat poorly drained and poorly drained, stratified soils; some areas of soils that have layers of organic material as much as 12 inches thick on the surface; and areas where these soils are underlain by organic material.

Runoff is slow to ponded, and the hazard of erosion is slight.

Most areas of these soils are in woodland or pasture. A few small areas are cultivated. These soils are moderately suited to poorly suited to farming unless excess water is removed and the soils are protected from flooding. The main concerns in management are flooding and wetness. Capability unit IIIw-3 (L-2c); Shoals soil in woodland suitability group 2o4, woody plant group 2; Sloan soil in woodland suitability group 2w1, woody plant group 5.

Sloan Series

The Sloan series consists of very poorly drained, nearly level soils on flood plains. These soils formed in loamy material deposited by floodwater. Sloan soils are mapped only in a complex with Shoals soils.

In a representative profile the surface layer is very dark brown loam about 11 inches thick. The subsoil is about 30 inches thick. The upper 7 inches is gray, friable, mottled loam, the next 14 inches is dark gray, friable, mottled silt loam, and the lower 9 inches is very dark grayish brown, very friable, mottled sandy loam. The underlying material, at a depth of 41 inches, is calcareous, grayish brown coarse and very coarse sand.

Runoff is very slow or ponded. Permeability is moderate, and available water capacity is moderate.

Sloan soils are generally moderately suited to poorly suited to farming because of the high water table and seasonal flooding. They are generally in permanent vegetation, pasture, or woodland.

Representative profile of Sloan loam, in an area of Shoals-Sloan loams, in an idle field, 1,200 feet east and 70 feet south of northwest corner sec. 24, T. 2 N., R. 3 W.:

A1—0 to 11 inches; very dark brown (10YR 2/2) loam; moderate medium and coarse granular structure; friable; slightly acid; abrupt wavy boundary.

B1g—11 to 18 inches; gray (10YR 5/1) loam; common medium distinct yellowish brown (10YR 5/6 and 5/8) mottles and few medium distinct dark gray (10YR 4/1) mottles; weak medium and coarse subangular blocky structure; friable; neutral; clear wavy boundary.

B21g—18 to 29 inches; dark gray (10YR 4/1) silt loam; few medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak medium and coarse subangular blocky structure; friable; neutral; gradual wavy boundary.

B22g—29 to 32 inches; dark gray (10YR 4/1) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; small pockets of very dark brown (10YR 2/2) organic matter; weak medium and coarse subangular blocky structure; friable; neutral; clear wavy boundary.

B3g—32 to 41 inches; very dark grayish brown (10YR 3/2) sandy loam; many fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; very friable; few pieces of partially decayed roots and twigs; slightly acid; abrupt wavy boundary.

IICg—41 to 60 inches; grayish brown (10YR 5/2) coarse and very coarse sand; single grained; loose; 15 percent coarse pebbles; slight effervescence; mildly alkaline.

The solum is 24 to 55 inches in thickness, and thickness coincides with the depth to calcareous material. The solum is slightly acid to mildly alkaline; it becomes less acid as depth increases.

The A1 horizon and Ap horizon, where present, are very dark brown (10YR 2/2), black (10YR 2/1) or very dark gray (10YR 3/1) silt loam, loam, or very fine sandy loam.

The B horizon is gray (10YR 5/1 or 6/1), grayish brown (10YR 5/2), light brownish gray (10YR 6/2), or dark gray (10YR 4/1) silt loam, loam, sandy loam, silty clay loam, or clay loam. In many places there is a thin horizon, 1 to 6 inches thick, that is very dark gray (10YR 3/1), black (10YR 2/1 or N 2/0), or very dark brown (10YR 2/2). This thin horizon generally contains partially decomposed or undecomposed fragments of leaves, roots, or small branches.

The IICg horizon is gray (10YR 5/1 or 6/1) or grayish brown (10YR 5/2) sand, coarse sand, very coarse sand, gravelly sand, fine and very fine sand, and, in some places, thin strata of loamy sand or light sandy loam.

Sloan soils are mostly near Shoals soils. Unlike Shoals soils, they have predominantly gray colors below the A horizon. Sloan soils are similar to Cohoctah and Sebewa soils. They have finer textures in the upper part of the C horizon than Cohoctah soils. Unlike Sebewa soils, they have an organic-matter content that increases irregularly as depth increases.

Spinks Series

The Spinks series consists of well drained, nearly level to hilly soils on sandy ridges on till plains, moraines, and sandy beach ridges along major streams. These soils formed in loamy and sandy material.

In a representative profile the surface layer is dark grayish brown loamy sand about 9 inches thick. The upper part of the subsoil is yellowish brown light loamy sand about 17 inches thick. The lower part of the subsoil is 32 inches of loose, yellowish brown sand banded with thin layers of dark brown, friable heavy loamy sand or light sandy loam. The underlying material, at a depth of 58 inches, is calcareous brown coarse sand.

Runoff ranges from very slow to medium, depending on the slope. Permeability is moderately rapid, and available water capacity is low.

Spinks soils are moderately suited to farming. The main limitations are soil blowing, low available water capacity, and low supply of phosphorus and potassium. Some of the more gently sloping areas are in specialty crops or vegetables. Most of the more sloping areas are in permanent vegetation or forest.

Representative profile of Spinks loamy sand, 0 to 6 percent slopes, in an idle field, 2,150 feet north and 150 feet east of southwest corner sec. 29, T. 3 N., R. 6 W.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loamy sand; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

B1—9 to 26 inches; yellowish brown (10YR 5/4) light loamy sand; weak fine granular structure; very friable; slightly acid; gradual wavy boundary.

A&B—26 to 58 inches; yellowish brown (10YR 5/4) sand; structureless; single grained; loose (A2 part); dark brown (7.5YR 4/4) heavy loamy sand; massive; friable (Bt part); neutral; gradual irregular boundary.

C—58 to 60 inches; brown (10YR 5/3) coarse sand; single grained; loose; slight effervescence; mildly alkaline.

The solum is generally 42 inches to about 90 inches in thickness. It is medium acid to neutral, but the lower part ranges to mildly alkaline.

The Ap horizon is dark grayish brown (10YR 4/2) or dark brown (10YR 3/3) loamy sand, loamy fine sand, or sand.

The B1 horizon is yellowish brown (10YR 5/4 or 5/6), dark yellowish brown (10YR 4/4), or light yellowish brown (10YR 6/4) loamy sand or sand. The A2 part of the A&B horizon is pale brown (10YR 6/3), light yellowish brown (10YR 6/4), yellowish brown (10YR 6/4) loamy sand, very fine sand, fine sand, or sand. Depth to the first band ranges from 15 to 34 inches. The Bt part of the A&B horizon is dark brown (7.5YR 4/4), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/6 or 5/8) heavy loamy sand, loamy sand, light sandy loam, or sandy loam. The individual bands, or lamellae, typically are 1/8 inch to 5 inches in thickness, but they range to as much as 10 inches in a few places. They are generally discontinuous. The cumulative thickness of these bands is more than 6 inches.

The C horizon is sand, coarse sand, or fine sand. In a few places it is loamy sand, very fine sand, loamy fine sand, or very coarse sand. It is dominantly mildly alkaline or slightly effervescent, but it ranges from neutral to moderately alkaline.

Spinks soils are mostly near Boyer and Oshtemo soils. They have a coarser textured, discontinuous B horizon and are deeper to the C horizon than Boyer soils. They are coarser throughout the solum than Oshtemo soils. Spinks soils are similar to Metea soils. They lack loamy material below a depth of 20 to 40 inches, which Metea soils have.

SpB—Spinks loamy sand, 0 to 6 percent slopes. This soil is on plains. Areas are long and narrow or are irregular in shape. They are 3 to 300 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of well drained Oshtemo sandy loam, Boyer loamy sand, and Marlette loam. Also included in a few places are small areas of moderately well drained soils in small, slight depressions, in narrow strips along boundaries of the mapped areas adjoining low wetter soils, and on low, benchlike terraces of old glacial drainage channels.

Runoff is very slow, and the hazard of soil blowing is severe if the surface is left bare.

Most areas of this soil have been used for crops. Many areas are idle, and many are in pasture or woodland. This soil is moderately suited to farming if soil blowing is controlled and organic-matter content and fertility are improved. The main concerns in management are conserving moisture and controlling soil blowing, but improving fertility and maintaining organic-matter content are also concerns. Capability unit IIIs–1 (4a); woodland suitability group 2s5; woody plant group 3.

SpC—Spinks loamy sand, 6 to 12 percent slopes. This soil is on side slopes and low hills. Areas are irregular in shape. They range from 3 to 30 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is generally lighter in color.

Included with this soil in mapping are small areas of well drained Oshtemo sandy loam, Marlette loam, and Boyer loamy sand.

Runoff is slow to medium, and the hazard of erosion is severe.

Many areas of this soil are in woodland, are idle, or are planted to pine trees. A few areas are farmed. This soil is moderately suited to farming if erosion and soil blowing are controlled and fertility and organic-matter content are improved. The main concerns in management are controlling erosion, conserving moisture, controlling soil blowing, and improving organic-matter content. Capability unit IIIe–3 (4a); woodland suitability group 2s5; woody plant group 3.

StB—Spinks-Metea loamy sands, 0 to 6 percent slopes. This complex is on plains and low moraines. Areas are irregular in shape, and they range from 3 to 40 acres in size.

The Spinks soil makes up about 50 percent of the acreage of this complex. It has a profile similar to the one described as representative of the series, but it has bands of sandy loam as much as 10 inches thick, and the sand in the lower part of the subsoil is high in very fine sand.

The Metea soil makes up about 25 percent of the acreage. It has the profile described as representative of the series.

Included with these soils in mapping are some areas of well drained Marlette and Tuscola soils and areas of soils that are similar to Spinks and Metea soils but are moderately well drained. Also included are a few areas of somewhat poorly drained Metamora and Kibbie soils or poorly drained and very poorly drained Colwood and Parkhill soils.

Runoff is very slow, and the hazard of soil blowing is severe.

A few areas of these soils are used for crops. The rest of the acreage is in permanent vegetation or is wooded. This soil is moderately suited to moderately well suited to farming if soil blowing is controlled, organic-matter content is maintained, and the soil is fertilized properly. The main concerns in management are conserving moisture, controlling soil blowing, and improving and maintaining organic-matter content and fertility. Capability unit IIIs–1 (4a, 4/2a); woodland suitability group 2s5; woody plant group 3.

StC—Spinks-Metea loamy sands, 6 to 12 percent slopes. This complex is on side slopes and low hills. Areas are irregular in shape, and they range from 2 to 25 acres in size.

The Spinks soil makes up about 45 percent of the acreage of this complex. It has a profile similar to the one described as representative of the series, but the bands in the lower part of the subsoil are finer textured and the sand in the lower part of the subsoil is high in very fine sand.

The Metea soil makes up about 30 percent of the acreage. It has a profile similar to the one described as representative of the series, but the surface layer is generally lighter in color.

Included with these soils in mapping are small areas of well drained Marlette and Owosso soils and areas of soils that are similar to Tuscola soils but are well drained. Also included are small spots of poorly drained Colwood soils or organic soils in small, bowl-shaped depressions.

Runoff is medium. The hazard of soil blowing is severe if the surface is left bare.

Many areas of this complex are idle or are wooded. A few areas are used for crops or are planted to pine trees. These soils are moderately suited to farming if erosion is controlled and organic-matter content is improved and maintained. The main concerns in management are controlling erosion and improving and maintaining organic-matter content and fertility. Capability unit IIIe–3 (4a, 4/2a); woodland suitability group 2s5; woody plant group 3.

Tuscola Series

The Tuscola series consists of moderately well drained, nearly level to gently sloping soils on till plains and low moraines. These soils formed in water-laid deposits of loam, very fine sand, and fine sand.

In a representative profile the surface layer is dark grayish brown fine sandy loam about 9 inches thick. The subsoil is about 22 inches thick. The upper 8 inches is dark yellowish brown, firm, mottled light silty clay loam; the next 9 inches is brown, firm, mottled loam; and the lower 5 inches is grayish brown, firm, mottled loam. The underlying material, at a depth of 31 inches, is calcareous grayish brown stratified silt loam, very fine sand, and fine sand.

Runoff is slow. Permeability is moderate, and available water capacity is high.

Tuscola soils are well suited to farming.

Representative profile of Tuscola fine sandy loam, 0 to 4 percent slopes, in a cultivated field, 50 feet east and 1,980 feet north of southwest corner sec. 32, T. 1 N., R. 4 W.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; friable; many fine roots; slightly acid; abrupt smooth boundary.

B21t—9 to 17 inches; dark yellowish brown (10YR 4/4) light silty clay loam; common medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate medium angular blocky structure; firm; many fine roots; thin brown (10YR 4/3) clay films on faces of peds and in root channels; medium acid; clear wavy boundary.

B22t—17 to 26 inches; brown (10YR 4/3) loam; common fine faint gray (10YR 6/1) mottles and few medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate medium and fine angular blocky structure; firm; common fine roots; thin dark grayish brown (10YR 4/2) clay films on faces of peds and root channels; slightly acid; clear wavy boundary.

B23gt—26 to 31 inches; grayish brown (10YR 5/2) loam; few medium distinct gray (N 6/0) mottles and common medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate coarse platy structure separating to moderate medium angular blocky; firm; few fine roots; thin clay films on faces of peds; slightly acid; clear wavy boundary.

IICg—31 to 60 inches; grayish brown (10YR 5/2) stratified silt loam, very fine sand, and fine sand; many medium distinct gray (N 6/0) and yellowish brown (10YR 5/6 and 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum is typically 30 to 45 inches in thickness, but it ranges from 26 to 50 inches. It is medium acid to neutral. In some profiles the lower part ranges to mildly alkaline.

The Ap horizon is dark grayish brown (10YR 4/2), dark brown (10YR 3/3), or dark gray (10YR 4/1) fine sandy loam, silt loam, or very fine sandy loam.

The B21t horizon is dark yellowish brown (10YR 4/4), brown (10YR 5/3), or dark brown (10YR 4/3) silt loam, light silty clay loam, or loam.

The B22t horizon is brown to dark brown (10YR 4/3) or yellowish brown (10YR 5/4) loam, silt loam, or light silty clay loam.

The B23gt horizon is grayish brown (10YR 5/2) or light brownish gray (10YR 6/2).

The IIC horizon is grayish brown (10YR 5/2), pale brown (10YR 6/3), or brown (10YR 5/3) stratified silt loam, very fine sand, and fine sand or stratified very fine sand and silt.

Tuscola soils are mostly near Kibbie soils. They lack dark grayish brown colors on the faces of peds immediately below the Ap horizon, which Kibbie soils have. Tuscola soils are similar to Bronson soils. They have finer textures in the B and C horizons than Bronson soils.

TuA—Tuscola fine sandy loam, 0 to 4 percent slopes. This soil is on plains and low knolls. Areas are irregular in shape. They range from 2 to 200 acres in size.

Included with this soil in mapping are small areas of well drained soils that have texture similar to that of this Tuscola soil; small areas of Marlette loam on knolls and ridges; and areas of somewhat poorly drained Colwood soils in drainageways and depressions. Also included are areas of soils adjacent to the Grand River near Grand Ledge that are underlain by shale at a depth of 5 to 7 feet and that are slightly coarser textured in the upper part than this soil and some areas that are slightly steeper along drainageways.

Most areas of this soil are farmed. Removing excess water is needed in some areas. Capability unit I–1 (2.5a–s); woodland suitability group 1o1; woody plant group 4.

Wasepi Series

The Wasepi series consists of somewhat poorly drained, nearly level and very gently sloping soils on broad outwash plains and terraces of glacial drainage channels. These soils formed in loamy material underlain by calcareous coarse and very coarse sand.

In a representative profile the surface layer is very dark grayish brown sandy loam about 9 inches thick. The subsoil is about 28 inches thick. In sequence from the top, it is 16 inches of brown, friable, mottled sandy loam, 3 inches of yellowish brown, friable, mottled heavy sandy loam, 5 inches of yellowish brown, friable, mottled light sandy clay loam, and 4 inches of yellowish brown, very friable, mottled light loamy sand. The underlying material, at a depth of 37 inches, is calcareous, grayish brown coarse sand and gravelly sand.

Runoff is slow. Permeability is moderately rapid, and available water capacity is low.

Wasepi soils are moderately suited to farming. Many of the smaller areas are idle or are in permanent pasture. These soils have medium fertility. They have a seasonal high water table, and they tend to be droughty during dry weather. Use of cover crops, crop residue, and green-manure crops should be included in management.

Representative profile of Wasepi sandy loam, 0 to 3 percent slopes, in a cultivated field, 1,940 feet south and 300 feet west of the northeast corner sec. 5, T. 1 N., R. 3 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam; grayish brown (10YR 5/2) dry; weak medium granular structure; friable; neutral; abrupt smooth boundary.

B1—9 to 25 inches; brown (10YR 5/3) sandy loam; few fine distinct yellowish brown (10YR 5/4) mottles and common medium faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

B21t—25 to 28 inches; yellowish brown (10YR 5/4) heavy sandy loam; common fine distinct grayish brown (10YR 5/2) mottles and few fine faint yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

B22t—28 to 33 inches; yellowish brown (10YR 5/4) light sandy clay loam; many medium distinct grayish brown (10YR 5/2) mottles and few medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

B3—33 to 37 inches; yellowish brown (10YR 5/4) light loamy sand; many fine faint brown (10YR 5/3) mottles and many fine faint grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; very friable; neutral; clear wavy boundary.

IICg—37 to 60 inches; grayish brown (10YR 5/2) coarse sand and gravelly sand; single grained; loose; 30 percent pebbles; strong effervescence; mildly alkaline.

The solum is 24 to 40 inches in thickness. It is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part.

The A horizon is sandy loam, loamy sand, or fine sandy loam. The Ap horizon is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1). The A2 horizon is brown (10YR 5/3) or pale brown (10YR 6/3).

The B1 horizon is brown (10YR 5/3), pale brown (10YR 6/3), yellowish brown (10YR 5/4), or light yellowish brown (10YR 6/4) sandy loam, loamy sand, or heavy loamy sand. The Bt horizon is yellowish brown (10YR 5/4), dark brown (10YR 4/3), or brown (10YR 5/3) heavy sandy loam, light sandy clay loam, or sandy loam. The B3 horizon, where present, is yellowish brown (10YR 5/4), brown (10YR 5/3), or grayish brown (10YR 5/2) loamy sand, heavy loamy sand, or light sandy loam.

The C horizon is grayish brown (10YR 5/2) or brown (10YR 5/3) and has yellowish brown (10YR 5/6 and 5/8), brown (10YR 5/3), or grayish brown (10YR 5/2) mottles. It is coarse sand, very coarse sand, or gravelly analogs of these textures.

Wasepi soils are similar to Brady, Bronson, Owosso, and Wasepi variant soils. They are shallower to the C horizon than Brady and Bronson soils, and they have grayish brown mottles in the upper part of the B horizon, which Bronson soils lack. They lack the loamy material in the C horizon characteristic of Owosso soils. Unlike Wasepi variant soils, they lack sandstone bedrock at a depth of 20 to 40 inches.

WaA—Wasepi sandy loam, 0 to 3 percent slopes. This soil is on plains. Areas are irregular in shape. They range from 2 to 45 acres in size.

Included with this soil in mapping are small areas of well drained Boyer sandy loam and Oshtemo sandy loam on knolls and ridges and small areas of very poorly drained Gilford sandy loam and somewhat poorly drained Brady, Kibbie, and Metamora soils in drainageways and depressions. Also included are some areas of soils that are similar to Wasepi soils but are moderately well drained and small areas of somewhat poorly drained soils that are similar to Spinks loamy sand but are wetter.

Some areas of this soil are farmed, and others are idle. If it is adequately drained and fertilized, this soil is moderately suited to farming. The main concern in management is removing excess water. Capability unit IIIw-1 (4b); woodland suitability group 3s3; woody plant group 2.

Wasepi Variant

The Wasepi variant consists of somewhat poorly drained, nearly level and very gently sloping soils on terraces. These soils formed in loamy outwash material 20 to 40 inches thick over sandstone bedrock.

In a representative profile the surface layer is very dark grayish brown sandy loam about 9 inches thick. The subsoil is about 17 inches thick. The upper part is yellowish brown, friable, mottled sandy loam. The lower part is dark brown, friable, mottled heavy sandy loam. Light yellowish brown sandstone bedrock is at a depth of 26 inches.

Runoff is slow. Permeability is moderately rapid, and available water capacity is low.

Wasepi variant soils are poorly suited to farming because they lack suitable drainage outlets and are difficult to drain. Most areas are in permanent vegetation; a few are wooded.

Representative profile of Wasepi sandy loam, bedrock variant, 0 to 3 percent slopes, in a hayfield, 1,190 feet west and 50 feet north of the southeast corner sec. 2, T. 1 N., R. 3 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam; grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; slightly acid; abrupt smooth boundary.

B1—9 to 19 inches; yellowish brown (10YR 5/4) sandy loam; common medium distinct yellowish brown (10YR 5/8) mottles and few fine distinct grayish brown (10YR 5/2) mottles, mainly in the lower part; weak medium subangular blocky structure; friable; medium acid; clear wavy boundary.

B2t—19 to 26 inches; dark brown (10YR 4/3) heavy sandy loam; common medium distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; thin discontinuous dark brown (7.5YR 4/2) clay films on surfaces of some peds and on the underside of pebbles in the lower part; medium acid; abrupt wavy boundary.

IIR—26 inches; light yellowish brown (10YR 6/4) sandstone bedrock; ½- to 1-inch thick strata, fractured; slightly weathered at contact with solum; medium acid.

The solum is 20 to 40 inches in thickness, and thickness generally coincides with depth to sandstone bedrock. The solum is medium acid or slightly acid.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) sandy loam, loam, or fine sandy loam.

The B1 horizon is yellowish brown (10YR 5/4), brown (10YR 5/3), or pale brown (10YR 6/3) sandy loam or fine sandy loam. The B2t horizon is dark brown (10YR 4/3), dark yellowish brown (10YR 4/4), or brown (10YR 5/3) light sandy clay loam, heavy sandy loam, or heavy loamy sand. It averages less than 18 percent clay. The B3 horizon, where present, is light sandy loam, loamy sand, or sand, and it contains variable amounts of sandstone fragments and pebbles.

Wasepi variant soils are similar to Wasepi soils. Unlike Wasepi soils, they have sandstone bedrock at a depth of 20 to 40 inches.

WbA—Wasepi sandy loam, bedrock variant, 0 to 3 percent slopes. This sloping soil is on plains. Areas are irregular in shape. They range from 10 acres to more than 100 acres in size. These areas are of small extent.

Included with this soil in mapping are many small scattered spots where depth to sandstone bedrock is less than 20 inches or more than 40 inches; some areas of soils that have a subsoil of sandy loam or light sand that is 5 to 20 percent sandstone fragments; and a few small scattered areas of soils that have 2 to 3 feet of sand or loamy sand with sandstone fragments over the sandstone bedrock. Also included are small areas of poorly drained loamy soils in narrow drainageways and small depressions; small areas of well drained soils over sandstone bedrock on the long, narrow, steeper side slopes along some of the drainageways; and areas of Boyer, Oshtemo, and Spinks soils on small scattered knolls and low ridges.

