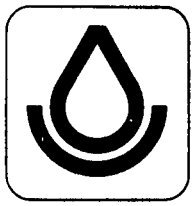
SOIL SURVEY

Gladwin County Michigan



Issued March 1972
UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
MICHIGAN AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1960–63. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1963. 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 Gladwin Soil Conservation District.

This published soil survey uses some names of soil series that have been correlated by the Soil Conservation Service differently from those used earlier by the Soil Conservation Service and the Michigan Agricultural Experiment Station. In the following, the Michigan Agricultural Experiment Station prefers the soil series names that are in parentheses: the loamy substratum phase of the Au Gres (Arenac), the clayey subsoil variant from the Belding (Dafter), Ceresco (Pennock), Chelsea (Graycalm), Cohoctah (Pinora), the loamy substratum phase of the Gladwin (Winegars), the loamy substratum phase of the Mancelona (Bentley), and the loamy substratum phase of the Rubicon (Melita).

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY 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 Gladwin 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 the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described, and the page for the capability unit 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 the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

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

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

Engineers, builders, community planners and others can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, information about soil features that affect engineering practices and the choice of sites for nonindustrial buildings and for recreation areas.

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

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

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SOIL SURVEY OF GLADWIN COUNTY, MICHIGAN

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

GLADWIN COUNTY lies in the north-central part of the Lower Peninsula of Michigan (fig. 1). It has a land area of about 322,176 acres, or 503.4 square miles. Gladwin, the county seat, is in the west-central part of the county.

Figure 1.—Location of Gladwin County in Michigan.

About 40 percent of the county is in farms, but large areas are also in woodland. The principal crops are corn, wheat, oats, and hay. Dairy cows and other livestock are on most farms.

How This Survey Was Made

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

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

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Allendale and Au Gres, 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 soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Chelsea sand, 0 to 6 percent slopes, is one of several phases within the Chelesa series.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly

equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Soil associations are such kinds of mapping units shown on the soil map of Gladwin County.

An association is a mapping unit made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort needed for mapping them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. An association is named for the major soils in it, for example, Au Gres-Kinross association.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are also 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.

On basis of yield and practice tables and other data they have collected, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they 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 Gladwin County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

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

Fourteen soil associations are in Gladwin County. Associations 1 through 5 are sandy and loamy soils on lake plains; associations 6 through 8 are sandy soils on lake plains, outwash plains, and moraines; associations 9 and 10 are loamy soils on lake plains and till plains; association 11 is made up of loamy and sandy soils on moraines; associations 12 and 13 are loamy soils on lake plains; and association 14 consists of sandy and mucky soils on lake plains.

Sandy and Loamy Soils on Lake Plains

The sandy and loamy soils on lake plains are level to undulating, and most of them are wet. They are in the eastern part of the county. Most of the soils are sandy to a depth between 18 and 42 inches and are underlain by loamy material. Many areas are excessively wet and remain as woodland.

Five of the associations in Gladwin County are sandy and loamy and are on lake plains.

1. Iosco-Brevort association

Level, somewhat poorly drained and poorly drained soils that have sandy and loamy subsoil and loamy underlying material

This association consists of level areas that are mainly along lake plains, though some are on low ridges and river terraces. It lies at the extreme western edge of the lake plain area. The main rivers in this association are deeply entrenched, and drainage is generally toward the east to the Tittabawassee River.

The association covers about 20 percent of the county. The Iosco and Brevort soils, in equal parts, make up about 50 percent of the association, and all of the minor soils together make up the remaining 50 percent.

The major soils formed in sandy material, 18 to 42 inches thick, that is underlain by loamy material. The Iosco soils, on low ridges and knolls, are somewhat poorly drained. The Brevort soils, on broad flats and in depressions, are poorly drained to very poorly drained. They are darker colored and grayer than Iosco soils, and they occupy the lower positions on the landscape.

Minor soils in this association are the Croswell, Epoufette, Gladwin, Mancelona, and Sims. The somewhat poorly drained Gladwin and the poorly drained or very poorly drained Epoufette soils occur near the city of Gladwin. These soils are underlain by stratified sand and gravel to a depth of 5 feet or more. On the highest sandy ridges are the moderately well drained Croswell soils, which formed in sandy material more than 5 feet thick. Mancelona soils are on ridges of stratified sand and gravel. In places loamy material underlies the Croswell and Mancelona soils at a depth between 42 and 66 inches. The Sims soils, in small depressional areas, are poorly drained or very poorly drained.

Except on the highest sandy ridges, most areas of this association are excessively wet. All of the soils are low in fertility, and they are droughty in summer if drainage is provided. They are wet in spring, but they dry out quickly when the water table recedes. If these soils are cultivated, the loose sand in the surface layer makes them highly susceptible to soil blowing. Drainage is difficult to provide in many areas because of the variable depth to loamy material and because suitable outlets are not available.

About half of this association has been cleared and farmed or pastured, but many areas are now idle or are reverting to brush or trees. Areas not previously farmed

have thick stands of aspen, birch, red maple, and elm. Willow and tag alder grow on the very poorly drained soils in the low areas.

2. *Allendale-Pickford-Pinconning association*

Level, somewhat poorly drained to very poorly drained soils that have sandy to clayey subsoil and clayey underlying material

This association consists of level soils on a lake plain that lies to the east of association 1. The largest area is in the south-central part of the county. The soils of this association formed in or are underlain by clayey material.

This association covers about 7 percent of the county. The Allendale soils make up about 30 percent of the association; the Pickford and the Pinconning soils, 15 percent each; and the minor soils, the remaining 40 percent.

The Allendale soils occupy the higher elevations on the landscape. They are somewhat poorly drained. These soils formed under a fluctuating water table in sandy material, 18 to 42 inches thick, that overlies clayey material. The Pickford and Pinconning soils are in depressions and drainageways and are poorly drained or very poorly drained. The Pickford soils formed entirely in clayey material, but the Pinconning soils formed in sandy material, 18 to 42 inches thick, that overlies clay. Both the Pickford and Pinconning soils formed in areas where the water table is high.

Minor soils in this association are the well drained Rubicon and the moderately well drained Croswell. These soils occupy beach ridges and are sandy to a depth of 5 feet or more.

All of the major soils in this association are excessively wet. In addition the Allendale soils are likely to be droughty if drained. Internal drainage is slow or very slow because of the high water table and the very slow permeability of the underlying clayey material. As a result, water ponds in depressions and in low, level areas. These soils are slow to dry out in spring and after a prolonged rain. Because they are clayey and level, Pickford soils generally remain wet longer than the other soils. Also if they are tilled when wet, Pickford soils compact readily.

This association is severely limited for crops because of excessive wetness and because clayey material is at a variable depth. Open ditches and tile drains can be used in places for removing excess water. The success of drainage, however, depends on the availability of outlets and the depth to clayey material. Most areas of the Allendale and Pinconning soils remain as woodland. The Pickford soils are more fertile than the other soils in this association and are more suitable for growing crops. They are therefore drained and farmed.

3. *Iosco-Brevort-Kawkawlin association*

Level to undulating, somewhat poorly drained to very poorly drained soils that have sandy to loamy subsoil and loamy underlying material

This association is made up of level to undulating soils on a lake plain in the extreme southeastern corner of the county.

About 5 percent of the county is covered by this association. The Iosco soils make up about 30 percent of the association; the Brevort soils, 20 percent; and the Kawkawlin soils, 15 percent; and the minor soils, the remaining 35 percent.

The Iosco and the Brevort soils formed in sandy material, 18 to 42 inches thick, that overlies loamy material. The Kawkawlin soils formed entirely in loamy material. The Iosco and Kawkawlin soils formed under a fluctuating high water table, but the Brevort soils formed under a constant high water table. Both the Iosco and the Kawkawlin soils occupy the higher areas above the poorly drained or very poorly drained Brevort soils, which are in depressions and on broad flats.

The minor soils in this association are the Au Gres, Roscommon, and the Rubicon. The Rubicon is a deep, sandy soil on ridges. It is droughty, and if it is farmed, it is highly susceptible to soil blowing. The Au Gres and Roscommon are sandy soils and occupy broad flats and depressions. The Au Gres are somewhat poorly drained, but the Roscomomn are very poorly drained.

Excessive wetness hinders the growth of plants and makes the soils of this association poorly suited to farming. The soils are difficult to drain, and much of the acreage therefore remains as woodland. Also, the choice of crops is limited. Drained areas of Kawkawlin soils are suitable for crops, but this soil occupies a small acreage. Because the soils of this association dry out and warm up slowly in spring, crops that grow quickly and resist frost are better suited than other kinds of crops.

4. *Iosco-Au Gres-Ingalls association*

Level, somewhat poorly drained soils that have a dominantly sandy subsoil

In this association are level soils on lake plains. The areas are in the northeastern and southeastern parts of the county.

This association covers about 3 percent of the county. The Iosco soils make up about 40 percent of the association; the Au Gres soils, 25 percent; the Ingalls soils, 10 percent; and minor soils, the remaining 25 percent.

All of the major soils in this association are sandy and formed under a fluctuating high water table. They are somewhat poorly drained and are wet in spring and after a prolonged rain. The Iosco and Ingalls soils are sandy in the upper 18 to 42 inches, but the Iosco are underlain by nonstratified, loamy material, and the Ingalls are underlain by stratified silt and very fine sand. The Au Gres soils have a loamy substratum. They consist of 42 to 66 inches of sandy material over loamy material.

Minor soils in this association are the Croswell, Menominee, and Ocqueoc. These soils are well drained or moderately well drained.

The soils in this association are low in organic matter and fertility and are excessively wet. If these soils are drained, they are droughty and are subject to soil blowing.

These sandy, wet soils are seldom used for crops. Drainage is difficult to provide, because depth to loamy material varies and suitable outlets for removing excess water are lacking. Most of the association remains as woodland. Aspen, white birch, red maple, and brackenfern are dominant on the low ridges and knolls. Swamp hardwoods and grasses grow in the depressions and on the broad flats.

5. *Rubicon-Ocqueoc-Ingalls association*

Level to undulating, well-drained to somewhat poorly drained soils that have a sandy subsoil.

This association is made up of level to undulating soils on lake plains that border the Tittabawassee River. The areas are long and narrow and cover about 5 percent of the county.

The Rubicon and Ocqueoc soils, in equal parts, make up about 50 percent of this association; the Ingalls soils, about 20 percent; and the minor soils, the remaining 30 percent.

All of the soils in the association formed in sandy material underlain by finer textured material. The Rubicon soils consist of 42 to 66 inches of sandy material over a loamy substratum. The Ocqueoc and Ingalls soils formed in sandy material, 18 to 42 inches thick, that overlies stratified silt and very fine sand. The Rubicon soils are well drained, the Ocqueoc are well drained or moderately well drained, and the Ingalls are somewhat poorly drained. The Rubicon and the Ocqueoc soils are near the Tittabawassee River, but the Ingalls soils occupy low-lying areas away from the river.

Minor soils of this association are the Menominee, Iosco, Burleigh, and Brevort. The Menominee soils are well drained or moderately well drained; the Iosco soils are somewhat poorly drained; and the Burleigh and Brevort soils are poorly drained or very poorly drained.

Most of the soils in this association are low in natural fertility and are droughty. If they are farmed intensively, these soils are subject to soil blowing. Excessive wetness is a hazard in areas of Ingalls soils, especially in spring. Drainage is difficult to provide in soils of this association. Adequate outlets are lacking, and ditches are difficult to dig in the sandy and silty material, which caves readily.

Few areas of these sandy and droughty soils are farmed. Most of the association is wooded, mainly with aspen and birch. Many areas of the well-drained soils are used as recreational sites for cabins, vacation homes, and resorts.

Sandy Soils on Lake Plains, Outwash Plains, and Moraines

The sandy soils on lake plains, outwash plains, and moraines are coarser textured and more hilly than the other soils in the county. Most of the soils formed in deep deposits of sandy material and are droughty, but some of the soils are excessively wet. These soils are severely limited for crops, and they remain mainly as woodland.

Three of the associations in Gladwin County consist of sandy soils that are on lake plains, outwash plains, and moraines.

6. *Croswell-Au Gres-Rubicon association*

Level to sloping, well-drained to somewhat poorly drained soils that have a sandy subsoil; on lake plains

This association consists of sandy soils on lake plains. Most of the soils are level, but some are sloping and are on low ridges and knolls. The areas are mostly in the eastern half of the county, though a scrub oak plain in the northwestern corner of the county is also in this association.

This is the largest association in Gladwin County, and it covers about 24 percent of it. The Croswell soils make up about 35 percent of the association; the Au Gres soils, 20 percent; the Rubicon soils, 12 percent; and the minor soils, the remaining 33 percent.

All of the soils of the association are sandy to a depth of 5 feet or more. These soils differ, however, in natural drainage. The Rubicon soils occupy the higher areas and are well drained; the Croswell soils are moderately well drained; and the Au Gres soils, in areas below the Rubicon and Croswell soils, are somewhat poorly drained.

Minor soils in this association are the Chelsea, Deford, Grayling, Kinross, Roscommon, Rousseau, and Wainola. The Roscommon and Kinross soils are in depressions and drainageways, and they are poorly drained or very poorly drained. They are darker colored than any other soil in the association. In the southeastern part of the county are the Rousseau, Wainola, and Deford soils, which formed in fine sand. The Rousseau soils, on knolls and ridges, are well drained. On low flats and in depressions are the somewhat poorly drained Wainola and the poorly drained or very poorly drained Deford soils. The Chelsea and Grayling soils are well drained. They formed in sand and are in the northwest corner of the county.

The soils in this association generally are low in fertility and are droughty. The hazard of soil blowing is severe if large areas are cleared and farmed. The Au Gres, Kinross, and Roscommon soils are excessively wet in spring and in other wet periods. Drainage is difficult, and ditchbanks and tile trenches readily cave in because the sandy material flows when wet.

The soils of this association are not suitable for farming. Most areas are wooded, and the trees are mainly aspen, birch, scrub oak, white oak, red oak, jack pine, and swamp hardwoods (fig. 2).

7. *Mancelona-Gladwin association*

Level to undulating, well-drained and somewhat poorly drained soils that have a sandy to loamy subsoil; on outwash plains

This association consists of level to undulating soils that lie mainly in the valley of the North Branch of the Cedar River in the northwestern part of the county. Along the valley floor, especially at the upper end of the river, are some soils that are moderately sloping to steep.

This association covers about 3 percent of the county. The Mancelona soils make up about 40 percent of the association; the Gladwin soils, 35 percent; and the minor soils, the remaining 25 percent.

The Mancelona and Gladwin soils formed in 18 to 42 inches of loamy sand or sand over stratified sand and gravel. The Mancelona soils are well drained and the Gladwin soils are somewhat poorly drained.

Minor soils in this association are mainly the Chelsea, Epoufette, and Montcalm. The sandy Montcalm and Chelsea soils are intermingled with the Mancelona soils in some places. The very poorly drained Epoufette soils occur on low terraces with the Gladwin soils. Poorly

Figure 2.—Typical vegetation of willow and brush on an Au Gres soil in soil association 6.

drained alluvial and organic soils are on the narrow bottom lands adjacent to the river.

The soils of this association are moderate to low in fertility. They are likely to be droughty during dry periods. The narrow bottom lands are subject to periodic flooding, generally in spring or after a prolonged rain.

Most of this association has been cleared and farmed at some time. Many areas once farmed are now in pasture, are planted to pines, or are idle. On the well-drained soils, the woodland consists of aspen and northern hardwoods. On the poorly drained soils, the woodland is made up of swamp hardwoods and conifers.

8. *Chelsea-Rubicon-Montcalm association*

Undulating to hilly, well-drained soils that have a dominantly sandy subsoil; on moraines

This association, the most hilly in the county, occurs mainly in the northwestern part. The soils are mostly rolling to hilly, but some are undulating. Several small lakes are in the association.

About 3 percent of the county is in this association. The Chelsea soils make up about 45 percent of the association; the Rubicon soils, 25 percent; the Montcalm soils, 20 percent; and the minor soils, the remaining 10 percent.

All of the major soils in this association formed in sandy material, and they are all well drained. Both the Chelsea and Montcalm soils contain thin layers of loamy sand. These layers are at a depth between 42 and 66 inches in the Chelsea soils but at a depth of less than 42 inches in the Montcalm soils. The Rubicon soils are sandy to a depth of 5 feet or more. The Chelsea soils occur with the Rubicon soils in Sherman Township and with the Montcalm soils in other parts of this association.

Minor soils in this association are the somewhat poorly drained Au Gres and the poorly drained or very poorly drained Epoufette and Tawas soils. The Au Gres occupy the lower areas and the Epoufette and Tawas are in the depressions or drainage areas. The Au Gres and the Epoufette soils are sandy, but the Tawas soils consist of 12 to 42 inches of organic material over sand.

These soils are droughty and are low in fertility. They blow readily if exposed to wind.

Most areas of this association are in woodland. The trees are mainly aspen, white birch, and such northern hardwoods as white oak. Small areas are cleared and are used for pasture. The scenic views provided by these hilly

soils make them desirable for campsites, picnic areas, and similar recreational uses, except where slopes are steep.

Loamy Soils on Lake Plains and Till Plains

The loamy soils on lake plains and till plains are nearly level to undulating. These soils are well suited to crops. Most of these soils formed entirely in loamy material. Excessive wetness and erosion are the major limitations.

Two associations in Gladwin County are made up of loamy soils on lake plains and till plains.

9. Nester-Kawkawlin-Sims association

Level to undulating, well-drained to very poorly drained soils that have a loamy subsoil; on till plains

In this association are level to undulating soils on till plains, mainly in the western half of the county (fig. 3). Slopes are seldom more than 6 percent, but they are less than 2 percent in about half of the association.

This association makes up about 6 percent of the county. The Nester soils make up about 40 percent of the association; the Kawkawlin soils, 15 percent; the Sims soils, 10 percent; and the minor soils, the remaining 35 percent.

All of the soils in this association formed in similar material, but they differ in natural drainage. The Nester soils are well drained or moderately well drained; the Kawkawlin soils are somewhat poorly drained; and the Sims soils are poorly drained or very poorly drained. All of these soils have a loamy surface layer. The subsoil and underlying material are clay loam. The Nester soils occupy the highest areas, and the Kawkawlin soils are in depressions. The Sims soils are mainly in drainageways.

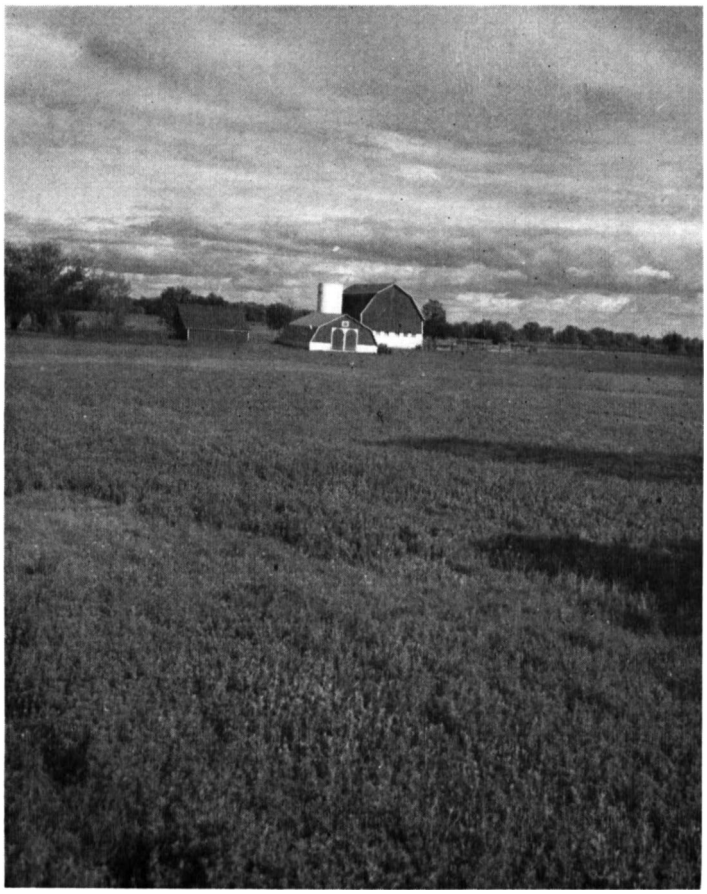

Figure 3.—Typical view of soil association 9.

Minor soils in this association are mainly the Belding, Cohoctah, Menominee, and Ubly. The Ubly and Menominee soils are well drained or moderately well drained. The Belding soils are somewhat poorly drained. The Cohoctah soils are very poorly drained. The Ubly and Menominee are on higher elevations. The Belding soils are intermingled with the Kawkawlin soils, and they generally are on slightly higher elevations than the Kawkawlin. The Cohoctah soils generally are on bottom lands adjacent to streams.

The soils of this association are fertile. Their capacity to supply water to growing plants is high. Many wet depressions occur in these soils in spring and after a heavy rain. In these areas wetness delays planting and harvesting of crops in some years. The Kawkawlin and Sims soils are likely to be excessively wet. They have a high water table, and water moves moderately slowly through them. The wetness limits the growth of plants because it hinders the downward growth of the roots.

The soils of this association are among the best in the county for farming. Most areas have been cleared and are now farmed. Some wet areas occur on most farms. If these areas are adequately drained, the soils are well suited to crops. Tile drains and open ditches can be used to provide drainage.

10. Sims association

Level, poorly drained and very poorly drained soils that have a loamy subsoil; on lake plains

In this association are level, poorly drained and very poorly drained soils. These soils are on a lake plain that contains some shallow depressions and drainageways. They occur in an area near Beaverton.

About 2 percent of Gladwin County is in this association. The Sims soils make up about 70 percent of the association, and the minor soils, the remaining 30 percent.

The Sims soils are poorly drained or very poorly drained and formed in clay loam material. Their subsoil is gray, which indicates that they are wet for long periods, especially in spring.

The minor soils in this association are the Iosco. These soils consist of 18 to 42 inches of sandy material that overlies loamy material similar to that in which the Sims soils formed. The Iosco soils occupy the low knolls and ridges in the association, and they are better drained than Sims soils.

The water table is high throughout much of this association, and the soils are excessively wet. If adequate outlets are available, artificial drainage can readily be provided. Ditches and tile drains can be used to help remove excess water and make the soils suitable for crops. Natural fertility is high, and the soils respond readily

to management. In some areas stones and cobblestones occur, particularly in section 16 of Tobacco Township.

If these soils are drained, they are among the best in the county for crops. Most areas are used for the crops commonly grown. Areas that remain as woodland are mostly in aspen and lowland hardwoods.

Loamy and Sandy Soils on Moraines

The loamy and sandy soils on moraines are undulating to rolling. They occur in the northwestern part of the county. Only one association in Gladwin County consists of loamy and sandy soils on moraines, and it is one of the better associations in the county for crops.

11. Nester-Kawkawlin-Iosco association

Dominantly undulating to rolling, well-drained to somewhat poorly drained soils that have a loamy to sandy subsoil; on moraines

In this association are mostly undulating to rolling soils on moraines in the western part of the county. Some entrenched drainageways and lakes are in the association, and the slopes next to these are steep.

This association makes up about 11 percent of the county. The Nester soils make up 55 percent of the association; the Kawkawlin soils, 15 percent; the Iosco soils, 10 percent; and the minor soils, the remaining 20 percent.

The Nester soils formed in clay loam and are well drained to moderately well drained. They are in the highest areas (fig. 4). The Kawkawlin and Iosco soils are both somewhat poorly drained, but the Kawkawlin soils formed entirely in clay loam and the Iosco soils formed in 18 to 42 inches of sandy material over clay loam. Both the Kawkawlin and the Iosco soils are in shallow depressions or are in drainageways.

Minor soils in this association are the Breckenridge, Montcalm, Rubicon, and Sims. The Breckenridge and Sims soils are poorly drained or very poorly drained and are in depressions or drainageways. The Montcalm and Rubicon soils are sandy and well drained and are on the highest ridges.

Most soils of this association are fertile and have an adequate supply of moisture available for plants. Because of rapid runoff, the sloping to rolling soils are subject to erosion. Excessive wetness is a problem in the Kawkawlin and the Iosco soils and must be corrected for good growth of crops.

Much of this association is used for crops and pasture. Livestock and dairy farms predominate. Wooded areas occur throughout the association.

Loamy Soils on Lake Plains

Loamy soils on lake plains are level to undulating and occur in the eastern half of the county. These soils differ greatly in drainage, but excessive wetness is a hazard in most places.

Two associations in Gladwin County consist of loamy soils on lake plains. Most areas of these soils are farmed, but some areas are in woodland.

406-304—72——2

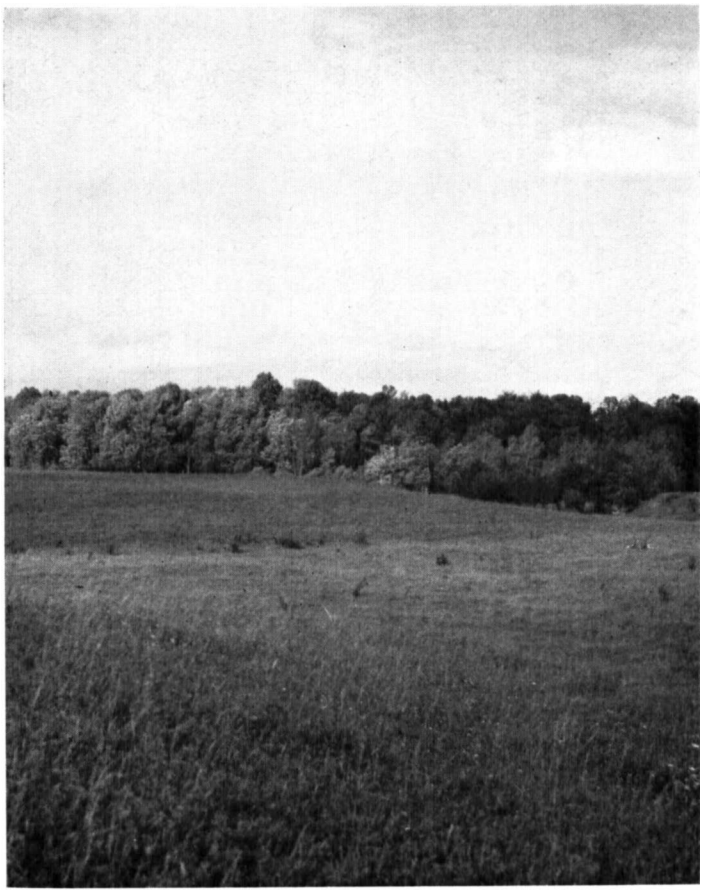

***Figure 4.*—Sloping Nester soils in soil association 11.**

12. Ubly-Brimley-Bruce association

Level, well-drained to poorly drained soils that have a dominantly loamy subsoil; on lake plains

This association consists mainly of level soils on lake plains, though along riverbanks and drainageways the soils are steep. It occurs in two small areas adjacent to the Tittabawassee River in the southern part of the county.

This association covers only about 1 percent of the county. The Ubly soils make up about 50 percent of the association; the Brimley soils, 25 percent; the Bruce soils, 15 percent; and the minor soils the remaining 10 percent.

The Ubly and Brimley soils occupy the higher areas and side slopes in the association. The Ubly soils are well drained or moderately well drained. They consist of sandy loam, 18 to 42 inches thick, over loam and clay loam. Both the Brimley and Bruce soils formed in similar material and are made up of stratified silt and very fine sand. The Brimley soils are somewhat poorly drained, and the Bruce soils are poorly drained. Minor soils in this association are mainly in the Burleigh, Deford, and Wainola series. They occur in low flats and depressions. The somewhat poorly drained Wainola and the poorly drained or very poorly drained Deford soils formed in fine sand. The poorly drained or very poorly drained Burleigh soils formed in sand or loamy sand over stratified very fine sand and silt.

In most areas of this association, the soils are excessively wet. Supplies of plant nutrients and moisture are adequate for most crops. Because of unstable silt and very fine sand in many areas, drainage is difficult to install and maintain. Ditchbanks and tile trenches cave in readily and are costly to maintain.

About two-thirds of this association is cleared and is used for farming. The wooded areas that remain are mainly in northern hardwoods, lowland hardwoods, and swamp conifers.

13. Hettinger-Bowers-Iosco association

Level to undulating, somewhat poorly drained to very poorly drained soils that have a loamy to sandy subsoil; on lake plains

In this association are level to undulating soils on a lake plain that is dissected in places by drainageways. These soils are mostly in the eastern part of the county within a few miles of the Tittabawassee River.

About 5 percent of the county is in this association. The Hettinger and Bowers soils, in equal parts, make up about 40 percent of the association; the Iosco soils, 15 percent; and the minor soils, the remaining 45 percent.

The Hettinger and Bowers soils consist of similar stratified clay loam and silty clay loam, but they differ in natural drainage. The Hettinger soils, in shallow depressions and on broad flats, are poorly drained or very poorly drained, and the Bowers soils are somewhat poorly drained. The somewhat poorly drained Iosco soils consist of 18 to 42 inches of sandy material over loamy material. The Bowers and Iosco soils occupy the higher elevations on the landscape.

Minor soils in this association are the Brevort, Bruce, Menominee, and Pickford. The Bruce and Pickford soils are poorly drained or very poorly drained and occur in shallow depressions. The Bruce soils are made up of stratified silt and very fine sand, but the Pickford are clayey. The well drained or moderately well drained Menominee soils occur on the small knolls and ridges. They consist of 18 to 42 inches of sandy material over loamy material.

In most of this association, the soils are fertile but are excessively wet. Artificial drainage is needed if these soils are used for crops. Most areas dry out slowly in spring, and planting is delayed longer than on most other soils of the county.

General, livestock, and cash crop farms are dominant in this soil association. The main cash crops are white beans, sugar beets, corn, and wheat. Wooded areas are mainly in lowland hardwoods.

Sandy and Mucky Soils on Lake Plains

The sandy and mucky soils on lake plains are wet and level. They are too wet for crops, and most areas are in woodland and brush. Only one association in Gladwin County is made up of sandy and mucky soils on lake plains, and it is in the eastern part of the county.

14. Roscommon-Carbondale association

Very poorly drained, mucky and sandy soils

This association consists of very poorly drained, level soils on flood plains or in depressions on moraines or lake plains. These soils are mostly in the eastern part of the county, but some areas are in the northwestern part. This association has more wet soils than any other association in the county.

About 5 percent of the county is in this association. The Roscommon soils make up about 70 percent of the association; the Carbondale soils, 15 percent; and the minor soils, the remaining 15 percent.

The Carbondale soils make up most of the association in the northwestern part of the county. These soils formed in organic material and are very poorly drained. The Roscommon soils formed entirely in sandy material, but they have a mucky surface layer. In the eastern part of the county, mucky and sandy soils are intermixed.

Minor soils in this association are the Au Gres and Brevort. The Brevort soils occupy a small acreage in the eastern part of the county. They consist of sandy material, 18 to 42 inches thick, over loamy material. The Au Gres occupy the slightly higher elevations. They are somewhat poorly drained and formed in sand.

During most of the year, the soils in this association are wet. Because of the difficulty of removing the excess water from these soils and because fertility is low, crops are seldom grown. Most areas of the association are covered by dense stands of brush, trees, or grasses.

Descriptions of the Soils [1]

This section describes the soil series and mapping units of Gladwin County. The acreage and proportionate extent of each mapping unit are given in table 1.

The procedure in this section is first to describe the soil series, including a short description of a typical soil profile. Then, in small print, is given a more detailed description of the same profile, the range of soil characteristics within the soil series, and a comparison with soils of other series. Next, in larger print, are descriptions of the mapping units within the series. The farmer and general reader probably will be interested only in the material in larger print, or the descriptions of the series and of the mapping units. Soil scientists and others who require more information need to read this material and the material in finer print as well.

All the soils having a symbol made up entirely of capital letters are mapped at less intensity than the other soils. The composition of these units is more variable than that of the others in the county but has been controlled well enough to interpret for the expected use of the soil.

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

For more general information about the soils, the reader can refer to the section "General Soil Map," in which the broad patterns of soils are described. The loca-

[1] C. E. REDMOND, Soil Conservation Service, U.S. Department of Agriculture, assisted in the preparation of the association mapping units.

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

Soil	Acres	Percent
Allendale sand, 0 to 4 percent slopes	5, 517	1. 7
Allendale-Pinconning-Pickford association	394	. 1
Au Gres sand, 0 to 2 percent slopes	8, 433	2. 6
Au Gres sand, loamy substratum, 0 to 2 percent slopes	2, 300	. 7
Au Gres-Kinross association	6, 024	1. 9
Au Gres-Kinross loamy substratum association	757	. 2
Au Gres-Roscommon association	4, 652	1. 4
Belding sandy loam, 0 to 2 percent slopes	1, 078	. 3
Belding sandy loam, 2 to 6 percent slopes	824	. 3
Belding sandy loam, clayey subsoil variant	621	. 2
Bowers silt loam, 0 to 4 percent slopes	1, 801	. 6
Bowers-Iosco-Hettinger association	2, 499	. 8
Breckenridge sandy loam	1, 243	. 4
Brevort loamy sand	8, 026	2. 5
Brevort sandy loam	3, 835	1. 2
Brimley silt loam, 0 to 4 percent slopes	782	. 2
Bruce very fine sandy loam	1, 426	. 4
Bruce-Brimley-Burleigh association	1, 543	. 5
Burleigh loamy sand	1, 014	. 3
Carbondale muck	2, 177	. 7
Ceresco loam	535	. 2
Chelsea sand, 0 to 6 percent slopes	2, 209	. 7
Chelsea sand, 6 to 12 percent slopes	1, 464	. 5
Chelsea sand, 12 to 18 percent slopes	846	. 3
Chelsea-Au Gres association	4, 607	1. 4
Chelsea-Rubicon association, undulating	1, 446	. 4
Chelsea-Rubicon association, rolling	3, 235	1. 0
Cohoctah loam	2, 832	. 9
Croswell sand, 0 to 6 percent slopes	9, 837	3. 0
Croswell stony sand, 0 to 6 percent slopes	165	. 1
Croswell-Au Gres association	6, 923	2. 1
Croswell-Au Gres-Kinross association	2, 130	. 7
Croswell-Au Gres-Roscommon association	6, 562	2. 0
Edwards muck	972	. 3
Epoufette sandy loam	11, 654	3. 6
Epoufette-Tawas association	3, 424	1. 1
Evart loamy sand	615	.2
Evart-Winterfield association	2, 293	. 7
Gladwin loamy sand, 0 to 2 percent slopes	6, 889	2. 1
Gladwin loamy sand, loamy substratum, 0 to 2 percent slopes	2, 692	. 8
Gladwin-Epoufette association	700	. 2
Gladwin-Epoufette-Croswell association, undulating	2, 936	. 9
Grayling sand, 0 to 6 percent slopes	547	. 2
Grayling association, rolling	883	. 3
Grayling association, undulating	2, 480	. 8
Grayling-Croswell-Au Gres association	4, 973	1. 5
Hettinger loam	2, 679	. 8
Hettinger-Brevort-Burleigh association	3, 218	1. 0
Houghton muck	566	. 2
Ingalls sand, 0 to 2 percent slopes	924	. 3
Iosco loamy sand, 0 to 2 percent slopes	12, 598	3. 9
Iosco loamy sand, 2 to 6 percent slopes	2, 328	. 7
Iosco stony sand, 0 to 2 percent slopes	229	. 1
Iosco-Au Gres-Ingalls association	5, 447	1. 7
Iosco-Brevort association	1, 123	. 3
Iosco-Brevort-Ingalls association	7, 867	2. 4
Iosco-Kawkawlin-Brevort association	759	. 2
Iosco-Menominee-Brevort association	2, 310	. 7
Kawkawlin loam, 0 to 2 percent slopes	5, 869	1. 8
Kawkawlin loam, 2 to 6 percent slopes	4, 077	1. 3
Kinross sand	2, 235	. 7
Lacota sandy loam	345	. 1
Linwood muck	342	. 1
Londo loam, 0 to 2 percent slopes	1,·472	. 5
Londo loam, 2 to 6 percent slopes	192	. 1
Loxley muck, coarse substratum	732	0. 2
Lupton muck	3, 246	1. 0
Mancelona sand, 0 to 2 percent slopes	2, 069	. 6
Mancelona sand, 2 to 6 percent slopes	2, 471	. 8
Mancelona sand, 6 to 12 percent slopes	649	. 2
Mancelona sand, 12 to 25 percent slopes	711	. 2
Mancelona loamy sand, loamy substratum, 0 to 2 percent slopes	216	. 1
Mancelona loamy sand, loamy substratum, 2 to 6 percent slopes	467	. 1
Manistee sand, 0 to 4 percent slopes	575	. 2
Markey muck	1, 193	. 4
Menominee sand, 0 to 2 percent slopes	629	. 2
Menominee sand, 2 to 6 percent slopes	3, 562	1. 1
Menominee sand, 6 to 14 percent slopes	1, 479	. 5
Menominee loamy sand, 0 to 2 percent slopes	511	. 2
Menominee loamy sand, 2 to 6 percent slopes	576	. 2
Montcalm loamy sand, 0 to 2 percent slopes	307	. 1
Montcalm loamy sand, 2 to 6 percent slopes	1, 443	. 4
Montcalm loamy sand, 6 to 12 percent slopes	1, 108	. 3
Montcalm loamy sand, 12 to 25 percent slopes	787	. 2
Munuscong sandy loam	338	. 1
Nester loam, 0 to 2 percent slopes	3, 038	. 9
Nester loam, 2 to 6 percent slopes	13, 031	4. 0
Nester loam, 6 to 12 percent slopes	4, 570	1. 4
Nester loam, 6 to 12 percent slopes, eroded	3, 823	1. 2
Nester loam, 12 to 18 percent slopes	1, 089	. 3
Nester loam, 12 to 18 percent slopes, eroded	1, 450	. 5
Nester loam, 18 to 30 percent slopes	1, 169	. 4
Nester loam, 18 to 30 percent slopes, eroded	543	. 2
Nester sandy loam, sandy substratum, 0 to 6 percent slopes	218	. 1
Ocqueoc sand, 0 to 2 percent slopes	262	. 1
Ogemaw sand	128	(1)
Ontonagon loam, 0 to 2 percent slopes	107	(1)
Ontonagon loam, 2 to 6 percent slopes	138	(1)
Otisco loamy sand, 0 to 2 percent slopes	1, 373	. 4
Parkhill loam	5, 263	1. 6
Pickford loam	1, 748	. 5
Pickford silty clay loam	2, 699	. 8
Pinconning loamy sand	3, 383	1. 1
Roscommon soils	12, 839	4. 1
Roscommon-Brevort-Tawas association	5, 229	1. 6
Roscommon-Deford association	4, 400	1. 4
Roscommon-Tawas association	1, 217	. 4
Rousseau fine sand, 2 to 12 percent slopes	1, 676	. 5
Rubicon sand, 0 to 6 percent slopes	3, 046	1. 0
Rubicon sand, 6 to 12 percent slopes	1, 466	. 5
Rubicon sand, 12 to 25 percent slopes	634	. 2
Rubicon sand, loamy substratum, 0 to 6 percent slopes	1, 973	. 6
Rubicon-Croswell association, undulating	5, 949	1. 9
Rubicon-Menominee association, undulating	1, 463	. 5
Rubicon-Ocqueoc-Ingalls association, undulating	7, 535	2. 3
Rudyard loam, 0 to 2 percent slopes	1, 411	. 4
Rudyard loam, 2 to 6 percent slopes	255	. 1
Saugatuck sand	564	. 2
Sims loam	6, 035	1. 9
Tawas muck	1, 028	. 3
Ubly sandy loam, 0 to 2 percent slopes	189	. 1
Ubly sandy loam, 2 to 6 percent slopes	1, 057	. 3
Ubly sandy loam, 6 to 12 percent slopes	500	. 2
Wainola-Deford association	1, 449	. 5
Wheatley loamy sand	662	. 2
	322, 176	100. 0

[1] Less than 0.1 percent.

tion of the mapping units is shown on the soil map at the back of this survey. Terms used to describe the soils are given in the Glossary, and some of them are explained in detail in the "Soil Survey Manual" (7).[2]

Allendale Series

The Allendale series consists of somewhat poorly drained, undulating soils on lake plains. These soils developed in sandy material, 18 to 42 inches thick, overlying clayey material. They are mainly level to gently sloping.

In a typical profile the surface layer is black sand about 3 inches thick. The subsurface layer is gray sand about 5 inches thick. The upper part of the subsoil consists of loose to very friable, dark-brown to yellowish-brown sand about 21 inches thick. The lower part is dark-brown clay about 5 inches thick. The underlying material, beginning at a depth of about 34 inches, is brown, very firm clay that is mottled with gray. This material is high in content of lime.

Allendale soils have slow runoff. Permeability is rapid in the upper part of the profile, but it is very slow in the lower part. The available moisture capacity is low. The organic-matter content is medium to low. Reaction is medium acid or slightly acid in the surface layer and is medium acid to neutral in the subsoil.

These soils are used mainly for woodland. Some areas have been cultivated or used for pasture, or have been left idle. Wetness and slight droughtiness in dry periods are the main limitations in the use of these soils for crops.

Typical profile of Allendale sand, 0 to 4 percent slopes:

A1—0 to 3 inches, black (10YR 2/1) sand; very weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—3 to 8 inches, gray (10YR 5/1) sand; single grain; loose; medium acid; abrupt, irregular boundary.

B21ir—8 to 11 inches, dark-brown (7.5YR 3/2) sand; very weak, coarse, subangular blocky structure; very friable; medium acid; clear, wavy boundary.

B22ir—11 to 22 inches, dark yellowish-brown (10YR 4/4) sand; single grain; loose; medium acid; gradual, wavy boundary.

B3—22 to 27 inches, yellowish-brown (10YR 5/4) sand; few, medium, distinct, yellowish-red (5YR 5/8) mottles; single grain; loose; slightly acid; abrupt, wavy boundary.

A'2—27 to 29 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; slightly acid; abrupt, irregular boundary.

IIB'—29 to 34 inches, dark-brown (7.5YR 4/4) clay; common, medium, distinct, gray (10YR 6/1) mottles; thick coatings of light brownish-gray (10YR 6/2) sand on ped faces; moderate, medium, angular blocky structure; very firm; neutral; abrupt, wavy boundary.