Most areas of this soil have been cultivated. Many areas are idle, are in crops, or are in urban areas. This soil is poorly suited to farming because excess water is difficult to remove. The main concerns in management are removing excess water and the shallow depth to sandstone bedrock. Removing excess water is difficult or impossible because the soil areas lack outlets. Capability unit IIIw-1 (4/Rb); woodland suitability group 3s3; woody plant group 2.

Winneshiek Series

The Winneshiek series consists of well drained, nearly level and very gently sloping soils on terraces. These soils formed in loamy outwash and water-laid material 20 to 40 inches thick over limestone bedrock.

In a representative profile the surface layer is very dark brown silt loam about 9 inches thick. The subsurface layer is 3 inches of brown silt loam. The subsoil is about 14 inches thick. The upper 5 inches is dark brown, friable loam, the next 6 inches is dark brown, firm clay loam, and the lower 3 inches is dark reddish brown, very firm heavy clay loam. Very pale brown limestone bedrock is at a depth of 26 inches.

Runoff is slow. Permeability is moderately slow, and available water capacity is low.

Winneshiek soils are moderately suited to farming. Many areas are idle. A few areas are used for crops.

Representative profile of Winneshiek silt loam, 0 to 3 percent slopes, in an idle area, 1,369 feet south and 115 feet east of northwest corner sec. 28, T. 1 N., R. 6 W.:

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; many roots; less than 10 percent coarse fragments; slightly acid; abrupt smooth boundary.

A2—9 to 12 inches; brown (10YR 5/3) silt loam; weak coarse platy structure; common roots; less than 1 percent coarse fragments; neutral; abrupt wavy and broken boundary.

B1—12 to 17 inches; dark brown (7.5YR 4/4) loam; moderate medium subangular blocky structure; friable; common roots; continuous thin dark reddish brown (5YR 3/4) clay films on surfaces of peds and root channels; less than 1 percent coarse fragments; neutral; clear wavy boundary.

B21t—17 to 23 inches; dark brown (7.5YR 4/4) clay loam; moderate fine and medium subangular blocky structure; firm; common roots; continuous moderately thick dark brown (7.5YR 4/4) clay films on surfaces of peds and root channels; 2 to 6 percent coarse fragments; neutral; abrupt wavy to irregular boundary.

B22t—23 to 26 inches; dark reddish brown (5YR 3/3) heavy clay loam; moderate fine prismatic structure separating to strong, fine, subangular blocky; very firm; common roots; continuous moderately thick dark brown (7.5YR 4/2) clay films on surfaces of peds and in root channels; 0 to 3 percent coarse fragments; neutral; gradual irregular boundary.

IIR—26 inches; very pale brown (10YR 8/3) limestone bedrock.

The solum is dominantly 20 to 40 inches in thickness, and thickness coincides with depth to limestone bedrock. It is 0 to 8 percent coarse fragments, which are mainly in the lower part.

The A horizon is silt loam, loam, and sandy loam. It is slightly acid or neutral. The Ap horizon is very dark gray (10YR 3/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2) and is 8 to 10 inches thick. The A2 horizon is brown (10YR 4/3) or grayish brown (10YR 5/2).

The B1 horizon is dark brown (7.5YR 4/4) or dark yellowish brown (10YR 4/4) loam or silt loam. The B21t horizon is brown (7.5YR 5/4), dark brown (7.5YR 4/4), or dark yellowish brown (10YR 4/4) clay loam, sandy clay loam, or light clay loam. The B22t horizon is dark reddish brown (5YR 3/3) or dark brown (7.5YR 4/4) heavy clay loam or light clay. It is neutral or mildly alkaline.

Winneshiek soils are similar to Marlette soils. Unlike Marlette soils, they have limestone bedrock at a depth of 20 to 40 inches.

WnA—Winneshiek silt loam, 0 to 3 percent slopes. This soil is on broad plains. Areas are irregular in shape. They range from 5 to 200 acres in size. These areas are of small extent.

Included with this soil in mapping are many areas where depth to bedrock is less than 20 inches or more than 40 inches; small areas of soils that have a coarser textured subsoil than this soil; and small areas of well drained Bixby loam. Also included are a few areas of well drained Oshtemo sandy loam; a few small areas of soils where the underlying limestone bedrock is exposed at the surface; and small areas of moderately well drained Tuscola soils.

Most areas of this soil have been cleared and cultivated, but they are now idle or are used for urban land or mining. The main concerns in management are shallow depth to bedrock, low available water capacity, and the risk of erosion. The underlying limestone bedrock is a source of agricultural lime. Several large quarries are in these soil areas (fig. 8). Many areas awaiting excavation for the limestone have been stripped of their surface layer and are idle. Capability unit IIs-1 (2/Ra); woodland suitability group 2o2; woody plant group 4.

Use and Management of the Soils

This section describes the major uses of the soils and the limitations and management needs of the soils for each of these uses. It explains the capability grouping used by the Soil Conservation Service, describes the capability units in detail, gives suggestions about use and management of the soils for farming, and

Figure 8.—**Limestone quarry in an area of the Winneshiek silt loam, 0 to 3 percent slopes, near Bellevue.**

then lists the predicted yields of principal crops. This section shows the soils grouped according to the kinds and amounts of timber they can produce and gives the kinds, shape, and potential height of trees and shrubs planted for landscape or windbreak purposes. Then, it shows the relative suitability of soils for wildlife habitat and for recreational developments. This section also contains information about the engineering uses of the soils; it describes the relative suitability and limitations of soils for roads and other engineering structures and gives information about urban uses, which is of interest to builders, homeowners, and city planners.

Crops

The loamy soils in the county are the most productive soils for cash crops, such as corn, wheat, beans, and sugar beets. The main concerns in management for these soils are removing excess water, controlling erosion, and maintaining fertility. The sandy soils have a high potential for pine plantations or small fruit and vegetable production in the better drained areas. The main concerns in management are controlling soil blowing, conserving moisture or using supplemental irrigation, and maintaining fertility. The mucky soils have a high potential for truck crops, commercial sod, soybeans, and corn. The main concerns in management are removing excess water, controlling soil blowing, protecting from frost, controlling water level with structures, and adding sufficient plant nutrients.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so 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 and does not apply to horticultural crops or other crops requiring special management. This classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for forest trees or engineering.

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

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

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

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

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or to esthetic purposes. (None in Eaton County.)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion; *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* shows that the chief limitation is climate that is too cold or too dry.

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

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

The capability classification of the soils in Eaton County is given in the "Guide to Mapping Units" at the end of this survey. For a complete explanation of the capability classification system, see Agriculture Handbook No. 210, Land Capability Classification (*8*).

Management by capability units [2]

In the following pages the capability units in Eaton County are described and suggestions for the use and management of the soils in each unit are given.

Certain practices basic to good soil management can

[2] RICHARD H. DRULLINGER, agronomist, Soil Conservation Service, helped to prepare this section.

be mentioned before discussing the individual capability units. An adequate supply of plant nutrients and organic matter, a good depth of root zone, and the proper balance of air and water are necessary to grow crops efficiently. Management practices needed to improve yields include drainage, control of erosion, rotation of crops, use of suited crop varieties, and the adequate use of lime and fertilizer. Lime and fertilizer should be applied according to soil tests and the needs of the crops.

Many of the soils in Eaton County, such as Parkhill and Capac soils, need artificial drainage. Drainage of cropland improves the air-water relationship in the root zone. Planting, spraying, and harvesting are hampered in spring, and weed control is more difficult where drainage is poor. Tile drains or surface drainageways, or both, can be used to remove excess water, but they should be properly designed. Suitable outlets are difficult to find in some areas, particularly in Lenawee silty clay loam, depressional, and Cohoctah fine sandy loam, frequently flooded. Diversions can be used in some wet areas to carry away surface runoff. Good soil structure and an ample supply of organic matter also benefit soil drainage. The low-lying areas are subject to a shortened growing season because of frost late in spring and early in fall. Low areas where water stands for more than a few days or weeks may be especially valuable for wildlife and should not be drained.

The loss of surface soil through erosion reduces soil productivity and increases the sediment in streams and in other bodies of water. This is common in steeper areas of Marlette and Owosso soils. Erosion can generally be controlled by reducing the rate and volume of runoff and by increasing the rate of water absorption by the soil. Soil loss through surface runoff is reduced by growing meadow crops, cover crops, or green manure crops and by the proper use of crop residue. Contour cultivation, stripcropping, grassed waterways, minimum tillage, and the use of diversions and terraces are other measures effective in controlling erosion. Windbreaks of trees or shrubs help to control soil blowing on Houghton muck and the other mucks and on Spinks soils and other sandy soils. Reducing width of fields, alternating small grain with strips of row crops, keeping crop residue on the soil surface, or planting permanent vegetative cover also help to prevent soil blowing.

Practices to maintain and improve the organic-matter content and soil tilth include growing cover crops and green manure crops, properly using crop residue, minimizing tillage, and applying livestock manure. Fall plowing at the right moisture content on nearly level, poorly drained or somewhat poorly drained soils may reduce damage to soil tilth and allow earlier tillage of the soils the following spring. Sloping land or soils subject to soil blowing should not be plowed in fall. Grazing loamy and clayey soils when they are wet causes compaction of the soil and poor tilth and should be avoided. Good soil conservation practices are needed most if the cropping system is intensive or if cultivation is continuous.

For additional help in managing the soils, consult the local representative of the Soil Conservation Service or the Cooperative Extension Service. The capability unit in which each soil has been placed can be found by referring to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1

This unit consists of Tuscola fine sandy loam, 0 to 4 percent slopes. This soil is moderately well drained. It has medium texture and moderately fine texture in the subsoil. Permeability is moderate. Available water capacity is high. Runoff is slow.

This soil has a high level of productivity. It is well suited to crops. Corn, wheat, oats, soybeans, field beans, and alfalfa are the main crops. This soil has no major limitations to use for crops. There are no major concerns in management, but removing excess water is needed in some areas.

A few areas need surface drains to remove runoff so that the drainageways do not form gullies.

CAPABILITY UNIT IIe-1

This unit consists only of Marlette loam, 2 to 6 percent slopes. This soil is well drained or moderately well drained. It has moderately fine texture in the subsoil. Permeability is moderate or moderately slow. Available water capacity is high. Runoff is medium.

This soil is well suited to crops. Corn, wheat, soybeans, alfalfa, and field beans are the main crops. The major hazard to the use of this soil for crops is susceptibility to erosion (fig. 9). The major concerns in management are controlling erosion, removing excess water in some areas, and maintaining tilth.

If this soil is tilled when wet, it compacts and loses its granular structure, and the surface becomes cloddy and hard. This reduces the movement of water and air through the soil.

CAPABILITY UNIT IIe-2

This unit consists of gently undulating, well drained to moderately well drained soils. These soils have moderately coarse texture to moderately fine texture in the subsoil. Permeability is moderately rapid to moderately slow. Available water capacity is moderate to high. Runoff is slow or medium.

The soils are well suited to crops. Corn, wheat, soybeans, field beans, and alfalfa are the main crops. The major hazard to the use of the soils for crops is susceptibility to erosion. The major concerns in management are controlling erosion, conserving moisture, and improving organic-matter content and fertility.

The soils can be cropped intensively if erosion is controlled and fertility is maintained. Many areas do not have the long, continuous slopes that are necessary for contour farming and terracing. In these areas, erosion must be controlled by growing cover crops and by using minimum tillage. Random tile systems are needed in some areas to remove excess water from drainageways and small depressions.

CAPABILITY UNIT IIw-1

This unit consists of nearly level and very gently sloping, somewhat poorly drained to very poorly drained soils. These soils have moderately fine texture in the subsoil. Permeability is moderately slow. Available water capacity is high. Runoff is slow to ponded.

If drained, these soils are well suited to crops. Corn, wheat, soybeans, and field beans are the main crops.

Figure 9.—**Contour stripcropping is an effective method to control erosion on Marlette and Capac soils.**

The major limitation to use of these soils for crops is wetness. The major concerns in management are removing excess water and maintaining soil tilth.

If these soils are tilled when wet, they compact and lose their granular structure, and the surface becomes cloddy and hard. Artificial drainage is beneficial to these soils. Both surface and subsurface drainage are needed in most areas. Water ponds in some areas of these soils in spring and after periods of heavy rainfall.

CAPABILITY UNIT IIw-2

This unit consists of nearly level and very gently sloping, somewhat poorly drained to very poorly drained soils. These soils have moderately fine texture to moderately coarse texture in the subsoil. Permeability is moderate. Available water capacity is moderate or high. Runoff is slow to ponded (fig. 10).

If adequately drained, these soils are well suited to crops. Corn, wheat, soybeans, field beans, and alfalfa are the main crops. The major limitation to the use of these soils is excessive wetness. The major concerns in management are removing excess water and maintaining fertility.

Installing tile drains is difficult in some areas because sandy material caves into the tile trenches. Tile can best be installed during dry periods. Special covering material over the tile lines and care in backfilling are necessary to prevent sandy material from flowing into and plugging drains.

CAPABILITY UNIT IIw-3

This unit consists of Metamora-Capac sandy loams, 0 to 4 percent slopes. These soils are somewhat poorly drained. They have moderately coarse texture to moderately fine texture in the subsoil. Permeability is moderate or high. Runoff is slow or medium.

These soils are well suited to crops. Corn, wheat, soybeans, alfalfa, and field beans are the main crops. The major limitation in the use of these soils is wetness. Some areas have poor tilth. The hazard of erosion is slight. The major concerns in management are removing excess water, maintaining fertility, and maintaining tilth.

Unless drained, these soils have a seasonal high water table. Water is near the surface in spring and during prolonged wet periods. Tile and surface drains remove the excess water from these soils. Tile is most easily installed during dry periods.

CAPABILITY UNIT IIw-4

This unit consists of Brady-Bronson sandy loams, 0 to 3 percent slopes. These soils are somewhat poorly

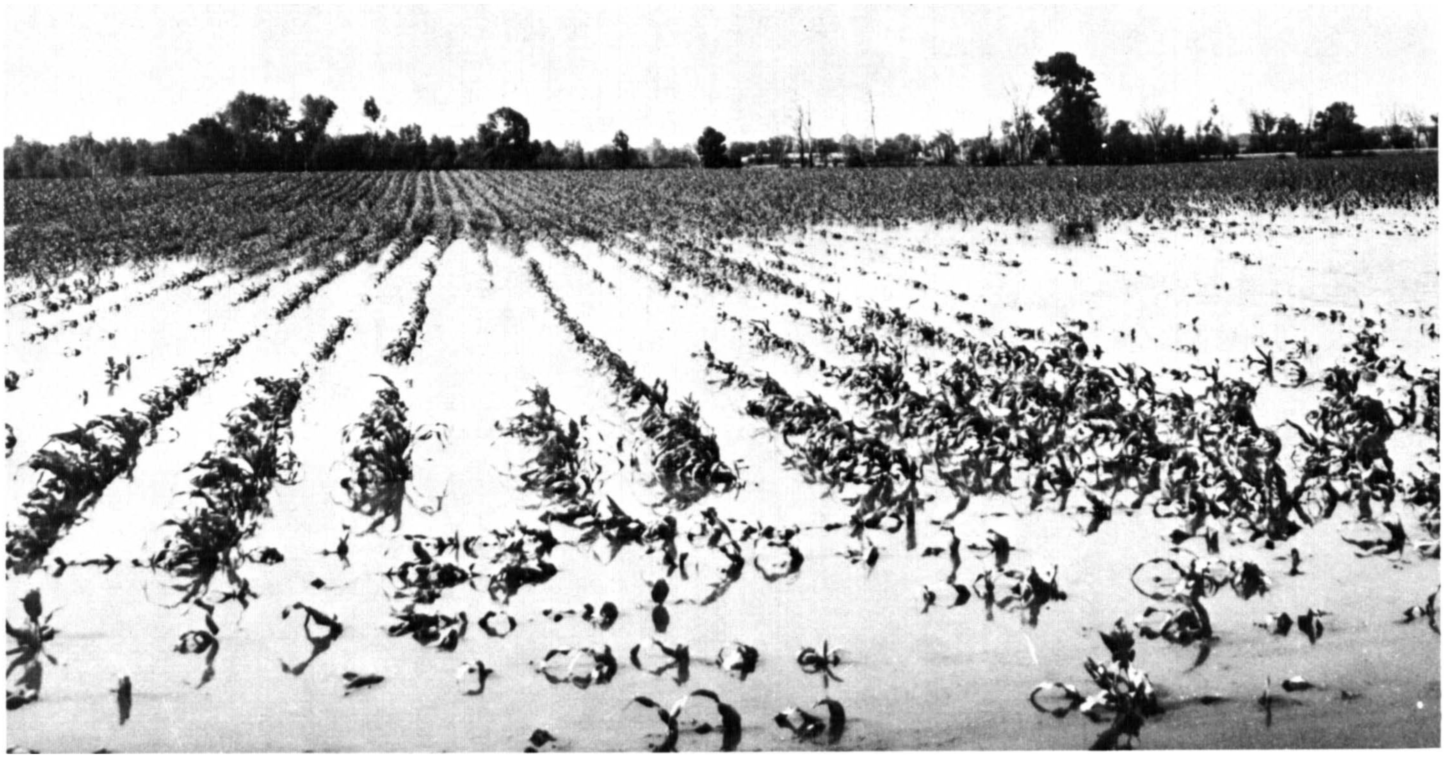

Figure 10.—Water standing on a Colwood loam where a tile system has not been installed. Somewhat poorly drained Kibbie fine sandy loam, 0 to 3 percent slopes, is on the slightly higher area in the background.

drained or moderately well drained. They have moderately coarse texture or coarse texture in the subsoil. Permeability is moderately rapid. Available water capacity is moderate. Runoff is slow.

These soils are moderately suited to crops. Corn, wheat, field beans, and soybeans are the main crops. The major limitations to the use of these soils for crops are excessive wetness, and, if the soils are drained, droughtiness. The major concerns in management are establishing drainage, conserving moisture, and improving fertility and organic-matter content. Drainage is generally not needed in the higher lying areas.

Installing tile drains where they are needed is difficult in some areas because sandy material caves into tile trenches. Tile can best be installed during dry periods. Special covering material over the tile lines and care in backfilling are necessary to prevent sandy material from flowing into and plugging drains.

CAPABILITY UNIT IIw-5

This unit consists of Palms muck. This very poorly drained soil is in depressional areas and broad flat areas. It consists of 16 to 49 inches of organic material. Permeability is rapid in the organic material and moderate in the substratum. Available water capacity is very high. Runoff is ponded or very slow.

If adequately drained, this soil is well suited to crops. Sod, corn, and vegetables are the main crops. The major limitations to the use of this soil are excessive wetness and susceptibility to soil blowing. The major concerns in management are establishing drainage, improving fertility, and providing protection from soil blowing.

Artificial drainage is needed before this soil can be cultivated intensively. The depth and spacing of the tile depend on the thickness of the organic material. Managing the water table level controls droughtiness, decreases subsidence, and reduces the hazard of soil blowing.

CAPABILITY UNIT IIw-6

This unit consists of Capac-Marlette loams, 1 to 6 percent slopes. These soils are well drained to somewhat poorly drained. They have moderately fine texture in the subsoil. Permeability is moderate or moderately slow. Available water capacity is high. Runoff is slow to medium.

These soils are well suited to row crops, small grain, hay, and pasture. The major concerns in management are establishing drainage and controlling erosion. In some areas, the intermingled soils and complex slopes make design and layout of a drainage system difficult. Some areas need only random drainage, whereas other areas need a complete drainage system. Minimum tillage and use of cover crops help to control erosion and improve tilth.

CAPABILITY UNIT IIs-1

This unit consists of nearly level to gently sloping, well drained soils. These soils have coarse texture to moderately fine texture in the subsoil. Permeability is moderate to moderately slow. Available water capacity is moderate or low. Runoff is slow.

These soils are moderately well suited to crops. Corn, wheat, soybeans, and alfalfa are the main crops. The major limitations to use of these soils are droughtiness and a slight to moderate hazard of soil blowing. Some areas have a shallow rooting depth. The major concerns in management are conserving moisture, maintaining fertility and organic-matter content, and providing protection from soil blowing where necessary.

CAPABILITY UNIT IIIe-1

This unit consists only of Marlette loam, 6 to 12 percent slopes. The soil is well drained. It has a moderately fine texture in the subsoil. Permeability is moderately slow. Available water capacity is high. Runoff is medium.

This soil is moderately suited to crops. Wheat, alfalfa, and some corn are the main crops. The major hazard to use of this soil is susceptibility to erosion. The major concerns in management are controlling erosion and maintaining organic-matter content (fig. 11).

If this soil is cultivated when wet, a crust forms on the surface. This soil needs ample organic matter. Care is needed to maintain tilth and water infiltration rates.

CAPABILITY UNIT IIIe-2

This unit consists of sloping to gently rolling, well drained soils. These soils have moderately coarse texture to moderately fine texture in the subsoil. Permeability is moderately rapid to moderately slow. Available water capacity is moderate or high. Runoff is medium.

These soils are moderately suited to crops. Wheat, alfalfa, and some corn are the main crops. The major hazard to the use of these soils for crops is susceptibility to erosion. The major concerns in management are controlling erosion, conserving moisture, and improving fertility and organic-matter content.

CAPABILITY UNIT IIIe-3

This unit consists of sloping to gently rolling, well drained soils. These soils have coarse texture to moderately fine texture in the subsoil. Permeability is moderately rapid in most of the soils in this unit; in a small acreage it is very rapid in the upper part of the subsoil and is moderately slow in the lower part of the subsoil. Available water capacity is moderate or low. Runoff is medium.

These soils are moderately suited to crops. Corn, wheat, and alfalfa are the main crops. Some areas of these soils are more droughty than others. The major concerns in management are controlling erosion, conserving moisture, and improving organic-matter content and fertility. Some areas would benefit from irrigation.

CAPABILITY UNIT IIIw-1

This unit consists of nearly level to very gently sloping, somewhat poorly drained soils. These soils have coarse texture to moderately fine texture in the subsoil.

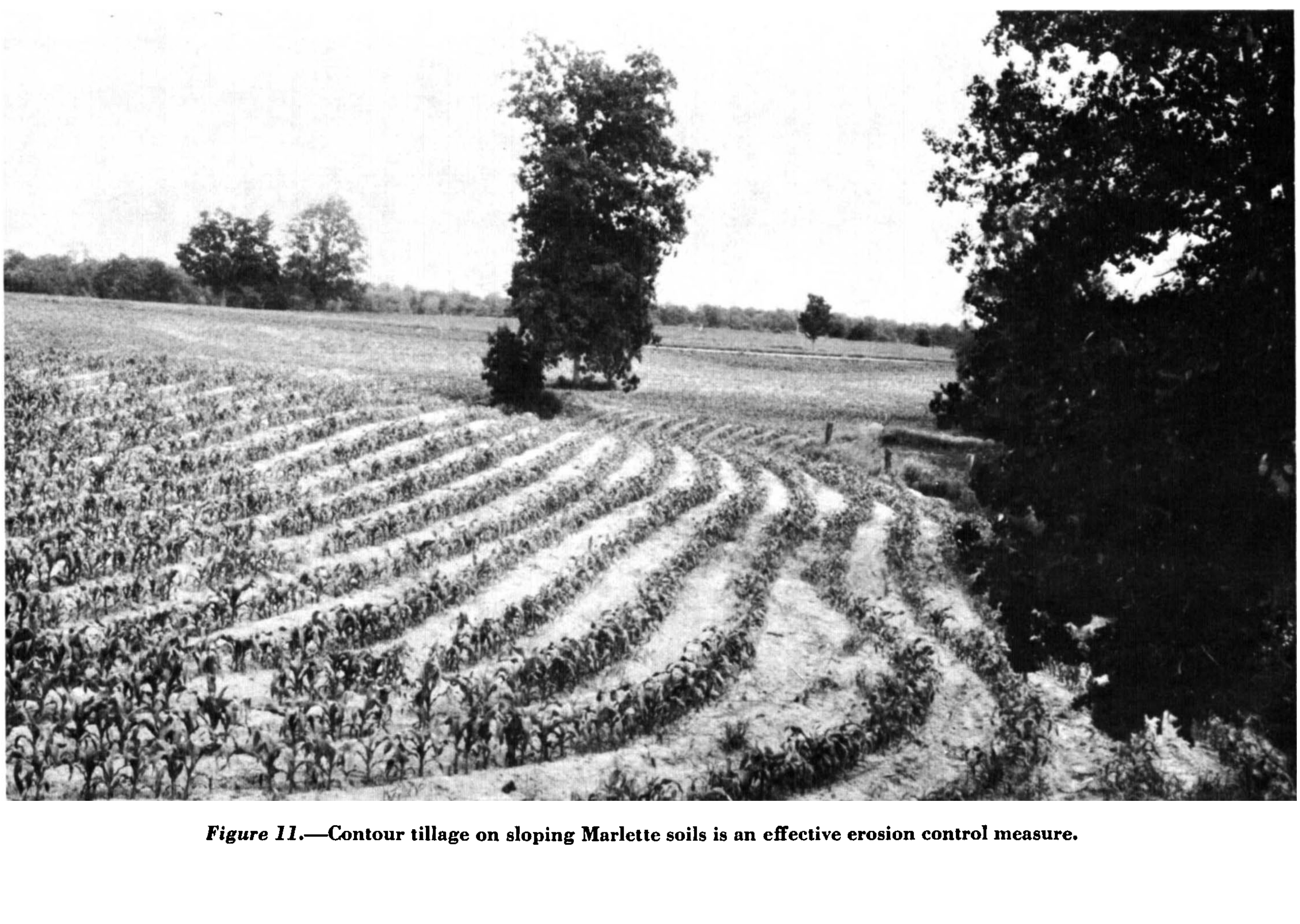

***Figure 11.*—Contour tillage on sloping Marlette soils is an effective erosion control measure.**

Permeability is moderately rapid in the subsoil. Available water capacity is low. Runoff is slow.

These soils are moderately suited to poorly suited to crops, but they are well suited to hay or pasture. Some of the areas of these soils are in permanent vegetation. Other areas are used for crops. Corn, wheat, oats, beans, and alfalfa are the main crops. The major concern in management is excessive wetness.

Tile drainage systems are generally difficult to install in areas that are underlain by sandstone bedrock because the soils are shallow. Tile lines are difficult to install in some areas because sandy material caves into the trenches. They can best be installed during dry periods. Special covering material over tile lines and care in backfilling are necessary to prevent sandy material from flowing into and plugging drains.

CAPABILITY UNIT IIIw-2

This unit consists only of Gilford sandy loam. This soil is nearly level and very poorly drained. It has moderately coarse texture and moderately fine texture in the subsoil. Permeability is moderately rapid. Available water capacity is low. Runoff is ponded or very slow.

This soil is moderately suited to crops. Corn, wheat, and soybeans are the main crops. The major limitation to use of this soil for crops is excessive wetness, and if the soil is drained, droughtiness. Artificial drainage benefits most crops. The major concerns in management are establishing drainage and maintaining fertility.

CAPABILITY UNIT IIIw-3

This unit consists of Shoals-Sloan loams. These soils are nearly level and somewhat poorly drained and very poorly drained. They have moderately coarse texture to moderately fine texture below the surface layer. Permeability is moderate. Available water capacity is moderate to high. Runoff is ponded to slow.

These soils are moderately suited to poorly suited to crops, depending on whether or not they can be drained. Most areas are wooded and in permanent vegetation or are in pasture. A few areas are used for crops. The major limitations to use of these soils are excessive wetness and occasional flooding. The major concerns in management are removing excess water and protecting from flooding where necessary.

CAPABILITY UNIT IIIw-4

This unit consists only of Houghton muck. This soil is nearly level and very poorly drained. The organic material is more than 49 inches thick. Permeability is rapid. Available water capacity is very high. Runoff is ponded.

This soil is moderately suited to crops. Corn, commercial sod, and vegetables are the main crops. The major limitations to use of this soil for crops are wetness, soil blowing, and frost action. The major concerns in management are establishing drainage, improving fertility, and controlling soil blowing (fig. 12).

Artificial drainage and water table control are

Figure 12.—**Windbreaks are an effective method to control soil blowing on Houghton muck.**

needed if this soil is used for crops. In most areas the water level can be controlled by tile or open ditch drainage, dams, and dikes. Tile drainage systems can be difficult to install because the organic material does not provide a stable foundation. Ditchbanks in this soil cave easily, and frequent maintenance is required.

CAPABILITY UNIT IIIs-1

This unit consists of nearly level to gently undulating, well drained soils. These soils have coarse texture to moderately fine texture in the subsoil. Most of these soils have moderately rapid permeability, but a few have very rapid permeability in the upper part of the subsoil and moderately slow permeability in the lower part of the subsoil. Available water capacity is low to moderate. Runoff is slow.

These soils are moderately suited to crops. They are best suited to crops that resist drought and mature early in the season. Wheat, alfalfa, and corn are the main crops. The major hazards to use of these soils for crops are droughtiness, susceptibility to erosion in the sloping areas, and susceptibility to soil blowing. The major concerns in management are conserving moisture, controlling soil blowing, and improving fertility and organic-matter content.

CAPABILITY UNIT IVe-1

This unit consists of moderately steep to hilly, well drained soils. These soils have moderately fine texture and moderately coarse texture in the subsoil. Permeability is moderately rapid to moderately slow. Available water capacity is moderate or high. Runoff is rapid.

These soils are generally poorly suited to crops. Alfalfa and some wheat are the main crops. The acreage not in crops is in pasture, woodland, or permanent vegetation. The major hazard to the use of these soils for crops is susceptibility to erosion. Steep slopes are a moderate limitation to the use of equipment. The major concern in management is controlling erosion.

CAPABILITY UNIT IVe-2

This unit consists only of Boyer-Spinks loamy sands, 12 to 18 percent slopes. These soils are moderately steep to hilly, and well drained. These soils have moderately fine texture to coarse texture in the subsoil. Permeability is moderately rapid. Available water capacity is low. Runoff is medium to rapid.

These soils are poorly suited to crops. They are mostly in permanent vegetation or in woodland. Alfalfa and wheat are the main crops where the soils are farmed. The major hazards to the use of these soils are susceptibility to erosion and droughtiness and the difficulty of maintaining organic-matter content. Steep slopes are a moderate limitation to the use of equipment. The major concerns in management are controlling erosion, conserving moisture, and improving organic-matter content and fertility.

CAPABILITY UNIT IVe-3

This unit consists only of Marlette clay loam, 6 to 12 percent slopes, severely eroded. This soil is well drained and moderately well drained. It has moderately fine texture in the subsoil. Permeability is moderate or moderately slow. Available water capacity is high. Runoff is medium to rapid.

This soil is moderately suited to small grain and forage crops and is poorly suited to row crops. The major hazard to the use of this soil is susceptibility to erosion. The major concerns in management are preventing further erosion, maintaining organic-matter content, and improving tilth.

If this soil is tilled when wet, a crust forms on the surface. This soil needs ample organic matter. Care is needed to maintain tilth and water infiltration rates.

CAPABILITY UNIT IVw-1

This unit consists only of Adrian muck. This soil is nearly level and very poorly drained. It consists of 16 to 49 inches of organic material underlain by coarse textured mineral material. Permeability is rapid. Available water capacity is very high. Runoff is ponded.

If this soil is drained, it is moderately suited to crops. Many areas are not drained. In drained areas, sod, corn, and vegetables are the main crops. The major limitations to the use of this soil for crops are excessive wetness and susceptibility to soil blowing and frost damage. The major concerns in management are establishing drainage, improving fertility, and controlling soil blowing.

In establishing drainage, the depth and spacing of the tile depends on the thickness of the organic material. Managing the level of the water table controls droughtiness, decreases subsidence, and reduces the hazard of soil blowing.

CAPABILITY UNIT IVw-2

This unit consists only of Edwards muck. This soil is nearly level and very poorly drained. It consists of 16 to 49 inches of organic material underlain by marl. Permeability is rapid in the organic material and variable in the marl. Available water capacity is very high. Runoff is ponded.

If this soil is drained, it is moderately suited to crops. Many areas are not drained. In drained areas, sod, corn, and vegetables are the main crops. The major limitations to the use of this soil for crops are excessive wetness and susceptibility to soil blowing and frost damage. The major concerns in management are establishing drainage, improving fertility, and controlling soil blowing.

In establishing drainage, the depth and spacing of tile depend on the thickness of the organic material. Managing the level of the water table controls droughtiness, decreases subsidence, and reduces the hazard of soil blowing. The underlying marl causes some deficiencies of major and minor nutrients.

CAPABILITY UNIT Vw-1

This unit consists of nearly level, poorly drained and very poorly drained soils. These soils have coarse texture to moderately fine texture in the subsoil. Permeability is moderately rapid to moderately slow. Available water capacity is moderate or high. Runoff is ponded or very slow.

These soils are generally not suited to crops. A few areas are used for crops where drainage and protection from flooding are feasible. Corn, wheat, and soybeans are the main crops grown in these areas. Large areas are in woodland. Other areas are idle or are in pasture.

The major limitations to use of these soils for crops are wetness and flooding. Some areas have poor tilth. Flooding is caused by runoff during periods of snowmelt and intense rainfall from the surrounding higher land. Ditches and drainage outlets are difficult to install in some areas. The major concerns in management are protecting the soils from flooding, establishing drainage, and maintaining tilth.

CAPABILITY UNIT VIe-1

This unit consists only of Marlette loam, 18 to 25 percent slopes. This soil is well drained. It has moderately fine texture in the subsoil. Permeability is moderate or moderately slow. Available water capacity is high. Runoff is very rapid.

This soil is generally not suited to farming. A few areas are used for pasture or alfalfa but most areas are in permanent vegetation or in woodland. Plant cover should be maintained on these soils at all times to reduce erosion.

The major hazard to the use of this soil for crops is susceptibility to erosion. Slope is a major limitation to use of equipment. The major concern in management is controlling erosion.

CAPABILITY UNIT VIIs-1

This unit consists of Borrow land. Borrow land is land from which soil material has been removed. Areas of this land type are poorly suited or are not suited to farming. Some Borrow land areas that are covered with water have some potential for recreational uses or for use as a limited source of water.

Predicted yields

The soils in Eaton County vary considerably in pro-

TABLE 2.—*Predicted average yields per acre under high level of management*

[Dashes indicate that the crop is not suited to the soil or is not ordinarily grown on it. Soils that are not suited to crops are not listed]

Soil	Corn (grain)	Corn (silage)	Oats	Wheat	Alfalfa	Soybeans	Field beans	Sugar beets
	Bu	*Tons*	*Bu*	*Bu*	*Tons*	*Bu*	*Bu*	*Tons*
Adrian muck	90	15	------	------	------	35	------	------
Bixby loam, 0 to 3 percent slopes	80	15	72	43	4.0	30	28	------
Boyer loamy sand, 0 to 6 percent slopes	65	12	50	28	3.2	23	20	------
Boyer loamy sand, 6 to 12 percent slopes	60	11	40	25	2.8	------	------	------
Boyer sandy loam, 0 to 6 percent slopes	78	14	64	34	3.3	30	26	------
Boyer sandy loam, 6 to 12 percent slopes	70	13	60	30	3.2	26	21	------
Boyer-Spinks loamy sands, 12 to 18 percent slopes	------	------	35	20	2.6	------	------	------
Brady-Bronson sandy loams, 0 to 3 percent slopes	88	15	75	38	3.5	32	30	14
Capac loam, 0 to 3 percent slopes	110	19	95	60	5.0	40	35	20
Capac-Marlette loams, 1 to 6 percent slopes	104	18	90	55	4.6	38	35	18
Colwood loam	115	18	88	55	4.8	38	35	21
Edwards muck	88	15	------	------	------	30	------	------
Gilford sandy loam	88	15	70	45	4.0	32	28	16
Hillsdale sandy loam, 2 to 6 percent slopes	88	15	70	47	4.0	30	28	------
Hillsdale sandy loam, 6 to 12 percent slopes	80	14	65	42	3.8	25	22	------
Houghton muck	100	17	------	------	------	35	------	------
Kibbie fine sandy loam, 0 to 3 percent slopes	108	18	85	55	4.8	37	35	20
Marlette loam, 2 to 6 percent slopes	105	17	80	60	5.2	35	30	17
Marlette loam, 6 to 12 percent slopes	95	16	70	55	4.5	28	25	------
Marlette loam, 12 to 18 percent slopes	70	13	60	38	3.5	20	20	------
Marlette loam, 18 to 25 percent slopes	------	------	------	------	3.0	------	------	------
Marlette clay loam, 6 to 12 percent slopes, severely eroded	65	12	55	35	2.8	------	------	------
Matherton loam, 0 to 3 percent slopes	100	17	80	50	3.8	32	30	19
Metamora-Capac sandy loams, 0 to 4 percent slopes	114	18	87	55	4.8	35	30	20
Oshtemo sandy loam, 0 to 6 percent slopes	80	14	65	32	3.6	25	23	------
Oshtemo sandy loam, 6 to 12 percent slopes	70	13	55	29	3.2	------	------	------
Owosso-Marlette sandy loams, 1 to 6 percent slopes	100	17	75	52	4.5	30	28	------
Owosso-Marlette sandy loams, 6 to 12 percent slopes	90	15	70	46	4.2	26	24	------
Owosso-Marlette sandy loams, 12 to 18 percent slopes	77	14	63	34	3.5	------	------	------
Palms muck	110	18	------	------	------	40	------	------
Parkhill loam	130	20	98	62	6.0	45	43	23
Sebewa loam	110	18	85	55	4.2	38	35	------
Shoals-Sloan loams	100	17	------	------	------	35	28	------
Spinks loamy sand, 0 to 6 percent slopes	60	11	50	30	3.0	20	18	------
Spinks loamy sand, 6 to 12 percent slopes	55	10	40	25	2.6	------	------	------
Spinks-Metea loamy sands, 0 to 6 percent slopes	78	14	65	35	3.6	21	18	------
Spinks-Metea loamy sands, 6 to 12 percent slopes	70	13	50	28	3.3	------	------	------
Tuscola fine sandy loam, 0 to 4 percent slopes	105	17	85	55	4.5	35	30	17
Wasepi sandy loam, 0 to 3 percent slopes	85	15	70	38	3.5	30	27	------
Wasepi sandy loam, bedrock variant, 0 to 3 percent slopes	60	11	45	25	3.0	------	------	------
Winneshiek silt loam, 0 to 3 percent slopes	80	14	65	50	3.5	25	------	------

ductivity. Some soils consistently produce high yields of cultivated crops, while others are better suited to less intensive uses because of erosion, soil blowing, or other soil limitations.

The average yields per acre of the principal crops for most soils of the county under high level management are given in table 2. The soils that are not suited to crops are not listed. These predicted yields will probably become outdated with time; however, the figures will serve as a guide to compare soils.

A high level of management includes most of the following practices: the cropping system is adapted to the soil, using the proper proportion of row crops to legume-grass crops; the cropping system is supplemented by the necessary conservation measures needed to control erosion and soil blowing, which may include contour tillage, stripcropping, minimum tillage, and return of crop residue; the quantity of lime applied is determined by soil tests; fertilizer application is also determined by soil tests and is based on the amounts and kinds of plant nutrients needed by the crop; where needed, an adequate system of artificial drainage is installed; improved varieties of plants and high quality seeds are used; weed, disease, and insect control are practiced; suitable methods and proper timing of tillage and harvesting are used; cover crops, crop residue, and manure are returned to the soil to improve tilth, supply organic matter, and control erosion.

The crop yields listed are those that are expected over a period of several years. The yields are not presumed to be the maximum obtainable. Maximum yields can be considerably higher in years with a favorable combination of soil, plant, and weather conditions.

Irrigation has not been considered a part of improved management, because this practice is limited mainly to the production of potatoes, truck crops, and small fruit crops.

Woodland[3]

Forest originally covered most of Eaton County, but clearing the soils for farms and cutting timber for commercial purposes eliminated the virgin stands. The woodland now consists mainly of second-growth and third-growth stands.

About 15 percent of the county is woodland. The principal forest cover type is northern hardwoods (fig. 13). Wooded areas on moraines, outwash plains, and till plains are predominantly maple, oak, beech, and basswood. Scattered black cherry, sycamore, hickory, black walnut, ash, and aspen are intermixed in these areas. Some sandy areas are planted to red pine and white pine. Larch, cedar, soft maples, swamp white oak, elm, white ash, and pin oak cover the wooded, swampy lowland areas.

Most of the hardwoods are valuable for saw logs and other forest products. The sugar maple, one of the most common hardwoods, is also valuable for maple sugar.

Pine is the most valuable tree for plantations because it is used for Christmas trees, posts, poles, sawtimber, and pulp.

[3] JACQUES J. PINKARD, forester, Soil Conservation Service, helped to prepare this section.

Figure 13.—**The Capac and Marlette soils are well suited to hardwoods. This woodlot has many sugar maple trees.**

The practices needed in management of existing woodland include protection from fire and grazing, underplanting with suitable species, removal of culls, and timely harvesting. Plantations will eventually need the same attention as existing woodland, but high priority needs now may include thinning and pruning.

Woodland suitability groups

The soils of Eaton County have been placed in woodland suitability groups to help owners plan the use of their soils for wood crops. Each group is made up of soils that are suited to the same kinds of trees, that need approximately the same kind of management when the vegetation on them is similar, and that have about the same potential productivity. Each woodland group is identified by a three-part symbol, for example, 1o1, 2o4, or 4w2. The first part of the symbol, always an Arabic numeral, is the woodland suitability class which indicates relative potential productivity of the soils in the group: 1 is high; 2 is medium high; 3 is medium; 4 is medium low; 5 is low. These five classes are used to approximate expected yields per acre in cords and board feet for an indicator forest type or key species (table 3).

One cubic foot equals about 5 board feet, and about 2.5 cords equal 1,000 board feet (International ¼-inch rule). A cord is dimensionally 128 cubic feet but only contains about 80 cubic feet of wood. Production of 0.2 cord per acre per year or less is "noncommercial" by definition.

The yields apply to managed stands in which intermediate cuttings are used to remove trees that would be crowded out and to give ample room for the crop trees to develop.

The ratings are determined from field evaluations that include determining site index. These site index figures are obtained by measuring the height and age of the dominant trees of a given species on a specified kind of soil in natural, unmanaged stands. For the

TABLE 3.—*Woodland productivity*

Woodland suitability class	Unit of measure	Important trees or key species	
		Northern red oak, sugar maple, and red maple	Aspen
1	Board feet Cords	More than 260 More than 1.0	More than 200. More than 1.2.
2	Board feet Cords	190 to 260 0.8 to 1.0	150 to 200. 0.8 to 1.2.
3	Board feet Cords	130 to 190 0.6 to 0.8	125 to 150. 0.5 to 0.8.
4	Board feet Cords	90 to 130 0.4 to 0.6	100 to 125. 0.2 to 0.5.
5	Board feet Cords	Less than 90 Less than 0.4	Less than 100. Less than 0.2.

merchantable hardwoods and softwoods in this county, the site index is based on the height reached in a specified number of years. Research studies of site index have been used to estimate approximate expected growth and yield per acre in cords and board feet.

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; *c*, clay in the upper part of the soil; *s*, sandy texture; and *r*, steep slopes. The letter *o* indicates no significant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the order in which the letters are listed above.

The third part of the symbol is another Arabic numeral. It brings together soil mapping units that respond similarly to management and is the final category of the system. The hazards or limitations that affect management of soils for woodland are erosion hazard, equipment limitations, seedling mortality, windthrow hazard, and plant competition. Each hazard or limitation is rated slight, moderate, or severe to aid the management of soils of the group for wood crops.

Erosion hazard is rated according to the risk of erosion on well-managed woodland that is not protected by special practices. It is *slight* where the needed management is minor. The erosion hazard is *moderate* if attention to treatment is needed during or after logging or logging construction. A rating of *severe* indi-

Figure 14.—**Trees growing on Marlette and Capac soils help to control erosion and keep sediment out of Grand River. The management needed to control erosion in this area is minor.**

cates that control methods must be based on intensive treatment in order to avoid excessive soil losses (fig. 14).

Equipment limitations differ according to slope, soil wetness, and other factors that restrict or prohibit the use of equipment commonly used in tending and harvesting trees. Equipment limitations are *slight* if the kind of equipment and its season of use are not restricted. Limitations are *moderate* if not all kinds of equipment can be used and if the periods when equipment cannot be used are not more than 3 months long. Limitations are *severe* if the type of equipment that can be used is limited and if the periods when equipment cannot be used are more than 3 months long.

Seedling mortality refers to the mortality of planted tree seedlings as influenced by the kinds of soil or topography when plant competition is not a limiting factor. The rating is *slight* if mortality is expected to be between 0 and 25 percent; *moderate* if between 25 and 50 percent; and *severe* if more than 50 percent.

Windthrow hazard is the danger of trees being blown over by the wind. It is *slight* if trees seldom blow down during storms; effective rooting depth is 20 inches or more. It is *moderate* if trees blow down during storms when soil is excessively wet; effective rooting depth is 10 inches to 20 inches. Windthrow hazard is *severe* if trees often blow down during storms; effective rooting depth is less than 10 inches to bedrock or less than 15 inches to fragipan or claypan.

Plant competition is the invasion or growth of unwanted shrubs, trees, or other plants when openings are made in the canopy by fire, logging, or other factors. Competition is *slight* if competing plants do not prevent the natural regeneration or the early growth of desirable species, or do not interfere with the growth of planted seedlings. Competition is *moderate* if competing plants delay natural or artificial regeneration but do not prevent the growth of a normal, fully stocked stand. Competition is *severe* if competing plants prevent adequate natural restocking or natural regeneration, unless the site is intensively prepared and maintained by weeding or other practices.

Table 4 gives the degree that the hazard, or limitation, will affect management. It also gives important trees, site index, and trees to plant for each woodland suitability group in the county. Site index is the average height of dominant and co-dominant trees at 50 years of age. The site index figures in table 4 refer to the first species listed under "Important Trees." The woodland suitability group for each soil is listed in the "Guide to Mapping Units."

Trees and shrubs for landscaping and windbreaks [4]

Homeowners and landscape architects need to know the kinds of soils in an area before they can make the right choices of trees and shrubs for planting.

People can make plantings needed for controlling erosion, farm and home windbreaks, landscaping building sites, establishing areas for wildlife food and cover, and beautification. Success in establishing the plants can only be expected if the area is properly prepared before planting and unwanted competing plants are controlled for at least 2 years or until the desired plants are established.

The soils in Eaton County have been placed in woody plant groups to indicate general types of suitable shrubs and trees for landscape plantings and windbreaks. These groupings are for soils in their natural state, with the exception of those in group 1. The soils in group 1 have been drained. Each group is made up of soils that are suited to similar kinds of shrubs and trees. Table 5 shows the suitable trees and shrubs for each woody plant group, height at maturity, shape, and shade tolerance.