IIC—34 to 48 inches, brown (7.5YR 5/4) clay; many, medium, distinct, gray (10YR 6/1) mottles; massive; very firm; calcareous.

The A1 horizon is 2 to 4 inches thick and in places is very dark grayish brown. Cultivated areas have a very dark-gray to very dark grayish-brown Ap horizon 6 to 10 inches thick. The B2ir horizon is weakly cemented in places. The thickness of the IIB' horizon ranges from 2 to 7 inches, and in some places the texture is silty clay.

Allendale soils have finer textured IIB' and IIC horizons than Iosco soils. Their C horizon consists of clay rather than sand, which is the texture of the C horizon of the Au Gres soils. They are better drained than Pinconning soils.

Allendale sand, 0 to 4 percent slopes (AlB).—This soil occurs on outwash plains and deltas and on very low sandy ridges on lake plains. Included in mapping were a few wet spots and moderately well drained areas on ridges and knolls, and, in slightly higher positions, areas of Au Gres sand where the soil material is more than 42 inches thick. Also included were small areas of well drained and moderately well drained Manistee sand, somewhat poorly drained and poorly drained Ogemaw sand, and areas of poorly drained Pinconning soils in waterways and wet spots. In addition, small eroded areas were included; here the surface layer is lighter colored than is typical.

Some of the acreage has been cleared and used for crops, but most is used for pasture or woodland. Wetness and the hazard of soil blowing are limitations. Erosion control measures, and possibly artificial drainage, would improve the potential of this soil for cultivated crops. Capability unit IIIw–7 (4/1b); woodland suitability group G.

Allendale-Pinconning-Pickford association (AP).—The soils in this association are nearly level and occur on lake plains along the Tittabawassee River in Hay and Secord Townships. Low ridges of sand and loamy sand, 2 to 3 feet high, have accumulated in these areas. Allendale soils make up about 30 to 50 percent of the association, Pinconning soils about 20 to 30 percent, and Pickford soils about 20 to 30 percent. Small areas of Manistee and Rudyard soils occur throughout the association.

Allendale soils, which are on the tops of low sandy ridges, are somewhat poorly drained. They consist of 18 to 42 inches of sand or loamy sand over clay or silty clay.

Pinconning soils, which occur on lower slopes of sandy ridges and in flat depressions, are poorly drained. They consist of 18 to 42 inches of sand or loamy sand over clay or silty clay.

The Pickford soils are poorly drained. They have a surface layer of loamy sand or sandy loam. This layer is less than 10 inches thick in about half the acreage.

The soils in this association have severe limitations that affect use for crops because they are difficult to drain adequately and soil blowing is hard to control. On the ridges the vegetation consists of dense stands of aspen, birch, and maple. In the low areas the vegetation includes swamp hardwoods. The Allendale soils are in capability unit IIIw–7 (4/1b) and woodland suitability group G; the Pinconning soils are in capability unit IIIw–8 (4/1c) and woodland suitability group W; and the Pickford soils are in capability unit IIIw–2 (1c) and woodland suitability group P.

Au Gres Series

The Au Gres series consists of somewhat poorly drained, nearly level soils that occur on lake plains and outwash plains. These soils commonly developed in sandy material over 66 inches thick, but in some places they are underlain by loamy to clayey material at a depth ranging from 42 to 66 inches.

[2] Italic numbers in parentheses refer to Literature Cited, p. 110.

In a typical profile the surface layer is very dark gray sand about 3 inches thick. The subsurface layer is gray sand about 6 inches thick. The subsoil is dark reddish-brown, dark-brown, and yellowish-brown, loose sand that is about 21 inches thick. This layer is mottled between a depth of 13 and 20 inches. The underlying material, beginning at a depth of about 30 inches, is pale-brown sand containing distinct, brownish-yellow mottles.

Runoff is very slow, but permeability is rapid. The available moisture capacity is low. These soils have medium to low organic-matter content. Reaction ranges from extremely acid to slightly acid in the surface layer and subsoil.

Most areas are woodland, but a few areas are cultivated or used for limited pasture. Wetness is the main limitation in the use of these soils for crops. Droughtiness also is a limitation in dry periods.

Typical profile of an Au Gres sand:

A1—0 to 3 inches, very dark gray (10YR 3/1) sand; very weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—3 to 9 inches, gray (10YR 6/1) sand; single grain; loose; medium acid; abrupt, irregular boundary.

B21ir—9 to 13 inches, dark reddish-brown (5YR 3/4) sand; very weak, coarse, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—13 to 20 inches, dark-brown (7.5YR 4/4) sand; many, fine, distinct, yellowish-red (5YR 5/8) mottles; single grain; loose; medium acid; gradual, wavy boundary.

B3—20 to 30 inches, yellowish-brown (10YR 5/4) sand; single grain; loose; medium acid; gradual, irregular boundary.

C—30 to 60 inches, pale-brown (10YR 6/3) sand; common, coarse, distinct, brownish-yellow (10YR 6/6) mottles; single grain; loose; slightly acid.

The A1 horizon ranges from 1 to 4 inches in thickness and in places is very dark grayish brown. Cultivated areas have a very dark grayish-brown Ap horizon 6 to 10 inches thick. The A2 horizon is absent in some cultivated areas.

Au Gres soils are better drained than Roscommon soils and are not so gray as those soils. They are more poorly drained and more highly mottled than Croswell and Rubicon soils. They lack the clayey underlying material that is common in Allendale soils.

Au Gres sand, 0 to 2 percent slopes (ArA).—This soil generally is nearly level, but in some areas there are cradle knolls as a result of windthrow of trees. This Au Gres soil occurs on the knolls, and small included areas of poorly drained Roscommon sand lie in the cradles. During wet periods water ponds in the cradles, which remain wet longer than the knolls. Also included are small areas, less than one acre in size, of Saugatuck sand, a soil that is intermediate in drainage between Au Gres and Roscommon soils. In addition, a few included areas have a loamy sand surface layer.

Most of this soil is used for pasture or woodland, but a few areas are cultivated. Excess moisture and soil blowing are the main limitations affecting the use of this soil for crops. Droughtiness also is a limitation during dry summer months. Capability unit IVw–2 (5b); woodland suitability group F.

Au Gres sand, loamy substratum, 0 to 2 percent slopes (AsA).—This nearly level soil occurs on till plains or lacustrine plains that are covered with a layer of sandy outwash. The depth of the sand is generally 42 to 66 inches, but in small depressions it is 18 to 42 inches. Included in mapping are small areas of several other soils. Pinconning loamy sand or Brevort loamy sand occurs on a few ridges in the southeastern part of Bentley Township. Small areas of Rubicon sand occur in higher positions; this Rubicon soil is better drained than the Au Gres soil, and it is slightly to moderately eroded, especially in intensively cultivated fields. Also included are some areas with a loamy sand surface layer.

Some areas of this Au Gres soil are used for crops, but most areas are woodland. Excess moisture is a limitation except during dry summers. Some areas require artificial drainage, and when cultivated all are susceptible to moderate soil blowing. Capability unit IVw–2 (5b); woodland suitability group F.

Au Gres-Kinross association (AU).—This association is on low-lying, nearly level outwash plains that have a periodically high water table. The association is extensive in the eastern part of the county, especially in Sheridan and Grim Townships. Slopes are dominantly less than 2 percent and seldom exceed 6 percent. There is considerable microrelief; many areas have hummocks, 2 to 4 feet high and 10 to 20 feet apart. Closed shallow troughs occur between the hummocks. The Au Gres soils make up about 45 percent of the association, the Kinross soils about 45 percent, and included soils about 10 percent.

The Au Gres soils are somewhat poorly drained and are more acid than Au Gres soils in the Au Gres-Roscommon association. They consist of sand that is more than 66 inches thick. The Kinross soils are poorly drained and are extremely acid to very strongly acid. They developed in sand deposits at least 42 inches thick.

Some soils included in mapping are covered by a thick, peaty mat and have a dark reddish-brown layer between a depth of 9 and 25 inches. In other included areas, very thin layers of silty material are present below a depth of 3 feet. These layers are not continuous. Included also are low ridges of moderately well drained Croswell soils and well drained Grayling soils, and small areas of shallow peat or Saugatuck sand.

The vegetation consists partly of a sparse cover of aspen, with groves of jack pine, neither of which is making good growth at present. Ground cover consists of leatherleaf, blueberries, and a thick mat of moss, which is most abundant in poorly drained depressions. Wetness, low fertility, soil blowing, and acidity are severe limitations in the use of these soils for crops. The Au Gres soils are in capability unit IVw–2 (5b) and woodland suitability group F. The Kinross soils are in capability unit IIIw–11 (5c) and woodland suitability group Q.

Au Gres-Kinross loamy substratum association (AV).—This association occurs on low-lying, nearly level outwash plains that have a periodically high water table. Slopes are dominantly less than 2 percent and seldom exceed 6 percent, but there is considerable microrelief. Many areas of hummocks, 2 to 4 feet high and 10 to 20 feet apart, occur between closed shallow troughs. The Au Gres soils make up about 30 to 60 percent of the association, the Kinross soils about 30 to 60 percent, and included soils the remaining percent.

The Au Gres soils are somewhat poorly drained and extremely acid to very strongly acid. They occur on the slightly higher positions. In 50 to 60 percent of the association, the Au Gres soils are underlain by sand and thin

layers of sandy loam to silty clay loam beginning at a depth of 24 to 48 inches.

The Kinross soils are poorly drained, are extremely acid to very strongly acid, and developed in deposits of sand.

Included in areas mapped as this association are low ridges of moderately well drained Croswell soils and well drained Grayling soils. These inclusions make up 1 to 10 percent of the acreage. Also included are small areas where the surface is covered by about 12 inches of peat, and small areas of Saugatuck sand in which a firmly cemented layer is in the subsoil.

This association occurs to a limited extent in the eastern part of the county. Part of the vegetation is a poor stand of aspen and groves of jack pine. The ground cover consists of leatherleaf, blueberries, and a mat of moss that is most abundant in the poorly drained areas. Neither the aspen nor jack pine is making good growth at present. The Au Gres soils are in capability unit IVw–2 (5b) and woodland suitability group F. The Kinross soils are in capability unit IIIw–11 (5c) and woodland suitability group Q.

Au Gres-Roscommon association (AW).—This association occurs on low-lying outwash plains where sand deposits are more than 66 inches thick. A complex drainage pattern exists because of low knolls, depressions, and elongated natural drainageways. A few steeper slopes occur along the sides of these knolls and drainageways, but 80 percent of the association has slopes of less than 2 percent The dominant soils are Au Gres and Roscommon, each of which makes up at least 30 percent of a given area mapped as the association, though the proportion varies from place to place.

Somewhat poorly drained Au Gres soils occur in higher lying positions and developed in at least 66 inches of sand. They are less acid than Au Gres soils of the Au Gres-Kinross association. Poorly drained to very poorly drained Roscommon soils occur in lower lying positions and developed in at least 42 inches of sand.

Other soils are included in some areas of this association. Moderately well drained, sandy Croswell soils occur on the higher knolls and ridges and occupy up to 20 percent of the acreage. Tawas muck occurs in some low-lying positions. Thin layers of silt or very fine sand are present below a depth of 42 inches in a few areas.

The vegetation in the highest positions is a fair cover of aspen, together with a ground cover of ferns, wintergreen, and blackberries. Swamp hardwoods, tag alder, and willow grow in lower, wetter positions. Unless they are artificially drained, these soils have severe limitations for most crops and pasture plants grown in the county. Even after drainage is improved, low fertility, soil blowing, and droughtiness severely limit use of this association for crops. The Au Gres soils are in capability unit IVw–2 (5b) and woodland suitability group F. The Roscommon soils are in capability unit IIIw–11 (5c) and woodland suitability group Q.

Belding Series

In the Belding series are somewhat poorly drained, nearly level to gently sloping soils on till plains and lake plains. These soils developed in sandy loam to loamy sand, 18 to 42 inches thick, over loam to silty clay loam.

In a typical profile the surface layer is very dark grayish-brown sandy loam about 8 inches thick. The subsoil consists of two parts. The upper part is very friable sandy loam, mainly dark brown and about 15 inches thick. The lower part of the subsoil is firm, dark-brown clay loam about 7 inches thick. The underlying material is grayish-brown clay loam mottled with yellowish brown. This layer is firm and high in content of lime.

Runoff is slow. Permeability is moderately rapid in the upper part of these soils but is moderately slow in the lower part. Available moisture capacity is moderate. Reaction is medium acid to slightly acid in the surface layer and subsoil. The organic-matter content is medium.

These soils are mainly cropland, although some areas remain in pasture or in woodland. They have generally good tilth and are easy to work. Artificial drainage is needed in some areas to obtain optimum crop growth. During some years excess wetness is a problem, especially in lower lying areas. In some of these lower lying areas, frost damages crops.

Typical profile of a Belding sandy loam:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

Bir—8 to 20 inches, dark-brown (7.5YR 4/4) sandy loam; few, fine, distinct, pale-brown (10YR 6/3) mottles; weak, medium, subangular blocky structure; very friable; medium acid; abrupt, irregular boundary.

A'2g—20 to 23 inches, light brownish-gray (10YR 6/2) light sandy loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, thin, platy structure; very friable; slightly acid; abrupt, irregular boundary.

IIB'tg—23 to 30 inches, dark-brown (7.5YR 4/2) clay loam; many, medium, distinct, light brownish-gray (10YR 6/2) mottles; moderate, medium, subangular blocky structure; firm; slightly acid; abrupt, wavy boundary.

IICg—30 to 48 inches, grayish-brown (10YR 5/2) clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; firm; calcareous.

Areas that have not been cultivated or disturbed have a very dark grayish-brown A1 horizon that ranges from 1 to 4 inches in thickness and a gray A2 horizon that is about 6 inches thick. In some areas the color of the Bir and IIB'tg horizons ranges to dark yellowish brown or strong brown. In places the IIB'tg horizon is heavy loam or silty clay loam. Depth to the finer textured underlying material ranges from 18 to 42 inches.

Belding soils are more poorly drained than Ubly soils. Belding soils have coarser textured A and B horizons than Kawkawlin soils. They have a finer textured B horizon than Iosco soils. Their C horizon is coarser textured than that in Belding soils, clayey subsoil variant.

Belding sandy loam, 0 to 2 percent slopes (BeA).—This nearly level soil is in drainageways or in broad, irregularly shaped areas on lake plains. The surface layer is dominantly sandy loam but minor spots of loam and loamy sand are included in mapping. Iosco loamy sand occurs in some of the loamy sand spots that are moderately deep. The upper part of this Belding soil is dominantly sandy loam to a depth of 18 to 42 inches, but included in mapping are some areas of sandy loam less than 18 inches thick. In these places Kawkawlin or Bowers sandy loam occurs.

Most areas of this Belding sandy loam have been artificially drained and are in cropland and pasture.

Runoff is slow, and water ponds for short periods after rain. As a result excess moisture is a limitation during spring and after prolonged rainfall. Depressional areas dry out slowly and hinder tillage operations. Undrained areas are mainly used for woodland. Capability unit IIw–8 (3/2b); woodland suitability group G.

Belding sandy loam, 2 to 6 percent slopes (BeB).—This gently sloping or undulating soil occurs next to drainageways or in irregularly shaped areas on lake plains. The surface layer is dominantly sandy loam. The sandy loam part of this soil ranges in thickness from 18 to 42 inches within short distances. Included in mapping are a few areas where the surface layer is loamy sand. Also included are small depressions in which Kawkawlin or Bowers soils occur. Both Kawkawlin and Bowers soils have a clay loam or silty clay loam subsoil. These small depressions dry out slowly after prolonged rain or in the spring. This wet condition delays planting and cultivation of crops.

Most of this Belding soil is cropland. Because it is gently sloping, the soil dries out faster and is not so wet as nearly level Belding soils. Also, most areas have better surface drainage than level areas of Belding soils. However, water ponds in depressions. Erosion is a problem on long slopes of 4 to 6 percent. In some areas random tile drainage removes enough excess water to make this soil suitable for crops. A few areas are still wooded because they lack outlets for drainage or are inaccessible. Capability unit IIw–8 (3/2b); woodland suitability group G.

Belding Series, Clayey Subsoil Variant

The Belding series, clayey subsoil variant, consists of nearly level, somewhat poorly drained soils that occur on lake plains. These soils developed in sandy loam material overlying clay or silty clay. Depth to the underlying material ranges from 18 to 42 inches.

In a typical profile the surface layer is very dark gray sandy loam about 8 inches thick. A subsurface layer is grayish-brown sandy loam and is about 3 inches thick. The upper part of the subsoil is mainly very friable, brown or yellowish-brown sandy loam about 10 inches thick. It contains yellowish-red and grayish-brown mottles. The lower part of the subsoil is firm, dark-brown sandy clay loam that is about 10 inches thick and contains light-gray mottles. The underlying material is light brownish-gray clay containing distinct, yellowish-brown mottles. This layer is high in lime content.

Runoff is slow. Permeability is moderate in the upper part of these soils, but is very slow in the lower part. These soils are saturated for extended periods of time, mainly in the spring. Available moisture capacity is high, and the content of organic matter is medium. Reaction of the surface layer and subsoil ranges from medium acid to mildly alkaline.

Most areas of these soils have been cleared and are being farmed. Excessive wetness is a limitation in some areas, and artificial drainage is required for optimum crop growth.

Typical profile of Belding sandy loam, clayey subsoil variant:

Ap—0 to 8 inches, very dark gray (10YR 3/1) sandy loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—8 to 11 inches, grayish-brown (10YR 5/2) light sandy loam; very weak, fine, granular structure; very friable; slightly acid; abrupt, wavy boundary.

Bir—11 to 15 inches, brown (7.5YR 5/4) sandy loam; few, fine, distinct, yellowish-red (5YR 4/8) mottles; weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

A'2—15 to 21 inches, yellowish-brown (10YR 5/4) light sandy loam; common, medium, distinct, grayish-brown (10YR 5/2) mottles; very weak, fine, subangular blocky structure; very friable; slightly acid; abrupt, irregular boundary.

B't—21 to 31 inches, dark-brown (7.5YR 4/4) light sandy clay loam; common, medium, distinct, light-gray (10YR 7/1) mottles; moderate, coarse, subangular blocky structure; firm; neutral; abrupt, wavy boundary.

IIC—31 to 48 inches, light brownish-gray (10YR 6/2) clay; common, coarse, distinct, yellowish-brown (10YR 5/6) mottles; massive; very firm; calcareous.

The color of the Ap horizon ranges to very dark grayish brown and the thickness ranges from 6 to 10 inches. In uncultivated areas there is a very dark gray A1 horizon that ranges from 1 to 3 inches in thickness. In some areas the B't horizon is sandy loam. Depth to the clayey material ranges from 18 to 42 inches.

Belding soils, clayey subsoil variant, have finer textured A and Bir horizons than Manistee or Allendale soils. They have a finer textured C horizon than normal Belding soils.

Belding sandy loam, clayey subsoil variant (Bf).—This nearly level soil is near the lower lying, poorly drained Pickford soils and the higher lying, well-drained, sandy Manistee and Menominee soils. The very dark gray surface layer is dominantly sandy loam. Slopes are generally 300 to 500 feet long and less than 1 percent. Slopes range to 3 percent near waterways and borders. Included in mapping are areas where the surface layer ranges to loamy sand and fine sandy loam. Also included are very poorly drained Munuscong sandy loam or Pickford loam in several narrow, shallow waterways.

Most of this Belding soil is cultivated. This soil is limited in use by excess moisture. Unless adequate drainage systems are installed, the soil is not dry enough for crops. Capability unit IIw–8 (3/2b); woodland suitability group F.

Bowers Series

The Bowers series consists of level to gently sloping, somewhat poorly drained soils that occur on lake plains. These soils developed in stratified silty clay loam, clay loam, and silt. Thin layers of clay and loam occur locally.

In a typical profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsurface layer is light brownish-gray silt loam about 3 inches thick. The subsoil is firm, brown, stratified silty clay loam, clay loam, and silt, about 11 inches thick, that contains reddish-brown mottles. At a depth of about 22 inches, firm, grayish-brown stratified silty clay loam, clay loam, and silt occur. This material has distinct brown mottles and is high in content of lime.

Runoff is slow, and water ponds in the lowest areas. Permeability is moderately slow, and the available moisture capacity is high. The content of organic matter is

high. Reaction ranges from slightly acid to neutral in the surface layer and subsoil.

Most areas have been cultivated. These soils occupy positions that receive runoff water from adjacent higher soils, but if adequate drainage is provided these soils are well suited for crops. During spring the water table is within 1 to 3 feet of the surface, and this restricts root growth and makes operation of machinery difficult. These soils dry out slowly in the spring and after prolonged rain.

Typical profile of Bowers silt loam:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—8 to 11 inches, light brownish-gray (10YR 6/2) silt loam; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, thin, platy structure; friable; slightly acid; abrupt, irregular boundary.

Btg—11 to 22 inches, brown (7.5YR 5/2), stratified silty clay loam, clay loam, and silt; common, medium, distinct, reddish-brown (5YR 4/4) mottles; thick coatings of gray (10YR 5/1) on ped faces, and in cracks in upper 2 to 4 inches; moderate, medium, subangular blocky structure; firm; neutral; abrupt, wavy boundary.

C—22 to 48 inches, grayish-brown (10YR 5/2), stratified silty clay loam, clay loam, and silt, with thin layers of clay and loam; common, medium, distinct, brown (7.5YR 5/4) mottles; massive; firm; calcareous.

Uncultivated areas have a very dark grayish-brown A1 horizon that ranges from 1 to 3 inches in thickness and a gray A2 horizon that ranges from 4 to 8 inches in thickness. The B horizon is mainly silty clay loam or clay loam. The combined thickness of the A and B horizons ranges from 16 to about 32 inches. The reaction of the A and B horizons is slightly acid to neutral.

Bowers soils are more stratified than Kawkawlin soils.

Bowers silt loam, 0 to 4 percent slopes (BgB).—The surface layer of this soil is dominantly silt loam. In most areas slopes are less than 2 percent. Included with this soil in mapping are a few areas in which the surface layer is sandy loam and a few areas that are limy at or near the surface. Small areas of poorly drained Hettinger soils are also included; they are in small, closed depressions and drainageways.

Most areas of this Bowers soil are cropped. A few areas are too wet or are too small to farm; these areas are used for pasture or woodland. Because of texture, slow runoff, and moderately slow permeability, this soil dries out slowly in the spring. Water ponds on the surface in spring, and because of its position, this soil receives runoff from adjacent, higher lying soils. If this soil is tilled when wet, the surface layer may become puddled and compact. During the spring and after prolonged rain, farm machinery easily bogs down in wet depressions and drainageways, and during wet periods excess water hinders crop growth. Little or no erosion has occurred on this soil. Capability unit IIw–2 (1.5b); woodland suitability group Z.

Bowers-Iosco-Hettinger association (BI).—This association is in low ridges of sand or loamy sand that are 2 to 3 feet high, depending on the thickness of the sand. The association is of limited extent along the branches of the Tittabawassee River in Secord, Clement, and Bourret Townships. The ridges occur on nearly level lake plains. On about 30 to 40 percent of the total acreage, there is a sand cover of 18 inches or more. Bowers soils make up about 45 percent of the association, Iosco soils about 35 percent, and Hettinger soils about 20 percent. Minor areas of Brevort and Au Gres loamy sands also occur throughout this association.

The somewhat poorly drained Bowers soils developed in moderately fine textured material and are level. The surface layer of these Bowers soils is loamy sand or sandy loam that is less than 10 inches thick in more than about one-half of the total area.

Iosco loamy sand occurs where the sandy surface layer exceeds a depth of 18 inches. Iosco soils are somewhat poorly drained and developed in 18 to 42 inches of sand or loamy sand overlying loam to silty clay loam.

The Hettinger loams occupy depressional areas within this association. They are poorly drained and very poorly drained soils that developed in stratified silty clay loam, clay loam, clay, and silt. The surface layer consists of up to 10 inches of sandy loam or loamy sand in about one-half of the area of Hettinger soils.

Excess wetness and poor surface drainage are major limitations. In addition, droughtiness limits use of the sandy Iosco soils during dry periods. Adequate drainage for crops is difficult to obtain because of the undulating relief and variability of soil material. Previously farmed areas are now mostly idle or are used for pasture or as woodland. The vegetation in uncleared areas consists of a dense stand of maple, ash, elm, white birch, and some aspen on higher sandy soils. The Bowers soils are in capability unit IIw–2 (1.5b) and woodland suitability group Z. The Iosco soils are in capability unit IIIw–9 (4/2b) and woodland suitability group G. The Hettinger soils are in capability unit IIw–2 (1.5c) and woodland suitability group P.

Breckenridge Series

Soils in the Breckenridge series are poorly drained, are nearly level to depressional, and occur on lake plains and till plains. They developed in sandy loam material that overlies loam, clay loam, or silty clay loam material. The depth to the finer textured underlying material ranges from 18 to 42 inches.

In a typical profile the surface layer is black sandy loam about 8 inches thick. The subsoil consists of gray sandy loam that is about 22 inches thick and contains distinct mottles of brownish yellow. The underlying material, beginning at a depth of about 30 inches, is grayish-brown clay loam that is distinctly mottled with yellowish brown. This layer is limy.

Runoff, some from higher, adjacent soils, is slow. Water ponds in the lowest areas. Permeability is moderately rapid in the upper part of these soils but is moderately slow in the lower part. Reaction ranges from slightly acid to mildly alkaline in the surface layer and subsoil. The available moisture capacity is moderate. The organic-matter content is high.

Undrained areas are used mainly for pasture or woodland because a high water table within 12 inches of the surface restricts downward root growth and makes operation of machinery difficult. Artificially drained areas are used as cropland but planting of crops is often delayed because these soils dry out slowly in spring and after

prolonged rain. Crops grown in lower areas of these soils are subject to frost damage. In some years, frost prevents crops from maturing. Harvesting is sometimes hindered by excessive rain in the fall.

Typical profile of Breckenridge sandy loam:

Ap—0 to 8 inches, black (10YR 2/1) sandy loam; weak, medium, granular structure; friable; slightly acid; abrupt, wavy boundary.

Bg—8 to 30 inches, gray (10YR 5/1) sandy loam; common, medium, distinct, brownish-yellow (10YR 6/6) mottles; weak, medium, subangular blocky structure; friable; neutral; abrupt, irregular boundary.

IIC—30 to 48 inches, grayish-brown (10YR 5/2) clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; firm; calcareous.

The Ap horizon ranges to very dark brown in color, and its thickness ranges from 6 to 10 inches. The B horizon ranges to grayish brown in color and to fine sandy loam in texture.

Breckenridge soils are more poorly drained and have a grayer B horizon than Belding soils. They are finer textured than Pinconning soils but are coarser textured than Sims soils.

Breckenridge sandy loam (Bm).—This nearly level to depressional soil occurs on moraines or lake plains. The surface layer is mainly sandy loam, but a mucky sandy loam surface layer is present in the lowest and wettest depressions. Cobblestones are on the surface but not in sufficient number to hinder tillage. Included in mapping are a few small areas in which the surface layer is loamy sand. Also, in some included areas the depth to loamy material is greater than 42 inches and unstable sand pockets occur.

Runoff is slow, and during wet periods the water table is at or near the surface. In areas that lack suitable outlets for water, drainage is neither practical nor possible, but drainage commonly can be improved by digging ditches and installing tile drains.

Most areas of this soil are in pasture or woodland. The remaining areas are drained and used for crops. Limitations for crops include poor surface drainage and internal drainage. Wet depressions and ponded water delay farm work in spring. Crops are subject to frost damage in spring, and frost may prevent maturing of crops. Capability unit IIw–8 (3/2c); woodland suitability group W.

Brevort Series

The Brevort series consists of poorly drained to very poorly drained, nearly level to depressional soils on lake plains and till plains. These soils developed in sand or loamy sand overlying loam, silt loam, clay loam, or silty clay loam. The depth to the finer textured material ranges from 18 to 42 inches.

In a typical profile the surface layer is black loamy sand about 10 inches thick. Underlying the surface layer is a layer of loose, gray sand about 20 inches thick. The underlying material, beginning at a depth of about 30 inches, is friable, grayish-brown silt loam that contains yellowish-brown mottles and is high in content of lime.

Runoff is very slow to ponded. Permeability is rapid in the sandy upper layer, but is only moderately slow in the lower, finer textured layers. The available moisture capacity is low. Undrained areas have a high water table during spring. The organic-matter content is medium to high. Reaction is medium acid to slightly acid in the surface layer and slightly acid to neutral below.

These soils originally supported lowland hardwoods and conifers. Areas that are artificially drained are used for cropland or pasture, but undrained areas are idle or wooded. The upper part of Brevort soils holds only a small amount of moisture; the finer textured lower layers hold a significant amount of moisture. Brevort soils dry out slowly in the spring and after prolonged rain. They occur on positions that receive runoff from adjacent higher soils, and this runoff adds to their excessive wetness. Harvesting operations are delayed or prevented during years of excessive rainfall. Frost damage to crops is a hazard in the lowest areas and may prevent crops from maturing in some years.

Typical profile of Brevort loamy sand:

Ap—0 to 10 inches, black (10YR 2/1) loamy sand; very weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

C1g—10 to 30 inches, gray (10YR 5/1) sand; single grain; loose; neutral; abrupt, wavy boundary.

IIC2—30 to 48 inches, grayish-brown (10YR 5/2) silt loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; friable; calcareous.

The Ap horizon ranges from 6 to 10 inches in thickness and ranges from very dark brown to black in color. Depth to the finer textured material ranges from 18 to 42 inches. The IIC2 horizon ranges to loam, clay loam, or silty clay loam in texture and is stratified in a few areas.

Brevort soils are more poorly drained than Iosco soils, although the Iosco soils developed in similar materials. Brevort soils have a coarser textured A horizon than Breckenridge soils.

Brevort loamy sand (Bn).—This soil is mainly on low-lying flats, but it also is in small, closed depressions and bottoms of minor, natural drainageways. In 10 to 20 percent of the undrained areas, the loamy sand surface layer is mucky. Included in mapping are small areas of Sims and Roscommon soils.

The larger areas of this soil are undrained and in woodland or brush. Unless artificially drained this soil is excessively wet for crops. Runoff is slow and there is a high water table. Small areas in the same field with better drained soils are used for crops. Capability unit IIIw–10 (4/2c); woodland suitability group W.

Brevort sandy loam (Bo).—This nearly level soil is mainly in the southwestern part of the county. In the lowest and wettest areas of this Brevort soil there is 2 to 10 inches of muck covering the surface. Tag alder grows in these mucky areas. Most areas of this soil have a sandy loam surface layer and have a finer textured subsoil than areas of Brevort loamy sand. This soil lies in low places between small ridges. The small ridges are included in mapping and consist of Iosco soils or Gladwin soils. Also included are small areas of poorly drained Epoufette soils.

The major areas are wooded or pastured. Areas that are artificially drained are cropped. The main limitations for crops are a high water table and frost hazard. Runoff is slow and causes ponding and yet depressions. Capability unit IIIw–10 (4/2c); woodland suitability group W.

Brimley Series

Soils of the Brimley series are somewhat poorly drained, are nearly level to undulating or gently sloping,

and occur on lake plains, outwash plains, and deltas. They developed in stratified water-laid material, dominantly silt and fine or very fine sand.

In a typical profile the surface layer is very dark gray silt loam about 8 inches thick. A subsurface layer of grayish-brown silt loam is about 3 inches thick. The subsoil, about 14 inches thick, is very friable, dark yellowish-brown loamy fine sand in the upper part and grades to firm, strong-brown heavy silt loam in the lower part, which contains grayish-brown mottles. Underlying the subsoil are pale-brown stratified silt, fine sand, and very fine sand with thin layers of silty clay loam. This material contains many, distinct, yellowish-brown and gray mottles. It is friable and high in lime content.

Runoff is very slow to slow or ponded. Permeability is moderate. The available moisture capacity is moderately high. These soils are saturated with water for extended periods of time, mainly in the spring. Reaction in the surface layer and subsoil ranges from medium acid to neutral, and in the underlying material from slightly acid to moderately alkaline. The organic-matter content is medium.

Brimley soils are used as cropland where artificial drainage is adequate, but undrained areas are used for pasture or woodland. These soils occur on positions that receive runoff from adjacent higher soils. They dry out slowly in the spring and after prolonged rain, and this saturated condition hinders the growth of roots and the operation of farm machinery. Planting of crops is delayed during excessively wet months in spring.

Typical profile of Brimley silt loam, 0 to 4 percent slopes:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—8 to 11 inches, grayish-brown (10YR 5/2) silt loam; weak, coarse, granular structure; friable; slightly acid; abrupt, wavy boundary.

IIBir—11 to 16 inches, dark yellowish-brown (10YR 4/4) loamy fine sand; very weak, subangular blocky structure; very friable; slightly acid; abrupt, smooth boundary.

IIB't—16 to 25 inches, strong-brown (7.5YR 5/6) heavy silt loam; common, medium, distinct, grayish-brown (10YR 5/2) mottles; moderate, medium, subangular blocky structure; firm; slightly acid; abrupt, wavy boundary.

IIIC—25 to 48 inches, pale-brown (10YR 6/3), stratified silt, fine sand, and very fine sand, and thin strata of silty clay loam; many, coarse, distinct, yellowish-brown (10YR 5/4) and gray (10YR 6/1) mottles; massive; friable; calcareous.

Uncultivated areas have an A1 horizon ranging from 2 to 4 inches in thickness. Color of the A1 horizon ranges to dark grayish brown. Color of the B horizon ranges to dark brown, and in some places there are yellowish-brown mottles. The IIBir horizon ranges to silt loam, loam, or very fine sandy loam. The IIB't horizon ranges to silty clay loam, sandy clay loam, or thinly stratified silt, very fine sandy loam, and light silty clay loam.

Brimley soils are better drained than Bruce soils and have a finer textured Bir horizon than Iosco soils.

Brimley silt loam, 0 to 4 percent slopes (BrB).—This nearly level soil is near higher lying Nester, Montcalm, and Ubly soils or it is between Ubly soils and lower lying Bruce soils. The surface layer is dominantly silt loam. Slopes are generally less than 1 percent, but they range to 4 percent in small areas. Included in mapping are small, random spots where the surface layer is fine sandy loam. Other inclusions are a few small areas and small, random spots where the surface layer is loamy fine sand. Also included are narrow strips of moderately fine textured Bowers silt loam in some areas and poorly drained Bruce silt loam in wet, narrow waterways. The Brimley soil, as well as the Bowers and Bruce soils, warm up and dry out slowly in the spring and after rain and, as a result, planting and tillage operations are delayed.

Most of this Brimley soil is drained and used for crops. Runoff is slow, and excess moisture is a limitation. Undrained areas are in pasture or woodland. This soil is unstable, and ditchbanks cave in readily. Capability unit IIw–6 (3b); woodland suitability group G.

Bruce Series

Soils of the Bruce series are poorly drained, are nearly level to undulating or gently sloping, and occur on lake plains, outwash plains, and deltas. They developed in water-laid material consisting of stratified layers of silt, fine sand, and very fine sand, together with thin layers of sandy loam and silty clay loam.

In a typical profile the surface layer is black very fine sandy loam about 7 inches thick. The upper part of the subsoil is friable, dark grayish-brown fine sandy loam that is about 6 inches thick and contains many dark-brown mottles. The lower part of the subsoil is friable, grayish-brown, stratified silt loam, fine sandy loam, and fine sand in which yellowish-brown mottles are common. The material underlying the subsoil consists of friable, grayish-brown, stratified silt, fine sand, loamy fine sand, and fine sandy loam. This material is high in lime content and contains a few yellowish-red mottles.

Runoff is very slow to ponded. Permeability is moderate, and these soils are saturated with water for long periods of time, mainly in spring. The available moisture capacity is moderately high. Reaction in the surface layer and subsoil ranges from slightly acid to mildly alkaline. The organic-matter content is high.

Small areas have been artificially drained and are cultivated or in pasture; most areas, however, remain in woodland. Many areas receive runoff from adjacent higher soils. Bruce soils dry out slowly in spring, and this saturated condition hinders the growth of roots. Planting of crops is often delayed because the soil is too wet to support farm machinery. Frost damage is a hazard, and frost delays or prevents maturing of crops in the fall months.

Typical profile of Bruce very fine sandy loam:

Ap—0 to 7 inches, black (10YR 2/1) very fine sandy loam; weak, fine, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

B21g—7 to 13 inches, dark grayish-brown (10YR 4/2) fine sandy loam; many, coarse, distinct, dark-brown (7.5YR 4/4) mottles; weak, coarse, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

B22g—13 to 26 inches, grayish-brown (10YR 5/2), stratified silt loam, fine sand, and fine sandy loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; abrupt, wavy boundary.

C—26 to 48 inches, grayish-brown (10YR 5/2), stratified silt, fine sand, loamy fine sand, and fine sandy loam; few, medium, prominent, yellowish-red (5YR 4/8) mottles; friable; calcareous.

The Ap horizon ranges from 6 to 9 inches in thickness, and its color ranges to dark brown. The B horizon ranges to silt loam or light silty clay loam and contains 1- to 5-inch strata of very fine sand and fine sandy loam and an occasional thin layer of clay. The texture and thickness of the various layers differ considerably within short distances. In some of the wetter and lower lying areas, the B horizon is gray.

Bruce soils are more poorly drained and have a grayer B horizon than Brimley soils. Bruce soils are finer textured than either Pinconning or Brevort soils and have a coarser textured C horizon than Breckenridge soils.

Bruce very fine sandy loam (Bs).—This soil is level or depressional. Spots of Brimley and Burleigh loamy fine sands are included in areas mapped as this soil. Small areas where the surface layer is loamy fine sand or silt loam are also included.

Most of this soil is idle or is woodland; the remainder of this soil is cropland. The major limitations are a high water table and excessive wetness. Surface runoff is slow to ponded. In the spring and after rain, this soil warms up slowly and dries out slowly. Frost damage to crops can be a hazard because this soil is low lying. When this soil is wet, farm machinery bogs down easily. Because of sandy and silty material, ditchbanks cave in readily. Capability unit IIw–6 (3c); woodland suitability group W.

Bruce-Brimley-Burleigh association (BU).—This nearly level to undulating association occurs on plains that have a high or periodically high water table. This association is of minor extent; it occupies scattered areas in Bourret and Bentley Townships. Slopes are short, are less than 6 percent, and do not exceed 2 percent in the large areas. There are small knolls and ridges, between which intervening depressions and troughs occur. Bruce and Brimley soils each make up about 35 percent of this association, and Burleigh soils about 30 percent. Included in mapping are areas of Burleigh soils where a thin layer of sand overlies the silty material.

The poorly drained Bruce and Burleigh soils occur in the low-lying positions, whereas the somewhat poorly drained Brimley soils are in the higher positions.

The vegetation consists mainly of dense stands of hardwoods, including elm, ash, maple, birch, and aspen. Some areas have been cleared and used for cropland. The Bruce soils are in capability unit IIw–6 (3c) and woodland suitability group W. The Brimley soils are in capability unit IIw–6 (3b) and woodland suitability group G. The Burleigh soils are in capability unit IIIw–6 (4c) and woodland suitability group W.

Burleigh Series

The Burleigh series consists of poorly drained and very poorly drained, nearly level to depressional soils that occur on lake plains and deltas. These soils developed in 18 to 42 inches of sand or loamy sand that overlies stratified very fine sand and silt.

In a typical profile the surface layer is very dark brown loamy sand about 9 inches thick. It is underlain by loose, light-gray sand about 23 inches thick that contains yellowish-brown mottles in the lower part. Gray, stratified, loose very fine sand and friable silt occur at a depth of about 32 inches. This layer is high in lime content and contains yellowish-brown mottles.

Runoff is very slow to ponded. Permeability is rapid in the sandy upper part of these soils and is moderately rapid through the lower, finer textured part. The available moisture capacity is low. The content of organic matter is medium. Reaction is slightly acid or neutral in the surface layer and is neutral to mildly alkaline in the underlying layers.

Most of the acreage remains in woodland or marsh grasses, but a few areas have been cleared and artificially drained and are used for crops or pasture. These soils remain wet for long periods in the spring or following prolonged rain. The wetness hinders the development and downward growth of roots. Crops grown in Burleigh soils are subject to frost damage, especially early in the growing season and in the fall. Frost delays and even prevents crops from maturing.

Typical profile of Burleigh loamy sand:

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

C1g—9 to 32 inches, light-gray (10YR 6/1) sand; common, fine, distinct, yellowish-brown (10YR 5/6) mottles in lower part; single grain; loose; mildly alkaline; abrupt, wavy boundary.

IIC2g—32 to 48 inches, gray (10YR 5/1), stratified very fine sand and silt; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; very fine sand is single grain and loose; silt is massive, friable, and calcareous.

The Ap horizon ranges from 7 to 10 inches in thickness and the color ranges to black or very dark grayish brown. The thickness and texture of the C horizons vary considerably within short distances; the individual layers range from 1 to 10 inches in thickness. In a few areas ¼-inch to 3-inch layers of silty clay loam and loam occur.

Burleigh soils have a coarser textured A horizon than Bruce soils. They have a coarser textured IIC horizon than either Brevort or Pinconning soils.

Burleigh loamy sand (Bv).—This soil is nearly level to depressional. Individual areas are generally small, and they are near soils of different drainage and texture. In some areas the surface layer is covered with as much as 12 inches of muck or peat.

If this soil is cleared and drained, it is suitable for crops or pasture. The major limitation is excess water, but because the soil is sandy, drained areas are somewhat droughty. In undrained areas the vegetation is willow, tag alder, grasses, and sedges. The loamy sand is unstable, and ditchbanks cave in readily. Capability unit IIIw–6 (4c); woodland suitability group W.

Carbondale Series

The Carbondale series consists of nearly level or depressional, very poorly drained, organic soils that lie on till plains, lake plains, and outwash plains. These soils developed in materials derived from coniferous and deciduous trees, mixed with fibrous plant remains. The thickness of the organic material is 42 inches to many feet.

In a typical profile the surface layer is about 12 inches thick and consists of granular muck. Very dark brown

muck, about 12 inches thick, is just below the surface layer. Numerous fragments of woody material are present in this layer. Brown, fibrous peat occurs at a depth of about 24 inches and extends to 42 inches or more. All layers are friable.