The woody plant group for each individual soil is given in the "Guide to Mapping Units." Borrow land was not placed in any of the groups because of its variability. The plants listed in each group are some of those commonly used; others may also be suitable. Some of the plants are shown in more than one group because they are suitable for several combinations of circumstances. Many plantings can serve dual purposes: they can provide wildlife food and cover while they also provide windbreaks and environmental improvement.

Wildlife [5]

Proper manipulation of soil, water, and plants to produce suitable habitat is the most effective way to maintain and improve wildlife populations.

Table 6 rates the soils according to their level of suitability for elements of wildlife habitat and for general kinds of wildlife; the ratings are expressed in terms of good, fair, poor, and very poor. A rating of *good* means that habitats are easily improved, maintained, or created. There are few or no soil limitations in habitat management, and satisfactory results can be expected. A *fair* rating indicates that habitats can be improved, maintained, or created on these soils, but moderate soil limitations affect habitat management or development. A moderate intensity of management and fairly frequent attention may be required to insure satisfactory results. A rating of *poor* means that habitats can be improved, maintained, or created on these soils, but the soil limitations are severe. Habitat management may be difficult and expensive and require intensive effort. Results are questionable. A rating of *very poor* indicates that under the prevailing soil conditions, it is impractical to attempt to improve, maintain, or create habitats. Unsatisfactory results are probable.

The seven elements of wildlife habitat for which the soils are rated are explained in the following paragraphs:

Grain and seed crops.—Domestic grain or other seed-producing annuals planted to produce wildlife food. Examples include corn, wheat, oats, rye, barley, buckwheat, millet, sorghum, soybeans, and sunflowers.

Domestic grasses and legumes.—Domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescues, timothy, bromegrass, clovers, orchardgrass, bluegrass, trefoil, alfalfa, crownvetch, sudangrass, and reed canarygrass.

Wild herbaceous plants.—The native or naturally

[4] By JACQUES J. PINKARD, forester, Soil Conservation Service.

[5] CHARLES M. SMITH, biologist, Soil Conservation Service, helped to prepare this section.

TABLE 4.—*Interpretations for management of woodland by woodland suitability groups*

[Borrow land (Bh) is too variable to rate]

Woodland suitability groups and map symbols	Erosion hazard	Equipment limitations	Seedling mortality	Windthrow hazard	Plant competition	Important trees	Site index	Trees to plant
1o1: OwB, OwC, OwD, TuA. For Marlette parts of OwB, Owc, and OwD, see group 2o1.	Slight	Slight	Slight	Slight	Moderate	Northern red oak, black cherry, sugar maple, white oak.	70	Black walnut, black cherry, eastern white pine, white spruce.
2o1: MaB, MaC, MaD, MbC3	Slight	Slight	Slight	Slight	Moderate	Sugar maple, northern red oak, white ash, black walnut.	58–65	White spruce, Norway spruce, black walnut, eastern white pine.
2o2: BbA, HaB, HaC, WnA	Slight	Slight	Slight	Slight	Moderate	Northern red oak, black walnut, white ash, sugar maple.	61–70	Black walnut, eastern white pine, white spruce, yellow-poplar.
2o4: CaA, CbB, KbA, MdA, MeA, Sh. For Marlette part of CbB, see group 2o1; for Sloan part of Sh, see group 2w1.	Slight	Moderate	Slight	Slight	Moderate	Northern red oak, sugar maple, American basswood, black oak.	61–70	White spruce, eastern white pine, eastern cottonwood, Norway spruce.
2r1: MaE	Moderate	Moderate	Slight	Slight	Moderate	Sugar maple, northern red oak, white ash, black walnut.	58–65	White spruce, Norway spruce, black walnut, eastern white pine.
2s5: BnB, BnC, BoB, BoC, BpD, OsB, OsC, SpB, SpC, StB, StC.	Slight	Slight	Moderate	Slight	Moderate	Northern red oak, white oak, shagbark hickory, sugar maple.	61–70	Red pine, eastern white pine, black spruce.
2w1: Ch, Le, Pr, Sb	Slight	Severe	Severe	Severe	Severe	Red maple, eastern cottonwood, silver maple, white ash.	61–70	Eastern cottonwood, white spruce, eastern white pine.
3s3: BrA, WaA, WbA. For ratings of Bronson parts of BrA, see group 2s5.	Slight	Moderate	Moderate	Slight	Slight	Quaking aspen, American beech, red maple, white ash.	56–65	White spruce, Norway spruce, eastern cottonwood.
3w1: Co, Cp, Gf	Slight	Severe	Severe	Severe	Severe	Red maple, white ash, silver maple, pin oak.	51–60	Eastern cottonwood, white spruce, Norway spruce.
4w2: Ad, Ed, Ho, Pa	Slight	Severe	Severe	Severe	Severe	Red maple, white ash, silver maple, quaking aspen.	41–50	Not planted to commercial tree production.

TABLE 5.—*Suitable trees and shrubs for landscaping and windbreaks*
[Suitable plants for windbreaks are shown by asterisk]

Woody plant group and map symbols	Suitable trees and shrubs	20-year height in feet	Shape	Shade tolerance
1: Ad, Ed, Ho, Pa.	*American cranberrybush	10	Oval	No.
	*Amur privet	12	Rounded	No.
	*Austrian pine	22	Pyramidal	No.
	Eastern hemlock	20	Pyramidal	Yes.
	*Eastern white pine	22	Pyramidal	Yes.
	*Green ash	37	Oval	No.
	*Laurel willow	24	Oval	No.
	*Northern white-cedar	29	Columnar	Yes.
	*Nannyberry viburnum	18	Rounded	No.
	*Norway spruce	27	Conical	No.
	Red maple	46	Oval	Yes.
	Red-osier dogwood	9	Mound	Some.
	*Scotch pine	31	Pyramidal	No.
	*Silky dogwood	9	Rounded	No.
	*Tamarack	16	Conical	No.
	*Tatarian honeysuckle	15	Rounded	No.
	*Vanhoutte spirea	7	Rounded	No.
	*White spruce	13	Conical	Some.
2: BrA, CaA, CbB, KbA, MdA, MeA, Sh, WaA, WbA. For Bronson part of BrA, see group 3; for Marlette part of CbB, see group 4; for Sloan part of Sh, see group 5.	American basswood	30	Round	Some.
	*American cranberrybush	8	Oval	No.
	*Amur privet	11	Rounded	No.
	*Austrian pine	22	Pyramidal	No.
	Black walnut	26	Rounded	Some.
	*Blue spruce	9	Conical	No.
	Eastern redcedar	14	Conical	No.
	*Eastern white pine	24	Pyramidal	Yes.
	*Green ash	39	Oval	No.
	*Late lilac	12	Oval	No.
	*Laurel willow	29	Oval	No.
	*Northern white-cedar	23	Columnar	Yes.
	*Norway spruce	26	Conical	Some.
	Red maple	46	Oval	Some.
	*Red pine	26	Pyramidal	No.
	Siberian crabapple	25	Vase	No.
	Silky dogwood	10	Rounded	No.
	Tallpurple willow	25	Oval	No.
	*Tatarian honeysuckle	12	Rounded	No.
	*Vanhoutte spirea	7	Rounded	No.
	*White ash	39	Round	No.
	*White spruce	14	Conical	Some.
	*Whitebelle honeysuckle	10	Rounded	No.
3: BnB, BnC, BoB, BoC, BpD, OsB, OsC, SpB, SpC, StB, StC.	*American mountain ash	23	Oval	No.
	*Amur privet	10	Rounded	No.
	*Autumn-olive	10	Oval	No.
	Creeping juniper	1	Flat	No.
	*Eastern redcedar	20	Conical	No.
	*Eastern white pine	28	Pyramidal	Yes.
	*Hawthorn	20	Rounded	No.
	*Lilac	12	Mound	Some.
	Paper birch	30	Oval	Some.
	*Red pine	30	Pyramidal	No.
	*Scotch pine	30	Pyramidal	No.
	*Siberian crabapple	18	Vase	No.
	*Tatarian honeysuckle	8	Rounded	No.
	*Vanhoutte spirea	6	Rounded	No.
	*White spruce	12	Pyramidal	Some.

TABLE 5.—*Suitable trees and shrubs for landscaping and windbreaks*—Continued

Woody plant group and map symbols	Suitable trees and shrubs	20-year height in feet	Shape	Shade tolerance
4: BbA, HaB, HaC, MaB, MaC, MaD, MaE, MbC3, OwB, OwC, OwD, TuA, WnA.	American basswood	35	Round	Some.
	*Amur privet	12	Rounded	No.
	Austrian pine	25	Pyramidal	No.
	*Autumn-olive	15	Oval	No.
	Black walnut	23	Round	Yes.
	*Eastern white pine	28	Pyramidal	Yes.
	Flowering dogwood	13	Flat-top	Yes.
	Green ash	49	Oval	No.
	Hackberry	28	Pyramidal	Some.
	*Juneberry	12	Oval	Yes.
	*Late lilac	14	Oval	No.
	*Laurel willow	25	Oval	No.
	*Lilac	14	Oval	Yes.
	*Northern pin oak	28	Pyramidal	No.
	*Northern white-cedar	19	Columnar	Yes.
	*Norway spruce	26	Conical	No.
	*Red pine	22	Pyramidal	No.
	*Scotch pine	31	Pyramidal	No.
	Shagbark hickory	30	Oval	Some.
	Silky dogwood	9	Rounded	No.
	*Tatarian honeysuckle	7	Rounded	No.
	*White spruce	20	Conical	Yes.
	*Vanhoutte spirea	7	Rounded	No.
	*Whitebelle honeysuckle	9	Rounded	No.
5: Ch, Co, Cp, Gf, Le, Pr, Sb.	American elder	9	Rounded	No.
	American sycamore	27	Rounded	Yes.
	*Amur privet	8	Rounded	No.
	*Arrowwood	12	Rounded	No.
	Eastern hemlock	21	Pyramidal	Yes.
	*Eastern white pine	17	Pyramidal	Yes.
	Green ash	25	Oval	No.
	*Hawthorn	15	Rounded	No.
	*Laurel willow	22	Oval	No.
	*Northern white-cedar	21	Columnar	Yes.
	Paper birch	31	Oval	Some.
	*Siberian crabapple	15	Vase	No.
	*Silky dogwood	8	Rounded	No.
	*Tamarack	16	Pyramidal	No.
	White spruce	10	Pyramidal	No.
	*Whitebelle honeysuckle	10	Rounded	No.

established herbaceous grasses and forbs (including weeds), commonly grown on upland areas, that provide food and cover for wildlife. Among these are goldenrod, ragweed, nightshade, strawberry, lambsquarters, dandelions, and native grasses.

Hardwood trees.—Deciduous trees and associated woody understory plants that provide wildlife cover or that produce nuts, buds, catkins, sprouts, twigs, bark, or foliage used for food by wildlife. Representative species are maple, beech, hazelnut, oak, poplar, birch, hickory, willow, cherry, paw paw, ash, walnut, mulberry, elm, hawthorn, basswood, and serviceberry.

Coniferous plants.—Cone-bearing trees, shrubs, or ground cover that furnishes wildlife cover or food in the form of browse, seeds, or fruitlike cones. They may be planted or transplanted but are commonly established through natural processes. Examples are pine, spruce, fir, cedar, larch, juniper, and yew.

Wetland plants.—Annual or perennial wild herbaceous plants of moist to wet sites, exclusive of submerged or floating aquatics, that produce food or cover used extensively by wetland wildlife. Examples are smartweed, wild millet, rushes, sedges, reeds, wildrice, cattail, arrowhead, pickerelweed, and water plantain.

Shallow water areas.—Areas of surface water that have an average depth of less than 5 feet and that are useful to wildlife. They may be natural wet areas or those created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife ponds, and beaver ponds.

The ratings in table 6 for elements of wildlife habitat and for kinds of wildlife apply to wildlife in general and not to a specific species. Not considered, therefore, are present land use, existing vegetation, and the extent of artificial drainage provided, because these factors are subject to change. Also not considered is the ability of wildlife to move from place to place.

The three kinds of wildlife for which the soils are rated are discussed in the following paragraphs:

Open-land wildlife.—Birds and mammals of cropland, pastures, meadows, lawns, and areas overgrown with grasses, herbs, shrubs, and vines. Examples are bobwhite quail, hawks, ring-necked pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, woodchuck, skunk, and weasel.

Woodland wildlife.—Birds and mammals of wooded areas containing hardwood or coniferous trees and shrubs, or a mixture of both. Examples are ruffed grouse, opossum, raccoon, white-tailed deer, woodcock, thrushes, vireos, woodpeckers, tree squirrels, gray fox, warblers, nuthatches, and owls.

Wetland wildlife.—Birds and mammals of swampy, marshy, or open-water areas. Examples are ducks, geese, herons, bitterns, rails, kingfishers, cranes, muskrat, mink, and beaver.

Recreational Development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 7 the soils of Eaton County are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails.

In table 7 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of cobbles and coarse fragments, freedom from flooding during periods of use, and a surface that is firm after rains but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used mainly for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry; are free of flooding during the season of use; and do not have slopes or stoniness that greatly increase cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or on motorcycle or horseback (fig. 15). Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Engineering Uses of the Soils [6]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movements of vehicles and construction equipment.

[6] KEITH I. BAKEMAN, engineer, Soil Conservation Service, helped to prepare this section.

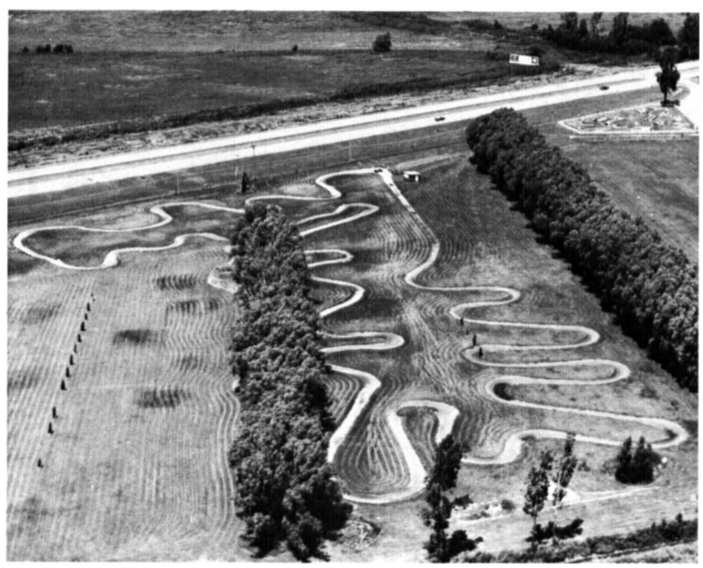

Figure 15.—**Small private recreational enterprise on Gilford sandy loam and Adrian muck; used for minibike and gocart riding, miniature golf, and a golf driving range. This area has been tile drained to remove excess water.**

TABLE 6.—*Suitability of soils for elements of wildlife habitat and as habitat for kinds of wildlife*

Soil series and map symbols	Suitability for elements of habitat							Suitability as habitat for—		
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Open-land wildlife	Woodland wildlife	Wetland wildlife
Adrian: Ad	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Bixby: BbA	Good	Good	Good	Good	Good	Good	Very poor.	Good	Good	Very poor.
Borrow land: Bh. Soil material too variable to rate.										
Boyer: BnB, BnC, BpD For Spinks part of BpD, see Spinks series.	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
BoB	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
BoC	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Brady: BrA For Bronson part, see Bronson series.	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Bronson Mapped only in a complex with Brady soils.	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Capac:										
CaA	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
CbB For Marlette part, see MaB of Marlette series.	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Cohoctah: Ch [1]	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Colwood:										
Co	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Cp [1]	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Edwards: Ed	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Gilford: Gf	Poor [1]	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Hillsdale:										
HaB	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
HaC	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Houghton: Ho [1]	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Kibbie: KbA	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Lenawee: Le [1]	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.

Marlette:										
MaB	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
MaC, MbC3	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MaD, MaE	Poor	Fair	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Matherton: MdA	Good	Good	Good	Good	Fair	Fair	Fair	Good	Good	Fair.
Metamora: MeA	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
For Capac part, see Capac series.										
Metea: Mapped only in complex with Spinks soils.										
Metea part of StB	Poor	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
Metea part of StC	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Oshtemo:										
OsB	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
OsC	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Owosso:										
OwB	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
For Marlette part, see MaB of Marlette series.										
OwC	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
For Marlette part, see MaC of Marlette series.										
OwD	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
For Marlette part, see MaD of Marlette series.										
Palms: Pa[1]	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Parkhill: Pr	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Sebewa: Sb	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Shoals: Sh	Poor	Fair	Fair	Good	Good	Fair	Fair	Fair	Good	Fair.
For Sloan part, see Sloan series.										
Sloan	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Mapped only in a complex with Shoals soils.										
Spinks:										
SpB, StB	Poor	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
For Metea part of StB, see Metea series.										
SpC, StC	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
For Metea part of StC, see Metea series.										
Tuscola: TuA	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Wasepi: WaA	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Wasepi variant: WbA	Fair	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
Winneshiek: WnA	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.

[1] Ratings made for undrained soils.

TABLE 7.—*Estimated degree and kind of limitation for recreation*

[An asterisk in the first column indicates that at least one mapping unit is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and it is necessary to follow carefully the instructions for referring to other series as indicated]

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Adrian: Ad	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; dusty.
Bixby: BbA	Slight	Slight	Slight	Slight.
Borrow land: Bh. Properties too variable to be rated. Onsite investigation needed.				
*Boyer:				
BnB	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy; slope.	Moderate: too sandy.
BnC	Moderate: too sandy; slope.	Moderate: too sandy; slope.	Severe: slope	Moderate: too sandy.
BoB	Slight	Slight	Moderate: slope	Slight.
BoC	Moderate: slope	Moderate: slope	Severe: slope	Slight.
BpD For Spinks part of BpD, see Spinks series.	Severe: slope	Severe: slope	Severe: slope	Moderate: too sandy; slope.
*Brady: BrA For Bronson part, see Bronson series.	Severe: wetness [1]	Moderate: wetness.	Severe: wetness [1]	Moderate: wetness.
Bronson Mapped only in a complex with Brady soils.	Moderate: wetness.[1]	Slight	Moderate: wetness.[1]	Slight.
*Capac: CaA, CbB For Marlette part of CbB, see MaB of Marlette series.	Severe: wetness [1]	Moderate: wetness.	Severe: wetness [1]	Moderate: wetness.
Cohoctah: Ch	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.
Colwood:				
Co	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Cp	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.
Edwards: Ed	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; dusty.
Gilford: Gf	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Hillsdale:				
HaB	Slight	Slight	Moderate: slope	Slight.
HaC	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Houghton: Ho	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; dusty.
Kibbie: KbA	Severe: wetness [1]	Moderate: wetness.	Severe: wetness [1]	Moderate: wetness.

TABLE 7.—*Estimated degree and kind of limitation for recreation*—Continued

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lenawee: Le	Severe: wetness; flooding.	Severe: wetness	Severe: wetness; flooding.	Severe: wetness.
Marlette:				
MaB	Slight	Slight	Moderate: slope	Slight.
MaC	Moderate: slope	Moderate: slope	Severe: slope	Slight.
MbC3	Moderate: slope; too clayey.	Moderate: slope; too clayey.	Severe: slope	Moderate: too clayey.
MaD, MaE	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Matherton: MdA	Severe: wetness [1]	Moderate: wetness.	Severe: wetness [1]	Moderate: wetness.
*Metamora: MeA For Capac part, see Capac series.	Severe: wetness [1]	Moderate: wetness.	Severe: wetness [1]	Moderate: wetness.
Metea: Mapped only in complexes with Spinks soils.				
Metea part of StB	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope; too sandy.	Moderate: too sandy.
Metea part of StC	Moderate: slope; too sandy.	Moderate: slope; too sandy.	Severe: slope	Moderate: too sandy.
Oshtemo:				
OsB	Slight	Slight	Moderate: slope	Slight.
OsC	Moderate: slope	Moderate: slope	Severe: slope	Slight.
*Owosso:				
OwB For Marlette part, see MaB of Marlette series.	Slight	Slight	Moderate: slope	Slight.
OwC For Marlette part, see MaC of Marlette series.	Moderate: slope	Moderate: slope	Severe: slope	Slight.
OwD For Marlette part, see MaD of Marlette series.	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Palms: Pa	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; soil blowing.	Severe: wetness; floods; excess humus; dusty.
Parkhill: Pr	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Sebewa: Sb	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
*Shoals: Sh For Sloan part, see Sloan series.	Severe: wetness; floods.	Moderate: wetness; floods.	Severe: wetness; floods.	Moderate: wetness; floods.
Sloan Mapped only in a complex with Shoals soils.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.
*Spinks:				
SpB, StB For Metea part of StB, see Metea series.	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope; too sandy.	Moderate: too sandy.
SpC, StC For Metea part of StC, see Metea series.	Moderate: slope; too sandy.	Moderate: slope; too sandy.	Severe: slope	Moderate: too sandy.
Spinks part of BpD	Severe: slope	Severe: slope	Severe: slope	Moderate: too sandy; slope.

TABLE 7.—*Estimated degree and kind of limitation for recreation*—Continued

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Tuscola: TuA	Moderate: wetness.[1]	Slight	Moderate: slope; wetness.[1]	Slight.
Wasepi: WaA	Severe: wetness[1]	Moderate: wetness.[1]	Severe: wetness[1]	Moderate: wetness.
Wasepi variant: WbA	Severe: wetness[1]	Moderate: wetness.	Severe: wetness[1]	Moderate: wetness.
Winneshiek: WnA	Slight	Slight	Slight	Slight.

[1] If season of use is only from June to October, rate soil limitation one class better.

7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 8, 9, and 10. Table 8 shows several estimated soil properties significant to engineering; tables 9 and 10 show interpretations for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 9 and 10, and it also can be used to make other useful maps.

This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many mapped areas of a given soil may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have different meanings in soil science than in engineering. The "Glossary" defines many of these terms as they are commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system, used by SCS engineers, the Department of Defense, and others, and the AASHTO system, adopted by the American Association of State Highway and Transportation Officials.

In the Unified system (*2*), soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are gouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes, for example, CL-ML.

The AASHTO system (*1*) is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups, ranging from A–1 through A–7, on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. The estimated AASHTO classification for the soils in Eaton County is given in table 8 for all soils mapped in the survey area.

Soil properties significant in engineering

Estimates of several soil properties significant in engineering are given in table 8. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the column headings in table 8.

Depth to seasonal high water table is distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 8 in the standard terms used by the United States Department of Agriculture (USDA). These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used are defined in the Glossary of this soil survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic state, and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 8.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 8 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed as pH. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume of soil material to be expected with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to the maintenance of structures built in, on, or with material having this rating. Shrink-swell potential is not indicated for organic soils or for certain soils that shrink markedly on drying but do not swell quickly when wet.

Corrosivity pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Depth to bedrock is the distance from the surface of the soil to a rock layer. Most of the soils in the county are deep enough over bedrock that the bedrock does not affect their use. In Winneshiek soils, limestone is at a depth of about 26 inches; in Wasepi variant soils sandstone is at a depth of about 26 inches. No column for depth to bedrock is given in table 8.

Engineering interpretations of the soils

The estimated interpretations in tables 9 and 10 are based on the engineering properties of soils shown in table 8, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Eaton County (*4*). In the tables, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for pond reservoirs, embankments, drainage, irrigation, terraces and diversions, and grassed waterways. For these particular uses, table 10 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties generally are favorable for the rated use, or that limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation and special designs. For some uses, the rating of severe is divided to obtain ratings of severe and very severe. *Very severe* means one or more soil properties are so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly is not practical for the rated use.

Soil suitability is rated by the terms *good, fair,* and *poor*, which have meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 9.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between the depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects layout and construction and also the risk of erosion, lateral seepage, and downslope flow of effluent. Large rock or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids (fig. 16, p. 78). A lagoon has a nearly level floor; its sides, or embankments, are of soil material compacted to medium density, and the pond is protected from flooding. Properties that affect the pond floor are permeability, organic matter, and slope, and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Trench-type sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 8 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. Even though reliable predictions can be made to a depth of 10 or 15 feet for

TABLE 8.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit is made up of two or more kinds of soil. The soils in such for referring to other series as indicated. The

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
	Ft	*In*				*Pct*
Adrian: Ad	0	0–29	Muck (sapric)	Pt		
		29–60	Fine sand and sand	SP or SP-SM	A-3	
Bixby: BbA	>6	0–13	Loam	ML	A-4	
		13–22	Heavy loam	CL or CL-ML	A-4 or A-6	
		22–39	Sandy clay loam and sandy loam.	SM or SC	A-2 or A-4	0–3
		39–60	Coarse sand, loamy sand, and gravelly sandy loam.	SP, SP-SM, or SM	A-1 or A-3	0–3
Borrow land: Bh. Properties too variable to estimate.						
*Boyer: BnB, BnC, BoB, BoC, BpD. For Spinks part of BpD, see the Spinks series.	>5	0–12	Sandy loam	SM	A-2	
		12–21	Light sandy clay loam.	SM or SC	A-2 or A-4	0–2
		21–38	Light sandy loam and loamy sand.	SM	A-2	0–2
		38–60	Gravelly coarse sand	SP	A-1	0–5
*Brady: BrA. For Bronson part, see the Bronson series.	1–2	0–23	Sandy loam or heavy loamy sand.	SM	A-2	
		23–37	Heavy sandy loam	SM or SC	A-2, A-4, or A-6	0–3
		37–56	Loamy sand	SM	A-2	0–3
		56–60	Coarse sand	SP	A-1	0–5
Bronson. Mapped only in a complex with Brady soils.	2–3.5	0–38	Sandy loam and heavy sandy loam.	SM	A-2	
		38–47	Heavy loamy sand	SM	A-2	
		47–60	Sand	SP or SP-SM	A-3	
*Capac: CaA, CbB. For Marlette part of CbB, see the Marlette series.	1–2	0–9	Loam	CL or CL-ML	A-4	
		9–24	Clay loam, heavy loam.	CL	A-6	0–3
		24–30	Heavy loam	CL	A-6	0–3
		30–60	Loam	ML or CL-ML	A-4	0–3
Cohoctah: Ch	<1	0–30	Fine sandy loam and sandy loam.	SM	A-2 or A-4	
		30–37	Loamy sand	SM	A-2	
		37–41	Loam	CL or CL-CM	A-4	
		41–60	Sand and coarse sand.	SP or SP-SM	A-1 or A-3	
Colwood: Co, Cp	<1.5	0–15	Loam	ML	A-4	
		15–24	Silt loam	SM-SC or CL-ML	A-2 or A-4	
		24–33	Light silty clay loam	CL	A-6	
		33–54	Silt loam	ML	A-4	
		54–60	Stratified silts and fine sands.	SM or ML	A-2 or A-4	
Edwards: Ed	0	0–35	Muck (sapric)	Pt		
		35–60	Marl			
Gilford: Gf	<1	0–21	Sandy loam	SM or SM-SC	A-2	
		21–26	Light sandy clay loam.	SC or SM-SC	A-4	
		26–33	Coarse sandy loam	SM	A-2	
		33–60	Coarse sand	SP	A-1	

significant in engineering

mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions symbol < means less than; > means more than]

Percentage less than 3 inches passing sieve— No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	Liquid limit	Plasticity index	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Corrosivity to— Uncoated steel	Corrosivity to— Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*			
						6.0–10	0.35–0.45	6.1–7.8		High	Low.
100	95–100	50–75	0–10		[1]NP	6.0–20	0.05–0.07	7.4–8.4	Low	High	Moderate.
95–100	90–95	80–90	60–70	18–38	2–9	2.0–6.0	0.15–0.19	5.6–6.5	Moderate	Low	Moderate.
95–100	95–100	75–90	70–85	24–38	8–15	0.6–2.0	0.16–0.19	4.5–5.0	Moderate	Low	High.
95–100	90–100	70–85	30–40	15–30	4–10	0.6–2.0	0.14–0.17	4.5–6.0	Moderate	Low	High.
95–100	80–85	45–60	0–25		NP	6.0–20	0.03–0.10	6.6–7.3	Low	Low	Low.
95–100	90–95	55–70	15–35	<20	NP–6	2.0–20	0.10–0.15	5.1–6.5	Low	Low	Moderate.
95–100	85–95	55–70	25–40	15–25	2–9	2.0–6.0	0.15–0.18	5.1–5.5	Low	Low	High.
90–100	85–95	50–65	15–35	10–15	NP–4	2.0–6.0	0.09–0.13	5.6–6.5	Low	Low	Moderate.
80–90	60–80	40–50	<5		NP	>20	0.02–0.04	7.9–8.4	Low	Low	Low.
95–100	90–100	60–70	25–35	12–22	NP–4	2.0–6.0	0.12–0.15	5.6–6.5	Low	Low	Moderate.
95–100	90–95	60–75	30–40	12–30	3–14	2.0–6.0	0.13–0.16	5.6–6.0	Low	Low	Moderate.
95–100	90–95	55–70	15–25		NP	6.0–20	0.08–0.10	6.6–7.3	Low	Low	Low.
85–95	80–90	25–45	<5		NP	6.0–20	0.02–0.04	7.4–7.8	Low	Low	Low.
95–100	90–100	55–70	20–35	12–22	NP–4	2.0–6.0	0.11–0.15	5.6–6.0	Low	Low	Low.
95–100	90–100	60–70	15–30		NP	6.0–20	0.09–0.11	5.6–6.0	Low	Low	Low.
90–95	90–95	50–70	0–10		NP	6.0–20	0.05–0.07	6.6–7.3	Low	Low	Low.
90–100	90–100	85–95	60–70	20–30	4–10	0.6–2.0	0.18–0.22	6.1–6.5	Low	High	Low.
90–100	90–100	90–95	60–70	33–40	15–22	0.2–2.0	0.15–0.19	6.1–6.5	Low	High	Low.
95–100	90–100	85–95	60–70	33–35	15–18	0.2–2.0	0.15–0.19	6.1–7.3	Low	High	Low.
85–95	85–90	70–85	50–60	20–35	4–9	0.2–0.6	0.15–0.19	7.4–7.8	Low	High	Low.
100	100	85–95	30–45	10–25	NP–6	2.0–6.0	0.13–0.18	7.4–7.8	Low	High	Low.
100	100	60–70	15–30	<10	NP–4	6.0–20	0.10–0.13	7.4–7.8	Low	High	Low.
100	100	70–90	50–70	18–30	3–10	2.0–6.0	0.17–0.19	7.4–7.8	Low	High	Low.
90–100	90–100	40–70	0–10		NP	6.0–20	0.03–0.07	7.4–7.8	Low	High	Low.
100	100	80–90	60–70	25–35	3–10	0.6–2.0	0.20–0.22	6.1–6.5	Low	High	Low.
100	100	80–90	30–55	15–25	5–7	0.6–2.0	0.13–0.17	6.1–6.5	Low	High	Low.
100	100	90–100	70–85	30–35	13–20	0.6–2.0	0.19–0.21	6.6–7.3	Low	High	Low.
100	100	90–100	70–90	25–35	3–10	0.6–2.0	0.20–0.22	7.4–7.8	Low	High	Low.
100	100	70–100	30–75	25–35	3–10	0.6–2.0	0.15–0.17	7.4–7.8	Low	High	Low.
						6.0–10	0.35–0.45	6.6–7.8		High	Low.
100	95–100	80–90	60–80					7.9–8.4		High	Low.
95–100	90–100	65–75	20–35	12–25	2–6	2.0–6.0	0.13–0.15	6.1–6.5	Low	High	Low.
90–100	85–95	75–85	36–45	25–30	5–10	2.0–6.0	0.16–0.18	6.1–6.5	Low	High	Low.
90–100	85–95	55–65	20–35	<20	NP–5	2.0–6.0	0.12–0.14	6.6–7.3	Low	High	Low.
80–95	75–85	40–50	0–5		NP	6.0–20	0.05–0.07	7.4–7.8	Low	High	Low.

TABLE 8.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
	Ft	*In*				*Pct*
Hillsdale: HaB, HaC	>5	0–22	Sandy loam	SM or SM–SC	A–2	0–3
		22–60	Fine sandy loam	SM or SM–SC	A–4	0–5
Houghton: Ho	0	0–60	Muck (sapric)	Pt		
Kibbie: KbA	1.5–2	0–9	Fine sandy loam	SM or SM–SC	A–4	
		9–30	Loam and heavy loam.	CL or CL–ML	A–4	
		30–60	Silt loam, loamy fine sand, and very fine sand.	ML, SM, or SM–SC	A–2 or A–4	
Lenawee: Le	<1	0–9	Silty clay loam	CL	A–6	
		9–30	Heavy silty clay loam and silty clay loam.	CL or CH	A–6 or A–7	
		30–60	Silty clay loam	CL	A–6	
Marlette: MaB, MaC, MaD, MaE, MbC3.	2.5–>5	0–9	Loam	ML, CL, or CL–ML	A–4	0–3
		9–38	Clay loam	CL or CL–ML	A–6 or A–4	0–5
		38–60	Loam	CL–ML or CL	A–4 or A–6	0–5
Matherton: MdA	1–2	0–11	Loam	CL or CL–ML	A–4	0–5
		11–35	Light clay loam and clay loam.	CL	A–6	0–5
		35–38	Sandy loam	SM or SM–SC	A–2	0–5
		38–60	Coarse sand	SP or SP–SM	A–1 or A–3	0–10
*Metamora: MeA For the Capac part, see Capac series.	1–2	0–29	Sandy loam	SM or SM–SC	A–2	0–3
		29–35	Light sandy clay loam.	SC or SM–SC	A–4 or A–6	0–3
		35–43	Clay loam	CL	A–6	
		43–60	Loam	CL–ML or CL	A–4 or A–6	
*Metea Mapped only in complexes with Spinks soils.	>6	0–31	Loamy sand	SM	A–2	
		31–35	Loam	ML or CL–ML	A–4	
		35–43	Light clay loam	CL	A–6	
		43–60	Loam	ML or CL–ML	A–4	
Oshtemo: OsB, OsC	>5	0–38	Sandy loam	SM or SM–SC	A–2	0–3
		38–46	Heavy sandy loam	SM or SM–SC	A–2	0–5
		46–60	Sand and coarse sand.	SP, SP–SM	A–1	0–3
*Owosso: OwB, OwC, OwD For the Marlette part, see Marlette series.	>4	0–31	Sandy loam and heavy sandy loam.	SM or SM–SC	A–2	
		31–41	Clay loam	CL	A–6	0–3
		41–60	Loam	ML or CL–ML	A–4	0–3
Palms: Pa	0	0–34	Muck (sapric)	Pt		
		34–60	Heavy silt loam	CL–ML, CL	A–4 or A–6	
Parkhill: Pr	<1.5	0–9	Loam	ML or CL–ML	A–4	
		9–34	Clay loam	CL	A–6	0–3
		34–60	Heavy loam and loam.	CL–ML or CL	A–4 or A–6	0–3
Sebewa: Sb	<1	0–14	Loam	ML, CL–ML or CL	A–4	
		14–36	Sandy clay loam, clay loam, and gravelly clay loam.	SC or CL	A–6	
		36–60	Gravelly sand	SP	A–1	0–5

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*			
95–100	90–100	60–75	20–35	12–29	2–8	2.0–6.0	0.12–0.15	4.5–6.0	Low	Low	High.
95–100	90–100	65–75	36–50	15–22	3–6	0.6–6.0	0.14–0.17	4.5–5.5	Low	Low	High.
						6.0–10	0.35–0.45	6.6–7.3		High	Low.
100	100	75–85	40–50	18–25	2–8	0.6–2.0	0.16–0.18	6.1–6.5	Low	High	Low.
100	100	90–95	70–85	18–28	6–10	0.6–2.0	0.17–0.19	6.6–7.3	Low	High	Low.
100	100	70–100	30–70	<25	NP–6	0.6–2.0	0.12–0.18	7.4–7.8	Low	High	Low.
100	100	95–100	80–95	28–38	11–22	0.6–2.0	0.20–0.22	6.1–6.5	Moderate	High	Low.
100	100	95–100	85–95	35–55	11–30	0.2–0.6	0.15–0.19	6.6–7.8	Moderate	High	Low.
100	100	95–100	80–90	28–38	11–24	0.2–0.6	0.18–0.20	7.4–7.8	Moderate	High	Low.
95–100	95–100	80–95	60–70	16–30	3–10	0.6–2.0	0.20–0.22	6.6–7.3	Low	Moderate	Low.
95–100	90–100	85–95	65–80	24–38	6–20	0.2–2.0	0.14–0.19	5.6–6.5	Low	Moderate	Moderate.
95–100	85–95	80–90	60–75	16–35	6–15	0.6–2.0	0.15–0.19	7.4–7.8	Low	Moderate	Low.
95–100	90–100	80–95	60–75	16–30	5–10	2.0–6.0	0.18–0.22	6.1–6.5	Low	High	Low.
95–100	85–95	85–95	65–80	26–36	13–20	0.6–2.0	0.15–0.19	6.1–7.3	Low	High	Low.
90–100	85–100	60–70	25–35	10–22	2–6	2.0–6.0	0.12–0.14	6.6–7.3	Low	High	Low.
85–95	80–90	40–60	0–10		NP	6.0–20	0.02–0.04	7.9–8.4	Low	High	Low.
95–100	95–100	60–70	20–35	10–22	2–6	2.0–6.0	0.12–0.15	6.1–6.5	Low	Moderate	Low.
95–100	90–100	80–90	36–50	25–35	4–15	2.0–6.0	0.16–0.18	6.1–6.5	Low	Moderate	Low.
95–100	95–100	85–100	70–85	25–35	13–18	0.2–0.6	0.15–0.18	7.4–7.8	Moderate	High	Low.
95–100	95–100	80–95	60–75	16–30	6–14	0.2–0.6	0.14–0.18	7.4–7.8	Low	High	Low.
100	100	55–60	15–25		NP	>20	0.09–0.12	6.1–7.3	Low	Low	Low.
100	95–100	85–90	60–75	20–35	4–8	0.6–2.0	0.17–0.19	6.6–7.3	Low	Low	Low.
100	90–95	85–95	65–75	35–40	17–20	0.2–0.6	0.15–0.19	6.6–7.3	Moderate	Moderate	Low.
100	90–100	80–95	60–75	20–35	4–8	0.2–0.6	0.17–0.19	7.4–7.8	Low	Low	Low.
95–100	90–95	60–70	25–35	12–25	2–7	2.0–6.0	0.12–0.15	5.6–6.5	Low	Low	Moderate.
95–100	85–95	65–70	25–35	12–30	2–7	2.0–6.0	0.12–0.15	6.1–6.5	Low	Low	Moderate.
80–85	75–85	40–50	0–10		NP	6.0–20	0.02–0.04	6.6–7.8	Low	Low	Low.
100	90–100	55–70	25–35	12–30	2–6	2.0–6.0	0.13–0.15	6.1–7.3	Low	Low	Moderate.
95–100	90–95	85–95	70–80	30–40	12–22	0.2–0.6	0.14–0.19	6.6–7.3	Moderate	Moderate	Low.
95–100	90–95	85–95	60–75	25–35	4–10	0.2–0.6	0.17–0.19	7.4–7.8	Moderate	Moderate	Low.
						6.0–10	0.35–0.45	6.6–7.8		High	Low.
100	95–100	85–95	65–80	>28	4–15	0.6–2.0	0.17–0.20	7.9–8.4	Low	High	Low.
100	95–100	85–95	60–75	23–37	4–9	0.6–2.0	0.20–0.22	6.1–6.6	Low	High	Low.
95–100	90–100	85–95	70–80	30–40	12–20	0.2–0.6	0.15–0.19	6.1–7.3	Low	High	Low.
95–100	90–100	85–90	65–75	15–35	6–14	0.2–0.6	0.14–0.19	7.4–8.4	Low	High	Low.
100	95–100	85–95	60–70	20–35	4–10	0.6–2.0	0.20–0.22	6.6–7.3	Low	High	Low.
95–100	80–95	75–85	40–75	25–38	12–20	0.6–2.0	0.16–0.18	7.4–7.8	Low	High	Low.
60–90	35–75	20–40	0–5		NP	6.0–20	0.02–0.04	7.4–7.8	Low	High	Low.

TABLE 8.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
	Ft	*In*				*Pct*
*Shoals: Sh	1–2	0–9	Loam	ML, CL–ML, or CL	A–4	
For the Sloan part, see Sloan series.		9–52	Silt loam	ML or CL–ML	A–4	
		52–60	Fine sand and very fine sand.	SM	A–4 or A–2	
Sloan	<1	0–18	Loam	ML, CL–ML, or CL	A–4	
Mapped only in complex with Shoals soils.		18–32	Silt loam	ML	A–4	
		32–41	Sandy loam	SM or ML	A–2 or A–4	
		41–60	Gravelly sand and very coarse sand.	SP	A–1	
*Spinks: SpB, SpC, StB, StC	>6	0–26	Loamy sand or light loamy sand.	SM or SP–SM	A–2 or A–3	
For the Metea part of StB and StC, see Metea series.		26–58	Layers of sand and heavy loamy sand.	SM or SP–SM	A–2	
		58–60	Sand	SP or SP–SM	A–3	
Tuscola: TuA	2–3.5	0–9	Fine sandy loam	SM, SC–SM, CL–ML, or ML	A–4	
		9–31	Loam and light silty clay loam.	CL–ML or CL	A–4 or A–6	
		31–60	Stratified silt loam, very fine sand, and fine sand.	SM, ML	A–4	
Wasepi: WaA	1–2	0–25	Sandy loam	SM or SC–SM	A–2	
		25–33	Heavy sandy loam and light sandy clay loam.	SC	A–6	
		33–37	Light loamy sand	SM	A–1 or A–2	
		37–60	Coarse sand and very coarse sand.	SP	A–1	
Wasepi variant: WbA	1–2	0–19	Sandy loam	SM	A–2 or A–4	
		19–26	Heavy sandy loam	SM, SC–SM, or SC	A–2 or A–4	0–5
		26	Sandstone.			
Winneshiek: WnA	>4	0–12	Silt loam	ML	A–4	
		12–17	Loam	ML or CL–ML	A–4	
		17–26	Clay loam and heavy clay loam.	CL	A–6	
		26	Limestone.			

[1] NP means nonplastic.

some soils, every site should be investigated before it is selected.

Area-type sanitary landfill is a method of disposing of refuse by placing it on the surface of soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material, at least 2 feet thick, is placed over the fill when it is completed.

Local roads and streets, as rated in table 9, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation *significant in engineering*—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*			
100	95–100	85–95	60–70	20–35	4–10	0.6–2.0	0.20–0.22	6.6–7.3	Low	High	Low.
100	100	90–100	70–90	25–35	3–10	0.6–2.0	0.20–0.22	6.6–7.8	Low	High	Low.
100	100	70–85	25–50	---	NP–10	6.0–20	0.04–0.08	7.4–7.8	Low	High	Low.
100	95–100	85–95	60–70	20–35	4–10	0.6–2.0	0.20–0.22	6.1–7.3	Low	High	Low.
100	100	90–100	70–90	25–35	3–10	0.6–2.0	0.20–0.22	6.6–7.3	Low	High	Low.
100	100	60–80	30–55	<25	NP–4	2.0–6.0	0.13–0.16	6.1–6.5	Low	High	Low.
80–100	70–80	40–50	0–5	---	NP	6.0–20	0.02–0.04	7.4–7.8	Low	High	Low.
100	95–100	50–70	5–20	---	NP	6.0–20	0.07–0.10	6.1–6.5	Low	Low	Low.
100	95–100	60–70	10–25	---	NP	2.0–20	0.06–0.08	6.6–7.3	Low	Low	High.
100	95–100	50–75	0–10	---	NP	6.0–20	0.05–0.07	7.4–7.8	Low	Low	Low.
100	100	70–85	40–55	15–30	4–9	2.0–6.0	0.16–0.18	6.1–6.5	Low	Moderate	Moderate.
100	100	85–95	60–90	14–40	6–20	0.6–2.0	0.18–0.20	5.6–6.5	Moderate	Moderate	Moderate.
100	100	75–90	40–90	<25	NP–4	0.6–2.0	0.15–0.17	7.4–8.4	Low	Moderate	Low.
100	85–95	60–70	25–35	12–22	NP–7	2.0–6.0	0.13–0.15	6.1–7.3	Low	Moderate	Low.
90–95	85–95	75–85	36–45	25–30	12–16	2.0–6.0	0.16–0.18	6.1–6.5	Low	Moderate	Low.
95–100	90–100	45–60	15–25	---	NP	6.0–20	0.09–0.11	6.6–7.3	Low	Moderate	Low.
70–90	60–80	40–50	<5	---	NP	6.0–20	0.02–0.04	7.4–7.8	Low	Moderate	Low.
95–100	90–100	60–95	25–40	---	NP–7	2.0–6.0	0.13–0.15	5.6–6.5	Low	Moderate	Low.
90–100	85–95	60–70	20–40	15–30	2–12	2.0–6.0	0.12–0.17	5.6–6.0	Low	Moderate	Low.
90–100	90–100	90–100	70–90	25–35	3–10	0.6–2.0	0.20–0.22	6.1–7.3	Moderate	High	Low.
90–100	90–100	80–95	60–75	20–35	4–8	0.2–0.6	0.17–0.19	6.6–7.3	Moderate	High	Low.
90–100	90–100	90–100	60–80	29–40	12–23	0.2–0.6	0.16–0.20	6.6–7.3	High	High	Low.

and amount of cut and fill needed to reach an even grade.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewerlines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings and small commercial buildings referred to in table 9 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation do 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 bed-

TABLE 9.—*Engineering interpretations of soils for*

[An asterisk in the first column indicates that at least one mapping unit is made up of two or more kinds of soil. The soils in such for referring to other series as indicated. "Seepage," "Area reclaim," and some other