Runoff is very slow to ponded in the lowest areas, especially in the spring and after rain. Permeability is moderately rapid. The available moisture capacity is very high. The upper layers are slightly acid, and the lowest layer is neutral. These soils are usually low in phosphorus and potassium and many of the micronutrients.

Most of the acreage is in trees or brush. Carbondale soils are difficult to farm because of their high water table and low fertility. It is difficult to obtain artificial drainage because of lack of outlets in many areas and because these soils settle readily. If these soils are drained, soil blowing and frost are major hazards.

Typical profile of Carbondale muck:

1—0 to 12 inches, black (10YR 2/1) muck; moderate, fine, granular structure; friable; slightly acid; gradual, wavy boundary.

2—12 to 24 inches, very dark brown (10YR 2/2) muck; weak, medium, granular structure; friable; contains numerous fragments of wood; slightly acid; gradual, wavy boundary.

3—24 to 48 inches, brown (10YR 5/3), fine, fibrous peat; friable; neutral.

The uppermost layer ranges to very dark brown in a few areas and contains partially decomposed woody fragments. In some areas the second layer is muck or peaty muck. Organic material is at least 42 inches thick and ranges to as much as 30 feet in thickness.

Carbondale soils are less acid than Loxley and Houghton soils. They contain more woody fragments than Houghton soils.

Carbondale muck (Ca).—This level soil occurs in bogs. The organic layers are medium acid to neutral and, in most places, are more than 42 inches in total thickness. Along the edges of most areas mapped as this soil, however, the organic layers are thin. A narrow rim of Tawas muck or Linwood muck is included in most areas mapped as this soil. The presence of Tawas muck or Linwood muck depends on the texture of the underlying mineral material.

Most of this Carbondale soil is in trees or brush, but some areas are used for improved pasture. The soil is very poorly drained, is ponded most of the time, and is susceptible to unseasonal frost. If it is cleared, drained, and cultivated, it is subject to a moderately severe hazard of soil blowing. Natural fertility is low. Capability unit Vwc–1 (Mc); woodland suitability group J.

Ceresco Series

The Ceresco series consists of somewhat poorly drained, nearly level soils that occur on flood plains of rivers and other streams. These soils developed in stratified, water-deposited loam, silt loam, and sandy loam.

In a typical profile the surface layer is very dark gray loam about 8 inches thick. The underlying material is friable, stratified loam, silt loam, and sandy loam. It is mainly grayish brown in color and contains distinct, reddish-brown and yellowish-brown mottles.

Runoff is very slow to ponded. Permeability is moderate, the available moisture capacity is high, and the content of organic matter is medium. These soils are saturated for long periods of time. Reaction is slightly acid to mildly alkaline above a depth of 30 inches. Below that depth the profile is mildly alkaline to calcareous.

Most of the acreage remains as woodland or pasture. Ceresco soils are subject to flooding, especially in spring and following prolonged rainfall. The saturated soil hinders tillage and restricts downward growth of roots. The meandering streams that cross these soils divide them into many small areas that are impractical to farm. For this reason, and because of the flooding hazard and wetness, Ceresco soils are seldom used for crops.

Typical profile of Ceresco loam:

A1—0 to 8 inches, very dark gray (10YR 3/1) loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

C—8 to 40 inches, grayish-brown (10YR 5/2), stratified loam, silt loam, and sandy loam; common, medium, distinct, dark reddish-brown (5YR 3/3) and yellowish-brown (10YR 5/6) mottles; massive; friable; mildly alkaline.

The A1 horizon ranges from 7 to 10 inches in thickness and ranges to very dark brown in color. The C horizon is dominantly loam or silt loam in some areas.

Ceresco soils have a finer textured profile than either Evart or Winterfield soils. They are better drained than Cohoctah soils.

Ceresco loam (Cc).—This level soil is on bottom lands along meandering rivers and other streams, and most areas are small. Included in mapping are small depressional areas of very poorly drained Cohoctah soils.

Because of the flooding hazard and excessive wetness, this soil is seldom used for crops. The meandering flood plains of streams make many areas nearly inaccessible and impractical to farm. Most areas are wooded or in pasture. Capability unit Vw–3 (L–2c); woodland suitability group O.

Chelsea Series

The Chelsea series consists of nearly level to moderately steep, well-drained soils that occur on moraines, outwash plains, and beach ridges. These soils developed in medium and coarse sands.

In a typical profile the surface layer is very dark gray sand about 3 inches thick. The subsurface layer is pale-brown sand about 4 inches thick. Below this layer, to a depth of about 44 inches, is very friable, dark yellowish-brown sand and loose, pale-brown sand. The material from 44 to about 60 inches consists of alternate layers of sand and loamy sand. The sand layers are loose, pale brown, and from 3 to 6 inches thick. The loamy sand layers are very friable, dark brown, and from 1/16 inch to 2 inches thick. Below a depth of 60 inches is a pale-brown sand that is loose and high in lime content.

Runoff is slow to medium, depending on the slope of the soils. Permeability is rapid. The available moisture capacity and organic matter content are low. Reaction is strongly acid to slightly acid in the surface layer and subsoil, but medium acid is the dominant reaction.

The major acreage of these soils is wooded. Some of the acreage has been cultivated or used for pasture. The major limitation of Chelsea soils for crop growth is their droughtiness. They cannot supply adequate moisture for

plant growth during dry summer periods. Crops show signs of moisture deficiency during some part of the summer. The low fertility and low content of organic matter in these soils also limit crop growth.

Typical profile of a Chelsea sand:

A1—0 to 3 inches, very dark gray (10YR 3/1) sand; very weak, fine, granular structure; very friable; strongly acid; abrupt, wavy boundary.

A2—3 to 7 inches, pale-brown (10YR 6/3) sand; single grain; loose; medium acid; clear, wavy boundary.

Bir—7 to 26 inches, dark yellowish-brown (10YR 4/4) sand; very weak, fine, subangular blocky structure; very friable; medium acid; clear, wavy boundary.

A'2—26 to 44 inches, pale-brown (10YR 6/3) sand; single grain; loose; medium acid; abrupt, wavy boundary.

A'2&B't—44 to 60 inches, dark-brown (7.5YR 4/4) heavy loamy sand, representing the B't horizons; B't horizons occur as 1/16- to 2-inch bands that are commonly discontinuous and are separated by 3- to 6-inch layers of an A'2 horizon; B't horizon is massive and very friable; A'2 horizon is pale-brown (10YR 6/3) sand; single grain; loose; medium acid; boundary between last B't horizon and C horizon is abrupt and wavy.

C—60 to 66 inches, pale-brown (10YR 6/3) sand; single grain; loose; calcareous.

In cultivated areas the Ap horizon ranges from 6 to 10 inches in thickness, and its color ranges to dark brown or very dark grayish brown. The color of the A2 horizon ranges to gray. The depth to the A'2&B't horizon ranges from 42 to 60 inches. In some areas a few, thin, discontinuous layers of loamy sand occur between 34 and 42 inches. Some of the finer textured layers are light sandy loam.

Chelsea soils have a slightly coarser textured profile than Montcalm soils but are finer textured than either Grayling or Rubicon soils.

Chelsea sand, 0 to 6 percent slopes (CdB).—This well-drained soil is generally level to gently sloping. The surface layer is dominantly sand but in some areas is fine sand that extends to a depth of 30 inches. Below a depth of 42 inches the sand is separated by thin layers of sandy loam, loamy sand, or materials of finer texture. In some areas Montcalm sand and Mancelona sand are included with this soil in mapping.

Most of this soil is woodland, but some areas are idle or pasture. The soil is very droughty and, if cultivated, is subject to a moderate hazard of soil blowing. Capability unit IVs–4 (5a); woodland suitability group E.

Chelsea sand, 6 to 12 percent slopes (CdC).—This moderately sloping and rolling soil is well drained. The surface layer is sand, and sand is dominant throughout most of the soil profile. In cultivated areas, the surface layer is a mixture of the upper 6 to 8 inches of the profile and is very dark grayish brown. Below a depth ranging from 38 to 60 inches, the sand is separated by many thin layers of sandy loam, loamy sand, or material of finer texture. Slopes are dominantly between 6 to 12 percent. However, included in mapping are areas where the slopes range outside these limits over short distances. Also included are small areas of coarse-textured Montcalm sand and Rubicon sand.

Most of this soil is woodland, pasture, or idle. This soil is droughty. If this soil is cultivated, the hazard of erosion is moderately severe. Capability unit VIs–1 (5a); woodland suitability group E.

Chelsea sand, 12 to 18 percent slopes (CdD).—This strongly sloping and hilly soil is well drained. The surface layer is dominantly sand, and the profile is mostly sand throughout. Below a depth of 38 to 60 inches, the sand is separated by a few thin layers of loamy sand or sandy loam. Included with this soil in mapping is a small area where the surface layer is brown. Also included on some of the upper slopes are small areas of Rubicon, Grayling, and Montcalm sands, and some areas in which the slopes are outside the typical range. These slopes range from 6 to 11 percent or from 19 to 25 percent within short distances, especially in hilly areas.

Most of this soil is wooded, but some acreage is in pasture or is idle. If cultivated, this soil is readily eroded. Capability unit VIIs–1 (5a); woodland suitability group E.

Chelsea-Au Gres association (CG).—This nearly level to undulating soils in this association lie on outwash plains. Most areas of the association are on stabilized dunes. In over 60 percent of the acreage, slopes are less than 2 percent. The remaining acreage has slopes of 2 to 12 percent. The dominant soils are the Chelsea and Au Gres soils, each of which makes up about 45 percent of the association. Included soils make up about 10 percent of the association.

Chelsea soils are well drained, and Au Gres soils are somewhat poorly drained. Chelsea soils typically have thin bands of loamy sand below a depth of 42 inches, but in about 20 percent of the Chelsea areas the bands are missing. The Au Gres soils are in the lower lying areas, where the water table is near the surface during spring and wet periods. These Au Gres soils are mainly sand and lack the thin bands of loamy sand that characterize the Chelsea soils. Included in mapping, where the water table is high, are small areas of the poorly drained Roscommon and Deford soils.

The vegetation consists partly of a poor stand of white and red oaks and some grasses. The wettest areas support swamp hardwoods, tag alder, or willow. Chelsea soils are in capability unit IVs–4 (5a) and woodland suitability group E. Au Gres soils are in capability unit IVw–2 (5b) and woodland suitability group F.

Chelsea-Rubicon association, undulating (CHB).—The nearly level soils in this association occur on outwash plains and have good natural drainage because of their nearness to deeply cut stream valleys. More than 70 percent of the association has slopes that are less than 2 percent. Soils on sides of narrow ridges have slopes up to 12 percent, and soils on sides of valleys that have cut into the outwash plains are very steep. Chelsea and Rubicon soils each makes up about 45 percent of this association, and included soils comprise the remaining 10 percent.

Both Chelsea and Rubicon soils are well drained. Chelsea soils contain thin bands of loamy sand and sandy loam that are stratified with the sand at a depth below 42 inches. Rubicon soils are developed entirely in sand to a depth exceeding 66 inches. The finer textured bands are in over 40 to 60 percent of the association.

Moderately well drained Croswell soils occur in some level areas. Somewhat poorly drained Au Gres soils are included in shallow depressions. Alluvial soils occur in narrow stream valleys, generally less than 100 feet wide, where stream bottoms are 10 to 30 feet below the general level of the outwash plain.

The vegetation consists of aspen and a large quantity of second-growth white pine, and a ground cover consisting of brackenfern and blackberries. Chelsea soils are in capability unit IVs–4 (5a) and woodland suitability group E. Rubicon soils are in capability unit VIIs–1 (5.3a) and woodland suitability group H.

Chelsea-Rubicon association, rolling (CHC).—This association occurs on morainic ridges and knolls in the northwestern part of Sherman Township. Slopes are complex because the tops of the ridges and knolls are undulating to rolling, and the sides are rolling to steep. Chelsea and Rubicon are the dominant soils in the association, each making up about 45 percent. Included areas make up the remaining 10 percent.

Chelsea sand is well drained and developed in sand containing thin bands of loamy sand and sandy loam below a depth of 42 inches. Rubicon sand is also well drained and developed in deep sand more than 66 inches thick. These two soils occur together in an intricate pattern.

Minor areas of Montcalm and Mancelona soils are included in this association. Both soils developed in loamy sand, but the Mancelona soils are underlain by calcareous sand and gravel at a depth of 18 to 42 inches.

The vegetation consists partly of stands of aspen that are more dense and vigorous on Chelsea soils than on Rubicon soils. Numerous white oaks grow on some of the knolls and ridges. Chelsea soils are in capability unit VIIs–1 (5a) and woodland suitability group E. Rubicon soils are in capability unit VIIs–1 (5.3a) and woodland suitability group H.

Cohoctah Series

The Cohoctah series consists of nearly level to depressional, very poorly drained soils that occur on flood plains of streams and rivers. These soils developed in waterlaid, stratified loam, silt loam, and heavy sandy loam.

In a typical profile the surface layer is black loam about 11 inches thick. The subsoil is friable, dark-gray loam that extends to a depth of about 18 inches and contains a few, distinct, dark yellowish-brown mottles. The underlying material is friable, grayish-brown loam with thin layers of fine sandy loam. It has distinct, yellowish-brown mottles.

Runoff is very slow, and the soil is frequently flooded. Permeability is moderate. These soils are saturated for long periods of time. The available moisture capacity is high. The content of organic matter is very high. Reaction is slightly acid to mildly alkaline. The profile is calcareous in some areas.

These soils are used mainly for woodland, wildlife, and recreation. The present vegetation in many areas is swamp vegetation, including grasses and sedges, elm, cedar, willow, and thickets of tag alder. The high water table and frequent flooding during spring and after prolonged rain are severe limitations to the use of these soils.

Typical profile of Cohoctah loam:

A1—0 to 11 inches, black (10YR 2/1) loam; weak, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

Bg—11 to 18 inches, dark-gray (10YR 4/1) loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; gradual, wavy boundary.

C—18 to 40 inches, grayish-brown (2.5Y 5/2) loam, and thin layers of fine sandy loam; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; massive; friable; mildly alkaline.

In a few areas a layer of muck 1 inch to 10 inches thick occurs on the surface. The A1 horizon ranges from 10 to 15 inches in thickness and ranges to dark brown in color. In some areas there are thin layers of silt loam and fine sandy loam below a depth of 11 inches. In a few areas thin layers of sandy loam, sand, and silty clay loam occur below a depth of 36 inches. The sequence and thickness of different layers vary greatly within short distances.

Cohoctah soils are more poorly drained and grayer than Ceresco soils, and they are finer textured than Evart soils.

Cohoctah loam (Co).—This nearly level and depressional soil occurs in low-lying, narrow flood plains. It is separated from other soils by steep, short escarpments and is inaccessible. The surface layer is loam, sandy loam, or silt loam. A large acreage is limy at or near the surface. The underlying stratified layers are mainly loam and sandy loam. Narrow areas of well-drained soils, as well as some gravel spots are included in areas mapped as this soil.

Because of a high water table, moderate permeability, and level topography, runoff is very slow to ponded. The organic-matter content is very high. As a result of frequent flooding and excessive wetness, this soil is limited for use as woodland, for wildlife, or for recreation. Capability unit Vw–3 (L–2c); woodland suitability group O.

Croswell Series

The Croswell series consists of nearly level to undulating or gently sloping, moderately well drained soils that occur on outwash plains and lake plains. These soils developed in deep, medium to coarse sands.

In a typical profile the surface layer is very dark grayish-brown sand about 2 inches thick. The subsurface layer, about 6 inches thick, is loose, grayish-brown sand. The subsoil is reddish-brown to dark-brown sand that extends to a depth of about 25 inches. It is very friable in the upper part and loose in the lower part. The underlying material is loose, brown sand and contains reddish-yellow mottles.

Runoff is slow to very slow. Permeability is very rapid. The available moisture capacity and the organic-matter content are low. The lower part of these soils is saturated for extended periods, mainly in the spring. Once the water table lowers, these soils dry out quickly. Reaction ranges from strongly acid to slightly acid in the surface layer and subsoil.

Most of the acreage is second-growth woodland. Some of it has been farmed in the past, but is now idle or planted with pines. The droughtiness and low fertility of Croswell soils limit their use for cropland. During spring the water table is within 2 to 3 feet of the surface, but it recedes quickly as summer arrives. The available water in the soils is rarely adequate for good crop growth.

Typical profile of Croswell sand, 0 to 6 percent slopes:

A1—0 to 2 inches, very dark grayish-brown (10YR 3/2) sand; weak, fine, granular structure; very friable; strongly acid; abrupt, wavy boundary.

A2—2 to 8 inches, grayish-brown (10YR 5/2) sand; single grain; loose; strongly acid; abrupt, wavy boundary.

B21ir—8 to 11 inches, reddish-brown (5YR 5/4) sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.
B22ir—11 to 25 inches, dark-brown (7.5YR 4/4) sand; single grain; loose; medium acid; gradual, wavy boundary.
C—25 to 60 inches, brown (10YR 5/3) sand; many, coarse, prominent, reddish-yellow (5YR 4/6) mottles; single grain; loose; medium acid.

The Ap horizon ranges to dark grayish-brown sand in cultivated areas. Over a small acreage of these soils stones occur on the surface. The A2 horizon is absent in many cultivated areas. Depth to the C horizon ranges from 18 to 40 inches.

Croswell soils are slightly wetter than Rubicon soils. They are better drained and less mottled than Au Gres soils.

Croswell sand, 0 to 6 percent slopes (CrB).—This nearly level to gently sloping soil is on outwash plains. Sand is dominant throughout the soil profile. The areas of this soil having slopes of 4 to 6 percent are slightly better drained than those having slopes of 0 to 2 percent. Included in mapping are small areas of somewhat poorly drained Au Gres soils and well-drained Rubicon soils. Also included are small areas with a loamy sand surface layer. Some included areas contain strongly cemented spots that occur in layers between depths of 8 and 25 inches.

Some areas of this soil are cultivated and, in these areas, soil blowing is a hazard. Most areas are woodland. Capability unit IVs–4 (5a); woodland suitability group E.

Croswell stony sand, 0 to 6 percent slopes (CsB).—This soil is nearly level to gently sloping. In the upper 30 inches and on the surface, 30 to 100 feet apart, are rounded stones that are of sufficient size and quantity to hinder cultivation. Stones must be removed before this soil can be cultivated without difficulty.

Most of this soil has been cleared, but it is idle or in pasture. If cultivated, this soil has a moderate hazard of soil blowing and stoniness. Capability unit IVs–4 (5a); woodland suitability group E.

Croswell-Au Gres association (CT).—This association consists of nearly level soils that occur on outwash plains comprised of sand to a depth of more than 66 inches. The association lies in extensive areas scattered throughout the eastern part of the county. In at least 80 percent of the areas, slopes are less than 2 percent. They exceed 2 percent only on sides of small ridges and along natural drainageways. Considerable microrelief is evident in some areas in the form of hummocks caused by windthrow of trees. Croswell and Au Gres soils are dominant in this association, each making up about 40 percent. Included soils make up about 20 percent.

Moderately well drained Croswell soils and somewhat poorly drained Au Gres soils both developed in sand deposits more than 66 inches thick. Although it is difficult to distinguish between high and low areas within this association, Croswell soils occur in the higher and Au Gres soils in the lower places. The proportion of these soils varies within areas of the association, but at least 30 percent of each is present in all areas.

Some areas of this association include up to 30 percent of well-drained Rubicon soils in higher places. Other areas include up to 20 percent of poorly drained and very poorly drained Roscommon soils in closed depressions and along minor natural drainageways. In a few areas thin layers of silt or fine sand occur below a depth of 42 inches.

The vegetation consists partly of a sparse cover of aspen, white birch, and red maple, and a ground cover of brackenfern and blackberries. Swamp hardwoods, willow and tag alder, are in the low-lying, poorly drained areas. Reaction throughout the profile ranges from slightly acid to mildly alkaline. Croswell soils are in capability unit IVs–4 (5a) and woodland suitability group E. Au Gres soils are in capability unit IVw–2 (5b) and woodland suitability group F.

Croswell-Au Gres-Kinross association (CU).—In this low-lying association are areas of sand dunes that are separated by level or nearly level areas where the water table is periodically high. The association is moderately extensive in the county and occupies areas scattered throughout the eastern part. About 25 percent of the acreage consists of dunes 4 to 8 feet high. The tops of these dunes are slightly rounded, and the sides have slopes of 2 to 8 percent. Intervening areas are nearly level; their slopes are less than 2 percent. Croswell soils make up about 45 percent of the association, Au Gres soils about 35 percent, and Kinross soils about 20 percent.

Moderately well drained Croswell soils developed in more than 66 inches of sand, and they occur on the dunes. Somewhat poorly drained Au Gres soils also developed in more than 66 inches of sand, but they are in the level or nearly level areas between the dunes. Poorly drained, very acid Kinross soils developed in sand deposits more than 42 inches thick. These soils lie in the lowest areas between the dunes.

Well-drained Rubicon or Grayling soils, both of which developed in more than 66 inches of sand, occur on steeper sides of the dunes. Small areas of these soils were included in mapping.

The vegetation on the dunes consists of aspen and a ground cover of sweet fern and grass. Ground cover in the low areas is brackenfern and leatherleaf. Moss grows in the lowest areas. Natural groves of jack pine are also in areas of low and intermediate drainage. Croswell soils are in capability unit IVs–4 (5a) and woodland suitability group E. Au Gres soils are in capability unit IVw–2 (5b) and woodland suitability group F. Kinross soils are in capability unit IIIw–11 (5c) and woodland suitability group Q.

Croswell-Au Gres-Roscommon association (CW).—In this nearly level association are low-lying outwash plains where sand deposits are more than 66 inches thick. The topography is complex, consisting of low knolls and ridges separated by shallow depressions and natural drainageways. The association is quite extensive in the eastern part of the county. Slopes are less than 2 percent in 70 to 90 percent of the acreage, and range from 2 to 6 percent on the sides of low ridges and shallow natural drainageways. The proportion of the individual soils varies from one area of the association to another, but Croswell and Au Gres soils generally make up 30 to 50 percent and Roscommon about 20 to 30 percent.

Moderately well drained Croswell soils are in the highest positions, and the somewhat poorly drained Au Gres soils are in intermediate positions. Both of these soils developed in sand more than 66 inches thick. Poorly drained to very poorly drained Roscommon soils, de-

veloped in at least 42 inches of sand, are in the lowest positions.

Well-drained Rubicon soils are included in some of the higher knolls and ridges. Sand is dominant throughout the profile, but included in a few areas are thin bands of sandy loam or silt below a depth of 42 inches.

The vegetation in the highest places consists of aspen and a ground cover of fern. Lower lying places contain willow and thickets of tag alder. During spring and winter the low areas between ridges are flooded. Reaction throughout the profile is slightly acid to moderately acid. Croswell soils are in capability unit IVs–4 (5a) and woodland suitability group E. Au Gres soils are in capability unit IVw–2 (5b) and woodland suitability group F. Roscommon soils are in capability unit IIIw–11 (5c) and woodland suitability group Q.

Deford Series

Soils of the Deford series are poorly drained or very poorly drained, are nearly level to depressional, and occur on lake plains and outwash plains. They developed in alternate layers of fine sand and loamy fine sand. In Gladwin County the Deford soils were mapped only in the Roscommon-Deford and the Wainola-Deford associations.

In a typical profile the surface layer is black fine sand about 4 inches thick. Below the surface layer is stratified material consisting of layers of loose fine sand and loamy fine sand. The upper part of this underlying material is mainly gray and contains distinct, strong-brown mottles. The lower part is pale brown, contains yellowish-brown mottles, and is high in content of lime.

Runoff is very slow, and many areas are ponded, especially in spring and after prolonged rain. The water table is high in spring, but once the ground water is lowered by artificial drainage, permeability is rapid. The available moisture capacity is low. The surface layer is normally high in organic-matter content and is in good tilth. Reaction of the upper 2 feet ranges from slightly acid to mildly alkaline.

Only a small acreage of these soils is in this county, but where it occurs it is used as woodland and as habitat for wildlife. Just a few areas have been cleared and artificially drained for crops. The naturally high water table, which is within 12 inches of the surface during spring, restricts development and downward growth of roots. If artificially drained, the Deford soils tend to be somewhat droughty but are easy to work and respond to good management.

Typical profile of a Deford fine sand:

A1—0 to 4 inches, black (10YR 2/1) fine sand; weak, fine, granular structure; very friable; slightly acid; clear, wavy boundary.

C1—4 to 18 inches, light-gray (10YR 7/2) fine sand; single grain; loose; slightly acid; gradual, wavy boundary.

C2g—18 to 28 inches, gray (10YR 6/1) fine sand and loamy fine sand; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; single grain; loose; neutral; abrupt, wavy boundary.

C3—28 to 48 inches, pale-brown (10YR 6/3) fine sand; common, coarse, distinct, yellowish-brown (10YR 5/6) mottles; single grain; loose; calcareous.

In the lowest areas a 2- to 12-inch layer of muck occurs on the surface. The A horizon ranges from 2 to 6 inches in thickness, and its color ranges to very dark brown. A few areas have thin layers of loamy sand and fine sandy loam below the surface.

Deford soils have a coarser textured profile than the Bruce soils. Deford soils have finer sands than either the Roscommon or the Kinross soils.

Edwards Series

The Edwards series consists of very poorly drained organic soils that are nearly level and depressional and occur in morainic areas. These soils developed in organic materials, 12 to 42 inches thick, over marl.

In a typical profile the surface layer is black muck about 8 inches thick. The next layer is also black muck and is about 16 inches thick. White marl, high in content of lime, underlies the organic material at a depth of about 24 inches. All of the layers are friable.

Runoff is very slow to ponded. Permeability in the marl layer is very slow, keeping the upper layers saturated. The available moisture capacity is very high. The organic material consists of mixed woody, grassy, and sedge materials. These soils are generally low in plant nutrients, especially many of the micronutrients. Reaction of the organic material ranges from neutral to mildly alkaline.

Most of the acreage of these soils remains in woodland or pasture. These soils are difficult to farm because of a high water table and low fertility. The very slow permeability of the marl substratum hinders the downward movement of water and keeps the upper part of the soil saturated. Unless Edwards soils are artificially drained, their water table is within 12 inches of the surface, but drainage is difficult to obtain because of the marl and also because outlets are lacking in many areas. These soils settle readily. Soil blowing and frost are major hazards.

Typical profile of Edwards muck:

1—0 to 8 inches, black (10YR 2/1) muck; moderate, medium, granular structure; friable; mildly alkaline; gradual, wavy boundary.

2—8 to 24 inches, black (10YR 2/1) muck; weak, coarse, subangular, blocky structure; friable; mildly alkaline; abrupt, smooth boundary.

IIC—24 to 50 inches, white (10YR 8/1) marl; massive; friable; calcareous.

The uppermost layer ranges to very dark brown. In some areas the second layer is peaty muck.

Edwards soils have a marl substratum, which is lacking in Linwood soils. Edwards soils have thinner organic layers than either Carbondale or Houghton soils.

Edwards muck (Ed).—This soil is nearly level. The black surface layer is muck, and muck is dominant in the organic part of the profile. Generally, the combined thickness of organic layers is 20 to 30 inches. Included in mapping are spots where the organic layers range from 12 to 42 inches. Also included are some areas where alternate layers of marl and muck are in the lower part of the profile.

Most of this soil is woodland or in pasture. Some areas have been cleared and successfully seeded to improve pasture, especially along the lake plain margin where natural drainage is slightly better. For the most part, Edwards muck is very poorly drained and crops are susceptible to unseasonal frost. Because of excessive wetness, poor surface drainage, and the hazards of frost

and soil blowing, this soil has severe limitations that affect its use for crops. Capability unit Vwc–1 (M/Mc); woodland suitability group J.

Epoufette Series

The Epoufette series consists of nearly level or depressional, poorly drained or very poorly drained sandy soils that occur on lake plains and outwash plains. These soils developed in loamy sand, sandy loam, and gravelly loamy sand, 18 to 42 inches thick, that overlie limy stratified gravel and coarse sand.

In a typical profile the surface layer is black sandy loam about 9 inches thick. The subsoil consists of two parts. The upper part is very friable, mottled, gray loamy sand about 6 inches thick. The lower part of the subsoil is friable, grayish-brown gravelly sandy loam about 11 inches thick that contains distinct, yellowish-brown mottles. Light brownish-gray, stratified gravel and medium and coarse sand occur at a depth of about 26 inches. This material is loose and high in content of lime.

Runoff is slow to very slow. Permeability is moderately rapid to very rapid in the absence of a high water table. The available moisture capacity is moderate. The content of organic matter is medium to high. Reaction is neutral to mildly alkaline in the surface layer and subsoil. These soils are wet for extended periods of time.

Most of the acreage of Epoufette soils is pastured or wooded, but a few areas are cropped. Some of the cleared areas are now idle and covered with grass, willows, or tag alder. Wetness is the main limitation that restricts use of these soils for crops. The water table is usually within 12 inches of the surface in spring and other wet periods, and the saturated soil hinders the downward growth of plant roots. Undrained areas are normally too wet for optimum growth of crops.

Typical profile of Epoufette sandy loam:

A1—0 to 9 inches, black (10YR 2/1) sandy loam; weak, medium, granular structure; very friable; neutral; abrupt, smooth boundary.

B21g—9 to 15 inches, gray (10YR 5/1) loamy sand; few, medium, distinct, yellowish-brown (10YR 5/6) mottles; very weak, fine, subangular blocky structure; very friable; neutral; clear, wavy boundary.

B22g—15 to 26 inches, grayish-brown (10YR 5/2), gravelly light sandy loam; common, medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure; friable, sticky; mildly alkaline; abrupt, wavy boundary.

IIC—26 to 48 inches, light brownish-gray (10YR 6/2), stratified fine gravel and medium and coarse sand; single grain; loose; calcareous.

The color of the A1 horizon ranges to very dark brown and the thickness ranges from 6 to 10 inches. Stones are on the surface in a few small areas. The texture of the B horizon ranges to gravelly loamy sand or light gravelly clay loam. A considerable amount of gravel is in the subsoil in many areas.

Epoufette sandy loam (Ep).—This nearly level to depressional sandy loam occurs on outwash plains. In places the surface layer is dark-colored mucky sandy loam. Included in mapping are small areas of Brevort loamy sand that has a finer textured substratum within 42 inches of the surface. Also included are small areas of somewhat poorly drained Gladwin loamy sand, which occurs in small rises and narrow ridges.

Most of the acreage of this soil is woodland, pasture, or cropland. Some cleared areas of large extent are idle and covered with grass or thickets of willow and tag alder. This soil has a limitation of excessive wetness and occurs in areas that are susceptible to unseasonal frost. Capability unit IIIw–6 (4c); woodland suitability group W.

Epoufette-Tawas association (ET).—This association occurs in outwash channels that are more than 200 feet wide and as much as 2½ miles long. These channels are 4 to 10 feet lower than the surrounding outwash plains. This association is in streaks running northwest to southeast in Butman and Clement Townships and, to a lesser extent, in Secord and Bourret Townships. Streams flow through parts of the channels. Epoufette soils make up about 50 percent of the association, Tawas soils about 40 percent, and included soils about 10 percent.

Epoufette soils developed in stratified sand and gravel. In some areas their surface layer is mucky loamy sand. Tawas soils consist of 12 to 42 inches of muck that overlies the same kind of sandy and gravelly outwash in which Epoufette soils developed. Both of these soils are limy at or near the surface.

Minor inclusions of Brevort and Roscommon soils are present in this association, as well as small areas of deep organic soils. In Sherman Township these organic soils are dominantly deeper than 42 inches.

The vegetation consists of tag alder, willow, white-cedar, and smaller amounts of elm and ash. Drainage is poor to very poor, and the water table is high. Epoufette soils are in capability unit IIIw–6 (4c) and woodland suitability group W. Tawas soils are in capability unit Vwc–1 (M/4c) and woodland suitability group J.

Evart Series

The Evart series consists of nearly level or depressional, poorly drained soils that occur on flood plains of rivers. These soils developed in sand and loamy sand material.

In a typical profile the surface layer is black loamy sand about 12 inches thick. The underlying material is loose, dark grayish-brown sand containing gray mottles.

Runoff is slow. Permeability is rapid, and the available moisture capacity is low. Reaction is slightly acid to neutral. The content of organic matter is medium.

Most areas of Evart soils are idle, in brush, or woodland. Many of the individual areas of these soils are too small in size to be farmed efficiently. These soils have a high water table at or near the surface in spring, and this limits the development of plant roots and restricts the growth of crops. In addition, Evart soils are flooded for short periods of time during spring and after prolonged rainfall. The duration and frequency of flooding are variable. Because of the flooding hazard, these soils are rarely used as cropland.

Typical profile of Evart loamy sand:

A1—0 to 12 inches, black (10YR 2/1) loamy sand; very weak, fine, granular structure; very friable; slightly acid; abrupt, wavy boundary.

C—12 to 48 inches, dark grayish-brown (10YR 4/2) sand; common, medium, distinct, gray (10YR 5/1) mottles; single grain; loose; neutral.

The A horizon ranges from 10 to 20 inches in thickness, and its color ranges to very dark grayish brown or very dark brown. The texture of the C horizon is loamy sand in a few areas.

The Evart soils are more poorly drained than Winterfield soils. They have a coarser textured profile than Cohoctah soils.

Evart loamy sand (Ev).—This nearly level and depressional soil is on low, narrow flood plains along rivers and streams. It occupies only a small acreage in the county. Included with this soil in mapping are a few areas where the surface layer is sand or muck. Also included are some areas where thin layers of finer textured material occur and other areas where the soil is gravelly.

Evart loamy sand is wet and is flooded frequently. It is used mainly as woodland, for wildlife, and for recreation. Capability unit Vw–3 (L–4c); woodland suitability group O.

Evart-Winterfield association (EW).—The soil in this association are on bottom land along the major streams in the county and are subject to periodic flooding in most areas. The largest areas of the association are along the Molasses River, the Little Molasses River, and their tributaries. The alluvial lands along the Tittabawassee River have largely been flooded by backwaters from the several dams on that river. Texture of the soils is extremely variable, vertically and horizontally, because the material was deposited by stream flooding. The dominant texture is moderately coarse to coarse. Evart soils make up about 60 percent of this association; Winterfield soils about 30 percent; and included soils about 10 percent.

Most soils of this association are poorly drained, but somewhat poorly drained soils are in many knolls and hummocks. Included in mapping are small areas in white-cedar swamps along sides of valleys of the Molasses River where the surface layer is 12 to 18 inches of muck and is underlain by sand.

The vegetation is dominantly brush and lowland hardwoods. There is white-cedar in areas where the surface layer is muck to a depth of more than 12 inches. Evart soils are in capability unit Vw–3 (L–4c) and woodland suitability group O. Winterfield soils are in capability unit Vw–3 (L–4c) and woodland suitability group O.

Gladwin Series

The Gladwin series consists of nearly level to undulating or gently sloping, somewhat poorly drained, sandy and gravelly soils that occur on outwash plains and lake plains. These soils developed in loamy sand, gravelly loamy sand, and sand that overlie calcareous, stratified coarse sand and gravel.

In a typical profile the surface layer is very dark grayish-brown loamy sand about 8 inches thick. The subsurface layer is grayish-brown sand about 5 inches thick. The subsoil consists of two parts. The upper part is very friable, mottled, dark-brown sand about 5 inches thick. The lower part is friable, mottled, dark yellowish-brown gravelly sandy loam about 10 inches thick. The material below the subsoil is brown, stratified, medium and coarse sand and gravel that contain brownish-yellow mottles. This material is loose and limy.

Runoff is very slow or slow. Permeability is moderately rapid in the upper part of the profile and very rapid in the sandy and gravelly substratum. These soils are saturated for a significant period of time, especially during the spring. Available moisture capacity is moderate. The organic-matter content is medium to low. Reaction is medium acid to mildly alkaline in the surface and subsurface layers and the subsoil.

Many areas of these soils are used for crops and pasture. Undrained areas are still wooded or are idle. The major limitation affecting the use of these soils is excessive wetness. These soils dry out slowly in the spring, and planting operations are delayed. As summer progresses, the water table recedes and the soils are better suited to plants.

Typical profile of a Gladwin loamy sand:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, fine, granular structure; very friable; neutral; abrupt, smooth boundary.

A2—8 to 13 inches, grayish-brown (10YR 5/2) sand; single grain; loose; neutral; clear, wavy boundary.

Bir—13 to 18 inches, dark-brown (7.5YR 4/4) sand; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; very weak, medium, subangular blocky structure; very friable; neutral; clear, wavy boundary.

B't—18 to 28 inches, dark yellowish-brown (10YR 4/4) gravelly, light sandy loam; common, medium, distinct, gray (10YR 6/1) mottles; weak, medium, subangular blocky structure; friable, sticky; mildly alkaline; abrupt, wavy boundary.

IIC—28 to 48 inches, brown (10YR 5/3), stratified, medium and coarse sand and gravel; common, medium, distinct, brownish-yellow (10YR 6/6) mottles; single grain; loose; calcareous.

Undisturbed areas have a very dark grayish-brown A1 horizon that ranges from 1 to 3 inches in thickness. The Ap horizon ranges to very dark gray in color and from 6 to 10 inches in thickness. The color of the A2 horizon is gray in some areas. Stones occur on the surface and throughout the profile in a few areas. The combined thickness of the A and B horizons ranges from 24 to about 40 inches. In places where the substratum is loamy, this material is clay loam or silty clay loam and occurs at a depth ranging from 42 to about 66 inches. The texture of the B't horizon ranges to heavy gravelly loamy sand. A thin gray layer 1 to 6 inches thick occurs between the Bir and B't horizons in many areas.

Gladwin soils have coarser sands and more gravel in the subsoil than Brimley soils. They are finer textured than Au Gres soils. Gladwin soils developed in similar material as Epoufette soils, but they are better drained and not so gray as those soils.

Gladwin loamy sand, 0 to 2 percent slopes (GhA).—The surface layer of this soil is loamy sand, but included in mapping are minor spots where the surface layer is sandy loam or sand. Also included, in broad areas mapped as this Gladwin soil, are small areas of poorly drained soils. In some of these small areas, a finer textured layer is within 66 inches of the surface. Gladwin loamy sand, loamy substratum, 0 to 2 percent slopes, and an Epoufette soil that has a loamy sand surface layer occur in these included areas.

Undrained areas of this Gladwin soil are wooded or in pasture. In undrained areas the water table is occasionally at a depth of less than 3 feet. In these areas excessive moisture is a limitation in spring and fall. During dry summers, however, the water table falls rapidly and growth of crops is slowed because moisture is inadequate.

Areas of this soil that are artificially drained are used for hay and grain crops. The thickness of clean sandy and gravelly material seldom exceeds 8 to 10 feet, and therefore this soil rarely yields large deposits of gravel that can be used commercially. Capability unit IIIw–5 (4b); woodland suitability group F.

Gladwin loamy sand, loamy substratum, 0 to 2 percent slopes (GlA).—This nearly level soil is in broad areas on the lake plain in the southwestern part of the county. In some areas the surface is very rough because of many pockets and cradle knolls. Included in mapping are a few areas where the surface layer is sand. Also included are small areas of poorly drained Brevort or Epoufette soils, which occur in small, wet depressions that dry out slowly in the spring and after rain. This wetness delays planting and tillage operations. Also included is a moderately well drained Mancelona soil that has a loamy substratum and occurs in some of the higher positions. Iosco and Gladwin soils are included in small areas where the depth of sandy and gravelly material is either less than 42 inches or greater than 66 inches. Also included are areas of very short slopes of 3 or 4 percent and occasional spots that are slightly eroded by wind.

Artificially drained areas are used for producing hay and grain. Undrained areas are primarily pasture or woodland. Capability unit IIIw–5 (4b); woodland suitability group F.

Gladwin-Epoufette association (GE).—The nearly level soils in this association occur on outwash-covered lake plains. The association is not extensive and is in scattered areas in Secord, Clement, and Bourret Townships. The undulating topography of this association consists of a series of low ridges that are about 100 to 300 feet wide and are separated by shallow troughs approximately the same width. Difference in elevation between tops of the ridges and bottoms of the troughs is seldom more than 2 to 3 feet. Slopes are less than 2 percent in most areas but are up to 6 percent along the sides of some of the ridges. Gladwin soils make up about 50 percent of this association; Epoufette soils about 40 percent; and included soils about 10 percent.

Somewhat poorly drained Gladwin soils are on the ridgetops. They developed in sand and gravel underlain at a depth of 42 to 66 inches by firm clay loam or silty clay loam.

Poorly drained and very poorly drained Epoufette soils are in the low troughs between ridges. They developed in sand and gravel deposits that are at least 42 inches thick.

Included in mapping are small areas in which there is a firm clay loam to silty clay loam substratum between depths of 42 and 66 inches. Minor areas of Croswell and Iosco soils are included on ridges, and Brevort and Markey soils are included in troughs.

The vegetation consists of aspen and a ground cover of brackenfern on the ridges, and willow and tag alder in the troughs. Some areas have been farmed in the past, and some of these are still used for crops. Gravel in the profile varies but is more prevalent in Epoufette soils than in Gladwin soils. The gravel has little commercial value because it is poorly sorted and mixed with fines. Gladwin soils are in capability unit IIIw–5 (4b) and woodland suitability group F. Epoufette soils are in capability unit IIIw–6 (4c) and woodland suitability group W.

Gladwin-Epoufette-Croswell association, undulating (GPB).—The nearly level soils in this association are on outwash plains where the water table is seasonally high. The soil material consists of alternate layers of sand and gravel. The association is quite extensive in a belt two to three miles wide on either side of the Tittabawassee River north of State Highway 61. Slopes are less than 6 percent in most areas of the association. The individual ridges and low areas range from 100 to 300 feet in width and cannot be separated at the scale used in mapping. Dominant soils are Gladwin and Epoufette, each of which makes up nearly 35 percent of the total acreage. Croswell soils make up almost 30 percent of the acreage.

Somewhat poorly drained Gladwin soils and poorly drained to very poorly drained Epoufette soils both developed in sand or loamy sand that overlies a mixture of sand or gravel at a depth of less than 42 inches. The Gladwin soils are on the sides and tops of low ridges, and the Epoufette soils are in the low areas between these ridges. The proportion of Gladwin and Epoufette soils varies from one area to another, but at least 30 percent of each soil occurs throughout the association. Some of the higher ridgetops contain moderately well drained Croswell soils. In the moderately well drained areas the depth to gravel is generally greater than in the somewhat poorly and poorly drained areas. Up to 15 inches of muck overlies sand and gravel in some of the natural drainageways. Minor inclusions of Iosco and Brevort soils occur where a finer textured substratum is at a depth of 18 to 42 inches.