Soil series and map symbols	Degree and kind of limitation for—			
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill (trench)	Sanitary landfill (area)
Adrian: Ad	Severe: wetness; floods.	Severe: seepage; wetness; excess humus.	Severe: wetness; seepage; floods.	Severe: wetness; seepage; floods.
Bixby: BbA	Slight [1]	Severe: seepage	Severe: seepage	Slight
Borrow land: Bh. Properties too variable to be interpreted; onsite inspection needed.				
*Boyer:				
BnB	Slight [1]	Severe: seepage	Severe: seepage	Severe: seepage
BnC	Moderate: [1] slope.	Severe: seepage	Severe: seepage	Severe: seepage
BoB	Slight [1]	Severe: seepage	Severe: seepage	Severe: seepage
BoC	Moderate: [1] slope.	Severe: slope; seepage.	Severe: seepage	Severe: seepage
BpD For Spinks part of BpD, see Spinks series.	Severe: [1] slope	Severe: slope; seepage.	Severe: seepage	Severe: seepage; slope.
*Brady: BrA For Bronson part, see Bronson series.	Severe: [1] wetness.	Severe: seepage; wetness.	Severe: wetness; seepage.	Severe: wetness; seepage.
Bronson Mapped only in a complex with Brady soils.	Severe: [1] wetness.	Severe: seepage; wetness.	Severe: wetness; seepage.	Severe: seepage
*Capac:				
CaA	Severe: wetness; percs slowly.	Severe: wetness	Severe: wetness	Severe: wetness
CbB For Marlette part of CbB, see MaB of Marlette series.	Severe: wetness; percs slowly.	Severe: wetness	Severe: wetness	Severe: wetness
Cohoctah: Ch	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods; seepage.	Severe: wetness; floods; seepage.
Colwood: Co, Cp	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.
Edwards: Ed	Severe: wetness; floods.	Severe: wetness; excess humus; seepage.	Severe: wetness; floods; seepage.	Severe: wetness; floods; seepage.
Gilford: Gf	Severe: wetness.	Severe: wetness; seepage.	Severe: wetness; seepage.	Severe: wetness; seepage.
Hillsdale:				
HaB	Slight [1]	Severe: seepage	Severe: seepage	Severe: seepage

sanitary facilities and building site development

mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions special terms used in this table are defined in the "Glossary" at the back of this survey]

Degree and kind of limitation for—Continued					Suitability as source of daily cover for landfill
Local roads and streets	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	
Severe: wetness; unstable organic material.	Severe: wetness; unstable organic material; floods.	Severe: wetness; low strength; floods.	Severe: wetness; unstable organic material; floods.	Severe: wetness; low strength; floods.	Poor: excess humus; hard to pack; wetness.
Moderate: frost action.	Moderate: cutbanks cave.	Moderate: frost action.	Slight	Moderate: frost action.	Fair: thin layer; area reclaim.
Moderate: frost action.	Severe: cutbanks cave.	Moderate: frost action.	Slight	Slight: slope	Fair: thin layer; area reclaim.
Moderate: slope; frost action.	Severe: cutbanks cave.	Moderate: slope; frost action.	Moderate: slope	Severe: slope	Fair: thin layer; area reclaim; slope.
Moderate: frost action.	Severe: cutbanks cave.	Moderate: frost action.	Slight	Moderate: frost action; slope.	Fair: thin layer; area reclaim.
Moderate: slope; frost action.	Severe: cutbanks cave.	Moderate: slope; frost action.	Moderate: slope	Severe: slope	Fair: thin layer; area reclaim; slope.
Severe: slope	Severe: cutbanks cave; slope.	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Severe: frost action.	Severe: wetness; cutbanks cave.	Severe: wetness; frost action.	Severe: wetness	Severe: wetness; frost action.	Fair: thin layer; area reclaim.
Severe: frost action.	Severe: wetness; cutbanks cave.	Severe: frost action.	Moderate: wetness.	Severe: frost action.	Fair: thin layer; area reclaim.
Severe: frost action.	Severe: wetness	Severe: frost action; wetness.	Severe: wetness	Severe: frost action; wetness.	Good.
Severe: frost action.	Severe: wetness	Severe: frost action; wetness.	Severe: wetness	Severe: frost action; wetness; slope.	Good.
Severe: floods; frost action; wetness.	Severe: wetness; floods.	Severe: wetness; frost action.	Severe: floods; wetness; frost action.	Severe: floods; wetness; frost action.	Poor: wetness; floods.
Severe: wetness; frost action; low strength.	Severe: wetness; floods; cutbanks cave.	Severe: wetness; frost action; floods; low strength.	Severe: wetness; floods; low strength.	Severe: wetness; floods; frost action; low strength.	Poor: wetness; floods.
Severe: wetness; unstable organic material.	Severe: wetness; floods; unstable organic material.	Severe: seepage; unstable organic material; floods.	Severe: wetness; floods; low strength.	Severe: wetness; unstable organic material.	Poor: excess humus; seepage; hard to pack.
Severe: wetness; frost action.	Severe: wetness; cutbanks cave.	Severe: wetness; frost action.	Severe: wetness	Severe: wetness; frost action.	Poor: wetness.
Moderate: frost action.	Slight	Moderate: frost action.	Slight	Moderate: frost action; slope.	Good.

TABLE 9.—*Engineering interpretations of soils for*

Soil series and map symbols	Degree and kind of limitation for—			
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill (trench)	Sanitary landfill (area)
Hillsdale:				
HaC	Moderate:[1] slope.	Severe: seepage; slope.	Severe: seepage	Severe: seepage
Houghton: Ho	Severe: wetness; floods.	Severe: wetness; excess humus; seepage.	Severe: wetness; seepage; floods.	Severe: wetness; seepage; floods.
Kibbie: KbA	Severe: wetness.	Severe: wetness	Severe: wetness	Severe: wetness
Lenawee: Le	Severe: wetness; percs slowly.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.
Marlette:				
MaB	Moderate: percs slowly.	Moderate: seepage; slope.	Slight	Slight
MaC, MbC3	Moderate: slope.	Severe: slope	Slight	Moderate: slope
MaD, MaE	Severe: slope	Severe: slope	Moderate: slope	Severe: slope
Matherton: MdA	Severe:[1] wetness.	Severe:[1] wetness; seepage.	Severe: wetness; seepage.	Severe: wetness; seepage.
*Metamora: MeA For Capac part, see Capac series.	Severe: wetness.	Severe: wetness	Severe: wetness	Severe: wetness
Metea: Mapped only in complex with Spinks soils.				
Metea part of StB	Moderate: percs slowly; slope.	Moderate: seepage.	Slight	Slight
Metea part of StC	Moderate: percs slowly; slope.	Severe: slope	Slight	Moderate: slope
Oshtemo:				
OsB	Slight[1]	Severe: seepage	Severe: seepage	Severe: seepage
OsC	Moderate:[1] slope.	Severe: seepage	Severe: seepage	Severe: seepage
*Owosso:				
OwB For Marlette part, see MaB of Marlette series.	Severe: percs slowly.	Severe: seepage	Slight	Slight
OwC For Marlette part, see MaC of Marlette series.	Severe: percs slowly.	Severe: slope; seepage.	Slight	Moderate: slope
OwD For Marlette part, see MaD of Marlette series.	Severe: slope; percs slowly.	Severe: slope; seepage.	Moderate: slope	Severe: slope
Palms: Pa	Severe: wetness; floods.	Severe: organic material; wetness; seepage.	Severe: wetness; floods; seepage.	Severe: wetness; floods; seepage.
Parkhill: Pr	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.

sanitary facilities and building site development—Continued

Degree and kind of limitation for—Continued					Suitability as source of daily cover for landfill
Local roads and streets	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	
Moderate: frost action; slope.	Moderate: slope	Moderate: frost action; slope.	Moderate: slope	Severe: slope	Fair: slope.
Severe: unstable organic material; frost action.	Severe: wetness; floods; cutbanks cave.	Severe: wetness; unstable organic material; floods.	Severe: wetness; floods; unstable organic material.	Severe: wetness; floods; unstable organic material.	Poor: excess humus; hard to pack; wetness.
Severe: frost action; low strength.	Severe: wetness; cutbanks cave.	Severe: wetness; frost action; low strength.	Severe: wetness; low strength.	Severe: wetness; frost action; low strength.	Good.
Severe: wetness; frost action.	Severe: wetness	Severe: wetness; frost action; floods.	Severe: wetness; floods.	Severe: wetness; frost action; floods.	Poor: wetness; floods.
Moderate: frost action.	Slight	Moderate: frost action.	Slight	Moderate: frost action; slope.	Fair: too clayey.
Moderate: frost action; slope.	Moderate: slope	Moderate: frost action; slope.	Moderate: slope	Severe: slope	Fair: slope; too clayey.
Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Severe: frost action.	Severe: cutbanks cave.	Severe: frost action; wetness.	Severe: wetness	Severe: frost action; wetness.	Fair: thin layer; area reclaim.
Severe: frost action.	Severe: wetness.	Severe: wetness; frost action.	Severe: wetness	Severe: wetness; frost action.	Good.
Moderate: frost action.	Slight	Moderate: frost action.	Slight	Moderate: frost action; slope.	Fair: too sandy; area reclaim.
Moderate: frost action.	Moderate: slope	Moderate: frost action; slope.	Moderate: slope	Severe: slope	Fair: too sandy; area reclaim.
Slight	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Poor: seepage.
Moderate: slope; frost action.	Severe: cutbanks cave.	Moderate: frost action; slope.	Moderate: slope	Severe: slope	Poor: seepage.
Moderate: frost action.	Slight	Moderate: frost action.	Slight	Moderate: frost action; slope.	Good.
Moderate: slope; frost action.	Moderate: slope.	Moderate: frost action; slope.	Moderate: slope	Severe: slope	Fair: slope.
Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Severe: wetness; unstable organic material.	Severe: wetness; floods; unstable organic material.	Severe: wetness; floods; low strength.	Severe: wetness; floods; low strength.	Severe: wetness; poor; low strength.	Poor: excess humus; hard to pack; wetness.
Severe: wetness; frost action; floods.	Severe: wetness; floods.	Severe: frost action; wetness; floods.	Severe: wetness; floods.	Severe: wetness; frost action; floods.	Poor. wetness.

TABLE 9.—*Engineering interpretations of soils for*

Soil series and map symbols	Degree and kind of limitation for—			
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill (trench)	Sanitary landfill (area)
Sebewa: Sb	Severe: wetness; floods.	Severe: wetness; floods; seepage.	Severe: wetness; seepage.	Severe: wetness; floods; seepage.
*Shoals: Sh For Sloan part, see Sloan series.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.
Sloan Mapped only in a complex with Shoals soils.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.	Severe: wetness; floods.
*Spinks:				
SpB, StB For Metea part of StB, see Metea series.	Slight [1]	Severe: seepage	Severe: seepage	Severe: seepage
SpC, StC For Metea part of StC, see Metea series.	Moderate: [1] slope.	Severe: seepage; slope.	Severe: seepage	Severe: seepage
Spinks part of BpD	Severe: slope	Severe: slope; seepage.	Severe: seepage	Severe: seepage; slope.
Tuscola: TuA	Severe: wetness.	Severe: wetness	Moderate: wetness.	Moderate: wetness.
Wasepi: WaA	Severe: wetness.	Severe: seepage; wetness.	Severe: wetness; seepage.	Severe: seepage; wetness.
Wasepi variant: WbA	Severe: depth to bedrock; wetness.	Severe: depth to bedrock; wetness.	Severe: depth to bedrock; wetness.	Severe: seepage; wetness.
Winneshiek: WnA	Severe: [1] depth to bedrock.	Severe: seepage	Severe: depth to bedrock; seepage.	Severe: seepage

[1] Possible contamination of shallow water supplies.

rock, slope, and the 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.

Daily cover for sanitary landfill should be soil that is easy to excavate and spread over the compacted fill during both wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better for cover than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

In addition to these features, the soils selected for final cover of landfill should be suitable for growing plants. In comparison with other 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, such as slope, erodibility, and potential of plant growth.

Following are explanations of some of the columns in table 10.

Roadfill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance about where to look for probable sources. A soil rated as *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the ma-

sanitary facilities and building site development—Continued

Degree and kind of limitation for—Continued					Suitability as source of daily cover for landfill
Local roads and streets	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	
Severe: wetness; frost action.	Severe: wetness; cutbanks cave; floods.	Severe: wetness; frost action; floods.	Severe: wetness; floods.	Severe: wetness; frost action; floods.	Poor: wetness.
Severe: frost action; floods.	Severe: wetness; floods.	Severe: wetness; floods; frost action.	Severe: wetness; floods.	Severe: wetness; frost action; floods.	Good.
Severe: wetness; frost action; floods.	Severe: wetness; floods.	Severe: wetness; frost action; floods.	Severe: wetness; floods.	Severe: wetness; frost action; floods.	Poor: wetness.
Slight	Severe: cutbanks cave.	Slight	Slight	Slight	Poor: too sandy; seepage.
Moderate: slope	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Poor: too sandy; seepage.
Severe: slope	Severe: cutbanks cave; slope.	Severe: slope	Severe: slope	Severe: slope	Poor: too sandy; seepage; slope.
Severe: frost action; low strength.	Severe: wetness; cutbanks cave.	Severe: frost action; low strength.	Severe: wetness; low strength.	Severe: frost action; low strength.	Fair: thin layer; area reclaim.
Severe: frost action.	Severe: wetness; cutbanks cave.	Severe: frost action; wetness.	Severe: wetness	Severe: frost action; wetness.	Fair: thin layer; area reclaim.
Severe: frost action; depth to bedrock.	Severe: depth to bedrock; wetness.	Severe: frost action; wetness; depth to bedrock.	Severe: depth to bedrock; wetness.	Severe: frost action; depth to bedrock; wetness.	Poor: area reclaim.
Moderate: depth to bedrock; frost action.	Severe: depth to bedrock.	Moderate: depth to bedrock; frost action.	Severe: depth to bedrock.	Moderate: depth to bedrock; frost action.	Fair: too clayey; thin layer.

terials, and neither do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among factors that are unfavorable.

An aquifer-fed excavated pond is a body of water created by excavating a pit or dugout into a ground water 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 is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumu-

TABLE 10.—*Engineering interpretations of the soils as*

[An asterisk in the first column indicates that at least one mapping unit is made up of two or more kinds of soil. The soils in such for referring to other series as indicated. "Seepage" "slow refill," and some other

Soil series and map symbols	Suitability as source of—			
	Roadfill	Sand	Gravel	Topsoil
Adrian: Ad	Poor: organic material; very poorly drained.	Poor	Unsuited	Poor: organic material oxidizes readily; very poorly drained.
Bixby: BbA	Good	Fair: excess fines	Fair: excess fines	Fair: thin layer
Borrow land: Bh. Properties too variable to be interpreted; onsite inspection needed.				
*Boyer:				
BnB	Good	Good	Good	Poor: too sandy
BnC	Good	Good	Good	Poor: too sandy
BoB	Good	Good	Good	Good
BoC	Good	Good	Good	Fair: slope
BpD For Spinks part of BpD, see Spinks series.	Fair: slope	Good	Good	Poor: too sandy; slope.
*Brady: BrA For Bronson part, see Bronson series.	Poor: frost action	Good	Fair: excess fines	Good
Bronson Mapped only in a complex with Brady soils.	Good	Good	Fair: excess fines	Good
*Capac:				
CaA	Poor: frost action	Unsuited	Unsuited	Fair: thin layer
CbB For Marlette part of CbB, see MaB of Marlette series.	Poor: frost action	Unsuited	Unsuited	Fair: thin layer
Cohoctah: Ch	Poor: wetness; frost action.	Poor: excess fines	Unsuited	Poor: wetness
Colwood: Co, Cp	Poor: wetness; frost action; low strength.	Unsuited	Unsuited	Poor: wetness
Edwards: Ed	Poor: wetness; organic material; low strength.	Unsuited	Unsuited	Poor: wetness
Gilford: Gf	Poor: wetness; frost action.	Fair	Poor: excess fines	Poor: wetness
Hillsdale:				
HaB	Fair: frost action	Unsuited	Unsuited	Good
HaC	Fair: frost action	Unsuited	Unsuited	Fair: slope

source of construction materials and for water management

mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions special terms used in this table are defined in the "Glossary" at the back of this survey]

Soil features affecting—						
Pond reservoirs	Embankments, dikes, and levees	Excavated ponds (aquifer fed)	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unstable organic material; seepage.	Seepage; unstable fill.	Cutbanks cave	Wetness; cutbanks cave; poor outlets.	Seepage: soil blowing.	Not needed	Not needed.
Seepage	Good in subsoil; seepage in substratum.	Deep to water	Not needed	Favorable	Not needed	Favorable.
Seepage	Seepage	No water	Not needed	Soil blowing; complex slope; fast intake.	Complex slope; too sandy.	Droughty.
Seepage; slope	Seepage	No water	Not needed	Soil blowing; complex slope; fast intake.	Complex slope; too sandy.	Droughty; slope.
Seepage	Seepage	No water	Not needed	Complex slope; fast intake.	Complex slope	Droughty.
Seepage; slope	Seepage	No water	Not needed	Complex slope; fast intake.	Complex slope	Droughty; slope.
Seepage; slope	Seepage	No water	Not needed	Slope; fast intake.	Slope	Droughty; slope.
Seepage	Seepage; piping.	Favorable	Wetness	Seepage; wetness.	Not needed	Favorable.
Seepage	Seepage; piping.	Deep to water	Wetness	Fast intake; wetness.	Not needed	Not needed.
Favorable	Favorable	Slow refill	Wetness; percs slowly.	Wetness; percs slowly.	Complex slope	Favorable.
Favorable	Favorable	Slow refill	Wetness; complex slope; percs slowly.	Wetness; complex slope; percs slowly.	Complex slope	Favorable.
Seepage	Seepage; piping.	Favorable	Wetness; poor outlets; floods.	Wetness; floods.	Not needed	Not needed.
Seepage	Low strength; piping; erodes easily.	Favorable	Wetness; cutbanks cave; fine sands may flow into tile.	Wetness	Not needed	Not needed.
Seepage	Low strength; hard to pack; seepage.	Cutbanks cave	Wetness; poor outlets; cutbanks cave.	Fast intake; soil blowing; floods; wetness.	Not needed	Not needed.
Seepage	Piping; seepage.	Favorable	Wetness; cutbanks cave.	Droughty; wetness.	Not needed	Not needed.
Seepage; slope.	Favorable	Deep to water	Not needed	Complex slope	Complex slope; erodes easily.	Erodes easily.
Seepage; slope.	Favorable	Deep to water	Not needed	Complex slope; slope.	Complex slope; erodes easily.	Erodes easily.

TABLE 10.—*Engineering interpretations of the soils as source*

Soil series and map symbols	Suitability as source of— Roadfill	Sand	Gravel	Topsoil
Houghton: Ho	Poor: wetness; organic material; low strength.	Unsuited	Unsuited	Poor: wetness
Kibbie: KbA	Poor: low strength; frost action.	Unsuited	Unsuited	Good
Lenawee: Le	Poor: frost action; wetness; low strength.	Unsuited	Unsuited	Poor: wetness
Marlette:				
MaB	Fair: frost action; low strength.	Unsuited	Unsuited	Fair: thin layer
MaC, MbC3	Fair: frost action; slope.	Unsuited	Unsuited	Fair: thin layer; too clayey.
MaD, MaE	Fair: frost action; slope.	Unsuited	Unsuited	Poor: slope; area reclaim.
Matherton: MdA	Poor: frost action	Good	Good	Fair: thin layer
*Metamora: MeA For Capac part, see Capac series.	Poor: frost action	Unsuited	Unsuited	Good
Metea Mapped only in complex with Spinks soils.	Fair: frost action	Unsuited	Unsuited	Poor: too sandy
Oshtemo:				
OsB	Good	Good	Good	Good
OsC	Good	Good	Good	Fair: slope
Owosso:				
OwB For Marlette part, see MaB of Marlette series.	Fair: frost action	Unsuited	Unsuited	Good
OwC For Marlette part, see MaC of Marlette series.	Fair: frost action	Unsuited	Unsuited	Fair: slope
OwD For Marlette part, see MaD of Marlette series.	Fair: frost action; slope.	Unsuited	Unsuited	Poor: slope
Palms: Pa	Poor: wetness; organic material.	Unsuited	Unsuited	Poor: organic material; wetness.
Parkhill: Pr	Poor: wetness; frost action.	Unsuited	Unsuited	Poor: wetness
Sebewa: Sb	Poor: wetness; frost action.	Good	Good	Poor: wetness
*Shoals: Sh For Sloan part, see Sloan series.	Poor: frost action	Unsuited	Unsuited	Good

of construction materials and for water management—Continued

Soil features affecting—						
Pond reservoirs	Embankments, dikes, and levees	Excavated ponds (aquifer fed)	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Seepage	Low strength; hard to pack; seepage.	Cutbanks cave	Wetness; poor outlets; cutbanks cave; floods.	Soil blowing; seepage; floods.	Not needed	Not needed.
Seepage	Unstable fill; piping; erodes easily.	Slow refill	Wetness; cutbanks cave; fine sands may flow into tile.	Wetness	Not needed	Not needed.
Favorable	Low strength	Favorable	Wetness; percs slowly.	Wetness; floods; percs slowly.	Not needed	Not needed.
Favorable	Low strength	Deep to water	Not needed	Complex slope; percs slowly.	Complex slope; erodes easily.	Erodes easily.
Slope	Low strength	Deep to water	Not needed	Complex slope; percs slowly.	Complex slope; erodes easily.	Erodes easily.
Slope	Low strength	Deep to water	Not needed	Slope; percs slowly.	Slope; erodes easily.	Erodes easily.
Seepage	Favorable	Favorable	Wetness; cutbanks cave.	Wetness	Not needed	Favorable.
Favorable	Favorable	Slow refill	Wetness; percs slowly.	Wetness	Not needed	Favorable.
Seepage	Favorable	Deep to water	Not needed	Droughty; fast intake; soil blowing.	Too sandy; complex slope.	Droughty.
Seepage	Favorable	Deep to water	Not needed	Seepage	Not needed	Favorable.
Seepage; slope	Favorable	Deep to water	Not needed	Seepage; complex slope; slope.	Complex slope	Slope.
Seepage	Favorable	Deep to water	Not needed	Erodes easily	Not needed	Favorable.
Slope	Favorable	Deep to water	Not needed	Complex slope; erodes easily.	Complex slope; erodes easily.	Slope; erodes easily.
Slope	Favorable	Deep to water	Not needed	Slope; erodes easily.	Slope	Slope; erodes easily.
Seepage	Low strength; hard to pack.	Favorable	Wetness; cutbanks cave; floods; poor outlets.	Wetness; floods; soil blowing.	Not needed	Not needed.
Favorable	Favorable	Favorable	Wetness; poor outlets; percs slowly.	Percs slowly; wetness.	Not needed	Wetness; percs slowly.
Seepage	Seepage	Favorable	Wetness; cutbanks cave.	Wetness	Not needed	Not needed.
Favorable	Favorable	Favorable	Wetness; floods; poor outlets.	Floods; wetness.	Not needed	Not needed.

TABLE 10.—*Engineering interpretations of the soils as source*

Soil series and map symbols	Suitability as source of— Roadfill	Sand	Gravel	Topsoil
Sloan Mapped only in a complex with Shoals soils.	Poor: frost action	Fair: excess fines	Poor: excess fines	Poor: wetness
*Spinks:				
SpB, SpC, StB, StC For Metea part of StB and StC, see Metea series.	Good	Good	Unsuited	Poor: too sandy; thin layer.
Spinks part of BpD	Fair: slope	Good	Unsuited	Poor: too sandy; thin layer.
Tuscola: TuA	Poor: frost action; low strength.	Unsuited	Unsuited	Fair: thin layer; area reclaim.
Wasepi: WaA	Poor: frost action	Good	Good	Fair: thin layer; area reclaim.
Wasepi variant: WbA	Poor: frost action; thin layer; area reclaim.	Unsuited	Unsuited	Fair: thin layer; area reclaim.
Winneshiek: WnA	Poor: thin layer; area reclaim.	Unsuited	Unsuited	Fair: thin layer

Figure 16.—**Sewage lagoons on Marlette and Capac soils.**

of construction materials and for water management—Continued

Soil features affecting—						
Pond reservoirs	Embankments, dikes, and levees	Excavated ponds (aquifer fed)	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Favorable	Piping	Favorable	Wetness; floods; poor outlets.	Wetness; floods.	Not needed	Not needed.
Seepage	Seepage	Deep to water	Not needed	Droughty; soil blowing; percs slowly.	Too sandy; complex slope.	Droughty.
Slope; seepage.	Seepage	Deep to water	Not needed	Slope	Too sandy; slope.	Droughty; slope.
Seepage; slope.	Unstable fill; erodes easily; piping.	Slow refill	Not needed	Erodes easily	Erodes easily	Erodes easily.
Seepage	Seepage; piping.	Favorable	Cutbanks cave; wetness.	Droughty; percs rapidly.	Not needed	Not needed.
Depth to bedrock; seepage.	Piping; thin layer.	Depth to bedrock.	Depth to bedrock; poor outlets.	Droughty; percs rapidly.	Not needed	Not needed.
Depth to bedrock.	Thin layer	Depth to water.	Not needed	Droughty	Not needed	Not needed.

lation of salts and alkali; depth of root zone; rate of water intake at the surface; permeability below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; need for drainage: and depth to water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or to other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Grassed waterway layout and construction are affected by such soil properties as texture, depth, and erodibility of the soil material, presence of cobbles or stones, and the steepness of slopes. Other factors affecting waterways are seepage, natural soil drainage, available water capacity, and ease of establishing and maintaining vegetation.

Community development

Community development creates a need for soil information somewhat different from that needed for farming. Land appraisers, realtors, city planners, builders, and others can use soil information to help determine what areas are suitable for houses and other small buildings. Soil information can also help determine what areas are best suited to recreation and open space. Homeowners can use soil information to help them in landscaping their property and protecting it against erosion.

Residences.—Drainage, permeability, slope, water erosion, soil blowing, soil stability, shrink-swell potential, and frequency of flooding have to be considered in evaluating the suitability of a site for an individual home or for a subdivision.

Homes built on poorly drained and very poorly drained soils such as Parkhill, Gilford, Lenawee, and Sebewa soils are likely to have wet basements unless some artificial drainage is provided. A high water table, even if only seasonal, keeps septic tank absorption fields from functioning properly. The section "Engineering Uses of the Soils" gives information about drainage and the presence of a high water table.

Permeability is another property that affects the functioning of septic tank absorption fields. If the filter field is in soils that have moderately rapid permeability, such as Boyer and Spinks soils, the effluent may contaminate the water in shallow wells. Table 8 gives estimates of permeability rates for all the soils, and interpretations in table 9 show the relative limitations of the soils for septic tank absorption fields.

Organic soils such as Edwards and Houghton soils are not stable enough to provide good foundation for houses and roads. Such sandy soils as Spinks soils have unstable cutbanks. The soils cave and slough in any shallow excavation. Boyer and Spinks soils have a low shrink-swell potential and a fair to good bearing capacity. Soils like these provide good foundations. Soils that have a high shrink-swell potential cause basement walls to crack and shift. Table 8 shows estimates of shrink-swell potential for all the soils, and table 9 helps to identify the soils that have the least serious limitations for use as foundations.

Soils on bottom lands are subject to flooding and consequently are not good choices for building sites. Cohoctah and Sloan soils are examples (fig. 17).

Erosion and the accumulation of sediment are serious hazards in housing developments where the soil is left bare for several weeks. Grading, paving, and compacting the soil during development can increase runoff from a built-up area from two to ten times what it was on the same area while it was still in farms or forest. The runoff concentrates in streets and gutters instead of flowing into natural drainageways, and the result is flooding and deposition of sediment in the lower areas. The steeper the slope, the more severe the hazard of erosion. The sloping and moderately steep soils of the Marlette series are particularly susceptible to erosion. Table 10 gives information relating to the construction of diversions and grassed waterways and the installation of drainage facilities. Measures that can be taken to control erosion in small residential tracts include the following:

1. Building driveways, walks, and fences on the contour or, if that is not possible, straight across the slope.
2. Grading to make the surface level or gently sloping. The surface layer can be removed before grading and used later for topsoil.
3. Building diversions that will intercept runoff and keep it from flowing over erodible areas.
4. Constructing waterways or improving existing waterways in order to prevent gullying.
5. Draining seepage areas and waterlogged areas with tile or other facilities.

Soil blowing is a serious hazard in housing developments where the soil is left bare for several weeks. Grading removes the protective cover. High winds can then cause the soil to blow and drift. If left unchecked, blowing sand can fill ditches and gutters and accumulate to a depth of several inches against houses. Blowing sand also reduces visibility on nearby streets.

Streets, driveways, sidewalks, and patios.—Of special interest to homeowners and developers are soil properties that cause cracking and shifting of pavement. Soils high in silt, such as Kibbie and Colwood soils, are subject to frost heave. Concrete placed on such soils cracks readily unless the surface of the soil is first covered with sand and gravel. Other properties that cause pavement to crack and shift excessively are a high water table and a high content of clay. The Lenawee soils are an example of soils that have these limitations. Pavement laid on such organic soils as

***Figure 17.*—Urban development on Sloan soils. Periodic flooding severely limits the soils for this use.**

Edwards and Houghton soils is likely to crack and become uneven as a result of settling of the organic material after drainage. Table 8 gives estimates of shrink-swell potential for all the soils, table 10 includes interpretations relating to the use of the soils for road fill, and table 9 includes interpretations for locations for local roads and streets; this information can be used to identify the soils that are unsuitable for streets, driveways, sidewalks, and patios.

Underground utility lines.—Water mains, gas pipelines, communication lines, and sewerlines that are buried in the ground may corrode and break unless protected against certain electro biochemical reactions that result from inherent properties of the soils but differ according to the nature of the soils. All metals corrode to some degree when buried, and some metals corrode more rapidly in some soils than in others. The corrosion potential of the soil depends on the physical, chemical, electrical, and biological properties of the soil; for example, oxygen concentration, concentration of anaerobic bacteria, and moisture content. Design and construction of the lines are also important. The likelihood of corrosion is intensified by connecting dissimilar metals, by burying metal structures at varying depths, and by extending pipelines through different kinds of soils. Table 8 gives a rating of the corrosion potential for uncoated steel and for concrete.

If cast-iron pipe is used, stress caused by shrinking and swelling of the soils is an additional hazard. In soils that have a high shrink-swell potential, such as Lenawee soils, cast-iron pipes may break unless cushioned with sandy material.

Gardening and landscaping.—The ideal soils for yard and garden plants are those that have a deep root zone, a loamy texture, a balanced supply of plant nutrients, adequate organic matter, adequate available water capacity, good drainage, and a structure that allows free movement of water. No soil exists in Eaton County that closely approaches this ideal. On droughty soils like Boyer loamy sand and Spinks soils, lawn grasses and shrubs dry up quickly in periods of dry weather unless they are watered frequently. Poorly drained and very poorly drained soils such as Lenawee soils are difficult to work when wet and become hard and cloddy at the surface when they dry out. If such soils are disturbed by construction, seeding them with lawn grasses is difficult.

Other information useful in landscaping is given in the section "Trees and Shrubs for Landscaping and Windbreaks."

Public health.—Soil information has many applications to public health problems, including those of sewage disposal, trash disposal, and the maintenance of a safe and adequate water supply.

Sewage lagoons, septic tank systems, and sewerlines need to be located and constructed so that seepage or drainage from them cannot pollute water supplies. One cause of pollution is leakage from sewage lagoons built on unsuitable soils, such as the moderately rapidly permeable Boyer and Spinks soils. Wells, streams, and lakes can become contaminated by runoff from clogged and improperly located septic tank absorption fields. The soil map, which shows the major drainageways of the county, can be used as a general guide in locating septic tank absorption fields where they will not cause pollution. Rapid percolation of septic tank effluent can result in the pollution of shallow underground water supplies. Table 9 includes interpretations that can be used as a guide for construction of lagoons or for location of septic tank absorption fields.

Stability of the soils is of major importance in selecting locations for sewerlines. If the gradeline is interrupted and the systems break down, a public health hazard results. The shrink-swell potential of a soil is an indication of its relative stability. Corrosion is another cause of breakdown in sewerlines.

In selecting sites for sanitary landfills, it is important to consider topography, drainage, soil texture, permeability, reaction, and the nature of the underlying material. Onsite studies of the underlying material, water table, hazards of aquifer pollution, and drainage into ground water need to be made for sanitary landfill deeper than 5 or 6 feet. Table 8 gives the estimates of pertinent properties of the soils for onsite testing, and table 9 contains interpretations of the soils for landfills.

Mosquitoes, fleas, and other disease-carrying insects breed in stagnant water. By the use of the soil descriptions and the soil map, it is possible to identify areas subject to flooding or ponding. Once the possible trouble spots are located, the health hazard can be controlled by spraying to eliminate insects and by installing drainage systems to remove standing water.

Formation and Classification of the Soils[7]

This section consists of two main parts. The first part tells how the factors of soil formation have affected the development of soils in Eaton County. The second part explains the current system of soil classification and places each soil series in the various classes of that system.

Factors of Soil Formation

Soil is developed by soil-forming processes acting on materials deposited or accumulated by geologic action. The characteristics of the soil at any given point are determined by the physical, chemical, and mineralogical composition of the parent material; the climate under which the parent material has existed since the beginning of soil formation; the plant and animal life on and in the soil; the relief, or lay of the land, including depth to the water table; and the length of time the processes of soil formation have acted on the parent material.

Climate and plant and animal life are active factors of soil formation. They act on the parent material and slowly change it to a natural body of soil that has genetically related layers called 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 a soil profile. It may be

[7] R. F. HARNER and N. W. STROESENREUTHER, soil scientists, Soil Conservation Service, helped to prepare this section.

much or little, but some time is always required for differentiation of soil horizons. Generally, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

Parent material is the unconsolidated mass from which a soil is formed. Parent material determines most of the limits of the chemical and mineralogical composition of the soil. Much of the parent material of the soils of Eaton County was deposited by glaciers or by melt water from the glaciers. Some of this material was reworked and redeposited by subsequent actions of ice, water, and wind. The glaciers last covered the county from about 10,000 to 12,000 years ago. Although the parent materials in Eaton County are commonly of glacial origin, their properties vary greatly, sometimes within small areas, depending on how the materials were deposited. The dominant parent materials in Eaton County were deposited as glacial till, outwash deposits, lacustrine deposits, alluvium, and organic material.

Glacial till is material laid down directly by glaciers with a minimum of water action. It consists of particles of different sizes mixed together. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water washing. The glacial till in Eaton County is calcareous and is friable or firm. It is sand, loamy sand, sandy loam, loam, and clay loam. An example of soils that formed in glacial till are Marlette soils. These soils typically are loamy and have a well-developed structure.

Outwash material is deposited by running water from melting glaciers. The size of the particles that make up outwash material varies according to the speed of the stream of water that carried them. When the water slows down, the coarser particles are deposited. Finer particles, such as very fine sand, silt, and clay, can be carried by slowly moving water. Outwash deposits generally consist of layers of particles of similar size. Sand, gravel, and other coarse particles are dominant. Boyer soils, for example, formed in deposits of outwash material in Eaton County.

Lacustrine material is deposited from still, or ponded, glacial melt water. Because the coarser fragments drop out of moving water as outwash, only the finer particles, such as very fine sand, silt, and clay, remain to settle out in still water. Lacustrine deposits are silty or clayey. In Eaton County the soils that formed in lacustrine deposits are typically loamy. Colwood soils are an example of soils that formed in lacustrine materials.

Alluvial material is deposited by floodwaters of present streams in Recent time. This material varies in texture, depending on the speed of the water from which it was deposited. Soils that formed in alluvium are Sloan and Cohoctah soils.

Organic material is made up of deposits of plant remains. After the glaciers withdrew from the area, water was left standing in depressions in outwash, lake, and till plains. Grasses and sedges growing around the edges of these lakes dried, and their remains fell to the bottom. Because of wetness of the areas, the plant remains did not decompose but remained around the edge of the lake. Later, a few white-cedar and other trees that grow in wet places occupied the areas. As these trees died, their residues became a part of the organic accumulation. The lakes were eventually filled with organic material and became areas of muck. In most of these areas, the plant remains subsequently decomposed to varying degrees. In a few areas the material has changed little since deposition. Houghton soils, for example, formed in organic material.

Plant and animal life

Plants have been the principal organisms influencing the soils in Eaton County; however, bacteria, fungi, earthworms, and the activities of man have also been important. The chief contribution of plants and animals is the addition of organic matter and nitrogen to the soil. The kind of organic material on and in the soil depends in part on the kinds of plants that grew on the soil. The remains of these plants accumulate on the surface or in the soil, decay, and eventually become organic matter. Roots of the plants provide channels for downward movement of water through the soil and, also, they add organic matter to the soil as they decay. Bacteria and other organisms in the soil help to break down the organic matter so that it can be used by growing plants.

The vegetation in Eaton County was mainly mixed forests. Differences in natural soil drainage and in the parent material have affected the composition of the forest species.

Generally, the well drained upland soils, such as Hillsdale, Owosso, and Marlette soils, were mainly covered with sugar maple, beech, or hickory, red oak, and white oak. On the well drained sites the organic additions decomposed rapidly and the soils were relatively light colored. On the wet soils the trees were primarily elm, red maple, swamp oak, and ash. The Cohoctah and Sebewa soils developed under wet conditions and contain considerable organic matter. In some wet areas herbs, grasses, sedges, and reeds predominated; as they died and accumulated, organic soils formed. In other wet areas the lowland tree species predominated, and woody as well as herbaceous organic material accumulated.

Climate

Climate is important in the formation of soils. It determines the kind of plant and animal life on and in the soil. It determines the amount of water available for weathering of minerals and the transporting of soil materials. Through its influence on temperatures in the soil, it determines the rate of chemical reaction that occurs in the soil. These influences are important, but they affect large areas rather than a relatively small area, such as a county.

The climate in Eaton County is cool and humid. This is presumably similar to that which existed as the soils formed. The soils in Eaton county differ from soils that formed in a dry, warm climate or from those that formed in a hot, moist climate. Climate is uniform throughout the county, although its effect is modified locally by runoff and overflow. Therefore, some minor differences in the soils of Eaton County are the results of the differences in climate.

Relief

Relief, or topography, has a marked influence on the soils of Eaton County through its influence on natural drainage, erosion, and the associated plant cover and seasonal soil temperature differences. In Eaton County slopes range from nearly level to steep. Natural soil drainage ranges from well drained on the ridgetops to very poorly drained in the depressions.

Relief influences the formation of soils by affecting runoff and drainage; drainage in turn, through its effect on aeration of the soil, determines the color of the soil. Runoff of water is most rapid on the steeper slopes. In low areas, water is temporarily ponded. Water and air move freely through soils that are well drained but slowly through soils that are very poorly drained. In soils that are well aerated, the iron and aluminum compounds that give most soils their color are oxidized and are brightly colored. In poorly aerated soils the color is dull, gray, and mottled. Marlette soils are examples of well drained, well aerated soils, while Parkhill soils are examples of poorly aerated, very poorly drained and poorly drained soils. However, Marlette and Parkhill soils formed from similar parent material.

Intermediate between the very poorly drained and well drained soils are the poorly drained, somewhat poorly drained, and moderately well drained soils.

Time

Time, usually a long time, is required for the agents of soil formation to form distinct horizons in the soil from parent material. The differences in length of time that the parent materials have been in place are commonly reflected in the degree of development of the soil profile. Some soils develop rapidly, and some develop slowly.

The soils in Eaton County range from young to mature. The glacial deposits from which many of the soils formed have been exposed to soil-forming factors for a long enough time to allow distinct horizons to develop within the soil profile. Some soils forming in recent alluvial sediments, however, have not been in place long enough for distinct horizons to develop. Young soils have weakly expressed horizons; mature soils have well expressed horizons. Shoals soils are examples of young soils. Except for a darker color in the surface layer, they retain most of the characteristics of the parent material. Capac soils are examples of mature soils; they have well-differentiated horizons.

Genesis and Morphology of Soils

The processes, or soil-forming factors, responsible for the development of soil horizons from unconsolidated parent material are referred to as soil genesis. The physical, chemical, and biological properties of the various soil horizons are termed soil morphology.

Several processes were involved in the formation of horizons in the soils of Eaton County. These processes are accumulation of organic matter, leaching of lime (calcium carbonates) and other bases, reduction and transfer of iron, and formation and translocation of silicate clay minerals. In most soils of Eaton County more than one of these processes has been active in the development of the horizons.

Organic matter accumulated at the surface to form an A1 horizon. The A1 horizon or its upper part is mixed into a plow layer (Ap) when the soil is plowed. The mineral soils of Eaton County have a surface layer that ranges from high to low in organic-matter content. Colwood soils are examples of soils that have high organic-matter content in the surface layer, whereas Spinks soils have low organic-matter content.

Leaching of carbonates and other bases has occurred in most of the soils. Leaching of free lime in soils generally precedes the translocation of silicate clay minerals. Many of the soils are moderately to strongly leached, and this contributed to the development of horizons. For example, the Oshtemo soils are leached of carbonates to a depth of 51 inches, whereas the Marlette soils are leached to a depth of only 38 inches.

Reduction and transfer of iron, a process called gleying, is evident in the somewhat poorly drained, poorly drained, and very poorly drained soils. The gray color in the subsoil horizons indicates the reduction and loss of iron. Some horizons contain reddish brown mottles, which indicate a segregation of iron.

In some soils the translocation of clay minerals has contributed to horizon development. The eluviated (leached) A2 horizon above the illuviated (accumulation) B horizon commonly has platy structure, is lower in content of clay, and generally is lighter in color than either the A1 horizon or the B horizon. The B horizon generally has an accumulation of clay (clay films) in pores and on surfaces of peds. These soils were probably leached of carbonates and soluble salts before translocation of silicate clay took place. Leaching of bases and translocation of silicate clays are among the more important processes in horizon differentiation in the soils. The Marlette series is an example of soils in which translocated silicate clays have accumulated in the B horizon in the form of clay films.

Classification of the Soils

Soils are classified so that their significant characteristics can be more easily remembered. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps we can apply our knowledge of soils to small specific areas or large tracts of land.

The current system was adopted by the National Cooperative Soil Survey in 1965 (*6*). This system is under continual study. Therefore, readers interested in new developments and revisions of this soil classification system should search the latest available literature (*9*).

The current system of classification has six categories. Beginning with the broadest, these categories are: Order, Suborder, Great Group, Subgroup, Family, and Series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. The six categories of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols which may occur in many different climates.

Five of the orders are in Eaton County: Alfisols, Entisols, Histosols, Inceptisols, and Mollisols.

Alfisols are soils that have a clay enriched B horizon that is high in base saturation. Hillsdale, Marlette, and Capac soils represent the Alfisols in Eaton County.

Entisols are recent soils; they lack genetic horizons or have only the beginnings of such horizons. The Shoals soils are an example of Entisols in Eaton County.

The Histosols are soils developed in organic material thicker than 40 centimeters. They include soils commonly called mucks, organic soils, or bogs. Houghton soils are an example of the Histosols in Eaton County.

Inceptisols most often are on young but not recent land surfaces. In Eaton County, Parkhill and Lenawee soils in depressional areas that have a high water table are examples of Inceptisols.

The Mollisols are mineral soils that have a thick, dark-colored, granular surface well supplied with bases, particularly calcium. Gilford soils are an example of Mollisols in the county.

SUBORDER: Each order is subdivided into suborders, mainly on the basis of those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. Examples of the suborder category are Saprists and Udalfs.

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with the growth of roots or movement of water. The features used are some properties of clays, soil temperature, and major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium). Hapludalfs, for example, are Udalfs with minimal development of the characteristic horizons.

SUBGROUP: Great groups are subdivided into subgroups, one representing the central concept of the group and others called intergrades and extragrades. Intergrade subgroups have properties of the group and also one or more properties of another great group, suborder, or order. Extragrade subgroups have properties of the group and have characteristics that are not diagnostic of another great group, suborder, or order. Examples of subgroup names are Typic Hapludalfs for the central concept, Mollic Haplaquepts for an intergrade, and Limnic Medisaprists for an extragrade.

FAMILY: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, depth, slope, and consistence. A family name consists of a series of adjectives which are the class names for texture, mineralogy, and so on. These are used as family differentiae. An example is the coarse-loamy, mixed, mesic family of Typic Hapludalfs.

SERIES: The series is a category of soils that have major horizons that, except for texture of surface layer, are similar in important characteristics and in arrangement in the profile. They are commonly given the name of a geographic location near the place where that series was first observed and mapped. Examples are the Hillsdale and Oshtemo series.

In table 11, each soil series in Eaton County is placed into the classification system.

General Nature of the County

This section provides general information about the climate, physiography and surface geology, water supply, streams and lakes, vegetation, and farming in Eaton County. The statistics are from reports published by the U.S. Department of Commerce (*10*) and the Michigan Department of Agriculture, Weather Service.

Climate [8]

Eaton County is inland, in south-central Michigan, and the Great Lakes' influence on the county's climate is small. The lakes' most noticeable influence is increased cloudiness, which moderates the minimum temperature during cold spells late in fall and early in winter. The county's climate is continental. Daily, seasonal, and annual temperature changes recorded at weather stations in the county, such as the one at Charlotte, are larger than those recorded at stations at a similar latitude nearer the Great Lakes. Because the day-to-day weather is controlled largely by the movement of pressure systems across the nation, prolonged periods of hot, humid weather in summer and extreme cold in winter are seldom experienced. Climatological data for the county are given in tables 12, 13, and 14.

The highest temperature on record was 106° F on July 14, 1936, and the lowest was -31° on February 10, 1912. The warmest monthly mean temperature was 78.2° in July, 1921, and the coldest was 8.6° in January, 1918. On the average, the temperature is 90° or higher 15 days per year. The temperature reached or exceeded 100° six times between 1940 and 1969. During the same period, 1952 was the only year that the temperature did not fall below zero. The influence of the lakes is reflected in the milder minimum tempera-

[8] FRED V. NURNBERGER, meteorologist for Michigan Department of Agriculture, Weather Service, helped to prepare this section.