The vegetation consists of aspen, white birch, and red maple on the Gladwin soils and is tag alder and willow in the lowest places between ridges. Gravel in this association is normally poorly sorted and mixed with finer textured materials. Its commercial value is limited. Gladwin soils are in capability unit IIIw–5 (4b) and woodland suitability group F. Epoufette soils are in capability unit IIIw–6 (4c) and woodland suitability group W. Croswell soils are in capability unit IVs–4 (5a) and woodland suitability group E.

Grayling Series

Soils of the Grayling series are nearly level to gently sloping, well-drained sands that occur on lake plains and outwash plains. These soils developed in deep deposits of medium and coarse sands.

In a typical profile the surface layer is very dark gray sand about 2 inches thick. The subsurface layer is grayish-brown sand about 2 inches thick. Both of these layers are strongly acid. The subsoil is loose, yellowish-brown sand about 16 inches thick. Underlying material is loose, pale-brown sand.

Runoff is slow, permeability is rapid, and the available moisture capacity is low. These soils have a low content of organic matter and a low level of fertility. Reaction is strongly acid in the surface and subsurface layers and is medium acid below.

Most of the acreage is used for woodland or wildlife. Trees are generally of poor quality and are poorly developed. Grayling soils are among the most droughty soils

in the county. Their moisture content is generally inadequate for good crop growth, and during dry periods of midsummer most crops show signs of moisture deficiency.

Typical profile of a Grayling sand:

A1—0 to 2 inches, very dark gray (10YR 3/1) sand; very weak, fine, granular structure; very friable; strongly acid; abrupt, smooth boundary.
A2—2 to 4 inches, grayish-brown (10YR 5/2) sand; single grain; loose; strongly acid; abrupt, irregular boundary.
Bir—4 to 20 inches, yellowish-brown (10YR 5/4) sand; single grain; loose; medium acid; gradual, wavy boundary.
C—20 to 48 inches, pale-brown (10YR 6/3) sand; single grain; loose; medium acid.

The A1 horizon ranges from 1 to 3 inches in thickness, and its color ranges to very dark grayish brown. The A2 horizon is absent in about 50 percent of the areas mapped as Grayling soils. The B horizon ranges to dark yellowish brown or brownish yellow in color.

Grayling soils developed in coarser sands than Rousseau soils and have a lighter colored B horizon than either Rubicon or Rousseau soils. Grayling soils are better drained than Croswell or Au Gres soils.

Grayling sand, 0 to 6 percent slopes (GrB).—This soil is nearly level to gently sloping. The surface layer is sand, and medium sand is dominant throughout the soil profile. The upper part of the layers between a depth of 4 to 20 inches is reddish brown to brown. Included in mapping are some areas where gravel occurs below a depth of 40 inches.

Most of this soil has a ground cover of grasses and sweet fern. In a few areas there are stands of stunted red and white oaks, aspen, and jack pine. If the soil is burned over or cultivated, soil blowing is a moderate hazard. Capability unit VIIs–1 (5.7a); woodland suitability group N.

Grayling association, undulating (GSB).—The nearly level to gently sloping soils in this association are on sandy outwash plains. These soils were modified by wind that formed a series of low sand dunes and intervening low areas. The dunes are 4 to 8 feet high and have slopes ranging from 4 to 6 percent. The dunes and low areas are quite narrow, and the slope pattern is complex. The area is dominantly well drained to moderately well drained. Well-drained Grayling soils that developed in more than 66 inches of sand and show little development of a profile make up 75 percent of the association. Included in this association in some low-lying places are minor areas of moderately well drained Croswell soils and somewhat poorly drained Au Gres soils. Also included are a few dunes having slopes up to 12 percent. This soil association is of moderate extent, and the largest areas are in Sheridan and Grim Townships.

Vegetation consists partly of aspen, scrub oak, and a ground cover of sweet fern and grass. Brackenfern and small patches of tag alder occur in the lowest lying areas. Groves of jack pine are in the intermediately drained positions. Capability unit VIIs–1 (5.7a); woodland suitability group N.

Grayling association, rolling (GSC).—The moderately sloping to strongly sloping soils in this association are on sand dunes that are more than 200 feet wide and more than a quarter of a mile long. The slope pattern on the sides and top of the dunes is complex, and individual slopes are short. Slopes exceed 6 percent on about 80 percent of the acreage and exceed 12 percent on approximately 30 to 40 percent. About 95 percent of this association is well-drained Grayling soils that developed in sand deposits more than 66 inches thick. The only inclusions are minor areas of moderately well drained Croswell soils at the base of some of the slopes.

Part of the vegetation on the dunes is a sparse covering of aspen, and the ground cover is composed of sweet fern and grass. A few areas are now subject to active erosion. The total acreage of this association is small, but the individual dunes are striking features in the landscape. Capability unit VIIs–1 (5.7a); woodland suitability group N.

Grayling-Croswell-Au Gres association (GU).—This association consists of stabilized sand dunes, as well as wet areas that are too small to be mapped separately. This association is extensive along the east county line in Sheridan and Grim Townships. The dunes make up 20 to 40 percent of the association; they are less than 200 feet wide, are generally less than one-fourth mile in length, and are shaped like a horseshoe. The height of the dunes ranges from 8 to 20 feet, and side slopes of the dunes normally range from 6 to 18 percent, but there are numerous small slopes outside this range. Grayling soils make up about 50 to 70 percent of the association, and Croswell soils about 20 to 30 percent. Au Gres, Kinross, and Saugatuck soils make up the rest.

The dominant soils on the dunes are Grayling soils that developed in sand more than 66 inches thick. These Grayling soils show little horizon development.

The level areas at the base of the dunes are moderately well drained Croswell soils that also developed in more than 66 inches of sand. The Croswell soils have slightly more horizon development than the Grayling soils. There are mottles in the lower part of the profile. The areas of Croswell soils have slopes of 1 to 6 percent.

The low areas between the dunes are occupied by the Au Gres, Kinross, and Saugatuck soils, all of which developed in deep sand. These wet areas are very acid and have slopes of less than 2 percent. The Au Gres soils are somewhat poorly drained, the Saugatuck soils are somewhat poorly drained to poorly drained, and the Kinross soils are poorly drained.

The vegetation on the dunes partly consists of a sparse stand of aspen and a ground cover of sweet fern and grass. Numerous open areas have only grass and a few active blowouts. The Croswell soils support a moderately good stand of aspen. In wet areas the vegetation consists mainly of leatherleaf, blueberries, and moss. Scattered throughout the lower areas are dense groves of jack pine, a tree that is making poor growth at present. Grayling soils are in capability unit VIIs–1 (5.7a) and woodland suitability group N. Croswell soils are in capability unit IVs–4 (5a) and woodland suitability group E. Au Gres soils are in capability unit IVw–2 (5b) and woodland suitability group F.

Hettinger Series

The Hettinger series is made up of poorly drained or very poorly drained, nearly level or depressional soils that lie on lake plains. These soils developed in stratified

silty clay loam and clay loam that contain layers of silt and clay.

In a typical profile the surface layer is black loam about 8 inches thick. The upper part of the subsoil is firm, dark grayish-brown silty clay loam. In the lower part the subsoil is gray, stratified silty clay loam and silt loam that contain layers of clay loam and light clay. The subsoil extends to a depth of about 18 inches. The underlying material is firm, mottled, grayish-brown, stratified silty clay loam and silt loam in which there are thin layers of light clay and clay loam. This material is high in content of lime.

Runoff is very slow to ponded. Permeability is moderately slow, and the available moisture capacity is high. These soils have a high water table and are excessively wet during part of the year. The organic-matter content is high. Reaction is slightly acid to neutral in the surface layer and is neutral to mildly alkaline in the subsoil.

About half the acreage of Hettinger soils is used as cropland or for pasture. Undrained areas remain wooded or are idle. Excess wetness is the major limitation that affects use of these soils for crops, and artificial drainage is generally required to obtain optimum crop growth. The water table is at or near the surface in spring and hinders planting and growth of crops.

Typical profile of Hettinger loam:

A1—0 to 8 inches, black (10YR 2/1) loam; moderate, medium, granular structure; friable; neutral; clear, wavy boundary.

B21g—8 to 14 inches, dark grayish-brown (10YR 4/2) silty clay loam; moderate, fine, subangular blocky structure; firm; mildly alkaline; clear, wavy boundary.

B22g—14 to 18 inches, gray (10YR 5/1), stratified silty clay loam and silt loam; common, coarse, distinct, dark grayish-brown (10YR 4/2) and yellowish-brown (10YR 5/6) mottles; moderate, medium, angular blocky structure; firm; contains thin layers of clay loam and light clay; mildly alkaline; abrupt, wavy boundary.

C—18 to 48 inches, grayish-brown (10YR 5/2), stratified silty clay loam and silt loam; strata of light clay and clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; firm; calcareous.

The A1 horizon ranges from 6 to 9 inches in thickness and to very dark gray in color. The texture of the A1 horizon is mainly loam, but it ranges to silty clay loam in a few areas. The B21g horizon is mottled with yellowish brown in some areas. Individual layers in the material below the A horizon range from 1 to 8 inches in thickness.

Hettinger soils are finer textured than Bruce soils, but not so fine textured as Pickford soils. The texture of Hettinger soils is similar to that of Sims soils, but the material is more stratified.

Hettinger loam (Hg).—This soil is nearly level to depressional. The surface layer is dominantly loam, 6 to 9 inches thick, and overlies the finer textured layers. Included in mapping are small areas where the surface layer is sandy loam, silt loam, or silty clay loam. Also included are small areas, 50 feet in diameter, that are limy at the surface.

About half of the acreage of this soil is used for growing hay, small grains, and cash crops. If adequately drained and managed, Hettinger loam is well suited to these crops. Undrained areas are in pasture or woodland. Organic-matter content is very high, and available moisture capacity is high. Undrained areas are of limited use because of excess moisture. Surface water is ponded for some time after rains. Capability unit IIw–2 (1.5c); woodland suitability group P.

Hettinger-Brevort-Burleigh association (HB).—This association is in depressional areas of lake plains. These areas have a thin covering of sandy material. The two largest areas are in western Sheridan Township and southwestern Bentley Township. Slopes are commonly less than 2 percent throughout the association, but some areas are hummocky. Poorly drained soils are dominant. They occur in more than 80 percent of the total acreage. The major poorly drained soils are Hettinger soils, which make up about 40 percent, Brevort soils which also make up about 40 percent, and Burleigh soils which make up about 20 percent. Minor inclusions of other soils are in this association.

Hettinger soils developed in layers of clay loam, silty clay loam, silt, and clay. They commonly have a mucky sand, mucky loamy sand, or sandy loam surface layer that extends to a depth of 8 to 10 inches.

The Brevort and Burleigh soils developed in sand. The Brevort soils are underlain by clay loam or silty clay loam. The Burleigh soils are underlain by very fine sand and silt. In both soils this underlying material begins at a depth of 18 to 42 inches.

Other poorly drained soils that are commonly included in this association are Deford and Breckenridge. Both of these soils tend to be mucky in the surface layer and have spots where the muck is more than a foot thick. Also included are small areas of somewhat poorly drained soils in low ridges. These soils are Iosco, Ingalls, and Au Gres.

The vegetation is swamp hardwoods and patches of tag alder, willow, and marsh grass. The latter are found in the wettest areas. The swamp hardwoods are mixed with aspen on the low ridges. Hettinger soils are in capability unit IIw–2 (1.5c) and woodland suitability group P. The Brevort soils are in capability unit IIIw–10 (4/2c) and woodland suitability group W. Burleigh soils are in capability unit IIIw–6 (4c) and woodland suitability group W.

Houghton Series

In the Houghton series are very poorly drained, nearly level to depressional soils that developed in organic material derived mainly from reeds, sedges, and other fibrous plants. The organic material ranges from 42 inches to many feet in thickness. These soils occur on till plains, outwash plains, lake plains, and moraines.

In a typical profile the surface layer is black muck about 8 inches thick. The material below the surface layer, to a depth of about 18 inches, is dark reddish-brown muck. Between depths of 18 inches and 48 inches or more, the soil material is reddish-brown peaty muck.

Runoff is very slow, and water stands on the surface most of the time in spring. Permeability is moderately rapid when the water table is low. The available moisture capacity is very high, and the organic-matter content is high. The content of plant nutrients, especially micronutrients, is low. In most places these soils are medium acid to slightly acid, but reaction ranges from strongly acid to neutral.

Houghton soils have severe limitations that restrict their use for crops, and only a small acreage is cultivated. The water table, which is within 12 inches of the surface in spring and after prolonged rainfall, prevents development and downward growth of roots. If these soils are cultivated, they are subject to soil blowing, and they settle readily when drained. Crops are subject to frost damage. The vegetation in most areas consists of marsh grasses, sedges, and reeds.

Typical profile of Houghton muck:

1—0 to 8 inches, black (10YR 2/1) muck; moderate, fine, granular structure; friable; medium acid; gradual, wavy boundary.
2—8 to 18 inches, dark reddish-brown (5YR 2/2) muck; moderate, fine, granular structure; friable; medium acid; gradual, smooth boundary.
3—18 to 48 inches, reddish-brown (5YR 4/4) peaty muck; weak, thick, platy structure; friable; slightly acid.

The color of the uppermost layer ranges to very dark brown. In some places the second layer is peaty muck and the underlying layer is peat.

Houghton soils lack the woody material common in Carbondale soils. Houghton soils have thicker deposits of organic material than Linwood and Tawas soils.

Houghton muck (Hu).—This level soil is in bogs. It is very poorly drained and is often ponded. The surface layer consists of black muck 5 to 18 inches thick. In some areas there is as much as 2 inches of recently accumulated plant material on the surface. In most places the organic material is more than 42 inches thick, but it is generally thin at the outer edge of the bogs. A narrow rim of Linwood muck surrounds most areas.

In most places the vegetation consists of marsh grasses, sedges, and reeds. Crops are subject to frost damage. Capability unit Vwc–1 (Mc); woodland suitability group J.

Ingalls Series

The Ingalls series consists of somewhat poorly drained, nearly level soils that occur on lake plains and outwash plains. These soils developed in medium and coarse sands, 18 to about 42 inches thick that overlie stratified very fine and fine sands and silt.

In a typical profile the surface layer is very dark brown sand about 2 inches thick. The subsurface layer is pinkish-gray sand about 8 inches thick. The subsoil is mainly sand about 20 inches thick. The upper part is very friable to loose and reddish brown to dark brown. The lower part is brown, loose, mottled sand. The underlying material, beginning at a depth of about 30 inches, is loose, light brownish-gray, stratified fine and very fine sands and silt. This material contains many, distinct, yellowish-brown mottles.

Runoff is very slow to ponded in the lowest areas. Permeability is rapid in the upper part of these soils, but is moderately rapid in the lower part. The content of organic matter ranges from low to medium. The available moisture capacity is low. Reaction in the surface and subsurface layers and subsoil ranges from medium acid to neutral, and in the underlying material from neutral to moderately alkaline.

In a few areas these soils have been cleared and used as cropland, but many of these areas are now idle or pastured. Most of the acreage remains as woodland. Excessive wetness is the major limitation in the use of these soils for crops. The water table is within 2 feet of the surface during the spring and after prolonged rain, and excess water hinders the development and downward movement of plant roots and reduces crop growth. Droughtiness is also a limitation if these soils are artificially drained.

Typical profile of Ingalls sand:

A1—0 to 2 inches, very dark brown (10YR 2/2) sand; very weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.
A2—2 to 10 inches, pinkish-gray (7.5YR 6/2) sand; single grain; loose; medium acid; abrupt, irregular boundary.
B21ir—10 to 14 inches, reddish-brown (5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; slightly acid; gradual, wavy boundary.
B22ir—14 to 19 inches, dark-brown (7.5YR 4/4) sand; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; single grain; loose; slightly acid; gradual, wavy boundary.
B3—19 to 30 inches, brown (10YR 5/3) sand; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; single grain; loose; slightly acid; abrupt, wavy boundary.
IIC—30 to 45 inches, light brownish-gray (10YR 6/2), stratified, fine and very fine sands and silt; many, medium, distinct, yellowish-brown (10YR 5/8) mottles; single grain; loose; mildly alkaline.

The color of the A1 horizon ranges to very dark grayish brown. Cultivated areas have an Ap horizon that ranges from 6 to 9 inches in thickness and to very dark grayish brown in color. The color of the A2 horizon ranges to gray or grayish brown. The sands in the upper part of these soils range from medium to coarse in size. The sequence and thickness of the layers of fine and very fine sands and silt vary within short distances. They range in thickness from 2 to 6 inches.

Ingalls soils have a coarser textured C horizon than Iosco soils. Ingalls soils are more poorly drained and have a higher water table than the Ocqueoc soils.

Ingalls sand, 0 to 2 percent slopes (IcA).—This nearly level soil is in small areas on lake plains, outwash plains, and deltas near glacial meltwater channels where stratified material was deposited. The very dark brown or gray surface layer is sand, but it is fine sand in some places. Some areas were included in mapping where the soil contains small chunks of reddish-brown cemented material at depths between 12 and 23 inches. Slopes are normally less than 1 percent, but included in mapping are areas where slopes are 2 to 4 percent. Also included are poorly drained Burleigh loamy sand that occurs in narrow drainageways and well-drained Ocqueoc sand that occurs in small ridges.

A large area of this soil is woodland, and most cleared areas are now idle or in pasture. Runoff is very slow, and the organic-matter content is medium to low. This soil is droughty and, if cultivated, has a moderate hazard of soil blowing. Capability unit IIIw–5 (4b); woodland suitability group G.

Iosco Series

The Iosco series consists of nearly level to undulating or gently sloping, somewhat poorly drained soils that occur on lake plains and till plains. These soils developed in sandy material overlying loam, silty clay loam, or clay

loam. The thickness of the sandy upper material ranges from 18 to about 42 inches.

In a typical profile the surface layer is very dark grayish-brown loamy sand about 8 inches thick. The subsurface layer is light brownish-gray loamy sand about 4 inches thick. The subsoil is dominantly dark brown or brown. It is mostly mottled and extends to a depth of about 38 inches. The upper part is very friable to loose sand and loamy sand. The lower part is firm silty clay loam. The underlying material is firm, grayish-brown light silty clay loam that is high in lime content.

Runoff is very slow to slow. Permeability is rapid in the upper part of these soils, but is only moderately slow in the lower part. The water table is high in spring and after prolonged rain. Organic-matter content is medium, and the available moisture capacity is low. Reaction in the sandy material is medium acid to slightly acid.

These soils are used for pasture, woodland, and cropland. Iosco soils are saturated within 2 feet of the surface during the spring and after prolonged rain. The excess wetness hinders planting operations, shortens the growing season, and restricts downward growth of roots. After the water table recedes, these soils dry out quickly.

Typical profile of an Iosco loamy sand:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—8 to 12 inches, light brownish-gray (10YR 6/2) loamy sand; single grain; loose; medium acid; abrupt, wavy boundary.

B21ir—12 to 18 inches, dark-brown (7.5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—18 to 24 inches, brown (7.5YR 5/4) sand; many, coarse, distinct, brownish-yellow (10YR 6/6) mottles; single grain; loose; slightly acid; clear, wavy boundary.

A'2—24 to 30 inches, grayish-brown (10YR 5/2) loamy sand; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; single grain; loose; slightly acid; abrupt, irregular boundary.

IIB't—30 to 38 inches, dark-brown (7.5YR 4/4) silty clay loam; many, medium, distinct, light-gray (10YR 7/2) mottles; moderate, medium, angular blocky structure; firm; grayish-brown (10YR 5/2) loamy sand, representing A'2 horizon, occurs as thick coatings and root and worm channel fillings in upper 3 to 4 inches; neutral; abrupt, wavy boundary.

IIC—38 to 60 inches, grayish-brown (10YR 5/2) light silty clay loam; many, medium, distinct, brown (7.5YR 5/4) mottles; massive; firm; calcareous.

In undisturbed areas the A1 horizon ranges from 1 to 3 inches in thickness and to very dark gray in color. The Ap horizon ranges to very dark gray in color and from 6 to 10 inches in thickness. It ranges from loamy sand to sand. In some cultivated areas the A2 horizon is absent. In a few areas stones occur on the surface and in the upper part of these soils. The texture of the B't horizon ranges to heavy loam or clay loam.

Iosco soils are more poorly drained than Menominee soils but are similar in texture to those soils. Iosco soils have coarser textured Ap and Bir horizons than Belding soils and a finer textured C horizon than Au Gres soils.

Iosco stony sand, 0 to 2 percent slopes (IdA).—The surface layer of this soil contains numerous large stones of sufficient size to hinder cultivation. These rounded stones, mostly 1 foot to 3 feet in diameter, are 30 to 100 feet apart on the surface and throughout the soil profile.

Most areas of this soil have been cleared but are idle or in pasture. The stones must be removed before the soil can be readily cultivated. In addition, excess moisture is a limitation. Capability unit IIIw–9 (4/2b); woodland suitability group G.

Iosco loamy sand, 0 to 2 percent slopes (IoA).—This soil is nearly level. Included with it in mapping are random spots of sand; small areas in the southeastern part of the county where the surface layer is fine sand; and some areas that are affected by soil blowing and have a lighter colored surface layer than this Iosco soil. Also included are small areas of moderately well drained Menominee loamy sands that occupy small, low ridges; and areas of Brevort loamy sand, Breckenridge sandy loam, and a Sims soil that has a sandy loam surface layer, all of which occur in small, closed depressions and narrow, natural drainageways.

A large acreage of this Iosco soil is used for growing hay, small grain, and pasture crops, and a sizable acreage is native woodland. In some cultivated areas, soil blowing is a hazard. Although some areas are tile drained, undrained areas are limited in use because moisture is excessive in wet periods. During dry summers, the high water table drops rapidly and crop growth is reduced because of insufficient moisture. Capability unit IIIw–9 (4/2b); woodland suitability group G.

Iosco loamy sand, 2 to 6 percent slopes (IoB).—This soil is on low, sandy ridges and on the sides of minor drainageways. It has slightly better surface drainage than nearly level Iosco loamy sand. Included in mapping are small areas where the surface layer is sandy loam; areas where slopes are as much as 8 percent; and ridges where the depth of sand exceeds 42 inches. Also included are areas in which the depth of sand is less than 14 inches, and in these areas the soil grades into the depressional Brevort loamy sand or a Sims soil that has a sandy loam surface layer.

This Iosco soil is used mainly as woodland and for pasture. However, isolated ridges are included in cultivated fields. The main limitations to use of this soil are excessive moisture, low fertility, and droughtiness. During dry summers, the usually high water table drops rapidly and crop growth is reduced because sufficient moisture is lacking. Capability unit IIIw–9 (4/2b); woodland suitability group G.

Iosco-Au Gres-Ingalls association (IA).—The nearly level soils in this association are on sand-covered lake plains where natural drainage is chiefly moderately good to somewhat poor. Slopes are less than 2 percent in more than 75 percent of the association. Steeper slopes, though prominent, are very short and occupy only a small part of the total acreage. Some areas have been made hummocky by the windthrow of trees.

Iosco sand makes up about 45 percent of the association, Au Gres sand about 25 percent, and Ingalls sand about 20 percent. The remaining 10 percent is made up of included soils.

Iosco sand consists of 18 to 42 inches of sand over loam, clay loam, or silty clay loam. Au Gres sand consists of 42 to 66 inches of sand over loam, clay loam, or silty clay loam. Ingalls sand is made up of 18 to 42 inches of sand over silt and very fine sand. All of these soils are somewhat poorly drained, and together with other somewhat

poorly drained soils, they occupy 70 to 90 percent of the individual areas mapped as the association.

Other somewhat poorly drained soils, which occupy small areas included in mapping, are the Otisco soils and other Au Gres soils. Also included are small areas of poorly drained Brevort, Burleigh, and Roscommon soils. These poorly drained soils occupy less than 30 percent of the areas mapped as the association and are in the lowest lying positions. On the higher ridges and knolls, there are small included areas of well drained and moderately well drained Menominee, Ocqueoc, and Croswell soils. These are in less than 35 percent of the areas.

The vegetation on the low knolls and ridges consists mainly of aspen, white birch, and red maple. Swamp hardwoods are in the poorly drained areas. Brackenfern prevails in the ground cover. Iosco soils are in capability unit IIIw–9 (4/2b) and woodland suitability group G. Au Gres soils are in capability unit IVw–2 (5b) and woodland suitability group F. Ingalls soils are in capability unit IIIw–5 (4/b) and woodland suitability group G.

Iosco-Brevort association (IB).—The nearly level soils in this association are on outwash plains, which appear as a series of low ridges separated by shallow troughs. Here, the water table is permanently or seasonally high. The association is of limited extent and is in parts of Secord, Clement, and Butman Townships.

The individual ridges and troughs are each about 100 to 300 feet wide and are not more than 2 to 3 feet high. Somewhat poorly drained Iosco soils are on the low ridges and make up about 60 percent of the association. Poorly drained Brevort soils are in the shallow troughs and make up about 40 percent of the association.

Both the Brevort soils and the Iosco soils developed in sandy outwash that is underlain by moderately fine textured material at a depth of 18 to 42 inches. Included in mapping are small areas of Gladwin loamy sand on the low ridges and of Epoufette and Roscommon loamy sands in the shallow troughs.

Several areas of this association have been cleared and used for crops, but only a few areas are now farmed. On the low ridges the vegetation consists partly of aspen, white birch, and red maple, and there is a ground cover of brackenfern. In the troughs the plant cover consists mainly of brushy willows and tag alder. Iosco soils are in capability unit IIIw–9 (4/2b) and woodland suitability group G. Brevort soils are in capability unit IIIw–10 (4/2c) and woodland suitability group W.

Iosco-Brevort-Ingalls association (II).—The nearly level soils in this mapping unit are on sand-covered lake plains that generally have poor or somewhat poor natural drainage. The association occupies scattered areas throughout the eastern part of Gladwin County. Slopes exceed 2 percent in only a few places, but some areas are hummocky because trees have been thrown by wind.

About 50 percent of the association is somewhat poorly drained Iosco soils, 25 percent is poorly drained Brevort soils, and 20 percent is somewhat poorly drained Ingalls soils. The remaining 5 percent is included areas of other soils.

Iosco sand and Ingalls sand are the dominant somewhat poorly drained soils. They consist of 18 to 42 inches of sand over finer textured material. The Iosco soil overlies clay loam or silty clay loam. The Ingalls soil overlies silt and very fine sand. These soils, together with inclusions of somewhat poorly drained Au Gres sand, occupy low ridges and level areas.

Brevort sands and mucky sands are the dominant poorly drained or very poorly drained soils. They consist of sand or loamy sand that is underlain by clay loam or silty clay loam at a depth of 18 to 42 inches. Other poorly drained soils, mapped as inclusions, are the Burleigh, Roscommon, Hettinger, Bruce, and Breckenridge. Poorly drained or very poorly drained soils lie on flats and in closed depressions.

Other included soils are the moderately well drained Croswell and Menominee soils. These soils occur on only a few knolls and ridges.

In parts of Bentley Township, there is an appreciable amount of fine sand in the upper part of the profile of soils in this association.

The vegetation consists mainly of swamp hardwoods, but these are intermingled with aspen trees in the higher places. The ground cover is principally brackenfern in the higher positions and swamp grass in the lower ones. Iosco soils are in capability unit IIIw–9 (4/2b) and woodland suitability group G. Brevort soils are in capability unit IIIw–10 (4/2c) and woodland suitability group W. Ingalls soils are in capability unit IIIw–5 (4b) and woodland suitability group G.

Iosco-Kawkawlin-Brevort association (IK).—The nearly level to undulating soils in this association are on till plains that are partly covered by sandy outwash. The association lies along the edge of the Port Huron moraine throughout the county. The landscape consists of knolls and depressions having short slopes that range from 0 to 6 percent.

Dominant soils are the Iosco and Kawkawlin, each of which makes up nearly 40 percent of the association, and the Brevort, which makes up about 20 percent. In low-lying positions are inclusions of Sims soils; these consist of less than 18 inches of sandy material overlying clay loam.

The Iosco soils are somewhat poorly drained. They developed in deposits of sand or loamy sand, 18 to 42 inches thick, overlying clay loam. Iosco soils occupy knolls and sandy ridges.

Kawkawlin soils also are somewhat poorly drained. They developed in clay loam, similar to that in which the Iosco soils developed, but in a few places the surface layer of Kawkawlin soils is sandy loam or loamy sand less than 18 inches thick. Kawkawlin soils occur as clay knobs on the knolls.

Poorly drained Brevort soils developed in sand or loamy sand deposits underlain by clay loam to silty clay loam at a depth of 18 to 42 inches. These soils occupy most areas between the knolls.

In most areas the soils of this association have been cleared and are now farmed or were farmed in the past. A few forested areas are covered by mixed stands of upland hardwoods and lowland hardwoods. Iosco soils are in capability unit IIIw–9 (4/2b) and woodland suitability group G. Kawkawlin soils are in capability unit IIw–2 (1.5b) and woodland suitability group Z. Brevort

soils are in capability unit IIIw–10 (4/2c) and woodland suitability group W.

Iosco-Menominee-Brevort association (IM).—The undulating to nearly level soils in this association lie on sand-covered till plains and lake plains. They are moderately extensive in the county and occur in two general areas. The first of these is on the west edge of the Port Huron moraine in the southeastern part of Bourret Township. Here, the soils in the lower part of their profile consist of glacial till. The second area lies between the west and middle branches of the Tittabawassee River in Clement and Secord Townships. Here, the soils in the lower part of their profile are made up of lake-laid material.

The lake plains and till plains appear as an intricate pattern of knolls and closed depressions. Slopes are mainly less than 6 percent, and locally the difference in elevation between the highest knoll and the lowest depression is 4 to 6 feet.

Iosco and Menominee soils, the dominant ones, each make up about 40 percent of the association. Also important are the Brevort soils, which make up the remaining 20 percent.

Somewhat poorly drained Iosco soils are on the lower knolls and on the lower side slopes of some of the higher knolls. These soils developed in deposits of sand, 18 to 42 inches thick, overlying clay loam to silty clay loam.

Moderately well drained Menominee soils occur on the highest knolls. They developed in sand deposits, 18 to 42 inches thick, over loam to clay loam.

Poorly drained and very poorly drained Brevort soils occur in the bottoms of the depressions. These soils developed in 18 to 42 inches of sand overlying clay loam or silty clay loam.

The vegetation is a moderately dense stand of aspen, red maple, and white birch; the ground cover is mainly ferns and blackberries. Tree growth on this association is considerably better than on areas on deep sand that have similar drainage characteristics. Iosco soils are in capability unit IIIw–9 (4/2b) and woodland suitability group G. Menominee soils are in capability unit IIIs–3 (4/2a) and woodland suitability group C. Brevort soils are in capability unit IIIw–10 (4/2c) and woodland suitability group W.

Kawkawlin Series

The Kawkawlin series consists of somewhat poorly drained, nearly level to gently undulating or gently sloping soils that occur on till plains and low moraines. These soils developed in clay loam or silty clay loam material.

In a typical profile the surface layer is very dark grayish-brown loam about 8 inches thick. The subsurface layer is grayish-brown loam about 3 inches thick. The subsoil is about 15 inches thick and consists of two parts. The upper part is grayish-brown loam and reddish-brown clay loam. The lower part is mottled, firm, reddish-gray heavy clay loam. The underlying material is firm, mottled, brown clay loam that is high in lime content.

Runoff is moderately slow. Permeability is moderately slow. The available moisture capacity is high, and these soils are saturated for extended periods of time, usually during spring. Organic-matter content is medium. The reaction is medium acid to slightly acid in the surface and subsurface layers and the subsoil.

These soils are used as cropland, pasture, and woodland. If adequately drained, they respond readily to good management, but excess wetness in the spring and after rain is a serious limitation in many areas. It bogs down machinery, delays planting, and hinders development and downward growth of roots. Harvesting is also difficult when excessive rainfall occurs in the fall.

Typical profile of a Kawkawlin loam:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loam; weak, coarse, granular structure; friable; medium acid; abrupt, smooth boundary.

A2g—8 to 11 inches, grayish-brown (10YR 5/2) loam; weak, coarse, granular structure; friable; medium acid; abrupt, irregular boundary.

A&B—11 to 16 inches, grayish-brown (10YR 5/2) loam, which is the A part; reddish-brown (5YR 4/3) clay loam, which is the B part; weak, medium, subangular blocky structure; firm; peds of B material partly or wholly surrounded by A material; medium acid; gradual, wavy boundary.

B22tg—16 to 26 inches, reddish-gray (5YR 5/2) heavy clay loam; common, medium, distinct, yellowish-brown (10YR 5/4) mottles; moderate, medium, angular blocky structure; firm; thin clay flows on ped faces; slightly acid; abrupt, wavy boundary.

Cg—26 to 48 inches, brown (7.5YR 5/2) clay loam; many, medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, angular blocky structure; firm; calcareous.

The Ap horizon ranges to very dark gray or dark grayish brown in color and from 6 to 10 inches in thickness. Undisturbed areas have a very dark gray A1 horizon 1 to 4 inches thick. The texture of the B horizon ranges to light clay or silty clay loam. The combined thickness of the A and B horizons ranges from 20 to 36 inches. The C horizon ranges to silty clay loam.

Kawkawlin soils are finer textured in the B and C horizons than the Londo soils, but they are not so fine textured in those horizons as the Rudyard soils.

Kawkawlin loam, 0 to 2 percent slopes (KaA).—This nearly level soil is in concave areas. Included in mapping are a few minor areas that have a silt loam surface layer, and some random areas of moderately deep sandy loam and loamy sand. Belding sandy loam and Iosco loamy sand are in the sandy spots. These included soils generally occupy less than 10 percent of the acreage in each area mapped, but in the southeastern part of Sage Township they occupy up to 40 percent.

This soil is commonly used for crops and pasture (fig. 5), but undrained areas remain in woodland for the most part. This soil has medium organic-matter content and moderately high available moisture capacity. Surface runoff is very slow, and excessive moisture is a limitation. If adequately drained, this soil is well suited to crops. Capability unit IIw–2 (1.5b); woodland suitability group Z.

Kawkawlin loam, 2 to 6 percent slopes (KaB).—This gently sloping soil is in concave areas. Included in mapping are a few minor areas that have a silt loam surface layer, and random spots of moderately deep sandy loam and loamy sand. Belding sandy loam and Iosco loamy sand are in the sandy spots. These spots generally occupy less than 10 percent of the individual areas mapped, but

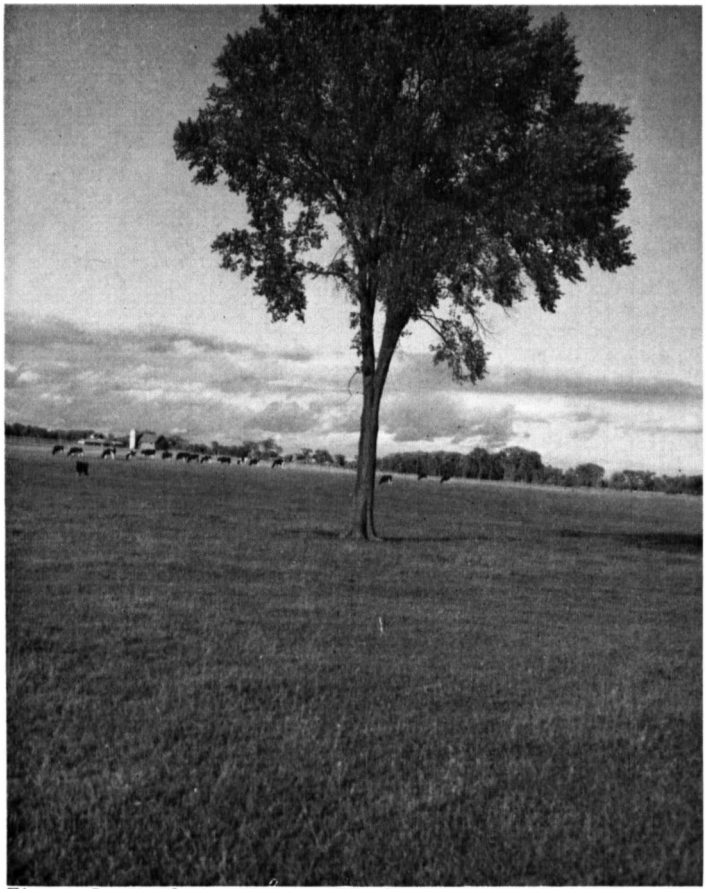

Figure 5.—Cattle grazing on Kawkawlin loam, 0 to 2 percent slopes.

in the southeastern part of Sage Township they occupy up to 40 percent. Also included, in the depressions between side slopes, are small areas of Sims soils, and these are sometimes flooded.

This soil is commonly used for cropland and pasture. Undrained areas are mainly wooded. This soil has a medium organic-matter content and a moderately high available moisture capacity. Surface runoff is slow, excess moisture is a limitation, and there is some flooding in the low spots. If adequately drained, this soil is well suited to crops. Capability unit IIw–3 (1.5b); woodland suitability group Z.

Kinross Series

This series consists of poorly drained, nearly level to depressional, sandy soils that occupy broad flats on outwash plains and lake plains. These soils developed in acid medium and coarse sands.

In a typical profile the surface layer is black, very strongly acid sand about 4 inches thick. Overlying this layer is about 2 inches of very dark grayish-brown peat. The subsurface layer is brown, very strongly acid sand about 12 inches thick. The subsoil, which extends to a depth of about 30 inches, is loose, dark grayish-brown sand that is mottled with dark reddish brown and is very strongly acid. This layer is underlain by loose, mottled, gray sand that is strongly acid.

Runoff is very slow to ponded. The water table is at or near the surface most of the year, but permeability is very rapid if the water table is lowered by artificial drainage. Available moisture capacity is very low. The organic-matter content ranges from medium to high. The reaction is extremely acid or strongly acid in the surface and subsurface layers and in the subsoil.

Because they are saturated, these soils are mainly wooded. Unless they are artificially drained, they are generally not used as cropland. In addition, the soils are very strongly acid, and this further limits their use for crops.

Typical profile of Kinross sand:

02—2 to 0 inches, very dark grayish-brown (10YR 3/2) peat; fibrous; very strongly acid; abrupt, smooth boundary.

A1—0 to 4 inches, black (10YR 2/1) sand; very weak, medium, granular structure; very friable; very strongly acid; abrupt, wavy boundary.

A2—4 to 16 inches, brown (10YR 5/3) sand; few, fine, faint, yellowish-brown (10YR 5/6) mottles; single grain; loose; very strongly acid; gradual, irregular boundary.

Bir—16 to 30 inches, dark grayish-brown (10YR 4/2) sand; many, coarse, distinct, dark reddish-brown (5YR 3/3) mottles; single grain; loose; very strongly acid; gradual, wavy boundary.

C—30 to 42 inches, gray (10YR 6/1) sand; few, medium, distinct, yellowish-brown (10YR 5/6) mottles; single grain; loose; strongly acid.

In some of the better drained areas, the 2-inch layer of peat overlying the A horizon is absent, and in these areas the A1 horizon ranges to very dark brown in color. The A1 horizon ranges from 1 to 6 inches in thickness.

The Kinross soils are more acid than Roscommon soils and are more poorly drained than Au Gres soils.

Kinross sand (Kr).—This soil is in large depressions on sandy outwash plains, where the water table is usually high. The soil is in areas scattered throughout the county, but the largest acreages are in Sheridan and Bourret Townships. Slopes are dominantly less than 2 percent.

More than 80 percent of this mapping unit is poorly drained Kinross sand, a soil that developed in sand to a depth of 42 inches or more and is extremely acid to strongly acid throughout the profile. In places where the surface is covered with peat, this material is as much as 12 inches thick. Included in mapping are a few areas of somewhat poorly drained Au Gres soils on narrow ridges, and small areas of Loxley soils that occur where the thickness of the surface peat exceeds 12 inches.

The vegetation consists mainly of leatherleaf, but there is some marshgrass, a few jack pines, and spruce. Capability unit IIIw–11 (5c); woodland suitability group Q.

Lacota Series

This series consists of poorly drained or very poorly drained, nearly level to depressional soils that occur on lake plains and outwash plains. These soils developed in clay loam or silty clay loam material that overlies sand or loamy sand at a depth of 18 to 42 inches.

In a typical profile the surface layer is very dark brown sandy loam about 9 inches thick. The subsoil is firm, mottled, gray heavy clay loam about 19 inches thick. The

underlying material is light brownish-gray sand that is loose and high in lime content.

Runoff is very slow to ponded. Permeability is moderately slow in the upper, finer textured part of these soils, but is very rapid in the underlying sandy material. These soils have a high available moisture capacity and a high content of organic matter. The subsoil is gray as a result of a saturated condition during much of the year. The water table is lower in artificially drained areas. Reaction ranges from slightly acid to mildly alkaline in the surface layer and subsoil.

Only a small acreage of these soils occurs in the county. Most of the acreage has been cultivated or pastured. In some areas artificial drainage has reduced excessive wetness, but other areas remain as woodland because they are too wet or are too small to be cleared and planted. These soils dry out slowly in the spring, and planting operations are delayed. During some years, harvesting operations are delayed by excessive rain.

Typical profile of Lacota sandy loam:

Ap—0 to 9 inches, very dark brown (10YR 2/2) sandy loam; weak, fine, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

Btg—9 to 28 inches, gray (10YR 5/1) heavy clay loam; common, coarse, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, angular blocky structure; firm; mildly alkaline; abrupt, wavy boundary.

IIC—28 to 50 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; mildly alkaline.

The A horizon ranges from 6 to 10 inches in thickness and to black in color. In a few areas the texture of the B horizon is silty clay loam. The combined thickness of the A and B horizons ranges from 24 to 36 inches.

Lacota soils have a coarser textured C horizon than Sims soils.

Lacota sandy loam (Lo).—This nearly level soil is inextensive in the county. Most of it occurs west of Winegars on lake plains. Natural drainage ranges from poor to very poor. Included in mapping are areas where the surface ranges from fine sandy loam to loamy sand over short distances. Also included are some spots and narrow low ridges of somewhat poorly drained Iosco loamy sand and low areas of Roscommon sand.

Most of this soil is cleared and cultivated. Most of the common crops are grown. This soil is wet and susceptible to unseasonal frost. Capability unit IIw-6 (3c); woodland suitability group W.

Linwood Series

This series consists of nearly level to depressional, very poorly drained, organic soils that occur on till plains, lake plains, and moraines. These soils developed in mixed woody and fibrous organic materials overlying loamy material. The thickness of the organic material ranges from 12 to 42 inches.

In a typical profile the surface layer is black muck about 8 inches thick. The next layer is dark-brown muck, about 10 inches thick, that contains some partly decomposed organic material. Just below is a layer of dark reddish-brown peat about 5 inches thick. The underlying material, beginning at a depth of about 23 inches, is firm, grayish-brown light clay loam. This material is mildly alkaline.

Runoff is slow to very slow, and water ponds in some of the lowest depressions and flats. Permeability is moderately rapid in the upper part of these soils but is moderately slow in the underlying material. The available moisture capacity is very high. These soils have low fertility and contain few micronutrients. Reaction of the organic material is medium acid to slightly acid.

Most of the acreage remains in woodland and brush, and only a few small areas are used as cropland. The water table is commonly at or near the surface in undrained areas. Drainage is difficult because outlets are lacking in many areas. If these soils are drained, they settle readily. Their low fertility level is another limitation to use of Linwood soils for crops.

Typical profile of Linwood muck:

1—0 to 8 inches, black (10YR 2/1) muck; moderate, fine, granular structure; friable; medium acid; gradual, wavy boundary.

2—8 to 18 inches, dark-brown (7.5YR 3/2) muck; contains some partly decomposed material; weak, medium, granular structure; friable; medium acid; gradual, wavy boundary.

3—18 to 23 inches, dark reddish-brown (5YR 3/4) peat; weak, thick, platy structure; friable; slightly acid; abrupt, smooth boundary.

IIC—23 to 48 inches, grayish-brown (2.5Y 5/2) light clay loam; massive; firm; mildly alkaline.

The surface layer ranges to very dark brown in color. The second layer is peaty muck in some areas. In places the texture of the underlying mineral material is loam, silt loam, or light silty clay loam.

The organic material that makes up the Linwood soils is thinner than that in the Carbondale, Houghton, and Lupton soils. Linwood soils are underlain by loamy material, whereas the Loxley and Tawas soils are underlain by sand.

Linwood muck (Lm).—This organic soil occurs in small, shallow depressions that are surrounded by undulating to steep soils developed in clay loam. The surface layer is commonly covered with recently deposited plant remains 1 to 2 inches thick. The black surface layer is muck. The organic layers are thinnest at the borders and thickest in the centers of individual areas. Included in mapping in some areas, where the total thickness of the organic layers is less than 12 inches or more than 42 inches, are thin rims of mineral soils with a mucky surface layer, and small spots of deep organic soils.

This soil is very poorly drained, and crops are subject to frost damage. Most of the acreage remains in woodland. Capability unit Vwc-1 (M/3c); woodland suitability group J.

Londo Series

This series consists of nearly level to undulating or gently sloping, somewhat poorly drained, loamy soils that occur on till plains and lake plains. These soils developed in loamy glacial material that is high in lime content.

In a typical profile the surface layer is very dark gray loam about 8 inches thick. The subsurface layer is grayish-brown sandy loam about 4 inches thick. The subsoil is firm, grayish-brown light clay loam, about 10 inches thick, that contains distinct, yellowish-brown mottles. The underlying material is friable, grayish-

brown loam. This material contains distinct, yellowish-brown mottles and is high in content of lime.

Runoff is very slow to slow. Permeability is moderately slow. These soils are saturated for long periods of time during spring. The available moisture capacity is high. Organic-matter content is medium. Reaction ranges from slightly acid to mildly alkaline in the surface and subsurface layers and the subsoil.

Most of the acreage is cropland, pasture, and woodland. The wetness of Londo soils hinders planting and tillage in the spring, but after the water table recedes these soils dry out quickly and are easy to work. If adequately drained, Londo soils respond to management and are suited to crops commonly grown in the county.

Typical profile of a Londo loam:

Ap—0 to 8 inches, very dark gray (10YR 3/1) loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—8 to 12 inches, grayish-brown (10YR 5/2) sandy loam; weak, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

Bg—12 to 22 inches, grayish-brown (10YR 5/2) light clay loam; many, coarse, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; firm; neutral; abrupt, wavy boundary.

Cg—22 to 48 inches, grayish-brown (2.5Y 5/2) loam; common, medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, coarse, subangular blocky structure; friable; calcareous.

The Ap horizon ranges to dark grayish brown in color and from 6 to 9 inches in thickness. Undisturbed areas have a very dark gray A1 horizon ranging from 1 to 3 inches in thickness. The A2 horizon ranges to loam in a few areas. The B horizon contains layers and pockets of sandy clay loam in a few areas.

Londo soils have a coarser textured C horizon than Kawkawlin soils. Londo soils are finer textured throughout the profile than Otisco soils.

Londo loam, 0 to 2 percent slopes (LoA).—This soil is slightly finer textured than other Londo soils. Its subsurface layer is sandy loam or loam. Included in mapping are small, depressed areas of poorly drained Sims loam. Also included are a few spots that have a sandy loam surface layer or are covered by a very thin deposit of drifted sand.

Most of this soil has been cleared, artificially drained, and used for pasture and for growing of hay and grain. Its organic-matter content is medium. The available moisture capacity is high. Excessive wetness is a limitation. Capability unit IIw–4 (2.5b); woodland suitability group Z.

Londo loam, 2 to 6 percent slopes (LoB).—This gently sloping soil occurs on the sides of shallow natural drainageways in areas 100 to 300 feet wide. Included in mapping are a few moderately eroded spots and, in a few areas, some spots of sandy material that exceed 18 inches in thickness.

Areas of this Londo soil are managed in conjunction with larger areas of other soils used as cropland, pasture, or woodland. The surface drainage and internal drainage of this soil are slightly better than those of nearly level Londo loam, and this soil dries out more quickly in spring. Capability unit IIw–4 (2.5b); woodland suitability group Z.

Loxley Series

This series consists of nearly level to depressional, very poorly drained, organic soils that occur on outwash plains, lake plains, and moraines. These soils developed in extremely acid peaty muck derived from woody and fibrous materials, less than 42 inches thick, overlying sand.

In a typical profile the surface layer of organic material is black to dark reddish-brown peaty muck about 20 inches thick. The material beginning at a depth of about 20 inches is dark-gray and dark-brown sand about 15 inches thick. This material is nonsticky when wet. The underlying material, beginning at a depth of about 35 inches, is grayish-brown sand that is nonsticky when wet. This soil is extremely acid throughout the profile.

Runoff is very slow to ponded. Permeability is moderately rapid if the water table is lowered. The available moisture capacity is very high. These soils have high organic-matter content, but they are low in plant nutrients, especially micronutrients. Reaction is extremely acid.

Most of the acreage remains in its natural condition. Because of their extreme acidity, low fertility, and excessive wetness, Loxley soils are seldom used as cropland. If they are artificially drained, they settle readily.

Typical profile of Loxley muck, coarse substratum:

1—0 to 4 inches, mixed living and dead organic material largely from leatherleaf and moss; extremely acid; abrupt, smooth boundary.

2—4 to 15 inches, black (10YR 2/1) peaty muck; moderate, fine, granular structure; very friable; many fine roots and some undecomposed fibrous plant remains; extremely acid; clear, wavy boundary.

3—15 to 20 inches, dark reddish-brown (5YR 2/2) peaty muck; moderate, medium, granular structure; slightly sticky when wet; extremely acid; clear, smooth boundary.

IIC1g—20 to 25 inches, dark-gray (10YR 4/1) sand; structureless; single grain; nonsticky when wet; upper one inch mixed with organic material from above; extremely acid; abrupt, wavy boundary.

IIC2—25 to 35 inches, dark-brown (7.5YR 4/2) sand; structureless (single grain); nonsticky when wet; humus and iron coatings loosely held on sand grains; extremely acid; gradual, wavy boundary.

IIC3—35 to 48 inches, grayish-brown (10YR 5/2) sand; structureless (single grain); nonsticky when wet; extremely acid.

The organic layers range from black to dark reddish-brown in color. In a few areas silty material occurs below a depth of 60 inches.

Loxley soils are more acid than Carbondale, Linwood, Lupton, Houghton, or Tawas soils. They have a thinner organic layer than Carbondale, Lupton, or Houghton soils. Linwood soils are underlain by loamy material rather than sand, which underlies the Loxley soils.

Loxley muck, coarse substratum (Lr).—This level, very poorly drained soil occurs in bogs where the vegetation is leatherleaf. The soil is organic and extremely acid. Disintegrated peaty muck is dominant in the organic part of the soil.

This soil is not used for crops. In wooded areas the trees are sparse and provide little food and only some cover for wildlife. This soil is extremely acid and very poorly drained, and crops are subject to frost damage. Capability unit Vwc–1 (M/4c); woodland suitability group J.

Lupton Series

The Lupton series consists of nearly level or depressional, very poorly drained, organic soils that occur in morainic areas and till plains. These soils developed in mildly alkaline to moderately alkaline woody and fibrous materials 42 inches to several feet thick.

In a typical profile the uppermost layer is black muck about 20 inches thick. Below this is a layer of friable, dark reddish-brown peaty muck about 22 inches thick. Beginning at a depth of about 42 inches is dark reddish-brown fibrous peat.

Runoff is very slow and is ponded many times during the year. Permeability is moderately rapid. The available moisture capacity is very high. These soils are low in fertility and contain few micronutrients. Reaction is neutral to mildly alkaline in the upper 42 inches.

Most of the acreage supports swamp hardwoods and conifers. Unless they are artificially drained, Lupton soils have a water table at or near the surface. Their saturated condition hinders crop growth. If artificially drained, these soils settle readily. Frost damage, the high water table, and low fertility severely limit the use of Lupton soils for crops.

Typical profile of Lupton muck:

1—0 to 8 inches, black (5YR 2/1) muck; moderate, fine, granular structure; friable; neutral; gradual, wavy boundary.
2—8 to 20 inches, black (5YR 2/1) muck; weak, medium, granular structure; friable; mildly alkaline; gradual, wavy boundary.
3—20 to 42 inches, dark reddish-brown (5YR 2/2) peaty muck; contains fibrous material that is easily broken down by rubbing; weak, thick, platy structure; friable; mildly alkaline; gradual, wavy boundary.
4—42 to 48 inches, dark reddish-brown (5YR 3/4) peat; fibrous; weak, thick, platy structure; mildly alkaline.

The upper 20 inches of muck ranges to dark reddish brown in color. In a few areas, this muck extends to a depth of 30 inches. In a few areas the lowest peaty layer is calcareous.

Lupton soils are less acid than Loxley soils. Lupton soils are more alkaline than either Carbondale soils or Houghton soils.

Lupton muck (Lu).—This very poorly drained, deep, organic soil lies in depressions, where perennial streams flow, or in seep areas. Water from the seeps and streams has cut numerous, meandering, shallow trenches throughout some areas, and this flowing water has made the surface rough and irregular. Slopes are generally less than 1 percent, but in some places, especially along the Cedar River, they are as much as 3 percent. Included in mapping are small areas along the edges of this soil where the organic layers are thin and where Linwood muck and other shallow organic soils occur.

Most of the acreage remains in swamp hardwoods and white-cedar. Excessive wetness is a limitation, and crops are subject to frost damage. Capability unit Vwc–1 (Mc); woodland suitability group J.

Mancelona Series

The Mancelona series consists of nearly level to steep, well drained or moderately well drained soils on outwash plains and lake plains. These soils formed in loamy sand, gravelly loamy sand, and sand, commonly over calcareous coarse sand and gravel. In some places they are underlain by loamy to clayey material at a depth of 42 to 66 inches.

In a typical profile the surface layer is very dark grayish-brown sand about 2 inches thick. The subsurface layer is light brownish-gray sand about 6 inches thick. The upper part of the subsoil is dark-brown, very friable loamy sand about 17 inches thick. Fine gravel makes up as much as 20 percent of this layer. The lower part of the subsoil is dark reddish-brown, friable gravelly sandy loam about 7 inches thick. The underlying material is brown, loose, stratified coarse sand and gravel that are high in content of lime.

Runoff is very slow to medium. Permeability is moderately rapid in the upper part of these soils and very rapid in the lower part. The available moisture capacity is moderate. The content of organic matter is low. Reaction ranges from medium acid to neutral in the surface layer and the subsoil. In places reaction is mildly alkaline in the lower part of the subsoil.

These soils are used for woodland, pasture, or crops. In many places nearly level to sloping areas are cultivated. In some years dry periods in midsummer persist so long that the stored moisture is used up and some crop damage results. The steeper areas are used mainly for woodland or pasture. Erosion is a severe hazard in cultivated areas of steep soils. Gullies form readily and, once established, are difficult to control. Stones and cobblestones occur in a few places, but ordinarily they do not interfere with tillage or harvesting.

Typical profile of a Mancelona sand:

A1—0 to 2 inches, very dark grayish-brown (10YR 3/2) sand; weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.
A2—2 to 8 inches, light brownish-gray (10YR 6/2) sand; very weak, medium, granular structure; very friable; slightly acid; abrupt, wavy boundary.
Bir—8 to 25 inches, dark-brown (7.5YR 4/4) loamy sand; weak, fine, subangular blocky structure; very friable; contains up to 20 percent fine gravel; slightly acid; abrupt, wavy boundary.
B't—25 to 32 inches, dark reddish-brown (5YR 3/4) gravelly sandy loam; weak, coarse, subangular blocky structure; friable; thick, light brownish-gray (10YR 6/2) coatings on peds in upper 3 to 4 inches, representing an A'2 horizon; neutral; abrupt, irregular boundary.
IIC—32 to 60 inches, brown (10YR 5/3), stratified coarse sand and gravel; single grain; loose; calcareous.

The A1 horizon is very dark brown in places. It ranges from 1 inch to 3 inches in thickness. In cultivated areas there is a very dark grayish-brown Ap horizon 4 to 10 inches thick. The A2 horizon is lacking or is only 1 or 2 inches thick in many cultivated areas. In places the Bir horizon is reddish brown or dark yellowish brown. In a few places this horizon is sand. In many areas a light brownish-gray or brown horizon, about 2 to 10 inches thick, occurs between the Bir and B't horizons. The texture of the B't horizon is light gravelly loam in a few places. The gravel content of the B horizon varies from place to place, but gravel generally makes up less than 20 percent of the volume.

Mancelona soils are better drained than Gladwin soils. Their C horizon generally consists of stratified coarse sand and gravel rather than clay loam, which is the texture of the C horizon in Menominee soils.

Mancelona sand, 0 to 2 percent slopes (MaA).—This well drained or moderately well drained soil is nearly level and occurs on ridges and outwash plains. In cultivated fields the surface layer is a mixture of the upper

6 to 16 inches of the soil. In level, moderately well drained areas, a few fine, faint mottles of red, yellow, and gray occur between depths of 25 and 40 inches. Included in mapping are several areas of Gladwin loamy sand, which is somewhat poorly drained, and some areas where the slope is 3 percent.

The organic-matter content is low. The available moisture capacity is moderate. Runoff is very slow.

Some areas of this soil are cultivated or have been in the past, and in these places soil blowing is a moderate hazard. Other areas are used for pasture or as woodland. Capability unit IIIs–3 (4a); woodland suitability group C.

Mancelona sand, 2 to 6 percent slopes (MaB).—This soil is gently sloping and occurs on the side slopes of ridges and on slopes that lead into drainageways. Included in mapping are small eroded areas, where the organic-matter content is low and the soil crusts more readily than in uneroded areas. Gravel and cobblestones are common on the surface in eroded areas. Also included in mapping are some areas that are level and others that are sloping. The sloping areas are subject to water erosion if farmed intensively.

Eroded inclusions make up a larger proportion of areas mapped as this soil than of nearly level Mancelona soils. Runoff is more rapid, too, and less moisture is stored. Lack of sufficient moisture damages crops during dry periods in summer, especially in eroded areas.

Most of the acreage is used for crops. A few areas are wooded or used for pasture. Capability unit IIIs–4 (4a); woodland suitability group C.

Mancelona sand, 6 to 12 percent slopes (MaC).—This moderately sloping soil is on beach ridges and outwash plains. The slopes are dominantly short. Included in mapping are small areas where the soil is gently sloping or strongly sloping. Also included are small, moderately eroded spots on upper slopes. These areas were formerly cultivated, and brownish subsurface material makes up about 40 percent of the surface layer. Also included are areas of Montcalm loamy sand that make up about 10 percent of the acreage in places.

The organic-matter content and fertility are low. Droughtiness is a limitation. The hazard of erosion is moderately severe in cultivated areas. Capability unit IIIe–9 (4a); woodland suitability group C.

Mancelona sand, 12 to 25 percent slopes (MaE).—This soil is strongly sloping or moderately steep. In most places the slopes are less than 300 feet long. Most areas on lower slopes are only slightly eroded, but small included spots near the tops of ridges and hills are severely eroded. Here, the surface layer is mainly dark-brown material from the subsoil. Also included, especially on hills and ridgetops, are some moderately sloping and gently sloping soils that make up about 5 to 15 percent of the acreage. Other inclusions are small areas of Montcalm loamy sand.

The organic-matter content in this Mancelona soil is low. The available moisture capacity is moderate. Runoff is medium, and the hazard of erosion is severe in cultivated areas.

Most of the acreage is wooded or pastured. Some areas are cultivated. Capability unit IVe–9 (4a); woodland suitability group C.

Mancelona loamy sand, loamy substratum, 0 to 2 percent slopes (McA).—This nearly level soil is on ridgetops and along major drainageways. Included in mapping are small areas of Menominee loamy sand and Mancelona sand, where the thickness of the sandy material is less than 42 inches or more than 66 inches. Also included are small areas of somewhat poorly drained soils in drainageways.

Runoff is slow, and water ponds in depressions during wet periods. Soil blowing is a hazard in cultivated areas. The soil is droughty in prolonged dry spells.

This soil is used for crops, but late-summer growth is retarded by lack of sufficient moisture. The areas are also used for pasture and trees. Capability unit IIIs–3 (4a); woodland suitability group C.

Mancelona loamy sand, loamy substratum, 2 to 6 percent slopes (McB).—This soil is on low ridges of sand and gravel. Included in mapping are small areas where the slope is less than 2 or more than 6 percent. Also included are eroded areas and a few small areas where the surface layer is sandy loam. Other inclusions are a few small areas of Menominee loamy sand and Mancelona sand, where the thickness of the sandy material is less than 42 inches or more than 66 inches.

Runoff is slow, and water erosion generally is not a problem. Soil blowing is a hazard in cultivated areas. This soil is droughty in prolonged dry spells.

This soil is used for crops, pasture, and trees, along with larger areas of adjoining soils. Capability unit IIIs–4 (4a); woodland suitability group C.

Manistee Series

The Manistee series consists of nearly level to undulating or gently sloping, well drained or moderately well drained soils that occur on lake plains. These soils developed in sand or loamy sand, 18 to 42 inches thick, overlying clay or silty clay. Only a small acreage of these soils occurs in the county.

In a typical profile the surface layer is very dark grayish-brown sand about 8 inches thick. The subsurface layer is light brownish-gray sand about 4 inches thick. The subsoil consists of two parts. The upper part of the subsoil is very friable, reddish-brown sand and loose, dark yellowish-brown sand about 16 inches thick. A 3-inch layer of light brownish-gray sand occurs between the upper and lower parts of the subsoil in most areas. The lower part of the subsoil is very firm, strong-brown clay about 5 inches thick. The underlying material is very firm, brown clay that is high in content of lime.

Runoff is slow to very slow. Permeability is rapid in the upper sandy part of these soils, but is very slow in the lower clayey part. The available moisture capacity is low. Organic-matter content is low. Reaction is medium acid in the sandy upper part of the subsoil and is slightly acid in the lower part of the subsoil.

Most of the acreage is cropland or woodland. Only a few areas are used for pasture. The major limitation in the use of Manistee soils as cropland is their tendency to be droughty during extended dry periods. Crops show signs of moisture deficiency in years of normal or less than normal rainfall. Another limitation is soil blowing during dry periods.

Typical profile of Manistee sand:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) sand; very weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—8 to 12 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; medium acid; abrupt, irregular boundary.

B21ir—12 to 18 inches, reddish-brown (5YR 4/3) sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—18 to 28 inches, dark yellowish-brown (10YR 4/4) sand; single grain; loose; medium acid; abrupt, wavy boundary.

A'2—28 to 31 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; medium acid; abrupt, irregular boundary.

IIB'—31 to 36 inches, strong-brown (7.5YR 5/6) clay; thick, light brownish-gray (10YR 6/2) ped coatings in upper 2 to 3 inches; strong, medium, angular blocky structure; very firm; slightly acid; abrupt, wavy boundary.

IIC—36 to 48 inches, brown (7.5YR 5/4) clay; weak, medium, angular blocky structure; very firm; calcareous.

In undisturbed areas the A1 horizon ranges from 1 to 3 inches in thickness. In some cultivated areas the A2 horizon is absent. The B21ir horizon ranges to dark brown in color. The B22ir horizon ranges from 3 to 12 inches in thickness.

Manistee soils are better drained and have brighter colors than Allendale soils. They have a finer textured C horizon than Menominee soils. Manistee soils have coarser textured A and Bir horizons than Ubly soils.

Manistee sand, 0 to 4 percent slopes (MdB).—This well drained or moderately well drained, nearly level soil occurs in areas near major drainageways and in slightly higher positions, where 18 to 42 inches of loamy sand and sand are deposited on clay. Slopes are generally less than 1 percent, but along the edges of some areas, slopes are as much as 4 percent. Wind has blown part of the original surface layer away. Included in mapping are small areas in cultivated fields where the surface layer is loamy sand 6 to 8 inches thick.

Some areas of this soil have been cultivated, and others are idle or wooded. If the soil is cultivated, soil blowing is a moderate hazard. Low fertility and droughtiness are other concerns of management. Capability unit IIIs–3 (4/2a); woodland suitability group C.

Markey Series

The Markey series consists of nearly level to depressional, very poorly drained, organic soils that occur on outwash plains and lake plains. These soils developed in mixed woody and fibrous organic materials, 12 to 42 inches thick, overlying sand or loamy sand.

In a typical profile the surface layer is black muck about 6 inches thick. Below the surface layer is dark reddish-brown muck that extends to a depth of about 26 inches and contains fragments of partially decomposed woody material. A 1-inch layer of very dark gray loamy sand occurs between this layer and the underlying material. The underlying mineral material is loose, gray loamy sand.

Runoff is very slow to ponded. Permeability is moderately rapid to rapid when the water table is low. The available moisture capacity is very high. Organic-matter content is very high. Reaction of the organic material ranges from medium acid to mildly alkaline in the upper 12 inches and from neutral to mildly alkaline in the lower part.

Most of the acreage is woodland. The water table is at or near the surface unless these soils are artificially drained, and this saturated condition prevents the early tillage of the soils and hinders use of farm machinery. These soils dry out slowly in the spring and after prolonged rain, and they are difficult to drain. Frost damage and soil blowing are further concerns in the use of these soils for crops. Soil blowing is a serious hazard if large areas are cultivated.

Typical profile of Markey muck:

1—0 to 6 inches, black (10YR 2/1) muck; moderate, coarse, granular structure; friable; contains small to large amounts of woody and grassy plant remains; mildly alkaline; abrupt, smooth boundary.

2—6 to 26 inches, dark reddish-brown (5YR 2/2) muck, grading to black in lower part; weak, coarse, subangular blocky structure; friable; contains some brown chunks of woody material; mildly alkaline; abrupt, smooth boundary.

IIA1b—26 to 27 inches, very dark gray (10YR 3/1) loamy sand; structureless (single grain); compacted; nonsticky when wet; mildly alkaline; abrupt, smooth boundary.

IICg—27 to 48 inches, gray (10YR 5/1) loamy sand; structureless (single grain); loose; nonsticky when wet; mildly alkaline.

The uppermost layer ranges to very dark brown in color. The organic material below a depth of 15 inches is peaty muck or peat in a few areas. The depth to the underlying sandy material ranges from 18 to 36 inches.

Markey soils have thinner organic material than either Carbondale, Houghton, or Lupton soils.

Markey muck (Me).—This level soil occurs in swamps where shallow deposits of organic material have accumulated over sand. In a few areas a thin layer of recently deposited plant remains, 1 to 2 inches thick, is on the surface. Included in mapping are some areas where the organic deposits are less than 12 or more than 42 inches thick, and in these areas Roscommon mucky sand or Carbondale muck occur.

Most of this Markey soil is woodland that contains tag alder and willow thickets. Markey muck is very poorly drained, and the organic matter will decompose rapidly if the soil is cultivated. Capability unit Vwc–1 (M/4c); woodland suitability group J.

Menominee Series

The Menominee series consists of nearly level to strongly sloping, well drained or moderately well drained soils that occur on till plains and moraines. These soils developed in sand or loamy sand, 18 to 42 inches thick, and in the underlying loam, clay loam, or silty clay loam.

In a typical profile the surface layer is very dark grayish-brown sand about 7 inches thick. The subsurface layer is gray sand about 2 inches thick. The subsoil consists of two parts and an intervening layer. The upper part is dark-brown to yellowish-brown, loose to very friable sand about 15 inches thick. The intervening layer is light brownish-gray, loose sand about 3 inches thick. The lower part of the subsoil is dark-brown, firm clay loam about 7 inches thick. The underlying material is brown, firm clay loam that is high in content of lime.

Runoff varies according to slope and type of vegetation. Permeability is rapid in the layers of sand but is moderately slow in the layers of clay loam. The available moisture capacity is low. Although the moisture content is rarely adequate for optimum crop growth, especially in the steeper areas, the finer textured layers hold a significant amount of moisture that keeps the sand moist and gives otherwise droughty soils a moderate capacity to supply moisture for plants. The content of organic matter is low. Reaction is slightly acid or medium acid in the surface layer and the upper part of the subsoil and is slightly acid or neutral in the lower part of the subsoil.

Many of the nearly level to sloping areas have been cultivated, but the steeper areas remain as woodland or are pastured. During extended dry periods, crops show lack of sufficient moisture and their growth is reduced. Water erosion is a serious hazard in steep areas that are cultivated.

Typical profile of a Menominee sand:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) sand; very fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

A2—7 to 9 inches, gray (10YR 6/1) sand; single grain; loose; medium acid; abrupt, irregular boundary.

B21ir—9 to 16 inches, dark-brown (7.5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—16 to 24 inches, yellowish-brown (10YR 5/4) sand; single grain; loose; medium acid; clear, wavy boundary.

A'2—24 to 27 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; medium acid; abrupt, irregular boundary.

IIB't—27 to 34 inches, dark-brown (7.5YR 4/4) clay loam; moderate, coarse, angular blocky structure; firm; slightly acid; abrupt, wavy boundary.

IIC—34 to 48 inches, brown (10YR 5/3) clay loam; massive; firm; calcareous.

Undisturbed areas have a very dark gray A1 horizon about 1 inch to 3 inches thick, and some cultivated areas lack an A2 horizon. The texture of the IIB't horizon ranges to silty clay loam or heavy loam and the thickness ranges from 4 to 10 inches. The texture of the C horizon is loam or silty clay loam in some areas.

Menominee soils have coarser textured upper horizons than Ubly soils, and their C horizon is not so fine textured as that of Manistee soils. Menominee soils are better drained and have brighter colors than Iosco soils.

Menominee sand, 0 to 2 percent slopes (MnA).—This well drained or moderately well drained soil is nearly level. Slopes are generally less than 1 percent. The texture of the surface layer is light loamy sand or sand that contains enough fines and organic matter to give it a loamy feel. In wooded areas this layer is 1 to 3 inches thick, black or very dark gray, and covered with ½ to 3 inches of leaf litter and plant residues. In cultivated areas it is 6 to 8 inches thick. Sand or sand and loamy sand are the dominant textures to a depth of 18 to 42 inches; below this depth, loam to silty clay loam is dominant. This soil has faint to distinct, gray or yellowish-red mottles at a depth of 25 to 40 inches. Included in mapping are small areas of somewhat poorly drained Iosco loamy sand that occur in some of the sags and narrow drainageways. Also included, near drainageways, are small areas where the slope slightly exceeds 2 percent.

Areas of this soil are cultivated, pastured, or wooded. Surface runoff is very slow, and the available moisture capacity is low. The organic-matter content and fertility are low. If the soil is cultivated, soil blowing is a moderate hazard. Capability unit IIIs–3 (4/2a); woodland suitability group C.

Menominee sand, 2 to 6 percent slopes (MnB).—This soil generally has slopes of 2 to 4 percent. In cultivated areas the surface layer is 4 to 7 inches thick and very dark grayish brown. The thickness of the sandy part of the profile ranges from 18 to 42 inches within distances of less than 100 feet. Included in mapping are some spots in which the sandy part is less than 18 inches or more than 42 inches thick. Also included, on some of the upper slopes, are many spots that are lighter colored and moderately eroded. Some inclusions on the narrow ridgetops are nearly level. In addition, small included areas near drainageways have slopes slightly exceeding 6 percent.

Areas of this soil are cultivated, pastured, or wooded. This soil has a low available moisture capacity, but it is low in organic-matter content and is subject to a moderate hazard of erosion where cultivated. Capability unit IIIs–4 (4/2a); woodland suitability group C.

Menominee sand, 6 to 14 percent slopes (MnD).—This well drained to moderately well drained soil is moderately sloping or rolling. Slopes are dominantly about 9 percent. The thickness of the sandy part of the profile ranges from 18 to 42 inches within distances of less than 50 feet. Included are small spots of Rubicon sand and Nester soils in which the sandy part is either deep or shallow.

Areas of this soil are pastured, wooded, or cultivated. This soil has slow surface runoff and a low available moisture capacity. It is low in content of organic matter. If cultivated, it is subject to a moderately severe hazard of erosion. Capability unit IIIe–9 (4/2a); woodland suitability group C.

Menominee loamy sand, 0 to 2 percent slopes (MrA).—This nearly level to level soil occurs in high positions above major streams. Included are small areas of wetter Iosco soils that lie in the lowest parts of areas mapped as this soil and are excessively wet in the spring and dry out more slowly than the Menominee soil.

Most of this soil is cultivated or in pasture, but the soil is only moderately well suited to these uses because of droughtiness and the risk of soil blowing. Capability unit IIIs–3 (4/2a); woodland suitability group C.

Menominee loamy sand, 2 to 6 percent slopes (MrB).—This soil is gently sloping, and the surface layer consists of 4 to 6 inches of loamy sand. Included in mapping are small areas of Iosco soils that occur in small depressions and drainageways and remain wet longer than this Menominee soil. Also included are moderately eroded spots in areas where slopes are 4 to 6 percent. These spots are lower in organic-matter content and fertility than uneroded areas.

Runoff is greater on this soil than on nearly level Menominee soils, and therefore this soil is slightly more droughty. Water ponds in depressions and delays planting during wet years. During dry summers a shortage of moisture reduces crop growth, and soil blowing is a hazard in cultivated areas. Capability unit IIIs–4 (4/2a); woodland suitability group C.

Montcalm Series

The Montcalm series consists of nearly level to steep, well drained or moderately well drained, sandy soils that occur on till plains and moraines. These soils developed in loamy sand and sand material.

In a typical profile the uppermost layer is very dark grayish-brown loamy sand about 2 inches thick. The subsurface layer is light brownish-gray sand about 7 inches thick. The subsoil consists of two parts. The upper part of the subsoil is very friable, dark-brown loamy sand about 9 inches thick. The lower part of the subsoil extends to a depth of about 55 inches and consists of alternate layers of sand and light sandy loam. The sand layers are light yellowish brown and are loose. The light sandy loam layers are dark brown and range in thickness from ½ inch to about 4 inches. These layers are friable. The underlying material is loose, pale-brown sand that is high in lime content.

Runoff is slow on the mild slopes and medium on the steep slopes. Permeability is moderately rapid, and the available moisture capacity is moderate. The organic-matter content is low. Reaction of the surface layers and subsoil is strongly acid or medium acid.

Most of the acreage is woodland, especially the steeply sloping areas. A few areas are cropland, and other areas are pasture or are idle and growing up to brush. Montcalm soils are normally filled nearly to capacity with water at the beginning of the growing season, but as the season progresses crops show signs that sufficient moisture is lacking during years of average or less than average rainfall. Droughtiness is a severe limitation in extreme dry periods.

Typical profile of a Montcalm loamy sand:

A1—0 to 2 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, medium, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—2 to 9 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; medium acid; abrupt, wavy boundary.

Bir—9 to 18 inches, dark-brown (7.5YR 4/4) loamy sand; weak, medium, subangular blocky structure; very friable; medium acid; clear, wavy boundary.

A'2—18 to 30 inches, light yellowish-brown (10YR 6/4) sand; single grain; loose; medium acid; abrupt, wavy boundary.

A'2–B't—30 to 55 inches, dark-brown (7.5YR 4/4) light sandy loam, representing the B't horizons; pale-brown (10YR 6/3) sand, representing the A'2 horizons; the B't horizons are massive and friable; the A'2 horizons are single grain and loose; the thickness of the B't horizons ranges from ½ to about 4 inches; medium acid; abrupt, wavy boundary between last B't horizon and C horizon.

C—55 to 60 inches, pale-brown (10YR 6/3) sand; single grain; loose; calcareous.

The A1 horizon ranges to very dark brown in color. The A2 horizon ranges to gray in color and from 4 to 12 inches in thickness. Cultivated areas have a very dark grayish-brown or dark grayish-brown Ap horizon about 6 to 10 inches thick. The combined thickness of the A and B horizons ranges from 45 to 60 inches.

Montclam soils have a finer textured profile than either Chelsea or Rubicon soils.

Montcalm loamy sand, 0 to 2 percent slopes (MtA).—This soil is nearly level. Included are some spots of clay material, gravel, or weakly cemented fragipan layers.

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This soil is used as cropland, pasture, or woodland. Main limitations are a moderate risk of soil blowing, droughtiness, low fertility level, and low organic-matter content. Capability unit IIIs–4 (4a); woodland suitability group C.

Montcalm loamy sand, 2 to 6 percent slopes (MtB).—This undulating and gently sloping soil occurs on till plains and moraines. Relief is complex in many areas, and slopes are generally less than 200 feet long. Small included areas, 1 to 3 acres in size, are moderately eroded; their organic-matter content is low, and they are readily affected by soil blowing. Also included are some areas where slopes range from 6 to 10 percent and where both soil blowing and water erosion are hazards.

This soil is used as cropland, pasture, or woodland. Because of the undulating relief, stripcropping is difficult to lay out. Low moisture holding capacity during dry months restricts the choice of crops to drought-resistant or early maturing crops. Capability unit IIIs–4 (4a); woodland suitability group C.

Montcalm loamy sand, 6 to 12 percent slopes (MtC).—This well-drained, coarse-textured soil is rolling. Included in mapping are some brown, moderately eroded spots on the upper parts of the slopes. Also included are spots with a sandy loam surface layer, and small areas where slopes range from 2 to 6 percent.

Most of the acreage is cultivated and pastured, but some areas remain wooded. Erosion is a moderately severe hazard. Droughtiness and low fertility are limitations. Capability unit IIIe–9 (4a); woodland suitability group C.

Montcalm loamy sand, 12 to 25 percent slopes (MtE).—This soil is hilly or strongly sloping. Included in mapping are some brown, moderately eroded spots that occur on the upper parts of the slopes.

Most of this soil is pastured, idle, or wooded. Erosion is a severe hazard. Droughtiness, low organic-matter content, and low fertility are limitations. Capability unit IVe–9 (4a); woodland suitability group C.

Munuscong Series

The Munuscong series consists of nearly level to depressional, very poorly drained or poorly drained soils that occur on lake plains and till plains. These soils developed in sandy loam material overlying clay or silty clay. The thickness of the sandy loam ranges from 18 to 42 inches.

In a typical profile the surface layer is black sandy loam about 8 inches thick. The subsoil is friable, gray sandy loam, about 22 inches thick, that is mottled with dark yellowish brown in the lower part. The underlying material is very firm, gray clay that contains many, distinct, yellowish-brown mottles. This layer is high in lime content.

Runoff is slow to very slow, and water ponds in depressions and low areas, particularly during the spring. Permeability is moderately rapid in the upper part of these soils, but is very slow in the lower part. These soils are saturated with water for long periods of time, but the available moisture capacity is only moderate. The organic-matter content is moderately high to high in the surface layer. Reaction of the surface layer and subsoil ranges from slightly acid to neutral.

Only a small acreage of Munuscong soils occurs in the county, and most of that acreage is used as woodland or pasture. A few areas have been cleared and artificially drained and are used as cropland. Excessive wetness is the major limitation in the use of these soils for crops. The water table is near the surface unless these soils are artificially drained, and their saturated condition restricts the growth and development of plant roots and hinders tillage.

Typical profile of Munuscong sandy loam:

Ap—0 to 8 inches, black (10YR 2/1) sandy loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

B21g—8 to 14 inches, gray (10YR 5/1) sandy loam; weak, medium, granular structure; friable; neutral; gradual, wavy boundary.

B22g—14 to 30 inches, gray (10YR 5/1) heavy sandy loam; common, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, coarse, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

IICg—30 to 48 inches, gray (10YR 5/1) clay; many, coarse, distinct, yellowish-brown (10YR 5/4) mottles; massive; very firm; calcareous.

The Ap horizon ranges to very dark gray in color and from 6 to 9 inches in thickness. The texture of the B22g horizon ranges to light clay loam in a few areas. The depth to the limy clay ranges from 24 to 36 inches. The upper 2 to 4 inches of the clayey material is neutral to mildly alkaline in a few areas.

Munuscong soils are finer textured in the upper part of their profile than Pinconning soils. They have coarser textured A and B horizons than either Parkhill or Pickford soils.

Munuscong sandy loam (Mu).—This nearly level soil occurs in areas where shallow sandy loam outwash is deposited over clay. Included in mapping are random spots where the surface layer is loam or loamy sand, and small areas of somewhat poorly drained soils.

Because of poor natural drainage, this soil is used mainly as woodland or pasture. A few small areas have been tile drained and are cultivated along with surrounding areas. Organic-matter content is high, but excessive wetness is a limitation and soil blowing is a hazard if the soil is cultivated. Capability unit IIw–8 (3/1c); woodland suitability group P.

Nester Series

The Nester series consists of level to very steep, well drained or moderately well drained soils that occur on till plains and moraines. These soils developed in clay loam or silty clay loam glacial material and have a fine-textured subsoil. In places the underlying material is sand at a depth of 42 inches or more.

In a typical profile the surface layer is very dark grayish-brown loam about 7 inches thick. The subsurface layer is light brownish-gray loam about 2 inches thick. The subsoil, about 16 inches thick, is friable, grayish-brown loam in the upper part and firm, reddish-brown clay loam and heavy clay loam in the lower part. The underlying material is firm, brown clay loam that is high in lime content.

Runoff varies according to slope and type of vegetation. Permeability is moderately slow, and the available moisture capacity is high. The organic-matter content is medium to low. Reaction of the surface and subsurface layers and subsoil is slightly acid or medium acid.

Most of the acreage is cropland in the nearly level areas. The more sloping areas are pasture or woodland. The major limitation in the use of these soils for crops is the severe hazard of erosion. Severely eroded areas have poor tilth and are difficult to work; cobblestones and gravel are scattered over the surface in eroded areas.

Typical profile of a Nester loam:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loam; moderate, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—7 to 9 inches, light brownish-gray (10YR 6/2) loam; weak, coarse, granular structure; friable; slightly acid; abrupt, irregular boundary.

A&B—9 to 12 inches, grayish-brown (10YR 5/2) loam representing the A horizon; reddish-brown (5YR 4/4) clay loam representing the B horizon; A horizon occurs as thick coatings on peds, in root and worm channels, and in cracks; weak, coarse, granular structure; friable; B horizon has moderate, medium, subangular blocky structure; firm; medium acid; gradual, wavy boundary.

B2t—12 to 25 inches, reddish-brown (5YR 4/4) heavy clay loam; strong, medium, angular blocky structure; firm; slightly acid; abrupt, wavy boundary.

C—25 to 48 inches, brown (7.5YR 5/4) clay loam; weak, medium, angular blocky structure; firm; calcareous.

The Ap horizon ranges to dark grayish brown in color and from 6 to 9 inches in thickness. Undisturbed areas have a very dark grayish-brown A1 horizon 1 inch to 3 inches thick. The B horizon ranges to dark brown in color. The B2t horizon ranges to light clay in texture.

Nester soils are better drained and are brighter colored than Kawkawlin soils. They have a coarser textured profile than Ontonagon soils and have a finer textured profile than Londo soils.

Nester loam, 0 to 2 percent slopes (NeA).—This soil is nearly level. Slopes are generally less than 1 percent, but are up to 2 percent on broad ground swells and domes. Included in mapping are small spots of Ubly sandy loam, Menominee loamy sand, and Nester sandy loam. In other small included areas, the limy underlying material occurs at a depth of 20 to 25 inches. Also included, in the narrow waterways and small sags, is somewhat poorly drained Kawkawlin loam or poorly drained and very poorly drained Sims loam.

Most of the acreage is intensively cultivated. Organic-matter content is medium, and runoff very slow. Permeability is moderate in the surface layer and moderately slow in the finer textured subsoil. The soil dries out and warms up slowly in the spring, and it is easily compacted if worked when it is wet. The waterways and sags are excessively wet in spring and after rain, and this delays planting and tillage in those areas. Capability unit IIs–1 (1.5a); woodland suitability group B.

Nester loam, 2 to 6 percent slopes (NeB).—This undulating and gently sloping soil lies on broad ridgetops and hilltops that are surrounded by more sloping soils. Included in mapping are spots of Menominee loamy sand. In addition, small areas of soils that have a brownish-gray heavy loam surface layer occupy about 10 percent of the acreage; in these soils the limy underlying material is at a depth of 16 to 20 inches. Also included, on ridgetops, are small areas where slopes are between 1 and 2 percent and, on some parts of side slopes, small areas where slopes are between 7 and 9 percent. Included in

the narrow waterways and small wet spots are somewhat poorly drained Kawkawlin loam and poorly drained or very poorly drained Sims loam; these wet spots dry out slowly in the spring and after rain, and this delays planting and tillage. Moderately eroded areas where the present surface layer is a mixture of the original surface layer and the upper part of the subsoil are also included; these areas have a lower organic-matter content, are lighter in color, and crust more readily than uneroded Nester soils.