TABLE 11.—*Classification of soil series*

Series	Family	Subgroup	Order
Adrian	Sandy or sandy-skeletal, mixed, euic, mesic	Terric Medisaprists	Histosols.
Bixby[1]	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Hapludalfs	Alfisols.
Borrow land[2]	Sandy and loamy, mixed, mesic	Udorthents and Udipsamments	Entisols.
Boyer	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Brady	Coarse-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Bronson	Coarse-loamy, mixed, mesic	Aquic Hapludalfs	Alfisols.
Capac	Fine-loamy, mixed, mesic	Aeric Ochraqualfs	Alfisols.
Cohoctah	Coarse-loamy, mixed, mesic	Fluvaquentic Haplaquolls	Mollisols.
Colwood	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Edwards	Marly, euic, mesic	Limnic Medisaprists	Histosols.
Gilford	Coarse-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Hillsdale[3]	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Houghton	Euic, mesic	Typic Medisaprists	Histosols.
Kibbie	Fine-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Lenawee	Fine, mixed, nonacid, mesic	Mollic Haplaquepts	Inceptisols.
Marlette	Fine-loamy, mixed, mesic	Glossoboric Hapludalfs	Alfisols.
Matherton	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Metamora[4]	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Metea	Loamy, mixed, mesic	Arenic Hapludalfs	Alfisols.
Oshtemo	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Owosso	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Palms	Loamy, mixed, euic, mesic	Terric Medisaprists	Histosols.
Parkhill	Fine-loamy, mixed, nonacid, mesic	Mollic Haplaquepts	Inceptisols.
Sebewa	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Argiaquolls	Mollisols.
Shoals	Fine-loamy, mixed, nonacid, mesic	Aeric Fluvaquents	Entisols.
Sloan	Fine-loamy, mixed, mesic	Fluvaquentic Haplaquolls	Mollisols.
Spinks	Sandy, mixed, mesic	Psammentic Hapludalfs	Alfisols.
Tuscola	Fine-loamy, mixed, mesic	Aquic Hapludalfs	Alfisols.
Wasepi	Coarse-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Wasepi variant	Coarse-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Winneshiek	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.

[1] These soils are taxadjuncts to the Bixby series because they lack the contrasting textures in the lower part of the solum that are defined in the range for the series.
[2] Borrow land is classified at the Great Group level.
[3] These soils are taxadjuncts because they are more acid than defined in the range for the series, and they have interfingering of the A horizon into the B horizon which is not defined in the range for the series.
[4] These soils are taxadjuncts because they lack the dominant gray colors in the upper part of the Bt horizon that are defined in the range for the series.

tures. On an average, 85 percent of the low temperatures from November through March are 32° or below, and 10 days per year experience below-zero temperatures. The average heating- and cooling-degree-days, base 65°, are 6,824 and 613, respectively. January is the coldest month, with an average of 1,323 heating-degree-days, and July is the warmest, with an average of 14 heating-degree-days and 198 cooling-degree-days.

The growing season averages 139 days. The average date of the last freezing temperature in spring is May 13, and the average date of the first freezing temperature in fall is September 29.

Precipitation is well distributed throughout the year. The crop season, May to October, receives an average of 18.45 inches, 58 percent of the average annual total of 31.83 inches. June receives an average of 3.83 inches and is the wettest month. August is a close second with 3.43 inches. February receives an average of 1.59 inches. It is the driest month. Summer precipitation is mainly in the form of afternoon showers and thundershowers. Thunderstorms occur on an average of 40 days annually. The greatest monthly precipitation total was recorded in August 1940 and was 9.80 inches. The driest month on record was July 1916, when no precipitation was observed. The greatest daily total, 3.53 inches, fell on July 6, 1934. About once in 2 years as much as 1.2 inches of rain falls in an hour, as much as 1.4 inches in 2 hours, and as much as 2.3 inches in 24 hours. About once in 10 years as much as 3.0 inches falls in 24 hours, and once in 50 years as much as 3.8 inches falls in 24 hours.

Snowfall averages 42.5 inches per year but varies from the high of 76.4 inches, recorded during the 1964–65 season to the low of 15.0 inches, recorded during the 1936–37 season. The heaviest single-day snowfall, 15.4 inches, occurred January 26, 1967. The greatest recorded snow depth, 30 inches, was recorded February 2–5, 1967. Table 14 gives probabilities of snow cover of selected depths before given dates. Measurable amounts of snow generally fall each month from October through April. Charlotte averages 64 days per season with 1 inch or more of snow on the ground.

Michigan is on the northeast fringe of the Midwest tornado belt. An average of 10 tornadoes per year have occurred since 1950. Since 1900, only 9 tornadoes are known to have touched down in the county.

Evaporation from a class "A" pan during the crop season averages about 35.0 inches for the county based on data taken at East Lansing. Because potential evaporation exceeds the average precipitation during the crop season by 82 percent, soil moisture replenishment during the fall and winter months plays an important

TABLE 12.—*Temperature and precipitation data*

[Based on National Weather Service climatological observations at Charlotte, 1951–71]

Month	Temperature				Precipitation				
	Average daily high	Average daily low	Two years in 10 will have at least 4 days with—		Average total	One year in 10 will have—		Average number of days with 1 inch or more of snow cover	Average depth of snow on days with snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
	°F	°F	°F	°F	In	In	In		In
January	30.3	13.8	45	−7	1.83	0.73	3.15	22	4.0
February	34.0	15.5	47	−5	1.59	.51	2.93	17	4.7
March	43.1	23.3	63	6	2.05	.86	3.47	9	3.8
April	59.1	35.2	77	22	3.21	1.78	4.83	1	3.2
May	70.5	44.7	85	30	2.88	1.18	4.92	0	0
June	80.5	54.2	93	41	3.83	2.06	5.86	0	0
July	84.1	57.3	93	46	3.43	1.60	5.58	0	0
August	82.4	55.5	92	43	2.90	1.28	4.82	0	0
September	75.3	49.2	90	35	2.71	1.11	4.62	0	0
October	63.9	39.5	80	25	2.70	.59	5.49	(1)	1.8
November	47.4	29.4	64	15	2.64	1.30	4.21	4	2.6
December	35.3	19.5	53	0	2.05	.60	3.88	15	3.5
Year	58.8	36.4	[2] 96	[3] −13	31.82	24.50	39.60	68	3.4

[1] Less than one half.
[2] Average annual highest.
[3] Average annual lowest.

role in crop production in the county. While drought occurs occasionally, drought conditions are extremely severe only 6 percent of the time.

The nearest National Weather Service station at which records of winds, cloudiness, and humidity are kept is at Capitol City Airport in Lansing. Based upon 15 years of record, the average annual windspeed is 10.4 miles per hour from the south. The month with the highest average windspeed is January; winds average 12.3 miles per hour from the south-southwest. April is next; winds average 12.0 miles per hour from the west. August has the lowest average windspeed, 8.1 miles per hour from the south; and July, the next lowest, 8.4 miles per hour, also from the south. The fastest 1-minute sustained windspeed was 63 miles per hour from the southeast in June 1963.

Cloudy days are most common late in fall and early in winter, and they are least common late in spring and in summer. Based upon 19 years of record, December averages 21 cloudy, 7 partly cloudy, and 3 clear days. August averages 9 cloudy, 11 partly cloudy, and 11 clear days. The annual average of amount of possible sunshine is 53 percent. The average relative humidity at 1 p.m., based on 10 years of record, varies from 53 percent in May to 77 percent in December.

Physiography and Surface Geology

Several ice sheets advanced over Eaton County and retreated during the glacial period. The most recent ice sheet, or glacier, left the Charlotte Morainic System. The Charlotte Morainic System consists of three ridges. It begins in Kent County and continues southeasterly across Eaton County into Ingham County, where it diminishes. The moraine is a product of glacial deposition, and the valleys and hills are mainly of glacial origin (*3*).

Two sizable areas where bedrock is at a depth of 20 to 40 inches are in Eaton County. Sandstone bedrock occurs in the Grant River valley at Eaton Rapids. Limestone bedrock occurs in the Battle Creek River valley at Bellevue. The elevation above sea level ranges from 775 feet to nearly 1,000 feet and averages about 900 feet, which is about 325 feet above Lake Michigan.

Streams and Lakes

Eaton County has three major drainage systems, the Grand River, the Thornapple River, and the Battle Creek River.

The Grand River drains the eastern and northern parts of the county. It enters the county in Hamlin Township and flows out near Grand Ledge in Oneida Township. Willow Creek and Spring Brook are important tributaries of the Grand River. Sebewa Creek, Sandstone Creek, and Carrier Creek are other tributaries; they drain the northern part of the county.

The Thornapple River drains the central part of the county: the Benton Township area and westward. The Thornapple valley is nearly a mile wide and is fully 100

TABLE 13.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data from Charlotte, Eaton County, Mich. 1940–69]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	April 5	April 18	April 27	May 16	May 28
2 years in 10 later than	March 31	April 13	April 22	May 11	May 23
5 years in 10 later than	March 21	April 3	April 12	May 1	May 13
Fall:					
1 year in 10 earlier than	November 8	October 27	October 14	September 29	September 13
2 years in 10 earlier than	November 13	November 1	October 19	October 4	September 18
5 years in 10 earlier than	November 24	November 12	October 30	October 15	September 29

TABLE 14.—*Probabilities of snow cover of specified depth before given dates* [1]

[Data from Charlotte. Based on depth of snow cover at time of afternoon observation. Dashes indicate snow cover at given depth not at probability level]

Probability	Depth of snow cover			
	1 inch	3 inches	6 inches	12 inches
5 percent	November 5	November 9	November 21	January 5
10 percent	November 11	November 18	December 3	January 17
30 percent	November 22	December 5	December 28	----------
50 percent	November 30	December 17	January 8	----------
70 percent	December 8	December 30	February 8	----------
90 percent	December 19	January 18	----------	----------

[1] From publication "Michigan Snowfall Statistics: First 1-, 3-, 6-, & 12-inch Depths," June 1968.

feet below the bordering moraines in the western part of the county. Scipio Creek, Mud Creek, Hager Creek, Thompson Creek, Shanty Brook, Lacey Creek, and the Little Thornapple River are the major tributaries of the Thornapple River.

The Battle Creek River drains the southwestern part of the county: the Brookfield Township area and westward. The main tributaries are Indian Creek and Big Creek. In glacial times, when the Grand River was blocked by ice just east of Eaton Rapids, water from the Grand River flowed westward across the level plains between Eaton Rapids and Charlotte and flowed into the Battle Creek River.

The major lakes are Narrow Lake, approximately 160 acres; Pine Lake, approximately 140 acres; Saubee Lake, approximately 80 acres; and Lacey Lake, approximately 80 acres. There are about 20 small lakes scattered throughout the county. Their total size is less than 1,000 acres. Most have marly or mucky bottoms, and very few have sandy beaches or bottoms.

Many artificial lakes and ponds have been dug. They are used for recreation, irrigation, and livestock.

Water Supply

Most water for farming, industry, and households comes from wells. Glacial deposits and underlying bedrock formations are the principal aquifers. These glacial deposits vary considerably in thickness. They range from 250 feet thick in the northwestern part of the county to 50 feet thick in the southern part (*11*).

The southeast part of Eaton County has moderately abundant water resources. Glacial deposits, the Saginaw Formation, and the Michigan Formation in the southern edge of the area are the principal aquifers. The Grand River and Battle Creek River are not presently suitable for most uses, because they receive municipal effluent.

The southwestern part of the county does not have abundant water resources. The chief aquifers are glacial drift and the Marshall Formation. The Saginaw, Bayport, and Michigan Formations are also minor sources of water supplies. The Marshall Formation yields saline water, except in its southwestern part. The glacial aquifers, in particular the valley outwash, offer potential for future development.

Most of the northeastern part of the county does not have abundant water resources. Glacial drift and the Saginaw Formation are the major aquifers. The valley outwash and buried outwash aquifers along the Grand River and Thornapple River have potential for future development of water supplies.

The water resources in the northwestern part of the county are limited also. Glacial deposits are the chief aquifer in the area. The Saginaw and Michigan Formations are tapped by some households, but they are not highly productive. Outwash deposits may have high potential for future development. The Thornapple River also has potential for future development of water supplies.

Vegetation

When Eaton County was first settled, lumbering was next in importance to farming. Several forest types occurred on soils of certain similar characteristics. The moderately coarse textured, well drained soils, such as Oshtemo, Boyer, and Hillsdale soils, supported oak-hickory type forests that locally included beech, sugar maple, elm, ash, and walnut. The finer textured, well drained and moderately well drained soils such as Marlette soils supported maple-beech type forests. Another hardwood forest type occurred on the somewhat poorly drained, poorly drained, and very poorly drained mineral soils, such as Brady, Capac, Parkhill, and Gilford soils. Elm, ash, soft maple, shagbark hickory, and swamp white oak were the dominant species. Vegetation on the very poorly drained organic soils, such as Palms, Adrian, and Edwards soils, consisted of bluejoint and various sedges in the open areas. Poplar, willow, elm, ash, and soft maple grew on these organic soils where the water table was lower. Black walnut, butternut, sycamore, ironwood, redcedar, and wild black cherry occurred randomly in the various forest types.

Only a few woodlots of second growth timber remain, mostly on the poorly drained mineral soils. This second growth timber is about the same as the original vegetation. Many areas that have been pastured support an undesirable thorny undergrowth.

Tree planting increased from 60,000 trees in 1966 to 100,000 in 1972. Approximately 75 percent of the planting was for forestry, but with multiple use in mind. Other purposes include wildlife, recreation, yard plantings, screens, and interplantings. The most favored species planted are white pine, Scotch pine, white spruce, and blue spruce.

Farming

The 1969 Census of Agriculture reported 1,747 farms in Eaton County. Of the land in farms, 192,914 acres was in crops, of which 109,263 acres was harvested. In 1910, 94.6 percent of the land was farmland. Land use has changed, and now 73 percent of the county is farms. The average farm size has decreased also. Farm incomes are low, and many operators work part time off the farm.

Corn, small grain, and hay are still the main crops. In 1969, field corn for grain was planted on 26,406 acres and field corn for silage on 7,270 acres. Of the hay crops harvested in 1969, alfalfa and grass mixtures were on 14,635 acres, and grass and clover mixtures were on 2,295 acres. Small grain is important. Winter wheat was planted on 13,402 acres and oats on 6,418 acres. Soybeans were increased to 2,347 acres. Tree fruits and grapes have decreased; only 65 acres was reported in orchards in 1969. Small berries for sale were increased to 79 acres. Vegetables, sweet corn, and melons were increased to 1,778 acres.

Livestock provides an important source of income. There were 31,013 cattle and calves reported in 1969. Of this, 7,166 were milk cows. There were 28,054 hogs and pigs and 10,942 sheep and lambs.

Forest and nursery products provide additional income to farms in Eaton County.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Leverett, Frank, and Frank B. Taylor. 1915. The Pleistocene of Indiana and Michigan and the history of the Great Lakes. U.S. Geol. Surv. Monogr. 53, 529 pp., illus.

(4) Michigan Department of State Highways. 1970. Field manual of soil engineering. Ed. 5, 474 pp., illus.

(5) Michigan State University. 1972. Fertilizer recommendations for Michigan vegetables and field crops. Ext. Bull. E-550, 32 pp.

(6) Simonson, Roy W. 1962. Soil classification in the United States. Sci. 137:1027-1034.

(7) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(8) ———— 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(9) ———— 1975. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv. U.S. Dep. Agric. Handb. 436, 754 pp, illus.

(10) United States Department of Commerce. 1972. 1969 Census of Agriculture. Soc. and Econ. Statis. Admin., Bur. of the Census. Vol. 1, pt. 36, Sec. 2, pp. 177-184.

(11) Vanlier, K. E., W. W. Wood, and J. O. Brunett. 1974. Water-supply development and management alternatives for Clinton, Eaton, and Ingham Counties, Michigan. U.S. Geol. Surv. Water Supply Pap. 1969, 107 pp., illus.

Glossary

[Asterisks indicate terms used in tables 9 and 10]

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

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.

Aquifer. A porous soil or geological formation that yields ground water to wells or springs.

***Area reclaim.** An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Brush. Shrubs and stands of short, scrubby trees that do not reach merchantable size.

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.

***Complex slope.** Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

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 farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

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.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

***Excess fines.** Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

***Excess humus.** Contains too much organic matter.

***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.

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.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

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.

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.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

***Hard to pack.** Difficult to compact.

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.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

***Low strength.** Inadequate strength for supporting loads.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

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 simple 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. 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.

Organic soil. A soil or a soil horizon that consists primarily of organic matter, such as peat soils, muck soils, and peaty soil layers. In chemistry, organic refers to the compounds of carbon.

Outlet channel. A waterway constructed or altered primarily to carry water from man-made structures, such as terraces, tile lines, and diversions ditches.

Outwash plain. A land form of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

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.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

***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).

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

***Piping.** Formation by moving water of subsurface tunnels or pipelike cavities.

Plow layer. The soil ordinarily moved in tillage; equivalent to surface soil; technically, the Ap horizon.

***Poor outlets.** Surface or subsurface drainage outlets difficult or expensive to install.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

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.

Sedimentary peat. The remains of aquatic plants (such as algae), fecal material of aquatic animals, the remains of aquatic animals, and other finely divided remains of aquatic organisms and inorganic material from various sources deposited during an open-water stage of bog formation.

***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.

***Slow intake.** The slow movement of water into the soil.

***Slow refill.** The slow filling of ponds, resulting from restricted permeability in the soil.

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 (0.05 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.

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.

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).

Subsidence. A settling or packing down of the soil material, as exemplified by muck that has been drained and cultivated many times.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface layer. A term used in nontechnical soil descriptions for the upper mineral horizon of a soil; the A horizon. Has no depth limit.

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 (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.

Tile drain. Concrete or pottery pipe placed at suitable spacings and depth in the soil or subsoil to provide outlets to carry water from the soil.

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.

Toposequence. A sequence of kinds of soil in relation to location on a topographic slope. The soils differ primarily because of topography, or relief, as a factor of soil formation.

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.

Trace elements. The chemical elements in soils, in only extremely small amounts, essential to plant growth. Examples are zinc, cobalt, manganese, copper, and iron.

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, 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.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit or a woodland or other management group, read the introduction to the section it is in for general information about its management. The symbol in parenthesis under capability unit is the management group in which the mapping unit has been placed on a statewide basis. A dash in a column indicates that the mapping unit was not placed in that particular group.

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Woodland suitability group Symbol	Woody plant group Symbol
Ad	Adrian muck	10	IVw-1 (M/4c)	47	4w2	1
BbA	Bixby loam, 0 to 3 percent slopes	11	IIs-1 (3a)	44	2o2	4
Bh	Borrow land	11	VIIs-1	48	---	---
BnB	Boyer loamy sand, 0 to 6 percent slopes	12	IIIs-1 (4a)	47	2s5	3
BnC	Boyer loamy sand, 6 to 12 percent slopes	12	IIIe-3 (4a)	45	2s5	3
BoB	Boyer sandy loam, 0 to 6 percent slopes	12	IIIs-1 (4a)	47	2s5	3
BoC	Boyer sandy loam, 6 to 12 percent slopes	12	IIIe-3 (4a)	45	2s5	3
BpD	Boyer-Spinks loamy sands, 12 to 18 percent slopes	13	IVe-2 (4a)	47	2s5	3
BrA	Brady-Bronson sandy loams, 0 to 3 percent slopes	14	IIw-4 (4b, 4a)	43	---	---
	Brady part	--	-------------------	--	3s3	2
	Bronson part	--	-------------------	--	2s5	3
CaA	Capac loam, 0 to 3 percent slopes	16	IIw-1 (2.5b)	42	2o4	2
CbB	Capac-Marlette loams, 1 to 6 percent slopes	16	IIw-6 (2.5b, 2.5a)	44	---	---
	Capac part	--	-------------------	--	2o4	2
	Marlette part	--	-------------------	--	2o1	4
Ch	Cohoctah fine sandy loam, frequently flooded	17	Vw-1 (L-2c)	47	2w1	5
Co	Colwood loam	18	IIw-2 (2.5c-s)	43	3w1	5
Cp	Colwood loam, depressional	18	Vw-1 (L-2c)	47	3w1	5
Ed	Edwards muck	19	IVw-2 (M/mc)	47	4w2	1
Gf	Gilford sandy loam	20	IIIw-2 (4c)	46	3w1	5
HaB	Hillsdale sandy loam, 2 to 6 percent slopes	21	IIe-2 (3a)	42	2o2	4
HaC	Hillsdale sandy loam, 6 to 12 percent slopes	21	IIIe-2 (3a)	45	2o2	4
Ho	Houghton muck	22	IIIw-4 (Mc)	46	4w2	1
KbA	Kibbie fine sandy loam, 0 to 3 percent slopes	23	IIw-2 (2.5b-s)	43	2o4	2
Le	Lenawee silty clay loam, depressional	24	Vw-1 (1.5c)	47	2w1	5
MaB	Marlette loam, 2 to 6 percent slopes	25	IIe-1 (2.5a)	42	2o1	4
MaC	Marlette loam, 6 to 12 percent slopes	25	IIIe-1 (2.5a)	45	2o1	4
MaD	Marlette loam, 12 to 18 percent slopes	25	IVe-1 (2.5a)	47	2o1	4
MaE	Marlette loam, 18 to 25 percent slopes	25	VIe-1 (2.5a)	48	2r1	4
MbC3	Marlette clay loam, 6 to 12 percent slopes, severely eroded	26	IVe-3 (2.5a)	47	2o1	4
MdA	Matherton loam, 0 to 3 percent slopes	27	IIw-2 (3/5b)	42	2o4	2
MeA	Metamora-Capac sandy loams, 0 to 4 percent slopes	28	IIw-3 (3/2b, 2.5b)	43	2o4	2
OsB	Oshtemo sandy loam, 0 to 6 percent slopes	29	IIIs-1 (4a)	47	2s5	3
OsC	Oshtemo sandy loam, 6 to 12 percent slopes	30	IIIe-3 (4a)	45	2s5	3
OwB	Owosso-Marlette sandy loams, 1 to 6 percent slopes	30	IIe-2 (3/2a, 2.5a)	42	---	4
	Owosso part	--	-------------------	--	1o1	---
	Marlette part	--	-------------------	--	2o1	---

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Woodland suitability group Symbol	Woody plant group Symbol
OwC	Owosso-Marlette sandy loams, 6 to 12 percent slopes	31	IIIe-2 (3/2a, 2.5a)	45	---	4
	Owosso part	--	------------------	--	1o1	---
	Marlette part	--	------------------	--	2o1	---
OwD	Owosso-Marlette sandy loams, 12 to 18 percent slopes	31	IVe-1 (3/2a, 2.5a)	47	---	4
	Owosso part	--	------------------	--	1o1	---
	Marlette part	--	------------------	--	2o1	---
Pa	Palms muck	32	IIw-5 (M/3c)	44	4w2	1
Pr	Parkhill loam	33	IIw-1 (2.5c)	42	2w1	5
Sb	Sebewa loam	34	IIw-2 (3/5c)	43	2w1	5
Sh	Shoals-Sloan loams	34	IIIw-3 (L-2c)	46	---	---
	Shoals part	--	------------------	--	2o4	2
	Sloan part	--	------------------	--	2w1	5
SpB	Spinks loamy sand, 0 to 6 percent slopes	36	IIIs-1 (4a)	47	2s5	3
SpC	Spinks loamy sand, 6 to 12 percent slopes	36	IIIe-3 (4a)	45	2s5	3
StB	Spinks-Metea loamy sands, 0 to 6 percent slopes	36	IIIs-1 (4a, 4/2a)	47	2s5	3
StC	Spinks-Metea loamy sands, 6 to 12 percent slopes	37	IIIe-3 (4a, 4/2a)	45	2s5	3
TuA	Tuscola fine sandy loam, 0 to 4 percent slopes	38	I-1 (2.5a-s)	42	1o1	4
WaA	Wasepi sandy loam, 0 to 3 percent slopes	38	IIIw-1 (4b)	45	3s3	2
WbA	Wasepi sandy loam, bedrock variant, 0 to 3 percent slopes	39	IIIw-1 (4/Rb)	45	3s3	2
WnA	Winneshiek silt loam, 0 to 3 percent slopes	40	IIs-1 (2/Ra)	44	2o2	4

☆ U.S. GOVERNMENT PRINTING OFFICE: 1978—224-895/32

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquires

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).