This soil has a medium to low organic-matter content. Runoff is slow, but water usually runs off rapidly enough to prevent excessive wetness. Permeability is moderate in the surface layer but is moderately slow in the lower, finer textured layers. The soil warms up slowly in spring and is easily compacted if worked when wet. Farming is intensive in most areas where erosion is a moderate hazard. Capability unit IIe–1 (1.5a); woodland suitability group B.

Nester loam, 6 to 12 percent slopes (NeC).—This soil is rolling and moderately sloping. The surface layer is dominantly loam, and the underlying limy material is at a depth of 20 to 25 inches. Slopes are generally 6 to 12 percent, but included in mapping are small areas where slopes range from 2 to 6 or from 12 to 18 percent.

This soil unit is used as cropland, pasture, and woodland. Organic-matter content is medium to low. Runoff is medium to slow, depending on ground cover. Erosion is a moderately severe hazard if the soil is cultivated; runoff must be carefully disposed of to control erosion. Capability unit IIIe–4 (1.5a); woodland suitability group B.

Nester loam, 6 to 12 percent slopes, eroded (NeC2).—This rolling and moderately sloping soil has a surface layer less than 6 inches thick overlying the finer textured subsoil. The present surface layer is a mixture of the original surface soil and the upper part of the subsoil. Organic-matter content, fertility, and permeability have all been reduced by erosion. This soil crusts readily and produces less growth of crops than uneroded soils. Included in mapping are severely eroded areas in which most of the original surface soil has been eroded away; good crop growth is difficult to obtain in these severely eroded areas. Also included are many small areas where the limy underlying material begins at depths of 16 to 20 inches. Slopes are 150 to 300 feet long, and small included areas have slopes of 1 to 6 percent or 12 to 18 percent. Somewhat poorly drained Kawkawlin loam and poorly drained or very poorly drained Sims loam are included in the narrow drainageways and wet spots.

All of this Nester soil is cultivated or has been cultivated in the past. Good management can improve tilth and check erosion, and under these circumstances crop growth is adequate. Capability unit IIIe–4 (1.5a); woodland suitability group B.

Nester loam, 12 to 18 percent slopes (NeD).—This soil is hilly or strongly sloping. The limy underlying material begins at a depth of 20 to 25 inches in some areas. Slopes are 200 to 400 feet long and, in some included areas, range from 18 to 25 percent. Poorly drained or very poorly drained Sims loam or organic soils are included in wet spots, and there are a few inclusions of Ubly sandy loam.

Most of the acreage is used for pasture, woodland, or cropland. This soil is suitable only for occasional cultivation because it is erodible and strongly sloping. If it is cultivated, erosion and medium to rapid runoff are hazards. Growing crops in long cropping systems, contouring, and contour stripcropping, or maintaining permanent vegetation, all help to control erosion. Capability unit IVe–1 (1.5a); woodland suitability group B.

Nester loam, 12 to 18 percent slopes, eroded (NeD2).—This soil is hilly or strongly sloping. Slopes are generally 150 to 300 feet long. Because of erosion, all but 3 to 6 inches of the original surface soil has been removed. The remaining surface soil has been mixed with the upper part of the subsoil to form a plow layer, which is lighter colored, is lower in organic-matter content and fertility level, crusts more readily, and is in poorer tilth than the surface layer in uneroded areas. Included in mapping are small areas where slopes are from 1 to 6 or from 18 to 25 percent. Also included are spots of loamy sand and sand, as well as spots of clay loam in severely eroded areas. Small areas where the limy underlying material begins at depths of 16 to 20 inches are also included.

This soil has been cultivated in the past, and many areas are still being farmed. Other areas are idle, in pasture, or growing up to weeds and brush. Erosion control is the major management concern. Improvement of tilth and fertility level are other concerns. Growing crops in a long cropping system or on the contour helps to control erosion and conserves water. Areas that are too small or too irregular to be farmed on the contour are better suited to pasture or to growing hay. Capability unit IVe–1 (1.5a); woodland suitability unit B.

Nester loam, 18 to 30 percent slopes (NeE).—This steep soil is of limited extent in the county. Slopes are generally 18 to 25 percent but, in a few areas, are up to 30 percent. The surface layer is about 60 percent loam and about 40 percent sandy loam. A few spots of Menominee loamy sand, Mancelona loamy sand, or Chelsea sand are included in areas mapped as this soil. In other small inclusions, limy underlying material occurs at a depth ranging from 20 to 25 inches. Small, wet spots are included in low areas and contain poorly drained and very poorly drained Sims soils and organic soils.

Most areas of this Nester soil are uneroded or only slightly eroded. Because of its steep slopes, this soil is difficult to farm without excessive loss of soil and water. The operation of farm machinery on the steep slopes is difficult and, in some cases, unsafe. Runoff is rapid, and erosion is a severe hazard if the soil is cultivated. A good vegetation cover is essential to control erosion. Capability unit VIe–1 (1.5a); woodland suitability group B.

Nester loam, 18 to 30 percent slopes, eroded (NeE2).—This steep soil occurs in areas that are within and adjacent to broad areas of other Nester soils. Slopes are dominantly 18 to 25 percent but range up to 30 percent. Because of erosion, the present surface layer is a mixture of the original surface soil and the upper part of the subsoil. This surface layer is lighter colored, is lower in organic-matter content and fertility level, and crusts more readily than the surface layer in uneroded areas. Many areas having a sandy loam or light clay loam surface layer are included; the clay loam is in severely

eroded spots. Small areas where a limy underlying material begins at depths of 16 to 20 inches are also included.

Most of this soil has been cultivated in the past, but many areas are now idle, in pasture, or growing up to weeds and brush. Because of steep slopes and past erosion, excessive loss of soil and water normally occurs if the soil is farmed. Operation of farm machinery is difficult and often unsafe on the steep slopes; runoff is rapid and further erosion is a severe hazard. A good vegetation cover is necessary to check soil losses. Capability unit VIe–1 (1.5a); woodland suitability group B.

Nester sandy loam, sandy substratum, 0 to 6 percent slopes (NbB).—This nearly level to gently sloping soil lies between the higher lying Nester soils formed in clay loam and the lower lying Montcalm, Chelsea, or Rubicon soils formed in loamy sand or sand. The surface layer is dominantly sandy loam. The underlying sand generally begins at a depth of about 42 inches, but in some areas it begins at depths of more than 48 inches. In places the clay loam subsoil is limy below a depth of 23 inches, and these areas are included in mapping. Also included are areas where the surface and subsurface layers have a total thickness of as much as 16 inches.

Most of the acreage is planted to crops and is intensively cultivated. The soil is medium to low in organic-matter content and is slightly susceptible to erosion. Runoff is very slow, and the soil stays moist for a long time and warms up slowly in the spring. Capability unit IIs–1 (1.5a); woodland suitability group B.

Ocqueoc Series

The Ocqueoc series consists of nearly level, well drained or moderately well drained soils that occur on lake plains. They developed in medium and coarse sands overlying stratified fine and very fine sands and silt. The thickness of the upper sandy layers ranges from 18 to 42 inches.

In a typical profile the surface layer is very dark gray sand about 2 inches thick. The subsurface layer is light brownish-gray sand about 10 inches thick. The subsoil is about 20 inches thick and consists of two parts. The upper part is very friable, dark-brown sand and grades to loose, light yellowish-brown sand in the lower part. The underlying material is stratified, loose, brown fine and very fine sand, and friable, brown silt.

Runoff is slow to very slow, and water ponds in the wet depressions and lowest lying areas. Permeability is rapid in the upper sandy layers, but is only moderately rapid in the underlying finer textured layers. The content of organic matter is low. Moisture capacity is rarely adequate for optimum crop growth. Reaction of the surface and subsurface layers and subsoil is strongly acid to slightly acid.

Most of the acreage is pasture, woodland, or idle. Only a small acreage of Ocqueoc soils occurs in the county, and the main limitations for crops is sandy texture and droughtiness. Crops usually show signs of moisture deficiency during the growing season.

Typical profile of Ocqueoc sand:

A1—0 to 2 inches, very dark gray (10YR 3/1) sand; very weak, fine, granular structure; very friable; strongly acid; abrupt, wavy boundary.

A2—2 to 12 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; medium acid; clear, wavy boundary.

B21ir—12 to 15 inches, dark-brown (7.5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—15 to 28 inches, yellowish-brown (10YR 5/4) sand; single grain; loose; medium acid; gradual, wavy boundary.

B3—28 to 32 inches, light yellowish-brown (10YR 6/4) sand; single grain; loose; slightly acid; abrupt, wavy boundary.

IIC—32 to 48 inches, brown (10YR 5/3) stratified fine and very fine sand and silt; sand is single grain, loose; silt is massive, friable; mildly alkaline.

Cultivated areas have an Ap horizon that ranges to very dark grayish brown in color and from 6 to 9 inches in thickness. The B horizon ranges to dark yellowish brown in color. The upper part of the profile is coarse sand in some areas. The thickness of the individual layers of sand and silt in the C horizon ranges from 2 to 12 inches or more.

Ocqueoc soils are better drained than Ingalls soils. Ocqueoc soils are coarser textured in the lower part of the profile than Menominee soils, but they have a finer textured lower profile than Rubicon soils.

Ocqueoc sand, 0 to 2 percent slopes (OcA).—This nearly level soil occurs in small areas. The surface texture ranges from sand and fine sand to loamy sand, but it is mainly sand. Included in some of the higher lying places are areas where the underlying silt and very fine sand material occur at a depth between 42 and 48 inches. Some moderately eroded spots and somewhat poorly drained spots are also included.

Some of this soil is cultivated or pastured, but most areas remain as woodland. Runoff is very slow. This soil is droughty; if cultivated, soil blowing is a moderate hazard. Capability unit IIIs–3 (4a); woodland suitability group C.

Ogemaw Series

The Ogemaw series consists of nearly level, somewhat poorly drained or poorly drained soils that occur on lake plains and outwash plains. These soils developed in medium and coarse sand overlying loam, clay loam, silty clay loam, or light clay. The thickness of the sandy upper part ranges from 18 to 42 inches.

In a typical profile the surface layer is black sand about 3 inches thick. The subsurface layer is light-gray sand about 7 inches thick. The subsoil consists of two parts. The upper part of the subsoil is dark reddish-brown sand, about 9 inches thick, that is cemented and hard when dry. The lower part of the subsoil is dark yellowish-brown, loose sand, about 11 inches thick, that contains distinct, light-gray mottles. The underlying material is yellowish-brown, firm silty clay loam that is high in lime content.

Runoff is very slow to ponded. Permeability is very slow to moderately rapid in the upper sandy part of these soils, depending on the degree of cementation of the sandy subsoil, and is moderately slow in the underlying finer textured material. These soils are saturated during the spring and after rain. The available moisture content and organic-matter content are low. Reaction of the upper part of the subsoil is strongly acid or medium acid. Reaction of the lower part of the subsoil is medium acid or slightly acid.

Only a small acreage of Ogemaw soils occurs in the county, and only a small amount of that acreage has been cleared and used as cropland. Most of the acreage is in pasture or poorly stocked stands of trees. The cemented layer in the subsoil restricts the downward growth of plant roots and retards the downward movement of water, causing a saturated condition that hinders the use of these soils for crops.

Typical profile of Ogemaw sand:

A1—0 to 3 inches, black (10YR 2/1) sand; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—3 to 10 inches, light-gray (10YR 6/1) sand; single grain; loose; strongly acid; abrupt, wavy boundary.

B21hirm—10 to 16 inches, dark reddish-brown (5YR 2/2) sand; massive; strongly cemented; strongly acid; gradual, irregular boundary.

B22hirm—16 to 19 inches, dark reddish-brown (5YR 3/3) sand; few, fine, distinct, yellowish-red (5YR 5/8) mottles; massive; weakly cemented; strongly acid; abrupt, irregular boundary.

B23ir—19 to 30 inches, dark yellowish-brown (10YR 4/4) sand; common, coarse, distinct, light-gray (10YR 6/1) mottles; single grain; loose; slightly acid; abrupt, wavy boundary.

IIC—30 to 48 inches, yellowish-brown (10YR 5/6) silty clay loam; common, medium, distinct, light-gray (10YR 7/2) mottles; massive; firm; calcareous.

The A1 horizon ranges from 1 to 4 inches in thickness. The Ap horizon ranges in cultivated areas from 6 to 9 inches in thickness and from very dark grayish brown to very dark brown in color. The strongly cemented layer of sand ranges from 5 to 15 inches in thickness.

Ogemaw soils have a finer textured C horizon than Saugatuck soils. They have a cemented layer in the B horizon and a moderately fine textured C horizon that are lacking in the Au Gres soils.

Ogemaw sand (Og).—This nearly level to slight depressional soil is on outwash plains and in sand-covered areas on lake plains. It is commonly adjacent to Allendale or Iosco soils, and it occurs in only a small area of the county. Trees are shallow rooted on this soil, and numerous cradle knolls are formed as a result of windthrow of trees. The soil contains a cemented layer that prevents downward growth of roots and also slows permeability. The hummocks are better drained and are 1 to 3 feet higher than the cradles. Up to 15 percent of the acreage in areas mapped as this soil contains numerous small spots that lack the cemented layers; Allendale sand or Iosco sand is included in these spots.

Most of this Ogemaw soil remains as woodland or is used for pasture. The soil is acid, and its fertility level is low. The root zone is shallow in this soil; excessive wetness is a limitation, and crops are susceptible to frost damage. Capability unit IVw–2 (5b–h); woodland suitability group F.

Ontonagon Series

The Ontonagon series consists of nearly level to undulating or gently sloping, well drained or moderately well drained soils that have a clayey subsoil and occur on lake plains. These soils developed in lake-laid clays in which the clay content exceeds 60 percent. There is only a small acreage of Ontonagon soils in Gladwin County.

In a typical profile the surface layer is dark-brown loam about 6 inches thick. The subsurface layer is light brownish-gray loam about 3 inches thick. The subsoil is very firm, reddish-brown clay about 11 inches thick. The underlying material, beginning at a depth of about 20 inches, is very firm, reddish-brown clay. This material is high in content of lime.

Runoff ranges from very slow on nearly level to depressional areas to medium on gently sloping areas. Permeability is very slow. Because the permeability is very slow, Ontonagon soils dry out slowly in the spring and after rain. The available moisture capacity is moderately high. Reaction ranges from medium acid to neutral in the surface and subsurface layers and subsoil. These soils have medium organic-matter content.

Most of the acreage is cropland. A few areas are pasture or woodland. The major limitations in the use of these soils for crops are very slow permeability and wetness in spring. Because Ontonagon soils dry out slowly in the spring and after rain, planting operations are often delayed. Harvesting of crops is difficult during wet months in fall.

Typical profile of an Ontonagon loam:

Ap—0 to 6 inches, dark-brown (7.5YR 4/2) loam; moderate, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—6 to 9 inches, light brownish-gray (10YR 6/2) loam; weak, fine, subangular blocky structure; friable; slightly acid; abrupt, irregular boundary.

B2t—9 to 20 inches, reddish-brown (5YR 4/3) clay; light brownish-gray (10YR 6/2) coatings on peds and in worm and root channels; strong, medium, subangular blocky structure; very firm; neutral; abrupt, wavy boundary.

C—20 to 48 inches, reddish-brown (5YR 4/3) clay; massive; very firm; calcareous.

The Ap horizon ranges from 5 to 9 inches in thickness. Undisturbed areas have a very dark brown A1 horizon 1 to 3 inches thick. The A2 horizon ranges to pinkish gray in color, and the B horizon ranges to dark reddish brown. Depth to the limy underlying clay ranges from 16 to 30 inches.

Ontonagon soils are better drained and slightly brighter colored than either Rudyard soils or Pickford soils. They have a finer textured profile than Nester soils.

Ontonagon loam, 0 to 2 percent slopes (OnA).—This nearly level soil is on lake plains. Included are a few areas where the loam extends to a depth of 8 to 16 inches and directly overlies the clay layer. In addition, there are small inclusions having a sandy loam or silty clay loam surface layer. Also included are small areas of somewhat poorly drained Rudyard loam and small areas of coarser textured Nester soils.

Most areas of this Ontonagon soil are cropland. Runoff is very slow, and the soil tends to warm up slowly in spring. Capability unit IIs–1 (1a); woodland suitability group B.

Ontonagon loam, 2 to 6 percent slopes (OnB).—This gently sloping soil occurs on the sides of natural drainageways. Included in mapping are a few areas where the surface layer is silty clay loam. Also included are moderately eroded spots in which the upper part of the subsoil is mixed with the original surface soil to form a plow layer.

This soil is used mainly as cropland. The steepest parts are moderately susceptible to erosion. Eroded spots have poor tilth and are lower in organic-matter content and

fertility than uneroded areas. Surface drainage is slightly better than on nearly level Ontonagon soils. Capability unit IIIe–4 (1a); woodland suitability group B.

Otisco Series

The Otisco series consists of nearly level, somewhat poorly drained sandy soils that occur on outwash plains and lake plains. These soils developed in sand or loamy sand.

In a typical profile the surface layer is very dark grayish-brown loamy sand about 7 inches thick. The subsurface layer is grayish-brown sand about 4 inches thick. The subsoil consists of two parts. The upper part of the subsoil is very friable, dark-brown and loose, dark yellowish-brown loamy sand about 11 inches thick. Between the upper and lower parts of the subsoil is a layer of very friable, grayish-brown loamy sand about 8 inches thick that contains distinct, dark-brown mottles. The lower part of the subsoil is friable, dark-brown light sandy loam, about 10 inches thick, that contains distinct, gray mottles. The underlying material, beginning at a depth of about 40 inches, is loose, pale-brown light loamy sand. This material contains distinct, yellowish-brown mottles.

Because the soils are level or nearly level in most places, runoff is slow to ponded. Permeability is moderately rapid to rapid. These soils are saturated for extended periods of time, especially in the spring. After the water table recedes in the spring, these soils can become droughty because they are sandy. These soils have low organic-matter content and available moisture content. Reaction ranges from strongly acid to medium acid in the surface and subsurface layers and subsoil. Reaction ranges from neutral to moderately alkaline in the underlying material.

Otisco soils are used as cropland, pasture, or woodland. Because they are sandy and wet, they are only moderately well suited for crops. Artificial drainage is difficult to obtain in many areas because outlets are lacking and the soils are sandy.

Typical profile of Otisco loamy sand:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, fine, granular structure; very friable; strongly acid; abrupt, smooth boundary.

A2—7 to 11 inches, grayish-brown (10YR 5/2) sand; single grain; loose; strongly acid; abrupt, irregular boundary.

B21ir—11 to 16 inches, dark-brown (10YR 3/3) loamy sand; very weak, medium, subangular blocky structure; very friable; strongly acid; gradual, wavy boundary.

B22ir—16 to 22 inches, dark yellowish-brown (10YR 4/4) loamy sand; few, medium, distinct, strong-brown (7.5YR 5/8) mottles; single grain; loose; strongly acid; abrupt, wavy boundary.

A'2—22 to 30 inches, grayish-brown (10YR 5/2) loamy sand; many, coarse, distinct, dark-brown (7.5YR 3/2) mottles; weak, medium, platy structure; very friable; strongly acid; abrupt, irregular boundary.

B't—30 to 40 inches, dark-brown (7.5YR 4/4) light sandy loam; common, medium, distinct, gray (10YR 5/1) mottles; weak, medium, subangular blocky structure; friable; medium acid; clear, wavy boundary.

C—40 to 60 inches, pale-brown (10YR 6/3) light loamy sand; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; single grain; loose; neutral.

The Ap horizon ranges from 6 to 9 inches in thickness and to very dark grayish brown in color. Undisturbed areas have a very dark gray A1 horizon 1 to 3 inches thick. The color of the B2ir horizon ranges to dark brown. The grayish-brown loamy sand that occurs between the B2ir and B't horizons is weakly cemented in some areas. The texture of the B't horizon ranges to heavy loamy sand in a few areas. The B't horizon occurs as bands or as thin layers ½ to 4 inches thick and is separated by coarser textured material in a few areas. Depth to the C horizon ranges from 35 to about 50 inches.

Otisco soils are more poorly drained and are more highly mottled than Montcalm soils. They have a coarser textured B horizon than Londo soils and a finer textured C horizon than Au Gres soils.

Otisco loamy sand, 0 to 2 percent slopes (OtA).—This soil is nearly level to undulating. The dominant slope is less than 1 percent, but included in this mapping unit are areas where the slope ranges to 4 percent. Also included are some areas where the surface layer is sandy loam, and there are several included areas in which layers of fine sand, silt, or gravel and sand are below a depth of 50 inches.

This soil is used mainly as woodland or pasture. Excessive wetness, especially during the spring, and sandiness are the major limitations that affect use for crops. When the water table recedes, this soil dries out quickly. Soil blowing is a hazard in cultivated areas. Capability unit IIIw–5 (4b); woodland suitability group G.

Parkhill Series

The Parkhill series consists of poorly drained soils that occur in level areas and depressions on the lake plain in the southwestern part of the county. These soils developed in loamy material that is high in lime content.

In a typical profile the surface layer is very dark gray loam about 8 inches thick. The subsoil is friable, dark-gray sandy clay loam that has spots of loam and sandy loam and is about 20 inches thick. The subsoil contains distinct, yellow, light-brown and reddish-brown mottles. The underlying material, beginning at a depth of about 28 inches, is firm, gray sandy clay loam. This material contains prominent, strong-brown mottles and is high in content of lime.

Runoff is very slow to ponded. Permeability is moderate. The available moisture capacity is high. These soils have very high organic-matter content. The reaction ranges from medium acid to neutral in the surface layer and subsoil.

These soils are used for pasture, woodland, and, if drained, cropland. Parkhill soils are not extensive, but they are important to farming on the lake plain in the southwestern part of the county.

Typical profile of Parkhill loam:

Ap—0 to 8 inches, very dark gray (10YR 3/1) loam; moderate, fine, granular structure; friable; slightly acid; abrupt, wavy boundary.

B2g—8 to 28 inches, dark-gray (5YR 4/1) sandy clay loam with spots of loam and sandy loam; common, medium, distinct, yellow (10YR 7/6), pale-brown (10YR 6/3), and reddish-brown (5YR 5/3) mottles; moderate, medium, subangular blocky structure; firm; slightly acid; gradual, wavy boundary.

Cg—28 to 48 inches, gray (10YR 5/1) sandy clay loam with spots of loam and sandy loam; common, medium, prominent, strong-brown (7.5YR 5/6) mottles; weak,

coarse, subangular blocky structure; firm; slightly plastic; calcareous.

The Ap horizon is loam or sandy loam and ranges from 4 to 14 inches in thickness. The B horizon ranges from 16 to 28 inches in thickness. Depth to the underlying, calcareous sandy clay loam ranges from 20 to 36 inches. Layers or spots of sandy material or gravelly material are commonly present in any of the layers.

Parkhill soils have a finer textured B horizon than Breckenridge soils. They are coarser textured than either Sims soils or Hettinger soils.

Parkhill loam (Pa).—This soil occurs in small closed depressions and on broad level areas. It surrounds small knolls and ridges. Included in mapping are small spots in which the soil is calcareous on the surface, but not necessarily below the surface. Also included are small areas of somewhat poorly drained Londo loam and, within broad areas of this Parkhill soil, areas of Sims loam that are less than 2 acres in size. Other inclusions are areas where the underlying material varies from loam to sandy clay loam, silty clay loam, or sandy loam in distances of less than 100 feet. Small areas are included that have a surface layer of mucky loam and, also, some areas that are covered with a layer of muck up to 12 inches thick.

Most of this Parkhill soil is drained and used for common crops of the area. The soil has a very high organic-matter content and a high available moisture capacity. However, undrained areas have an excessive moisture limitation and are wet most of the time. The surface becomes cloddy and the lower layers compact if worked in a wet condition. Capability unit IIw–4 (2.5c); woodland suitability group P.

Pickford Series

The Pickford series consists of nearly level to depressional, poorly drained or very poorly drained soils that occur on lake plains and in small, depressional lake areas within till plains. These soils developed in water-laid clay.

In a typical profile the surface layer is very dark gray silty clay loam about 7 inches thick. The subsoil is very firm, dark-gray heavy clay, about 15 inches thick, that contains prominent, yellowish-brown mottles. The underlying material, beginning at a depth of about 22 inches, is very firm, pale-brown heavy clay. This material contains distinct, gray and brownish-yellow mottles and is high in content of lime.

Because these soils are nearly level, runoff is slow to very slow. Water ponds in depressions or in the lowest lying areas. Permeability is very slow. These soils are saturated for long periods of time, and unless they are artificially drained, the water table is at or near the surface. This saturated condition restricts the downward growth of plant roots and prevents early cultivation of these soils. The available moisture capacity and organic-matter content are moderately high. Reaction ranges from slightly acid to mildly alkaline in the surface layer and subsoil.

Pickford soils are used for pasture, cropland, or woodland. The best drained and higher lying areas are cropland. The wettest areas are still wooded or have reverted from cropland to pasture or brush. The major limitations for crops are the high water table, excessive wetness, and clayey texture of the soils. Pickford soils dry out slowly in the spring and, because they are low lying, crops are subject to frost damage.

Typical profile of Pickford silty clay loam:

A1—0 to 7 inches, very dark gray (10YR 3/1) silty clay loam; weak, medium, granular structure; firm; neutral; clear, wavy boundary.

Bg—7 to 22 inches, dark-gray (10YR 4/1) heavy clay; coarse, medium, prominent, yellowish-brown (10YR 5/6) mottles; moderate, medium, angular blocky structure; very firm; neutral; abrupt, irregular boundary.

C—22 to 48 inches, pale-brown (10YR 6/3) heavy clay; many, coarse, distinct, gray (10YR 6/1) and brownish-yellow (10YR 6/6) mottles; weak, coarse, angular blocky structure; very firm; very plastic; calcareous.

The A1 horizon ranges from 6 to 12 inches in thickness and to black in color. The B horizon ranges to gray, and in some areas there is little or no mottling in the upper few inches. Combined thickness of the A and B horizons ranges from 16 to about 25 inches. In some areas, thin layers of silty clay loam and clay loam occur in the C horizon.

Pickford soils are more poorly drained and are grayer than Rudyard soils. They have a finer textured profile than either Sims soils or Hettinger soils.

Pickford loam (Pc).—This level or depressional soil is on lake plains. A shallow deposit of loamy material has been washed over clayey lake-laid material. Included in mapping are some areas where the surface layer is sandy loam or clay loam. A few areas of somewhat poorly drained Rudyard soils are also included.

Most areas are cleared, drained, and used for crops or improved pasture. A few areas are woodland. This soil is dense and drains very slowly. It compacts readily when wet and becomes hard when dry. Runoff is slow, and water ponds in low areas. This soil warms up slowly, and planting of crops is delayed during wet months in spring. Capability unit IIIw–2 (1c); woodland suitability group P.

Pickford silty clay loam (Pm).—This level or depressional soil is on lake plains. Small areas are included that have a very thin sandy or loamy surface layer. Also included are a few areas that have a very thin layer of muck on the surface.

Pickford silty clay loam is the most extensive of the Pickford soils. Most areas are cleared of trees and artificially drained. The major limitations are excessive wetness and poor tilth. This soil dries out slowly in the spring and after rain, and this delays planting and tillage operations. Capability unit IIIw–2 (1c); woodland suitability group P.

Pinconning Series

The Pinconning series consists of nearly level to depressional, poorly drained or very poorly drained soils that occur on lake plains. These soils developed in sand or loamy sand material, 16 to about 40 inches thick, that overlies clay or silty clay material.

In a typical profile the surface layer is black loamy sand about 7 inches thick. The underlying material consists of three parts. The first part is loose, gray loamy sand about 7 inches thick. The second part is loose, gray sand, about 14 inches thick, that contains distinct, yellowish-brown mottles. The third and lowest part of

the underlying material, beginning at a depth of about 28 inches, is very firm, dark-gray clay. This lowest part is high in content of lime.

Because these soils are nearly level, runoff is slow to ponded. Permeability is rapid in the upper part of these soils but very slow in the clayey underlying layers. The available moisture capacity is low. Organic-matter content is very high. Reaction is slightly acid to neutral to a depth of about 28 inches.

Because the Pinconning soils are wet, most of their acreage is woodland. Only a few areas have been cleared and artificially drained, and have been used for cropland or pasture. Unless these soils are artificially drained, the water table is at or near the surface. This wetness is the main limitation in the use of these soils as cropland. Also, crops grown on these soils are subject to frost damage.

Typical profile of Pinconning loamy sand:

A1—0 to 7 inches, black (10YR 2/1) loamy sand; very weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

C1g—7 to 14 inches, gray (10YR 5/1) loamy sand; single grain; loose; neutral; gradual, wavy boundary.

C2g—14 to 28 inches, gray (10YR 5/1) sand; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; single grain; loose; neutral; abrupt, wavy boundary.

IICg—28 to 48 inches, dark-gray (10YR 4/1) clay; massive; very firm; calcareous.

Cultivated areas have a very dark gray or black Ap horizon 6 to 8 inches thick. In some undisturbed areas there is a layer of muck 2 to 8 inches thick on the surface. The dominant depth to the clayey material ranges from 18 to 32 inches.

Pinconning soils are coarser textured in the upper part of the profile than Munuscong soils, and they are finer textured in the lower part of the profile than Brevort soils.

Pinconning loamy sand (Ps).—This soil is nearly level. The surface appears mucky or sticky, owing to a large content of organic matter. Loamy sand dominates the coarse-textured upper part of this soil. Included in mapping are some areas where loamy sand is present only in the surface layer and is underlain by sand.

A few areas of this soil are artificially drained and used for crops or pasture, but most areas are woodland. Undrained areas are excessively wet and crops are subject to frost damage. Capability unit IIIw–8 (4/1c); woodland suitability group W.

Roscommon Series

The Roscommon series consists of nearly level to depressional, poorly drained or very poorly drained soils that occur on outwash plains and lake plains. These soils developed in medium sand and coarse sand more than 60 inches thick.

In a typical profile the surface layer is black loamy sand about 4 inches thick. The underlying material to a depth of about 42 inches or more is loose, grayish-brown and light brownish-gray sand.

Runoff is very slow or ponded. In the absence of a high water table, permeability is very rapid. The available moisture capacity is very low. Organic-matter content is moderate to very high. Reaction ranges from slightly acid to mildly alkaline.

Acreage that is adequately drained is used as cropland. Undrained areas or areas that are inaccessible are used as woodland or pasture. The major limitations of Roscommon soils are excessive wetness and the sandy texture. If the water table is low, Roscommon soils lack sufficient moisture for optimum crop growth. However, unless the soils are artificially drained, the water table is at or near the surface. Because the Roscommon soils are sandy, they are low in natural fertility. Owing to a lack of outlets in some areas, it is difficult to improve drainage.

Typical profile of a Roscommon loamy sand:

A1—0 to 4 inches, black (10YR 2/1) loamy sand; very weak, fine, granular structure; very friable; slightly acid; abrupt, wavy boundary.

C1—4 to 20 inches, grayish-brown (10YR 5/2) sand; common, coarse, distinct, yellowish-brown (10YR 5/8) mottles; single grain; loose; neutral; gradual, wavy boundary.

C2—20 to 40 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; neutral.

The A1 horizon ranges from 2 to 5 inches in thickness and to very dark brown in color. In the lowest lying areas the A1 horizon is mucky.

Roscommon soils have a coarser textured profile than Bruce soils. They are more poorly drained and are grayer than Au Gres soils. Roscommon soils are less acid than Kinross soils.

Roscommon soils (Rc).—These nearly level soils are on the lake plain. They have a loamy sand surface layer, which is underlain by sand at a depth of 2 to 5 inches. Small areas having a sand or mucky sand surface layer are included in areas mapped as these soils.

The vegetation commonly consists of swamp grass and reeds in the wettest areas. Some areas are pastured or cultivated. These soils are low in fertility, and they are subject to soil blowing if cultivated. Excessive moisture is a limitation. Capability unit IIIw–11 (5c); woodland suitability group Q.

Roscommon-Brevort-Tawas association (RB).—The soils in this association are depressional, and are flooded during wet periods. Roscommon mucky sand makes up about 60 percent of this association. Brevort mucky loamy sand and Tawas muck each make up about 20 percent.

The present vegetation is cattails, grass, willow, and tag alder. Excessive wetness is the major limitation that affects use of the soils. Roscommon mucky sand is in capability unit IIIw–11 (5c) and woodland suitability group Q. Brevort mucky loamy sand is in capability unit IIIw–10 (4/2c) and woodland suitability group W. Tawas muck is in capability unit Vwc–1 (M/4c) and woodland suitability group J.

Roscommon-Deford association (RD).—This low-lying association is on outwash plains that are characterized by a high water table and slow runoff. The association is extensive in Bentley Township and in southern Grim Township. Slopes are less than 2 percent over 90 percent of the association, exceeding 2 percent only on small ridges. The soils developed primarily in medium sand or fine sand that contains, in places, thin layers of fine sand, sandy loam, loamy sand, silt, or silt loam. The presence of these finer textured bands is extremely variable, both horizontally and vertically, but they are present throughout 40 to 60 percent of the association. Roscommon soils

make up about 55 percent of the association, and Deford soils about 35 percent. Included also are small ridges of Au Gres soils and Wainola soils, and areas of Burleigh soils that contain layers of very fine sand and silt within a depth of 42 inches. These included soils account for about 10 percent of the total acreage.

Poorly drained to very poorly drained Roscommon soils developed in at least 42 inches of sand that contains no finer textured material. Deford soils also are poorly drained to very poorly drained, and they developed mainly in fine sand. The sand or stratified sand extends to a depth of at least 42 inches and, in some areas, overlies clay loam or silt loam.

The vegetation consists of a dense stand of swamp hardwoods, and there are patches of tag alder and willow in the most poorly drained areas. The surface layer is not mucky in some places, but in others it is a mixture of sand and muck up to 10 inches thick. In general, the mucky surface layer is thickest in the most poorly drained areas. Roscommon soils are in capability unit IIIw–11 (5c) and woodland suitability group Q. Deford soils are in capability unit IIIw–6 (4c) and woodland suitability group W.

Roscommon-Tawas association (RT).—This association occurs in low-lying, swampy areas where drainage is very poor because of flooding or seepage. The association is adjacent to some of the streams tributary to the Molasses River, and it is also in a large swamp along the main stem of the Molasses River in southeastern Bourret Township. Small elongated depressions occur in the northwestern part of the county. Slopes are less than 2 percent over 90 percent of the area, but a few areas of steeper slopes occur where the drainage is very poor because of seepage. Roscommon soils make up about 45 percent of the association, and Tawas soils make up about 45 percent. Included soils make up about 10 percent of the association.

Roscommon soils developed in less than 12 inches of muck over sand; Tawas soils developed in 12 to 42 inches of muck over sand. Roscommon soils and Tawas soils are about equally distributed in the association, and a few small areas of Markey soils are included.

The vegetation consists largely of white-cedar in smaller areas of the association and a mature stand of swamp hardwoods in the large swamp along the Molasses River. The association is poorly suited to crops; its major limitations are excessive wetness and low fertility. If the soils are cultivated, soil blowing is a hazard. Roscommon soils are in capability unit IIIw–11 (5c) and woodland suitability group Q. Tawas soils are in capability unit Vwc–1 (M/4c) and woodland suitability group J.

Rousseau Series

The Rousseau series consists of undulating to sloping, well-drained soils that occur on lake plains and outwash plains. These soils developed in fine sand and very fine sand.

In a typical profile the surface layer is very dark gray fine sand about 2 inches thick. The subsurface layer is light brownish-gray fine sand about 2 inches thick. The subsoil consists of two parts. The upper part of the subsoil is very friable, dark-brown fine sand about 11 inches thick. The lower part is loose, strong-brown fine sand and very fine sand about 9 inches thick. The underlying material, beginning at a depth of about 24 inches, is loose, pale-brown fine sand and very fine sand.

Runoff is very slow to slow. Permeability is rapid. The available moisture capacity is low. These soils have a low organic-matter content. Reaction ranges from strongly acid to slightly acid in the surface and subsurface layers and subsoil.

Most areas are woodland or are idle. Because of their sandy texture and limited available moisture capacity during dry periods, Rousseau soils have severe limitations for use as cropland. Because the size of the sand is fine, Rousseau soils have a somewhat better available moisture capacity than soils in which the sands are medium and coarse. If large areas are exposed by cultivation, Rousseau soils are also subject to blowing.

Typical profile of Rousseau fine sand:

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

A2—2 to 4 inches, light brownish-gray (10YR 6/2) fine sand; single grain; loose; medium acid; abrupt, smooth boundary.

B21ir—4 to 15 inches, dark-brown (7.5YR 4/4) fine sand; very weak, fine, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—15 to 24 inches, strong-brown (7.5YR 5/6) fine and very fine sand; single grain; loose; medium acid; gradual, wavy boundary.

C—24 to 66 inches, pale-brown (10YR 6/3) fine sand and very fine sand; single grain; loose; medium acid.

The A1 horizon ranges from 1 to 3 inches in thickness and to very dark grayish brown in color. The A2 horizon ranges to pinkish gray in color. In some cultivated areas the A2 horizon is very thin or absent.

Rousseau soils developed in finer sized sands than Rubicon soils.

Rousseau fine sand, 2 to 12 percent slopes (RoC).—This gently sloping and sloping, well-drained soil is on large or low dunes. The surface layer is fine sand 1 to 3 inches thick, and fine sand is dominant throughout the entire soil profile. Some slopes are moderately steep to steep on the lee side of the dunes. These slopes are included in mapping and are 10 to 35 feet long. Also included are the lower lying, narrow edges of dunes, and these areas are moderately well drained.

This soil is well suited to permanent vegetation, such as trees or grass. If the ground cover is removed, soil blowing is a serious hazard. This soil holds limited available moisture during dry periods. Capability unit IIIs–4 (4a); woodland suitability group C.

Rubicon Series

The Rubicon series consists of nearly level to steeply sloping, well-drained sandy soils that occur on outwash plains, lake plains, and moraines. These soils developed in medium sand and coarse sand.

In a typical profile the surface layer is black sand about 2 inches thick. The subsurface layer is light brownish-gray sand about 7 inches thick. The subsoil is very friable, dark-brown sand and loose, strong-brown sand that have a combined thickness of about 21 inches. The underlying material, beginning at a depth of about 30 inches, is loose, light yellowish-brown sand.

Figure 6.—Aspen growing on an area of a Rubicon sand.

Runoff is slow to medium. Permeability is very rapid. Available moisture capacity is very low. The organic-matter content is low. Reaction is strongly acid to slightly acid in the surface and subsurface layers and subsoil.

Most areas are in second-growth forest, and aspen is the dominant tree (fig. 6). Because the soils are sandy and droughty, only a small acreage is used as cropland. Owing to a very low available moisture capacity, plant growth is slowed during midsummer by lack of sufficient moisture. During dry summers, this lack of sufficient moisture seriously reduces crop growth.

Typical profile of a Rubicon sand:

A1—0 to 2 inches, black (10YR 2/1) sand; very weak, fine, granular structure; very friable; strongly acid; abrupt, smooth boundary.

A2—2 to 9 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; strongly acid; abrupt, wavy boundary.

B21ir—9 to 20 inches, dark-brown (7.5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—20 to 30 inches, strong-brown (7.5YR 5/6) sand; single grain; loose; medium acid; gradual, wavy boundary.

C—30 to 48 inches, light yellowish-brown (10YR 6/4) sand; single grain; loose; slightly acid.

The A1 horizon ranges from 1 to 3 inches in thickness. In some areas the color of the A2 horizon ranges to pinkish gray. The combined thickness of the A and B horizons ranges from 24 to 36 inches. In places the C horizon is loamy to clayey material at a depth of 42 to 66 inches.

Rubicon soils developed in coarser sized sands than Rousseau soils. Rubicon soils are better drained and lack the mottles that are common in Croswell soils and Au Gres soils.

Rubicon sand, 0 to 6 percent slopes (RsB).—This well-drained soil is nearly level and gently sloping. It is on plains, ridges, and hilltops. The surface layer is dark colored and thin in wooded areas. It is dark grayish brown in cultivated areas. In small areas of cultivated fields, the upper part of the subsoil has been exposed by soil blowing. Included in mapping are small areas of Croswell sand.

Most of this soil is woodland. Some areas have been cleared but are now idle or reforested. This soil is very droughty and is low in fertility. If this soil is burned over or is cultivated, blowing is a moderate hazard. Capability unit VIIs–1 (5.3a); woodland suitability group H.

Rubicon sand, 6 to 12 percent slopes (RsC).—This well-drained, sloping soil is on plains, ridges, and hilltops. Erosion has generally been only slight because of the protective forest cover, and the upper part of the subsoil is exposed in only a few places. Included in mapping are areas of Rubicon sand that are underlain by loam to clay at a depth of 42 to 66 inches. Small spots of moderately well drained Croswell soils are also included, and so are lee slopes on dunes that exceed 12 percent and short slopes of 12 to 25 percent.

Most of this soil is woodland. Cleared areas are idle grassland or reforested. This soil is droughty and is low in fertility. If it is burned over or is cultivated, soil blowing is a severe hazard. Capability unit VIIs–1 (5.3a); woodland suitability group H.

Rubicon sand, 12 to 25 percent slopes (RsE).—This well-drained, strongly sloping to steep soil is on ridges, hillsides, and dunes. Medium sand is dominant throughout the profile except on the dunes where about 50 percent of the profile is fine sand. There are a number of areas in which the subsoil is exposed, and these are included. Also included are many areas where numerous layers of thin loamy sand occur at a depth of 6 to 8 feet.

Most of this soil is woodland. Some areas have been cleared but are now idle grassland or are reforested. This soil is droughty and is low in fertility. Soil blowing is a severe hazard. Capability unit VIIs–1 (5.3a); woodland suitability group H.

Rubicon sand, loamy substratum, 0 to 6 percent slopes (RtB).—This well-drained, deep sand overlies loam to clay and is on the tops of ridges and knolls. Some areas of moderately well drained soils are included in mapping.

Areas of this soil are cleared and are cultivated in a limited way, are pastured, or are wooded. This soil is low in fertility and in organic-matter content. Although runoff is very slow, this soil is droughty during dry summer months. If this soil is cultivated, soil blowing is a moderate hazard. Capability unit IVs–4 (5/2a); woodland suitability group C.

Rubicon-Croswell association, undulating (RUB).—This association is on stabilized sand dunes, beach ridges, and outwash plains where sand deposits are greater than 66 inches deep. The association is most extensive on an outwash plain along both sides of Black Creek in Secord

and Hay Townships. The ridges and dunes are at least 200 feet wide and are a quarter of a mile or more long. The ridges are 8 to 20 feet high, and their side slopes range from 2 to 8 percent. The ridgetops are generally level, and slopes are less than 2 percent. Slopes exceed 8 percent on the sides of some of the ridges. On the broad outwash plains, more than 80 percent of the association has slopes of less than 6 percent, although numerous ridges occur where side slopes are up to 8 percent and, in a few places, exceed 8 percent.

Rubicon soils make up about 50 percent of this association, and Croswell soils about 40 percent. Included soils comprise about 10 percent of the association.

Well-drained Rubicon soils and moderately well drained Croswell soils developed in sand deposits more than 66 inches thick. The texture of most profiles is medium or coarse sand. Rubicon soils occur on the convex slopes, and moderately well drained Croswell soils occur in the lower slopes of the ridges and in slightly concave positions in the outwash plains. The soils in the dunes include a few thin layers of fine sand. Small areas of Au Gres soils, Grayling soils, and Chelsea soils are included in some places.

The vegetation consists of a sparse covering of aspen, white birch, and red maple, and a ground cover of brackenfern and wintergreen. Rubicon soils are in capability unit VIIs–1 (5.3a) and woodland suitability group H. Croswell soils are in capability unit IVs–4 (5a) and woodland suitability group E.

Rubicon-Menominee association, undulating (RVB).—This association is in areas where natural drainage is moderately good to good. The association occurs along the west edge of the Port Huron moraine in Grim Township and in the northwestern corner of the county; in these two areas slopes range from 2 to 8 or more percent and the underlying material is glacial till. In the larger area of this association, adjacent to the Tittabawassee River in Billings Township, slopes are dominantly less than 6 percent, although large areas occur where slopes are less than 2 percent. The underlying material in this area is water laid. This area contains some very steep slopes adjacent to the river and its tributaries, but these slopes are too short to be separated from the association. The sandy deposits of this association are underlain by firm clay loam at a depth of 3 feet to more than 7 feet. Rubicon soils are dominant, comprising 45 percent of the association. Menominee soils make up about 40 percent of the association, and included soils about 15 percent.

Rubicon sand, loamy substratum, developed in 42 to 66 inches of sandy material overlying clay loam, and Rubicon sand developed in more than 66 inches of sandy material. Menominee sand developed in less than 42 inches of sandy material overlying clay loam. These three soils comprise about 85 percent of this association. Somewhat poorly drained Au Gres soils occur in a few shallow depressions included in this association. In some areas of the association, there is stratified, moderately coarse textured to moderately fine textured material within 66 inches of the surface. And, in a few areas in Billings Township, the underlying material is clay rather than clay loam.

The vegetation is a vigorous stand of aspen and lesser amounts of red maple and white birch. The ground cover is brackenfern. Rubicon soils are in capability unit VIIs–1 (5.3a) and woodland suitability group H. Menominee soils are in capability unit IIIs–3 (4/2a) and woodland suitability group C.

Rubicon-Ocqueoc-Ingalls association, undulating (RWB).—The soils in this association are nearly level to gently sloping and occur on sand-covered lake plains that are characterized by moderately good natural drainage and are adjacent to the valleys of the major streams and on higher ridges throughout the lake plains. The largest areas of the association are adjacent to the valleys of the Tittabawassee and Molasses Rivers. Within the association, the Ocqueoc soils and Ingalls soils are more prevalent along the Molasses River and on the ridges in Sheridan and Bourret Townships; Menominee soils and Iosco soils are dominant in some areas along the Tittabawassee River; Manistee soils are limited to the area around All Bright Shores in Billings Township. Slopes are less than 6 percent over 80 percent of the area. Slopes exceeding 6 percent are short and occur on the sides of stream valleys cut into the general level of the plain.

Rubicon soils and Ocqueoc soils are the dominant soils of the association, each comprising about 35 percent. Ingalls soils comprise about 30 percent of the association.

Rubicon soils, loamy substratum, consist of sand to a depth of 42 to 66 inches, below which is a layer of loam, clay loam, clay, or silt. Ocqueoc soils consist of 18 to 42 inches of sand or loamy sand overlying silt and very fine sand. Rubicon soils are well drained, and Ocqueoc soils are well drained and moderately well drained. Other well-drained soils present in smaller amounts in this association are Menominee sand, Manistee sand, and Chelsea sand.

Iosco soils consist of 18 to 42 inches of sand or loamy sand overlying loam, clay loam, or silty clay loam. Ingalls soils consist of 18 to 42 inches of sand overlying silt and very fine sand. Both of these soils are somewhat poorly drained, and they occur in lower lying positions than the well drained to moderately well drained soils.

Small areas of poorly drained and very poorly drained Brevort and Burleigh soils are included in the association. They occupy less than 10 percent of the acreage and occur in small depressions and natural drainageways.

The vegetation consists of aspen, white birch, and maple, and a ground cover of brackenfern, blackberries, and wintergreen. Rubicon soils are in capability unit VIIs–1 (5.3a) and woodland suitability group H. Ocqueoc soils are in capability unit IIIs–3 (4a) and woodland suitability group C. Ingalls soils are in capability unit IIIw–5 (4b) and woodland suitability group G.

Rudyard Series

The Rudyard series consists of nearly level to undulating or gently sloping, somewhat poorly drained soils that have a clayey subsoil and occur on lake plains. These soils developed in heavy clay.

In a typical profile the surface layer is very dark grayish-brown loam about 7 inches thick. The subsoil is very firm, dark reddish-gray heavy clay, about 13 inches thick, that contains distinct, gray mottles. The underlying material, beginning at a depth of about 20 inches, is very

firm, reddish-brown heavy clay. This material is high in content of lime.

Runoff is very slow to slow in most places, but it ponds in depressional and level areas. Permeability is very slow. These soils are saturated for extended periods of time, especially in the spring. This saturated condition is the result of very slow permeability and a temporarily high water table during wet periods. The available moisture capacity is moderately high. These soils have medium to high organic-matter content. Reaction ranges from slightly acid to neutral in the surface layer and subsoil.

Rudyard soils are used as cropland, pasture, and woodland. If adequate drainage is provided, they are suited to crops. These soils dry out slowly in the spring and after rain, and this delays planting operations during wet periods. If Rudyard soils are wet, farm machinery bogs down readily. During wet months in fall, harvesting operations are delayed or prevented.

Typical profile of a Rudyard loam:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

Bg—7 to 20 inches, dark reddish-gray (5YR 4/2) heavy clay; many, medium, distinct, gray (10YR 5/1) mottles; strong, medium, angular blocky structure; very firm; neutral; abrupt, wavy boundary.

C—20 to 48 inches, reddish-brown (5YR 4/3) heavy clay; weak, coarse, angular blocky structure; very firm; calcareous.

Undisturbed areas have a very dark gray A1 horizon, 1 to 2 inches thick, that overlies a grayish-brown A2 horizon 3 to 5 inches thick. The Ap horizon ranges from loam to silty clay loam. The B horizon ranges to reddish brown in color. The combined thickness of the A and B horizons ranges from 15 to about 30 inches.

Rudyard soils are more poorly drained and are more highly mottled than Ontonagon soils. They are better drained and not so gray as Pickford soils. Rudyard soils are finer textured than either Kawkawlin soils or Bowers soils.

Rudyard loam, 0 to 2 percent slopes (RyA).—This nearly level soil is on lake plains. Small areas included in mapping have a silty clay loam, clay, or silty clay surface layer. Also included are a few areas where sand underlies this soil at a depth ranging from 18 to 42 inches, and drainage is somewhat better in these areas because of rapid permeability in the sandy material.

Most of the acreage has been cleared and drained and is cropped. Runoff is very slow. The major limitations are excess moisture, slow warmup in spring, and slow permeability. Capability unit IIIw–2 (1b); woodland suitability group Z.

Rudyard loam, 2 to 6 percent slopes (RyB).—This gently sloping soil is on lake plains, generally on the slopes adjoining minor drainageways. Included in mapping are a few areas that are moderately eroded, and in these areas the upper part of the subsoil has been mixed with the surface layer. Also included are small areas of Ontonagon loam.

Most of this Rudyard soil is used as cropland. Runoff is slow, and excess moisture is a limitation. Because of very slow permeability, this soil tends to warm up slowly in spring. Capability unit IIIw–2 (1b); woodland suitability group Z.

Saugatuck Series

The Saugatuck series consists of nearly level to depressional, somewhat poorly drained or poorly drained, sandy soils that occur on outwash plains and lake plains. These soils developed in medium sand and coarse sand. They are of limited extent in Gladwin County and occur in widely scattered areas.

In a typical profile the surface layer is black sand about 2 inches thick. The subsurface layer is light brownish-gray sand about 10 inches thick. The subsoil consists of three parts. The uppermost part of the subsoil is strongly cemented, dark reddish-brown sand about 5 inches thick. The second part of the subsoil is strongly cemented to weakly cemented, dark-brown sand about 11 inches thick. The lowest part of the subsoil is loose, dark-brown sand, about 6 inches thick, that contains distinct, dark-brown mottles. The underlying material, beginning at a depth of about 34 inches, is loose, pale-brown sand.

Permeability is very slow in the cemented part of the subsoil. Runoff is very slow to ponded. The available moisture capacity is very low. The organic-matter content ranges from low to moderately high. Reaction ranges from medium acid to very strongly acid in the surface layer and subsoil.

These soils are mainly used for wildlife habitat and recreation. The water table is near the surface during the spring but recedes as the growing season progresses. During the dry summer months, these soils are droughty and the moisture content is rarely adequate for optimum crop growth. The cemented layer in the upper part of the subsoil restricts the downward growth of plant roots in many areas. The major limitations are excessive wetness and the cemented layer in the subsoil.

Typical profile of Saugatuck sand:

A1—0 to 2 inches, black (10YR 2/1) sand; very weak, fine, granular structure; very friable; very strongly acid; abrupt, wavy boundary.

A2—2 to 12 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; very strongly acid; abrupt, wavy boundary.

B21hirm—12 to 17 inches, dark reddish-brown (5YR 2/2) sand; massive; strongly cemented; very strongly acid; clear, wavy boundary.

B22hirm—17 to 28 inches, dark-brown (7.5YR 3/2) sand; massive; strongly cemented in upper part, gradual change to weakly cemented in lower part; very strongly acid; gradual, irregular boundary.

B3—28 to 34 inches, dark-brown (10YR 4/3) sand; common, coarse, distinct, dark-brown (7.5YR 3/2) mottles; single grain; loose; strongly acid; gradual, wavy boundary.

C—34 to 48 inches, pale-brown (10YR 6/3) sand; common, coarse, distinct, dark-brown (7.5YR 3/2) mottles; single grain; loose; strongly acid.

The A2 horizon ranges from 1 to 12 inches in thickness and to light gray in color. The B22 horizon ranges to dark reddish-brown in color. The cemented part of the B horizon ranges from 6 to 20 inches in thickness.

Saugatuck soils have a cemented layer in the B horizon that is absent in Au Gres soils. Saugatuck soils lack the finer textured underlying material of Ogemaw soils.

Saugatuck sand (Sc).—This soil is nearly level to depressional. Slopes are dominantly less than 1 percent. The surface layer is sand or loamy sand. This soil is somewhat poorly drained or poorly drained, is medium

acid to very strongly acid, and is infertile. It commonly occurs as small areas that adjoin larger areas of Au Gres sand and Kinross sand. Small inclusions of these soils make up as much as 15 percent of the acreage in areas mapped as this Saugatuck soil.

Most of this soil is in poorly stocked stands of trees. The strongly cemented layer in the subsoil slows permeability and hinders the downward growth of roots. Trees fail to root firmly and are blown over easily. Small areas of this soil are used for pasture. Capability unit IVw–2 (5b–h); woodland suitability group F.

Sims Series

The Sims series consists of nearly level to depressional, poorly drained or very poorly drained soils that occur on till plains and moraines. These soils developed in clay loam or silty clay loam. They are of limited extent and are mainly in the northwestern and southeastern parts of the county.

In a typical profile the surface layer is black loam about 7 inches thick. The subsoil is firm, grayish-brown and gray clay loam, about 20 inches thick, that contains distinct, yellowish-brown mottles in the lower part. The underlying material, beginning at a depth of about 27 inches, is firm, grayish-brown clay loam. This material contains distinct, dark yellowish-brown mottles and is high in content of lime.

Runoff is very slow to ponded. Permeability is moderately slow. These soils are saturated for long periods of time. They have high to very high organic-matter content. The available moisture capacity is high. Reaction ranges from slightly acid to mildly alkaline in the surface layer and subsoil.

Many areas are cleared of trees and are cultivated or pastured. The suitability of these soils as cropland varies with their degree of drainage. Artificial drainage is generally required. The saturated condition of these soils delays planting and tillage operations. Undrained areas remain in swamp vegetation or are idle and are growing up to brush.

Typical profile of Sims loam:

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

B21g—7 to 14 inches, grayish-brown (10YR 5/2) clay loam; moderate, coarse, angular blocky structure; firm; neutral; gradual, wavy boundary.

B22g—14 to 27 inches, gray (10YR 5/1) clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; moderate, coarse, angular blocky structure; firm; mildly alkaline; abrupt, wavy boundary.

Cg—27 to 48 inches, grayish-brown (10YR 5/2) clay loam; common, coarse, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, coarse, angular blocky structure; firm; calcareous.

The Ap horizon ranges from 6 to 9 inches in thickness and to very dark brown in color. The texture of the B horizon ranges to light clay or silty clay loam. In some areas the texture of the C horizon is silty clay loam.

Sims soils are more poorly drained and grayer than Kawkawlin soils. They are finer textured than Parkhill soils.

Sims loam (Sn).—This soil is nearly level to depressional and occurs in low-lying areas. In some areas slopes are up to 3 percent. In cultivated areas the original surface layer is mixed with part of the gray subsoil. Included in mapping are small areas having a silty clay loam surface layer. Also included are small spots of a sandy loam; a somewhat poorly drained Kawkawlin loam, stratified sand; a medium-textured alluvial soil; and shallow muck.

Most of the acreage is woodland or is used for permanent pasture. A small part has been artificially drained and is cultivated. Excess moisture is a limitation. If the soil is worked when wet, it will become compact. Capability unit IIw–2 (1.5c); woodland suitability group P.

Tawas Series

The Tawas series consists of level, very poorly drained, organic soils that occur in low areas throughout the county. These soils developed in woody and fibrous organic material, 12 to 42 inches thick, overlying sand or loamy sand. The organic material is the remains of deciduous trees and coniferous trees mixed with materials from sedges, reeds, and grasses.

In a typical profile the surface layer is black muck about 6 inches thick. The next layer is friable, dark reddish-brown muck about 20 inches thick. This layer contains some chunks of partially decomposed wood. The underlying material, beginning at a depth of about 26 inches, is loose, gray loamy sand.

Runoff is slow to ponded. In the absence of a high water table, permeability is moderately rapid. The available moisture capacity is very high. Generally, reaction is medium acid to mildly alkaline in the organic material, but this material is calcareous in some areas. The sandy material is mildly alkaline.

Most of the acreage is wooded. Difficulty in draining these soils and a high water table prevent intensive use for crops. If these soils are farmed, soil blowing and frost damage to crops are hazards.

Typical profile of Tawas muck:

1—0 to 6 inches, black (10YR 2/1) muck; moderate, medium, granular structure; friable; slightly acid; gradual, wavy boundary.

2—6 to 26 inches, dark reddish-brown (5YR 2/2) muck; weak, coarse, granular structure; friable; contains some pieces of partially decomposed wood; slightly acid; abrupt, smooth boundary.

IICg—26 to 48 inches, gray (10YR 5/1) loamy sand; single grain; loose; mildly alkaline.

In some areas the mucky surface layer ranges to 30 inches in thickness. The combined thickness of the organic layers is generally 26 inches, but the thickness ranges from 12 to 42 inches.

Tawas soils are more acid than Markey soils. They have a thinner layer of organic material than Carbondale, Houghton, or Lupton soils.

Tawas muck (Ta).—This level soil is in swamps, where shallow deposits of organic material have accumulated over sand. The surface layer is black. In some areas, a 1- to 2-inch layer of plant remains has been recently deposited on the surface. The total thickness of organic layers is variable. In some areas the thickness of organic layers ranges slightly outside the limits of 12 to 42 inches over distances of less than 100 feet. These areas are included in mapping and consist of small spots of Roscommon mucky sand and deep Carbondale muck.

Most of the acreage remains as woodland that consists commonly of tag alder and willow thickets. This soil is

very poorly drained and is susceptible to unseasonal frost. Capability unit Vwc–1 (M/4c); woodland suitability group J.

Ubly Series

The Ubly series consists of level to sloping, well drained or moderately well drained soils that occur on till plains and moraines. These soils developed in sandy loam or heavy loamy sand, 18 to about 42 inches thick, overlying loam to clay loam glacial material.

In a typical profile the surface layer is very dark grayish-brown sandy loam about 9 inches thick. The subsoil consists of two parts. The upper part of the subsoil is friable, dark yellowish-brown sandy loam about 7 inches thick. Between the upper and lower layers of the subsoil is very friable, light brownish-gray sandy loam about 6 inches thick. The lower part is firm, brown sandy clay loam and clay loam about 14 inches thick. The underlying material, beginning at a depth of about 36 inches, is firm, brown clay loam that is high in content of lime.

Runoff is slow to rapid. Permeability is moderate to moderately rapid in the upper part of these soils and is moderately slow in the lower part. These soils have low organic-matter content and moderate available moisture capacity. Reaction ranges from medium acid to neutral in the surface layer and subsoil.

Many areas are cultivated. Some areas are used for pasture or as woodland. Although the moisture content is generally adequate for crop growth, there are periods during midsummer when soil moisture is short. Erosion is a hazard in sloping areas.

Typical profile of an Ubly sandy loam:

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

Bir—9 to 16 inches, dark yellowish-brown (10YR 4/4) sandy loam; weak, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

A'2—16 to 22 inches, light brownish-gray (10YR 6/2) sandy loam; weak, coarse, granular structure; very friable; medium acid; abrupt, irregular boundary.

B'21t—22 to 30 inches, brown (7.5YR 4/4) sandy clay loam; weak, coarse, subangular blocky structure; firm; slightly acid; clear, wavy boundary.

B'22t—30 to 36 inches, brown (7.5YR 4/2) clay loam; moderate, coarse, angular blocky structure; firm; neutral; abrupt, wavy boundary.

C—36 to 48 inches, brown (7.5YR 5/4) clay loam; massive; firm; calcareous.

The Ap horizon ranges to dark grayish brown in color. Undisturbed areas have a very dark gray A1 horizon, 1 to 6 inches thick, that overlies a light brownish-gray A2 horizon 2 to 5 inches thick. The depth to the C horizon ranges mainly from 26 to 40 inches.

Ubly soils have a coarser textured upper B horizon than Nester soils. They have a finer textured upper B horizon than Menominee soils.

Ubly sandy loam, 0 to 2 percent slopes (UlA).—This nearly level or level soil occupies small areas. Some of these areas occur on outwash plains, where the upper part of the profile is moderately stratified and the underlying material is water worked. Included in mapping are some areas where the surface layer is fine sandy loam or loamy fine sand. Also included are a few areas where stratified silt and fine sand underlie the subsoil.

Most of the acreage is cultivated. During prolonged dry periods, the soil is slightly droughty. Slow runoff and water erosion are slight to moderate hazards. Capability unit IIe–3 (3/2a); woodland suitability group A.

Ubly sandy loam, 2 to 6 percent slopes (UlB).—This soil is undulating and gently sloping. Individual areas are small. The surface layer is mainly sandy loam, but included are small areas where the surface layer is fine sandy loam or loamy fine sand. Also included are small areas of Menominee soils that have coarser textured surface and subsoil layers. Menominee soils are more droughty and subject to more erosion than Ubly soils. Other inclusions are moderately eroded spots that are lower in fertility and organic-matter content than uneroded areas. In addition, these moderately eroded spots are less productive. Also included are a few areas where stratified silt and fine sand underlie the subsoil.

Most of the acreage of this Ubly soil is planted to crops. This soil is suited to most crops commonly grown in the county. Owing to a shortage of soil moisture during dry summer months, plant growth is retarded. Because of the presence of eroded areas and slightly more runoff, this soil is not so well suited to crops as nearly level Ubly soils. Capability unit IIe–3 (3/2a); woodland suitability group A.

Ubly sandy loam, 6 to 12 percent slopes (UlC).—This sloping soil is on till plains and moraines, where it normally occupies small areas. The surface layer is generally sandy loam, but small areas of loamy sand are included in mapping. Small moderately eroded and severely eroded spots are also included. In these eroded spots, the thickness of the sandy material is about 18 inches or only a little more. There are small inclusions of stratified silt and fine sand, and small included areas have slopes that exceed 12 percent.

Most of this Ubly soil is in permanent pasture or remains forested. The soil has medium runoff and is slightly droughty. Water erosion is a moderately severe hazard. Capability unit IIIe–4 (3/2a); woodland suitability group A.

Wainola Series

The Wainola series consists of nearly level, somewhat poorly drained, sandy soils that occur on lake plains. These soils developed in fine sand, very fine sand, and loamy fine sand. In Gladwin County the Wainola soils were mapped only in the Wainola-Deford association.

In a typical profile the surface layer is very dark gray fine sand about 3 inches thick. The subsurface layer is gray fine sand about 9 inches thick. The subsoil consists of two parts. The upper part of the subsoil is very friable, dark yellowish-brown loamy fine sand about 4 inches thick. The lower part of the subsoil is loose, yellowish-brown fine sand and very fine sand about 14 inches thick. The underlying material is loose, very pale brown fine sand.

Runoff is very slow, and water ponds in the lowest depressions during wet periods. Permeability is rapid, and the available moisture capacity is low. The organic-matter content also is low. Reaction of the surface layer and subsoil is strongly acid or slightly acid.

Only a small acreage of Wainola soils occurs in the county. Most of the acreage remains wooded because of excessive wetness and sandy nature of these soils. The saturated condition is the result of a high water table, especially in the spring, and the wetness of the soils delays planting and tillage.

Typical profile of a Wainola fine sand:

A1—0 to 3 inches, very dark gray (10YR 3/1) fine sand; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—3 to 12 inches, gray (10YR 5/1) fine sand; single grain; loose; medium acid; abrupt, irregular boundary.

B21ir—12 to 16 inches, dark yellowish-brown (10YR 4/4) loamy fine sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—16 to 30 inches, yellowish-brown (10YR 5/6) fine sand and very fine sand; common, medium, distinct, strong-brown (7.5YR 5/6) and pale-brown (10YR 6/3) mottles; single grain; loose; slightly acid; gradual, wavy boundary.

C—30 to 48 inches, very pale brown (10YR 7/4) fine sand; common, medium, distinct, gray (10YR 5/1) mottles; single grain; loose; slightly acid.

The A1 horizon ranges from 2 to 4 inches in thickness and to very dark brown in color. The B21ir horizon ranges to brown in color and from 3 to 6 inches in thickness. The A and B horizons contain a considerable amount of sand.

Wainola soils developed in finer sands than Au Gres soils. Wainola soils are not so well drained or so bright colored as Rousseau soils.

Wainola-Deford association (WD).—The soils in this association are nearly level and occur on outwash plains that have a high or periodically high water table. The association is of greatest extent in southern Bentley Township, but smaller acreages of the association also occur in Secord Township. Slopes are less than 6 percent throughout the association, and slopes of large areas do not exceed 2 percent. Wainola soils are dominant, making up about 50 percent of the association. Deford soils make up about 40 percent of the association, and included soils about 10 percent.

Wainola soils occur in slightly higher areas than Deford soils. The proportion of Wainola and Deford soils varies from area to area in the association, but at least 30 percent of each soil is present in each area. Au Gres soils and Roscommon soils are included, and they lack the fine-textured bands.

The vegetation of this association is a mixed stand of aspen, white birch, and red maple on the small knolls and ridges and a dense stand of swamp hardwoods, including elm and ash, in the low areas. Wainola soils are in capability unit IIIw–5 (4b) and woodland suitability group F. Deford soils are in capability unit IIIw–6 (4c) and woodland suitability group W.

Wheatley Series

The Wheatley series consists of poorly drained, sandy and gravelly soils that occupy low positions on outwash plains. These soils developed in sandy material overlying gravelly sand.

In a typical profile the surface layer is black loamy sand about 8 inches thick. Next is a layer of loose, light-gray sand about 16 inches thick. This layer is underlain by loose, light brownish-gray, stratified gravel and coarse sand.

Runoff is slow to ponded. The water table is normally at or near the surface, but if it is lowered by artificial drainage, permeability is rapid or very rapid and the available moisture capacity is very low. The organic-matter content is moderate to high. Reaction of the surface layer is neutral or mildly alkaline.

These soils occupy only a small acreage in the county and are used mainly for pasture or as woodland. The high water table and sandy texture are the major limitations that affect use of these soils for crops.

Typical profile of Wheatley loamy sand:

A1—0 to 8 inches, black (10YR 2/1) loamy sand; weak, medium, granular structure; very friable; neutral; abrupt, smooth boundary.

C1—8 to 24 inches, light-gray (10YR 7/2) sand; single grain; loose; mildly alkaline; abrupt, wavy boundary.

C2—24 to 42 inches, light brownish-gray (10YR 6/2), stratified gravel and coarse sand; single grain; loose; calcareous.

In a few areas, a layer of muck, 1 to 4 inches thick, overlies the sand. In some areas the C horizon consists of alternate layers of sand and gravel or coarse sand. In a few areas, finer textured material underlies the sandy and gravelly material at a depth of 3½ to 10 feet.

In Wheatley soils the underlying material is coarser textured and more variable than in Roscommon soils. Wheatley soils lack the finer textured B horizon of Epoufette soils.

Wheatley loamy sand (Wh).—This level to depressional soil is on outwash plains, where it is adjacent to Gladwin soils. In the lowest areas a mucky loamy sand surface layer is common. Small areas of Epoufette and Brevort soils are included.

Most of the acreage is idle or is forested. Some areas are in permanent pasture. This soil remains wet for long periods of time and dries out slowly in the spring. Crops are subject to frost damage, especially in depressional areas. Capability unit IIIw–6 (4c); woodland suitability group W.

Winterfield Series

The Winterfield series consists of nearly level, somewhat poorly drained, sandy soils that occur on the flood plains of rivers and other streams. These soils developed in water-laid sandy material. Only a small acreage of these soils occurs in the county, and it was mapped only in the Evart-Winterfield association.

In a typical profile the surface layer is very dark gray sand about 8 inches thick. The underlying material, to a depth of about 42 inches or more, is loose, brown sand that contains distinct, reddish-brown mottles.

Runoff is very slow, and water ponds in old stream channels and in depressions. Permeability is rapid. The available moisture content is low. The organic-matter content is moderate. Reaction ranges from slightly acid to mildly alkaline in the upper 30 inches of the profile.

These soils are subject to occasional flooding, especially in the spring and after prolonged rain. Because of the flooding hazard and the sandy texture of these soils, they are used mainly as woodland or for pasture. Most areas are flooded at some time during the spring. A further limitation of Winterfield soils is that many areas are

small in size and impractical to farm because of meandering streams.

Typical profile of Winterfield sand:

A1—0 to 8 inches, very dark gray (10YR 3/1) sand; very weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

C—8 to 42 inches, brown (10YR 5/3) sand; common, medium, distinct, reddish-brown (5YR 4/4) mottles; single grain; loose; neutral.

The A1 horizon ranges from 6 to 10 inches in thickness and to very dark brown in color. In some areas the texture of the C horizon is loamy sand.

Winterfield soils are better drained and not so gray as Evart soils. Winterfield soils are coarser textured than either Ceresco or Cohoctah soils.

Use and Management of the Soils

This section explains the system of capability classification used by the Soil Conservation Service and describes the management of the soils by capability units. Then predicted average acre yields of the principal crops are given, and management of the soils for woodland and engineering purposes is discussed.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

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

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

Capability Classes, the broadest 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. (None in Gladwin County.)

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, range, woodland, or wildlife.

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

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

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

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

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

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–1 or IIIe–4. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Gladwin County are described and suggestions for the use and management of the soils are given. The Arabic numerals used in this survey are not consecutive, because not all the capability units used in Michigan are represented in Gladwin County.

In this soil survey, symbols made up of Arabic numerals and small or capital letters follow the symbols of each capability unit. These symbols in parentheses identify the management group or groups, all or portions of which are represented by the soils in the capability unit. These management groups are part of a statewide system used in Michigan for making recommendations

about applications of lime and fertilizer, about drainage, and about other practices. For an explanation of this classification, refer to "Fertilizer Recommendations for Michigan Crops" (*4*).

Management by Capability Units

In the pages that follow, the capability units in Gladwin County are described and suggestions for the use and management for all the soils of each unit are given. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all soils of a given series appear in the unit. The names of all soils in any given capability unit can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Capability unit IIe–1 (1.5a)

Nester loam, 2 to 6 percent slopes, is the only soil in this unit. It is well drained or moderately well drained. The subsoil and underlying material of this soil are moderately fine textured.

Water moves moderately slowly through this soil. Available moisture capacity is high. Fertility is moderate, and content of organic matter is low to medium.

Wheat, rye, hay, and corn are the main crops grown on this soil. Management is needed that provides for controlling runoff and erosion and for maintaining tilth and the content of organic matter.

This soil dries out and warms up more slowly in spring than soils of coarser texture. As a result, planting and harvesting dates are delayed. Plowing in fall permits earlier planting in spring, but excessive erosion is likely if plowing is done in fall. Tilth can be improved and erosion reduced by keeping tillage to a minimum; using terraces, stripcropping, and grassed waterways; and adding green manure and fertilizer. Slopes are short and complex in many places, however, and make the laying out and building of terraces and contour strips difficult.

Capability unit IIe–3 (3/2a)

This unit consists of level or gently sloping, well drained and moderately well drained soils of the Ubly series. The subsoil in these soils is moderately coarse textured and is underlain by medium-textured material.

Water moves through these soils at a moderately slow to moderately rapid rate. Available moisture capacity is moderate. During extremely droughty seasons, however, the supply of moisture is not adequate for crop growth. Runoff is slow, but these soils seldom are excessively wet.

Corn, oats, wheat, hay, and potatoes are the common crops grown on these soils. Management is needed that provides for controlling erosion, for conserving moisture, and for maintaining fertility and content of organic matter.

Soils in this unit are easy to till within a wide range of moisture content. They can be tilled early in spring, and they dry out quickly after a rain. These soils warm up more rapidly in spring than finer textured soils. The surface layer seldom crusts, especially if tillage is kept to a minimum and all organic material is plowed under. Minimum tillage also helps to control erosion and to maintain good tilth. The use of terraces, stripcropping, and contour tillage also helps to control erosion. Keeping cover crops on the soils in winter provides organic matter and helps to control soil blowing and water erosion.

On these acid soils, lime is needed for good growth of legumes and other crops.

Capability unit IIw–2 (1.5b, 1.5c)

In this unit are somewhat poorly drained to very poorly drained soils in the Bowers, Hettinger, Kawkawlin, and Sims series. These soils are nearly level and level, and some areas are in shallow depressions. The subsoil and underlying material are moderately fine textured. Unless these soils are artificially drained, the water table is at or near the surface.

During wet periods water stands in wet depressional areas and delays planting and cultivating. Runoff is slow to ponded, and available water capacity and fertility are high. In areas undrained, these soils warm up and dry out slowly in spring. During wet periods the soils are saturated because water moves down through the soil moderately slowly.

Excessive wetness, the hazard of frost, and the maintenance of good tilth are the major limitations of these soils for crops. If adequately drained, however, these soils are well suited to crops. Drainage prevents small grains from drowning or from growing rank and falling down before harvest. Farm machinery readily bogs down in these soils, and planting, controlling weeds, and harvesting therefore are difficult. These soils are in low-lying areas, and crops are damaged by frost in some years. Corn on these soils is readily damaged by excessive wetness.

In many places natural outlets for drainage are lacking, and ditches are needed. Drainage is impractical in other areas because no outlet is available or the position in the landscape is too low. Tile drains can readily be installed, and tile trenches generally do not cave in before the tile is installed. Diversion terraces are needed above areas of these soils to keep runoff water from saturating them. If these soils are farmed when wet, they puddle readily, their good tilth is destroyed, they become cloddy and hard when dry, and they crust readily. The crust keeps new seedlings from emerging, and the plants die.

Crusting can be reduced and tilth and workability can be improved by returning crop residues to the soils and turning under green-manure crops. Plowing in fall permits earlier planting in spring and also improves tilth.

Capability unit IIw–3 (1.5b)

Kawkawlin loam, 2 to 6 percent slopes, is the only soil in this unit. It is somewhat poorly drained. The subsoil and underlying material are moderately fine textured.

Runoff is slow on this soil, and water ponds in many depressions. The water table is high, but it fluctuates and is near the surface in spring. Available moisture capacity and fertility are high. Many areas are too wet in spring or after a rain to support farm machinery.

If drained, this soil is well suited to the crops commonly grown in the county. If tilled while wet, however, the soil puddles, becomes cloddy and hard when dry, and forms a crust. Tilth then is poor, and the crust hinders the growth of new seedlings. Stony areas of this soil are not suited to crops but can be used for pasture. Removing the stones is impractical in most areas.

Because of the undulating slopes, drainage is difficult to install and apply on these soils. In many areas only random layout of tile and surface drains is suited. In some areas, however, adequate outlets for drainage are lacking. Because this soil is stable, ditchbanks and tile trenches need little maintenance.

Returning large amounts of crop residues to the soils and turning under green-manure crops improve tilth and help to reduce crusting of the surface layer. Keeping tillage to a minimum also reduces soil damage.

Capability unit IIw-4 (2.5b, 2.5c)

This unit consists of somewhat poorly drained or poorly drained soils of the Londo and Parkhill series. Most of these soils are nearly level, but some are gently sloping. The subsoil and underlying material are medium textured.

Water moves at a moderate or moderately slow rate through these soils. Runoff is slow, and water ponds in depressions. The supply of moisture generally is adequate for optimum growth of plants. Because of the fluctuating high water table, these soils are excessively wet in spring and after rain. After these soils are drained and dry out, they are easy to work and tilth is good.

If these soils are properly drained, they are suited to most crops commonly grown in the county. In a few areas, however, relief is undulating, and a complete drainage system is difficult to install. Where adequate outlets are available, random tile drains and surface drains can be used to provide drainage. The soils are stable, and tile trenches and open drains seldom cave in.

The kind of forage crops that can be grown on these soils depends on the degree of drainage or wetness. The content of organic matter can be maintained and a good stand of plants can be grown by plowing under all green-manure crops and crop residues. Adding lime and fertilizer benefits most crops.

Capability unit IIw-6 (3b, 3c)

In this unit are level and nearly level, somewhat poorly drained to very poorly drained soils in the Brimley, Bruce, and Lacota series. Except for the Lacota soils, which are underlain by sand, these soils have medium-textured subsoil and underlying material.

Water moves through these soils at a moderate rate. Runoff is slow, and water ponds in depressions. The supply of moisture generally is adequate for optimum growth of crops. Available moisture capacity is moderately high or high, and fertility is high. Because of a fluctuating high water table, these soils are excessively wet in spring and after a rain. After these soils are drained and dry out, they are easy to farm.

If these soils are drained, they are suited to most crops commonly grown in the county. Where outlets are available, tile and surface drains can be used to provide drainage. Installing tile drains is difficult in some areas because the silty and sandy material caves into the tile and trenches readily. The Lacota soils are especially unstable when wet. Back filling the trenches with organic material or surface soil helps to prevent the silty and sandy material from flowing into and plugging tile drains.

The kind of forage crops that can be grown depends on the degree of drainage or wetness. The content of organic matter can be maintained and the chance of obtaining good stands of plants can be improved by plowing under all green-manure crops and crop residues. Adding fertilizer benefits most crops.

Capability unit IIw-8 (3/1c, 3/2b, 3/2c)

In this unit are level to gently sloping, somewhat poorly drained to very poorly drained sandy loams in the Belding, Breckenridge, and Munuscong series. The soils that are poorly drained and very poorly drained are level to depressional. The subsoil and underlying material of the soils in this unit is medium textured to fine textured.

Water moves through the upper part of these soils moderately or moderately rapidly, but it moves moderately slowly to very slowly through the finer textured underlying material. Runoff is very slow or slow, and water ponds in depressions. Available moisture capacity is moderate, and fertility is medium for most of the soils. Unless these soils are drained, the water table is near the surface in spring.

If the soils in this unit are drained, they are suited to most crops commonly grown in the county. Excessive wetness is the major hazard if these soils are used for crops. Tile and surface drains can be used to remove excess water and permit tillage earlier in the season. Areas that have uneven relief are more difficult to drain than level soils, but random tiles and surface drains can be used to remove excess water from undulating areas. The depth and spacing of the tiles depends on the depth to the finer textured material. In some places sand pockets cause caving in of tile trenches. Installing tile therefore is easiest during dry periods.

In some years crops in low-lying areas are damaged by frost. The result is reduced growth and uneven stands. If these soils are drained, they are suited to forage crops. The kind of forage crops that can be grown depends on the degree of drainage attained.

Capability unit IIs-1 (1a, 1.5a)

This unit consists of level or gently sloping, well drained and moderately well drained soils in the Nester and Ontonagon series. These soils have a surface layer of loam or sandy loam. The subsoil is moderately fine textured or fine textured. The Nester loam is underlain by clay loam, the sandy substratum Nester soil by sandy material, and the Ontonagon loam by clay.

Water moves moderately slowly or slowly through these soils, and runoff is slow. Wet spots occur in many areas. These soils dry out slowly in spring because of the slow runoff and moderately slow or very slow permeability. Wetness delays planting in some years. Available moisture capacity of these soils is moderately high or high, and fertility is medium.

These soils are suited to most crops commonly grown in the county. The Ontonagon soils are somewhat wet and have poorer tilth than the other soils in this unit and are no so well suited to crops. Clods form if these soils are plowed or cultivated when wet. Keeping tillage to a minimum and turning under all crop residues and green-manure crops help to maintain tilth and the content of organic matter. Fertilizer is needed for good growth of crops on these soils.

Capability unit IIIe–4 (1a, 1.5a, 3/2a)

This unit consists of well drained and moderately well drained soils in the Nester, Ontonagon, and Ubly series. Most of these soils are sloping, but some are gently sloping. A few areas are eroded, and in some areas the soils are gravelly or stony. The subsoil and underlying material of the Nester soil are moderately fine textured, but they are fine textured in the Ontonagon soil. The Ubly soil has a moderately coarse textured subsoil and medium-textured underlying material.

Because of the slopes, runoff is rapid on these soils and erosion is a hazard. Available moisture capacity is moderate to high, and fertility is moderate. The content of organic matter is low in eroded soils. The eroded soils are in poor tilth and runoff is greater than on the uneroded soils.

The soils in this unit are suited to corn, small grains, and hay. Management is needed that controls runoff and erosion, maintains tilth and content of organic matter, and renews fertility. The soils in this unit puddle readily if they are worked when too wet. The surface tends to crust, especially on the eroded soils, and makes germination of seeds difficult and stands of plants uneven. A few spots in low areas and on steep slopes are wet, but these can be drained by random tile drains.

A cropping system that helps control runoff and erosion is one that includes row crops for no more than 2 consecutive years and provides for a high percentage of close-growing crops. In areas that are row cropped, the soils are likely to be droughty because much of the rainfall runs off. Close-growing crops on the other hand protect the soil and permit continuous use. The soils in this unit have short, complex slopes that make contour stripcropping and layout and construction of terraces difficult. Contour farming is feasible in only a few areas.

Capability unit IIIe–9 (4a, 4/2a)

In this unit are sloping, well drained and moderately well drained sands and loamy sands in the Mancelona, Menominee, and Montcalm series. These soils are on uplands. The Menominee soils are underlain by clay loam, the Mancelona by stratified sand and gravel, and the Montcalm by sand. Most areas are not eroded or are only slightly eroded, but a few small areas are moderately eroded or severely eroded. The Montcalm soils erode more readily than the other soils in this unit.

Water moves rapidly or moderately rapidly through most of these soils. It moves moderately slowly through the lower part of Menominee soils because the material is finer textured. Available moisture capacity is low or moderate, and fertility is low to medium. Runoff and sandy texture make the supply of moisture short in these soils during the dry summer months.

These soils are easy to work, but they erode readily when cultivated intensively. If crops are planted up and down the slope, water runs off rapidly and moisture needed for growth of plants is lost. Soil blowing also is a hazard if large areas are exposed by tillage. The soils in the small eroded areas have a lower content of organic matter than those in the uneroded areas, and they are more droughty. All the soils in this unit warm up early in spring, however, and are ready for planting sooner than finer textured soils.

The hazard of erosion and the shortage of soil moisture limit use of these soils for crops. Crops that have shallow roots cannot attain optimum growth in dry years and are not so suitable as crops that have deep roots, such as alfalfa. Small grains are suitable because they normally mature before the amount of moisture in the soil becomes short.

Erosion can be controlled and the soils can be used more intensively if tillage is kept to a minimum, and stubble mulching and stripcropping are used. In some areas slopes are not continuous, and stripcropping is difficult or impractical. Grassed waterways can be used to carry surplus water along natural drainageways without damage to the soils. Maintaining a grass cover in waterways is difficult, however, on the coarsest textured soils of this unit.

Plowing under crop residues, green-manure crops, and barnyard manure improves the content of organic matter and reduces the risk of erosion and drought. Adding large amounts of fertilizer in dry years may not justify the cost because not enough moisture is available in the soil to mature the crops.

Capability unit IIIw–2 (1b, 1c)

In this unit are somewhat poorly drained to very poorly drained loams and silty clay loams of the Pickford and Rudyard series. These soils have a clayey subsoil. Most of these soils are level or depressional, but some are gently sloping. Unless they are artificially drained, the water table is near the surface of these soils in spring.

Permeability of these soils is very slow, and water stands on the surface of the level or depressional areas for long periods. Available moisture capacity is moderately high. Fertility is moderately high or high, and the content of organic matter is moderate to high.

Wetness and restricted permeability severely limit use of these soils for crops. The clayey subsoil and high water table hinder penetration of plant roots. Crops in low areas also are likely to be damaged by frost. Farm machinery bogs down in these soils when they are wet. As a result planting, cultivating, and harvesting are difficult.

If drainage is provided, the soils of this unit are well suited to the crops commonly grown in the county. Because the soils are rich in organic matter, however, small grains on these soils are likely to grow rank and lodge. Tile or surface drains or a bedding system can be used to provide drainage. When drained, planting can be done earlier in spring on these soils and the crops will have a better chance to reach maturity.

These soils can be kept in good tilth by plowing in fall at the right moisture content. This practice also permits earlier tillage of the soils the following spring. Plowing under organic material improves movement of water into the soil and allows water to move more readily to the tile drains.

Capability unit IIIw–5 (4b)

This capability unit consists of level to undulating soils that are somewhat poorly drained. These soils are in the Gladwin, Ingalls, Otisco, and Wainola series. They

are coarse textured throughout. The Gladwin soils are underlain by stratified sand and gravel, and the Otisco soils are underlain by loamy sand.

All of the soils in this unit have a seasonal high water table unless they are artificially drained. When the water table is lowered, water moves moderately rapidly to very rapidly through these sandy soils and they dry out quickly. Consequently, if these soils are drained, they tend to be droughty in dry summer months. Natural fertility is moderately low in these soils, and content of organic matter is low.

Excessive wetness, moderately low fertility, and shortage of moisture during extreme droughts limit use of these soils for crops. Soil blowing also is a hazard. Soils of this unit, however, support farm machinery better than more clayey soils, and machinery seldom bogs down in them.

If drainage is provided, the soils of this unit can be tilled earlier in spring and after a rain and are suited to the crops commonly grown in the county. Tile drains or surface drains can be used. The sandy material readily caves into tile trenches and ditches. Tile drains therefore are most easily placed during dry periods. Lack of adequate outlets and uneven relief make artificial drainage impractical in some areas. In the undulating soils random surface drains or tile drains can be used to provide drainage.

Small grains normally mature before soil moisture is in short supply. They therefore grow better on these soils during dry periods than corn. Crops on these soils are more likely to benefit if small amounts of fertilizer are applied at frequent intervals than if a large amount is added at one time.

Capability unit IIIw–6 (4c)

In this unit are level or depressional soils that are poorly drained and very poorly drained. These soils are in the Burleigh, Deford, Epoufette, and Wheatley series. They formed in coarse textured and moderately coarse textured material.

These soils are saturated in spring because of a high water table. When the water table lowers, however, water moves very rapidly to moderately rapidly through the soils. Runoff is very slow, and water ponds on the surface in depressions and flats. These soils are mainly sandy, and they are droughty where drained. Natural fertility is low to medium.

Corn, small grains, and hay are the chief crops grown on these soils. The kind of crops grown depends on the amount of drainage. Undrained areas are suited to pasture or to forage plants that tolerate wetness.

Tile drains and open ditches can be used to remove excess water and improve these soils for crops. Ditchbanks and tile trenches cave in readily when the soils are wet. Installing tile drains and digging of ditches are best done, therefore, during dry periods. Controlling drainage helps to regulate the amount of moisture available to plants.

The quality and growth of crops can be improved by adding fertilizer and organic material. Keeping tillage to a minimum helps to decrease the chance of soil blowing.

Capability unit IIIw–7 (4/1b)

This unit consists of nearly level to gently sloping, somewhat poorly drained soils in the Allendale series. These soils consist of 18 to 42 inches of coarse-textured material over fine-textured material.

Water moves rapidly through the upper sandy layers of these soils, but it moves very slowly through the finer textured underlying material. Available moisture capacity is low. Fertility is low or moderately low. Runoff is slow, and water ponds in low depressions in wet periods.

These soils are saturated in spring and after a rain because of a seasonal high water table and the slowly to very slowly permeable underlying material. If drained, these soils generally dry out quickly and are droughty but support farm machinery well. In a few areas stones on the surface hinder tillage. Soil blowing is a hazard if large areas are left bare by tillage.

The soils in this unit are suited to the crops commonly grown in the county. In dry years small grains grow better than such crops as corn because they mature before the supply of moisture becomes short. Adding large amounts of fertilizer in dry years is not likely to justify the cost, because not enough moisture is available for the crops to mature.

Tile drains and open ditches can be used in these soils to provide adequate drainage. When these soils are wet, however, the sandy material readily caves into the trenches and ditchbanks also cave in. The installing of tile drains and the digging of ditches therefore are best done when the soils are dry. In some areas drainage is impractical because outlets are not available. Constructing diversion terraces on adjacent higher lying areas keeps runoff off these soils and allows the soils to dry out more quickly.

If large areas of these soils are farmed, stripcropping or windbreaks are needed for control of soil blowing. Returning large amounts of crop residues and green manure is a way to improve tilth and absorption of water. Keeping tillage to a minimum leaves the surface rough and resistant to erosion.

Capability unit IIIw–8 (4/1c)

In this unit are level or depressional, poorly drained and very poorly drained soils in the Pinconning series. These soils are coarse textured in the upper 18 to 42 inches and are fine textured below.

Water moves rapidly through the sandy upper part of these soils, but it moves very slowly through the finer textured lower part. Runoff is very slow or ponded. Available moisture capacity and fertility are low.

These soils are saturated because of the high water table and the very slowly permeable underlying material. If drained, these soils dry out quickly and become droughty in dry periods. Because the soils are in low-lying areas, frost is a hazard to crops in spring and in fall and prevents crops from maturing in some years. In years when rainfall is excessive, harvesting is delayed.

If these soils are drained, they can be used for crops or pasture. Many areas presently are undrained because suitable outlets are lacking or the areas are not farmed. Also, many areas remain in woodland.

These soils dry out slowly in spring, and tillage therefore is delayed. Tile drains and open ditches can be used to provide drainage. The sandy material caves in readily when wet, however, and installing tile and digging ditches are best done in dry periods. Depth and spacing of the tile drains depends on depth to the fine-textured underlying material. Building diversions on adjacent higher soils diverts water from these soils and allows them to dry out sooner.

Small grains generally mature before soil moisture becomes short. They therefore are a more dependable crop on these soils than crops that mature late in summer. Ways of improving crop growth and conserving moisture during dry periods are using minimum tillage, adding organic materials, and applying fertilizer.

Capability unit IIIw-9 (4/2b)

In this unit are nearly level to gently sloping, somewhat poorly drained soils in the Iosco series. These soils are coarse textured in the upper 18 to 42 inches and moderately fine textured below.

Water moves rapidly through the upper sandy layers of these soils, but it moves moderately slowly through the finer textured underlying material. Runoff is slow, and water ponds in low depressions in wet periods. Available moisture capacity is low. Fertility is low or moderately low.

These soils are saturated in spring and after a rain because of a seasonal high water table and the moderately slowly permeable underlying material. If drained, these soils generally dry out quickly and are droughty but support farm machinery well. In a few areas stones on the surface hinder tillage. Soil blowing is a hazard if large areas are left bare by tillage.

The soils in this unit are suited to the crops commonly grown in the county. In dry years small grains grow better than such crops as corn because they mature before the supply of moisture becomes short. Adding large amounts of fertilizer in dry years is not likely to justify the cost, because not enough moisture is available for crops to mature.

Tile drains and open ditches can be used in these soils to provide drainage. The sandy material caves into the trenches when wet, however, and ditchbanks also cave in. The installing of tile drains and the digging of ditches therefore are best done during dry periods. Drainage is impractical in some areas because outlets are not available. Constructing diversion terraces on adjacent higher lying areas keeps runoff off these soils and allows them to dry out more quickly.

If large areas of these soils are farmed, stripcropping or windbreaks are needed for control of soil blowing. Returning large amounts of such organic materials as crop residues and green manure to the soils improves tilth and absorption of water. Keeping tillage to a minimum leaves the surface rough and resistant to erosion.

Capability unit IIIw-10 (4/2c)

This unit consists of level or depressional, poorly drained and very poorly drained soils in the Brevort series. These soils are coarse textured in the upper 18 to 42 inches and moderately fine textured below.

Water moves rapidly through the sandy upper part of these soils, but it moves moderately slowly through the finer textured lower part. Runoff is very slow or ponded. Available moisture capacity and fertility are low.

These soils are saturated because of the high water table and the moderately slowly permeable underlying material. If drained, these soils dry out quickly and are droughty in extremely dry periods. Because the soils are in low-lying areas, frost is a hazard to crops in some years. In years when rainfall is excessive, harvesting is delayed.

If these soils are drained, they can be used for crops or pasture. Many areas presently are undrained because adequate outlets are lacking or because the areas are not farmed. Also, many areas remain in woodland.

These soils dry out slowly in spring, and tillage therefore is delayed. Tile drains and open ditches can be used to provide drainage. They can be installed more easily during dry periods than in wet periods because when the sandy material is wet it caves in more readily. Depth and spacing of the tile drains depends on the depth to the moderately fine textured underlying material. Building diversions on adjacent higher soils diverts water from these soils and allows them to dry out sooner.

Small grains generally mature before soil moisture becomes short. They therefore grow better on these soils than crops that mature late in summer. Ways of improving crop growth and conserving moisture during dry periods are using minimum tillage, adding organic materials, and applying fertilizer.

Capability unit IIIw-11 (5c)

In this unit are poorly drained or very poorly drained soils that formed entirely in sandy material. These soils are in the Kinross and Roscommon series.

Runoff is very slow on these soils, and water ponds in depressions. Available moisture capacity is very low, and fertility is low. The water table is near the surface unless these soils are artificially drained. If they are drained, water runs very rapidly through these soils. The water table then is too low to provide sufficient moisture for good crop growth during extreme drought.

These soils seldom are planted to crops because they are saturated, or if drained, they have very low available moisture and low fertility and are subject to soil blowing. The Kinross soil is very strongly acid. Outlets for drainage are lacking in many areas. Ditches therefore must be dug to provide outlets. When tile drains are installed, the sandy material flows into and plugs the tile and also is likely to cave into tile trenches. Ditchbanks also cave in readily and gradually fill with soil material.

These sandy soils are droughty after they are drained. Controlling drainage helps to regulate the moisture content of the soil and assures adequate moisture for crops in dry summer months. Because these soils occur in low-lying areas, frost is a hazard to crops and prevents them from maturing in some years. Soil blowing is a hazard if large areas are left bare by tillage.

Capability unit IIIs-3 (4a, 4/2a)

This unit consists of nearly level to gently sloping, well drained and moderately well drained soils in the Mancelona, Manistee, Menominee, and Ocqueoc series. These

soils have a friable surface layer and a coarse-textured subsoil, underlain by coarse-textured to fine-textured material.

Runoff is slow on these soils. Available moisture capacity and fertility are low to moderate. The content of organic matter and nitrogen is low. The supply of moisture in the soils seldom is adequate for optimum growth of crops. The Manistee and Menominee soils, however, have slightly higher available moisture capacity than the other soils because underlying their coarse-textured subsoil is moderately fine textured or fine textured material.

The soils in this unit are easy to farm. They are suited to most crops commonly grown in the county, though deep-rooted forage plants and crops that resist drought and mature early are better suited than other crops. Corn, small grains, hay, potatoes, and beans are the major crops.

Water erosion is seldom a hazard, but soil blowing is a serious hazard if these soils are farmed intensively. In cultivated areas suitable methods of controlling erosion are keeping tillage to a minimum and the use of windbreaks and stripcropping. Adding organic matter helps to improve fertility and the content of organic matter. If the supply of moisture is adequate, crop growth can be improved by adding fertilizer. In dry years, however, not enough moisture is available for crops to mature, and adding large amounts of fertilizer does not pay.

Capability unit IIIs–4 (4a, 4/2a)

This unit consists of sloping or gently sloping, well drained and moderately well drained soils on uplands. These soils are in the Mancelona, Menominee, Montcalm, and Rousseau series. Except for the Menominee and Mancelona, loamy substratum, all of the soils are coarse textured to a depth of 5 feet or more. Menominee soils consist of 18 to 42 inches of coarse-textured material, over moderately fine textured material. Mancelona, loamy substratum, soils consist of 42 to 66 inches of coarse-textured material over medium- to fine-textured material.

Runoff is slow on these soils, and water erosion seldom is a hazard. Water moves rapidly or moderately rapidly through most of these soils. Fine-textured material in the Menominee soils, however, restricts the downward flow of water and keeps them more moist than the other soils in this unit. The Rousseau soils are more droughty and are more subject to soil blowing than the other soils in this unit.

The soils of this unit generally are filled to capacity with moisture at the start of the growing season. As the season progresses, however, rainfall is not adequate to replenish the water used by plants. During dry periods crops are short of water, and during extreme drought growth of crops is poor. The soils are easy to work throughout a wide range of moisture content without clodding or crusting. Excessive tillage increases the hazard of soil blowing.

Most crops commonly grown in the county can be grown on these soils. Corn, small grains, hay, potatoes, and beans are the chief crops. Crops that resist drought and mature early in the season are better suited than other crops.

Keeping tillage to a minimum and use of windbreaks and stripcropping are ways of controlling soil blowing in cropped areas. Turning under large amounts of crop residues, green-manure crops, or barnyard manure increases water absorption, fertility, and content of organic matter. Adding large amounts of fertilizer in dry years is not likely to justify the cost, because the soils lack the moisture needed for crops to mature.

Capability unit IVe–1 (1.5a)

In this unit are moderately steep or hilly, well drained or moderately well drained soils in the Nester series. Some areas are eroded. The subsoil and underlying material are moderately fine textured.

Water moves down through these soils at a moderately slow rate. Available moisture capacity is high, and fertility is moderate. Runoff is rapid and is greater on the moderately eroded soils than on the uneroded ones. The eroded soils are difficult to work.

The soils in this unit are generally too steep to be used intensively for crops. The chief crops grown are small grains and hay.

Using a cropping system that includes close-growing crops for a long period, keeping tillage to a minimum, and use of stripcropping are ways of reducing runoff and the hazard of erosion. Adding large amounts of organic matter improves tilth and also reduces runoff. Grassed waterways can be used to carry water safely along natural drainageways and reduce soil washing. During dry years crop growth is low because much of the rainfall runs off and little is stored in the soil for use by plants.

In many areas stripcropping is impractical on these soils because the slopes are complex and short. Runoff and erosion can be reduced in these areas if a cropping system is used that includes a large proportion of close-growing crops.

Capability unit IVe-9 (4a)

In this unit are moderately steep or hilly, well drained or moderately well drained sandy soils on uplands. These soils are in the Mancelona and Montcalm series. Most of these soils are coarse textured to a depth of 5 feet or more. The Mancelona soils, however, are underlain by stratified sand and gravel. The soils are mostly uneroded or are slightly eroded, but a few areas are moderately eroded.

Water moves moderately rapidly through most of these soils. Runoff is rapid, and the supply of moisture in the soils is short in summer. Available moisture capacity is moderate.

These soils are easy to work, but use of farm machinery is limited on some steep slopes. Erosion is a serious hazard in areas that are cropped. The eroded soils have a lower content of organic matter and fertility than the uneroded or slightly eroded soils and are likely to be more droughty. Soil blowing is a hazard where large areas are left exposed by tillage.

The hazard of erosion and the shortage of moisture severely limit use of these soils for crops. Shallow-rooted crops cannot attain optimum growth in dry years. Small grains are better suited than other crops because they mature before soil moisture is short.

Keeping tillage to a minimum and use of stubble mulch and stripcropping are ways of controlling erosion. In

many areas slopes are not continuous. Here tillage is difficult and conservation measures are hard to install. Erosion can be effectively controlled by keeping a cover of grass on these soils. Overgrazing should be avoided to prevent gullies from forming. If organic materials and fertilizer are applied, stands of plants are improved and provide a better protective cover for the soils. Adding large amounts of fertilizer in dry years is not likely to justify the cost because soil moisture is inadequate for crops to mature.

Capability unit IVw–2 (5b, 5b–h)

This unit consists of nearly level or level, coarse-textured, somewhat poorly drained to poorly drained soils in the Au Gres, Ogemaw, and Saugatuck series. Au Gres, loamy substratum, is underlain by medium-textured to fine-textured material at a depth between 42 and 66 inches. The Ogemaw and Saugatuck soils have a cemented hardpan in the subsoil. In addition the Ogemaw soils are underlain by fine-textured material at a depth between 18 and 42 inches.

These soils formed under a fluctuating high water table, and they are excessively wet in spring. In Au Gres, loamy substratum, and in the Ogemaw soils, movement of water downward is restricted by finer textured material. A cemented layer further restricts downward movement of water in the Ogemaw and Saugatuck soils and makes them saturated in spring and after a rain. If drainage is provided, the water table is lowered and then water moves rapidly through the sandy material. Water runs off these soils slowly and ponds in depressions. Available moisture capacity is very low or low and fertility is low. Soil blowing is a hazard in large areas that are cleared and cropped.

Use of these soils for crops is severely limited by excessive wetness, low fertility, low available moisture capacity, and the hazard of soil blowing. Also, the cemented layer in Ogemaw and Saugatuck soils restricts growth of roots. In dry summer months, plants on these soils cannot make use of supplies of moisture deep in the soil.

Drainage is difficult on soils of this unit because the sandy material caves into tile trenches and open ditches. Tile therefore is best installed in dry periods when the sandy material is less likely to cave in. Unless special care is taken to prevent sand from flowing into the tile, sandy material is likely to fill the tile drains. Ditchbanks also cave in readily and are difficult to maintain and vegetate. The soils in this unit are droughty when the water table is lowered by drainage. Controlling drainage helps to maintain the content of moisture at the best level for crop growth.

These soils are easy to work after they are drained. The use of stripcropping and windbreaks reduces the risk of erosion and allows more intensive use of the soils for crops. Fertility and content of organic matter are difficult to maintain in these sandy soils. If drainage is provided and the soils otherwise are well managed, crops on these soils respond well to fertilizer. Adding large amounts of fertilizer in dry years, however, is not likely to justify the cost, because soil moisture is not adequate for crops to mature. These soils are acid, and some crops on them are improved if lime is added.

Capability unit IVs–4 (5a, 5/2a)

In this unit are level to undulating or gently sloping soils that are well drained or moderately well drained. These soils are in the Chelsea, Croswell, and Rubicon series. They are coarse textured to a depth of 42 inches or more. The Rubicon, loamy substratum soils, however, are underlain by medium-textured to fine-textured material at a depth between 42 and 66 inches.

Water moves through these sandy soils rapidly or very rapidly, and little water runs off. Available moisture capacity and fertility are low. The amount of moisture in the soils seldom is adequate for good growth of crops, especially in dry summer months. Drought affects these soils sooner than other soils in the county. During extremely dry years, such shallow-rooted crops as corn cannot obtain enough moisture to mature.

Use of these soils for crops is severely limited by low fertility and available moisture capacity and the hazard of soil blowing. In a few areas hay, oats, and potatoes are grown.

These sandy soils blow readily when exposed by tillage, and control of erosion is necessary. Crops that grow best are those that mature early in the season before the amount of moisture in the soil gets short. Forage crops grow well early in the season, but lack of soil moisture in the dry summer months reduces their growth. Keeping tillage to a minimum helps reduce the loss of soil moisture through evaporation. Lime and fertilizer are needed for legumes and many other crops. Adding large amounts of fertilizer in dry years, however, is not likely to justify the cost, because the soils lack sufficient moisture for crops to mature.

Capability unit Vwc–1 (Mc, M/Mc, M/3c, M/4c)

This unit consists of very poorly drained organic soils in the Carbondale, Edwards, Houghton, Linwood, Lupton, Loxley, Markey, and Tawas series. These soils are in level or depressional areas that are subject to ponding. The Edwards soils formed in 12 to 42 inches of organic material over marl, and the Carbondale, Houghton, and Lupton soils formed in organic material more than 42 inches thick. The organic material in which the Linwood, Loxley, Markey, and Tawas soils formed was 12 to 42 inches thick over mineral material of variable texture.

Available moisture capacity is very high in these soils, but fertility is low. The content of organic matter is high. Supplies of phosphorus, potassium, and of many micronutrients are low.

These soils have a high water table and are saturated most of the year. Because these soils occupy low areas, they remain cold and dry out slowly, even when drained. Frost is a serious hazard to crops. Soil blowing damages soils and crops and fills ditches with soil material.

Most areas of these soils are not farmed because of wetness, low fertility, and the frost hazard. In many places the lack of suitable outlets makes drainage difficult or impractical. Other areas could be drained, but crop growth would not justify the cost.

Capability unit Vw–3 (L–2c, L–4c)

This unit consists of level, well-drained to very poorly drained soils in the Ceresco, Cohoctah, Evart, and Win-

terfield series. These soils are on bottom lands and are subject to flooding. They formed in stratified material laid down by water and range from mainly coarse textured to moderately fine textured.

Use of these soils for crops is severely limited by the hazards of flooding and frost and a high water table. Many areas are small because of a meandering stream and are impractical to farm. Areas of these soils are suited to pasture when they dry out and are not flooded.

Capability unit VIe–1 (1.5a)

In this unit are moderately steep to steep, well drained and moderately well drained soils in the Nester series. These soils are on uplands. Their subsoil and underlying material are moderately fine textured. They are slightly eroded to severely eroded.

Runoff is rapid on these soils, especially on the severely eroded ones. The eroded soils generally are in poor tilth and crust readily when dry. Available moisture capacity is high, and fertility is moderately high. Fertility and content of organic matter are lower on the severely eroded soils than on the uneroded or moderately eroded soils.

Steep slopes, poor tilth, rapid runoff, and limitations in use of farm machinery severely limit use of these soils for crops. Forage crops are suited. These soils can be used for pasture if erosion is controlled. Gullies form if the pastures are overgrazed.

The severely eroded soils of this unit need more careful management than the less eroded ones. Adding fertilizer helps to replace fertility lost through erosion.

Capability unit VIs–1 (5a)

Chelsea sand, 6 to 12 percent slopes, is the only soil in this unit. It is well drained and is coarse textured throughout.

This soil dries out quickly, and soil moisture is deficient during dry summer months. It is easy to till, but because of its loose structure it erodes readily. Available moisture capacity and fertility are low. The content of organic matter is low and is quickly depleted by tillage.

The slight hazard of erosion and low fertility and soil moisture are the chief factors limiting use of these soils for crops and pasture. Shallow-rooted crops grow poorly on these soils. In extremely dry years crops cannot obtain enough moisture to mature. The hazard of erosion can be reduced by keeping a protective cover of vegetation on the soils. Pasture and forage plants grow well early in the growing season, but they dry up when soil moisture is depleted during the dry summer months. Planting trees helps to control erosion and also provides habitat for wildlife.

Capability unit VIIs–1 (5a, 5.3a, 5.7a)

In this unit are well drained and moderately well drained, nearly level to steep soils of the Chelsea, Grayling, and Rubicon series. These soils are mostly sandy.

Available water capacity and fertility are low in most places, but the range is from low to very low. Content of organic matter is low, and the organic matter decomposes rapidly when the soils are farmed. The hazard of erosion is severe.

These soils are not suited to crops. Pasture plants on these soils dry up quickly during the hot summer months and furnish little forage for livestock. In places stones on the surface interfere with tillage. In some areas steep slopes restrict the use of farm machinery.

Predicted Yields

Table 2 gives predicted average acre yields of the principal crops grown in Gladwin County under two levels of management. These predictions are based on interviews with farmers, on data obtained from the staff of the Michigan Agricultural Experiment Station, and on observations made by Soil Conservation Service personnel and other agricultural workers who are familiar with the soils and crops of the county.

In columns A are average yields obtained under the management common in the county when the soil survey was made. Lime is applied, although in many places in minimum amounts. Some commercial fertilizer is applied but generally not enough to obtain optimum yields. Barnyard manure that is produced on the farm is returned to the soil. Some artificial drainage measures have been installed. Wetness is still a problem in low areas, and more drainage is needed. In most areas a cropping system is used that includes a mixture of legumes and grasses. The cropping system used on steep and sandy soils includes longer periods of legume-grass mixtures than that used on more nearly level finer textured soils. Minor attention is given to small details of management, and timeliness of farm operations is such that yields are reduced by a few poor stands, seeding failures, and harvesting losses.

In columns B are average yields obtained under improved management. Under improved management the amounts of lime and fertilizer used are based on soil tests and kinds of crop grown. Where wetness is a limitation a complete drainage system is installed. Adapted varieties of plants and seeds of high quality are planted. Other conservation practices are used, where needed, to control erosion and to conserve moisture. The cropping systems used are adapted to the soils. Close attention is given to small details of management, and timeliness of farm operations is such that yields are not reduced by a few poor stands, seeding failures, or harvesting losses.

The predicted yields may vary as much as 30 percent from season to season because of fluctuating weather. Some white beans and sugar beets are grown on a limited acreage. The acreage is small, however, and these crops are not listed in table 2.

Woodland [3]

Gladwin County originally was covered almost entirely by trees. Pines and northern hardwoods grew on the uplands, and swamp hardwoods and conifers grew on the lowlands and bottom lands. Cutting of the pines began in about 1860 and continued until about 1900. Then, the hardwoods were cut. Most of the cuttings were made for lumber.

About 60 percent of the land area of the county is now in woodland. Farmers and other individuals own about

[3] By Ronald Wilson, woodland conservationist, Soil Conservation Service.

TABLE 2.—*Predicted average yields per acre of principal crops under two levels of management*

[Yields in columns A are those expected for management common to the county; those in columns B are obtained under improved management. Absence of information means that the soil or soil association is not suited to the crop, or that the crop ordinarily is not grown on it]

Soil	Corn (grain)		Corn (silage)		Oats		Wheat		Mixed hay		Alfalfa or alfalfa-brome hay	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*
Allendale sand, 0 to 4 percent slopes	35	65	6	11	35	60	22	45	1. 6	2. 8	2. 0	3. 5
Allendale-Pinconning-Pickford association	30	65	5	11	30	50	17	35	1. 3	2. 2	1. 6	2. 8
Au Gres sand, 0 to 2 percent slopes	25	45	4	8	20	40	16	25	1. 0	1. 7	1. 3	2. 1
Au Gres sand, loamy substratum, 0 to 2 percent slopes	25	45	4	8	20	40	16	25	1. 0	1. 7	1. 3	2. 1
Au Gres-Kinross association												
Au Gres-Kinross loamy substratum association												
Au Gres-Roscommon association	25	45	4	8	21	42	14	25	1. 0	1. 8	1. 2	2. 2
Belding sandy loam, 0 to 2 percent slopes	45	85	8	14	40	70	28	50	1. 8	3. 2	2. 2	4. 0
Belding sandy loam, 2 to 6 percent slopes	45	85	8	14	40	70	28	50	1. 8	3. 2	2. 2	4. 0
Belding sandy loam, clayey subsoil variant	45	75	8	13	40	68	25	40	1. 8	2. 8	2. 2	3. 5
Bowers silt loam, 0 to 4 percent slopes	45	80	8	13	40	75	27	43	1. 8	2. 8	2. 3	3. 5
Bowers-Iosco-Hettinger association	45	80	8	13	40	75	27	43	1. 8	2. 8	2. 2	3. 5
Breckenridge sandy loam	50	80	7	14	42	70	25	45	1. 2	2. 8	1. 5	3. 5
Brevort loamy sand	25	65	4	10	25	45	15	30	1. 0	1. 8	1. 2	2. 2
Brevort sandy loam	25	65	4	11	25	45	15	30	1. 0	1. 8	1. 2	2. 2
Brimley silt loam, 0 to 4 percent slopes	50	85	9	14	40	70	27	42	1. 6	2. 4	2. 0	3. 0
Bruce very fine sandy loam	50	80	9	13	40	75	27	45	1. 7	2. 7	2. 1	3. 3
Bruce-Brimley-Burleigh association	45	75	8	12	35	70	24	40	1. 6	2. 4	2. 0	3. 0
Burleigh loamy sand	38	70	7	12	35	65	22	35	1. 4	2. 4	1. 8	3. 0
Carbondale muck									1. 0	2. 2		
Ceresco loam												
Chelsea sand, 0 to 6 percent slopes	20	40	3	7	18	35	13	22	1. 0	1. 6	1. 2	2. 0
Chelsea sand, 6 to 12 percent slopes									1. 0	1. 6	1. 2	2. 0
Chelsea sand, 12 to 18 percent slopes									. 8	1. 5	1. 0	1. 8
Chelsea-Au Gres association	25	45	4	8	20	40	16	25	1. 0	1. 7	1. 3	2. 1
Chelsea-Rubicon association, undulating												
Chelsea-Rubicon association, rolling												
Cohoctah loam												
Croswell sand, 0 to 6 percent slopes	25	55	4	9	25	45	15	25	1. 0	1. 8	1. 2	2. 3
Croswell stony sand, 0 to 6 percent slopes												
Croswell-Au Gres association	25	50	4	8	22	42	15	25	1. 0	1. 8	1. 2	2. 2
Croswell-Au Gres-Kinross association	25	50	4	8	22	42	15	25	1. 0	1. 8	1. 2	2. 2
Croswell-Au Gres-Roscommon association	25	50	4	8	22	45	15	25	1. 0	1. 8	1. 2	2. 2
Edwards muck												
Epoufette sandy loam	38	70	7	12	35	50	22	35	1. 4	2. 4	1. 8	3. 0
Epoufette-Tawas association												
Evart loamy sand												
Evart-Winterfield association												
Gladwin loamy sand, 0 to 2 percent slopes	35	65	6	11	32	52	22	33	1. 2	2. 1	1. 5	2. 6
Gladwin loamy sand, loamy substratum, 0 to 2 percent slopes	35	65	6	11	32	52	22	33	1. 2	2. 1	1. 5	2. 6
Gladwin-Epoufette association	35	65	6	11	30	50	22	33	1. 3	2. 2	1. 6	2. 8
Gladwin-Epoufette-Croswell association, undulating	30	60	5	10	27	45	20	30	1. 2	2. 1	1. 5	2. 6
Grayling sand, 0 to 6 percent slopes												
Grayling association, rolling												
Grayling association, undulating												
Grayling-Croswell-Au Gres association	20	40	3	7	18	35	13	22	1. 0	1. 6	1. 2	2. 0
Hettinger loam	50	85	9	14	40	85	25	47	1. 9	3. 0	2. 4	3. 7
Hettinger-Brevort-Burleigh association	38	70	7	12	35	65	22	35	1. 4	2. 4	1. 8	3. 0
Houghton muck												
Ingalls sand, 0 to 2 percent slopes	30	55	5	9	30	50	20	32	1. 0	1. 7	1. 3	2. 1
Iosco loamy sand, 0 to 2 percent slopes	40	65	6	11	35	60	22	38	1. 6	2. 8	2. 0	3. 5
Iosco loamy sand, 2 to 6 percent slopes	40	65	6	11	35	60	22	38	1. 6	2. 8	2. 0	3. 5
Iosco stony sand, 0 to 2 percent slopes												
Iosco-Au Gres-Ingalls association	30	55	5	9	30	50	20	32	1. 2	2. 0	1. 5	2. 5
Iosco-Brevort association	30	65	5	11	30	55	20	35	1. 3	2. 2	1. 6	2. 8
Iosco-Brevort-Ingalls association	30	60	5	10	30	50	20	34	1. 2	2. 0	1. 5	2. 6
Iosco-Kawkawlin-Brevort association	30	70	5	12	35	65	25	40	1. 5	2. 6	1. 9	3. 3
Iosco-Menominee-Brevort association	30	65	5	11	35	50	20	33	1. 2	2. 1	1. 5	2. 6
Kawkawlin loam, 0 to 2 percent slopes	45	80	8	13	50	85	27	45	2. 0	3. 2	2. 5	4. 0
Kawkawlin loam, 2 to 6 percent slopes	45	80	8	13	50	85	27	45	2. 0	3. 2	2. 5	4. 0
Kinross sand												
Lacota sandy loam	50	85	9	14	40	85	25	47	1. 9	3. 2	2. 4	4. 0
Linwood muck												
Londo loam, 0 to 2 percent slopes	45	85	8	14	50	72	30	50	2. 5	3. 2	2. 7	4. 0
Londo loam, 2 to 6 percent slopes	40	80	7	13	45	68	25	45	2. 2	3. 2	2. 7	4. 0
Loxley muck, coarse substratum												

TABLE 2.—*Predicted average yields per acre of principal crops under two levels of management*—Continued

Soil	Corn (grain)		Corn (silage)		Oats		Wheat		Mixed hay		Alfalfa or alfalfa-brome hay	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons.*	*Tons*	*Tons*	*Tons*
Lupton muck												
Mancelona loamy sand, loamy substratum, 0 to 2 percent slopes	35	65	6	11	30	50	25	40	1. 6	2. 4	2. 0	3. 0
Mancelona loamy sand, loamy substratum, 2 to 6 percent slopes	35	65	6	11	30	50	25	40	1. 6	2. 4	2. 0	3. 0
Mancelona sand, 0 to 2 percent slopes	35	65	6	11	30	50	25	40	1. 6	2. 4	2. 0	3. 0
Mancelona sand, 2 to 6 percent slopes	35	65	6	11	30	50	25	40	1. 6	2. 4	2. 0	3. 0
Mancelona sand, 6 to 12 percent slopes	30	60	5	10	25	45	20	35	1. 6	2. 4	2. 0	3. 0
Mancelona sand, 12 to 25 percent slopes									1. 0	2. 2	1. 2	2. 7
Manistee sand, 0 to 4 percent slopes	30	55	5	9	35	60	23	35	1. 1	2. 3	1. 4	2. 9
Markey muck												
Menominee loamy sand, 0 to 2 percent slopes	30	65	5	10	35	50	20	30	1. 0	1. 6	1. 3	2. 0
Menominee loamy sand, 2 to 6 percent slopes	30	65	5	10	35	50	20	30	1. 0	1. 6	1. 3	2. 0
Menominee sand, 0 to 2 percent slopes	30	65	5	11	35	50	20	30	1. 0	1. 6	1. 3	2. 0
Menominee sand, 2 to 6 percent slopes	30	65	5	11	35	50	20	30	1. 0	1. 6	1. 3	2. 0
Menominee sand, 6 to 14 percent slopes	27	60	4	10	32	45	18	27	1. 0	1. 6	1. 3	2. 0
Montcalm loamy sand, 0 to 2 percent slopes	35	65	6	11	30	50	25	40	1. 6	2. 4	2. 0	3. 0
Montcalm loamy sand, 2 to 6 percent slopes	35	65	6	11	30	50	25	40	1. 6	2. 4	2. 0	3. 0
Montcalm loamy sand, 6 to 12 percent slopes	30	60	5	10	27	45	20	35	1. 6	2. 4	2. 0	3. 0
Montcalm loamy sand, 12 to 25 percent slopes									1. 4	2. 0	1. 8	2. 5
Munuscong sandy loam	30	70	5	12	35	50	25	35	1. 2	2. 4	1. 5	3. 0
Nester loam, 0 to 2 percent slopes	45	75	8	13	50	70	25	40	1. 8	2. 5	2. 3	3. 2
Nester loam, 2 to 6 percent slopes	45	75	8	13	50	70	25	40	1. 8	2. 5	2. 3	3. 2
Nester loam, 6 to 12 percent slopes	40	70	7	12	45	65	20	35	1. 8	2. 5	2. 3	3. 2
Nester loam, 6 to 12 percent slopes, eroded	35	65	6	11	40	60	18	30	1. 8	2. 5	2. 3	3. 2
Nester loam, 12 to 18 percent slopes	25	55	4	9	30	50	18	30	1. 8	2. 5	2. 3	3. 2
Nester loam, 12 to 18 percent slopes, eroded	25	55	4	9	30	50	18	30	1. 8	2. 5	2. 3	3. 2
Nester loam, 18 to 30 percent slopes									1. 6	2. 4	2. 0	3. 0
Nester loam, 18 to 30 percent slopes, eroded					25	45	15	30	1. 6	2. 4	2. 0	3. 0
Nester sandy loam, sandy substratum, 0 to 6 percent slopes	45	75	8	13	50	70	25	40	1. 8	2. 5	2. 3	3. 2
Ocqueoc sand, 0 to 2 percent slopes	35	65	6	11	30	50	20	30	1. 2	2. 0	1. 5	2. 6
Ogemaw sand												
Ontonagon loam, 0 to 2 percent slopes	35	65	6	11	45	60	23	35	1. 7	2. 4	2. 1	3. 0
Ontonagon loam, 2 to 6 percent slopes	35	65	6	11	45	60	23	35	1. 7	2. 4	2. 1	3. 0
Otisco loamy sand, 0 to 2 percent slopes	30	65	5	11	30	55	22	33	1. 2	2. 2	1. 5	2. 6
Parkhill loam	50	85	9	14	56	75	25	45	2. 0	3. 6	2. 5	4. 5
Pickford loam	35	80	6	13	45	75	27	40	1. 9	2. 8	2. 4	3. 5
Pickford silty clay loam	35	75	6	13	45	70	27	35	1. 9	2. 8	2. 4	3. 5
Pinconning loamy sand	25	65	4	11	25	45	15	30	1. 0	1. 8	1. 2	2. 2
Roscommon soils	25	48	4	8	22	45	12	25	1. 0	1. 8	1. 2	2. 2
Roscommon-Brevort-Tawas association	15	55	4	9	22	45	12	25	1. 0	1. 8	1. 2	2. 2
Roscommon-Deford association	30	55	5	9	25	55	18	30	1. 0	2. 0	1. 3	2. 5
Roscommon-Tawas association												
Rousseau fine sand, 2 to 12 percent slopes	20	45	4	8	18	35	18	26	1. 1	1. 8	1. 4	2. 3
Rubicon sand, 0 to 6 percent slopes												
Rubicon sand, 6 to 12 percent slopes												
Rubicon sand, 12 to 25 percent slopes												
Rubicon sand, loamy substratum, 0 to 6 percent slopes									1. 1	1. 8	1. 4	2. 2
Rubicon-Croswell association, undulating									1. 0	1. 6	1. 2	2. 0
Rubicon-Menominee association, undulating									1. 1	1. 8	1. 4	2. 2
Rubicon-Ocqueoc-Ingalls association, undulating	30	55	5	9	30	50	20	32	1. 1	1. 8	1. 4	2. 2
Rudyard loam 0 to 2 percent slopes	35	70	6	12	40	65	25	35	1. 8	2. 3	2. 2	3. 1
Rudyard loam, 2 to 6 percent slopes	35	70	6	12	40	65	25	35	1. 8	2. 3	2. 2	3. 1
Saugatuck sand												
Sims loam	50	85	9	14	45	75	25	47	1. 9	3. 0	2. 4	3. 7
Tawas muck									1. 4	1. 8		
Ubly sandy loam, 0 to 2 percent slopes	45	85	8	14	40	65	30	40	1. 8	2. 8	2. 2	3. 5
Ubly sandy loam, 2 to 6 percent slopes	45	85	8	14	40	65	30	40	1. 8	2. 8	2. 2	3. 5
Ubly sandy loam, 6 to 12 percent slopes	40	75	7	12	35	60	27	35	1. 8	2. 8	2. 2	3. 5
Wainola-Deford association	30	65	5	11	35	60	22	35	1. 0	2. 2	1. 3	2. 7
Wheatley loamy sand												

half of the woodland. State holdings total about 85,000 acres.

Forest cover types

The three major forest cover types in the county are (1) northern hardwoods, (2) aspen and white birch, and (3) pines. Swamp hardwoods and conifers are minor types in the county and occur on small tracts throughout the major forest types. The types of natural forest that develop depend largely on soil texture, drainage, and past management. Areas of these forest types generally coincide with the soil areas shown on the General Soil Map at the back of this survey.

Northern hardwoods.—This forest type consists chiefly of sugar maples, but varying quantities of beech, elm, and basswood trees are in the stands. In places red oak, white ash, and scattered yellow birch trees also occur. Northern hardwoods predominate on the well-drained, moderately coarse textured to fine textured soils, and in some places they grow on the well-drained, coarse textured soils. The northern hardwoods are important commercially. For example, sugar maple, one of the most common hardwoods, is valuable for saw logs and also for maple sugar.

Aspen and white birch.—Predominant species in the aspen type of forest cover are trembling (quaking) aspen and largetooth aspen, or white birch. Aspen occurs naturally in pure stands or in a mixture with most of the native pines and hardwoods. It is the most widespread of all forest types in Gladwin County and occurs throughout a wide range of soil conditions. Aspen stands are even aged and originated after extensive and severe logging and after fires. These aspen stands will be naturally replaced by pines and hardwoods. Aspen is important commercially for pulp, but stumpage values are low.

Pines.—The pine type of forest cover consists of pure or mixed stands of jack, red, or white pine. Most of these stands are in plantations. Natural jack and red pine stands are predominant on some of the well-drained sands and loamy sands. White pines are mixed with hardwoods on the well-drained sandy loams to clay loams. Pines are the most valuable trees for plantations because of their use for Christmas trees, posts, poles, sawtimber, and pulp.

Woodland suitability groups

The soils of Gladwin County have been placed in woodland suitability groups to provide a guide for woodland planning. Woodland groups are established on statewide basis, and some Michigan groups are not present in Gladwin County. Each group consists of soils that are similar in productivity, in management problems and response to management, and in requirements for conservation practices. Information is given in each group about the potential productivity for pine, spruce and fir, aspen and white birch, and hardwoods. Species priority, major limitations, and degree of limitations are given for each group.

The names of soil series represented are mentioned in the description of each woodland group, but this does not mean that all soils of a given series are in the group. The names of all soils in any given woodland group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Productivity.—The information in this survey on potential productivity for a given species of trees on a particular group of soils is based on an average annual growth rate of fully stocked, well-managed stands that have not been affected by special practices, such as artificial drainage or the adding of fertilizer. Fully stocked stands have the required amount of good growing stock required to produce maximum growth per acre. The number of trees in a fully stocked stand depends on the tree species and on the sizes and ages of the trees in the stand. Well-managed stands will sustain production and maintain full stocking. They are improved and harvested by timely and orderly cuttings and are protected from fire and livestock. Many of the stands in Gladwin County are overstocked with undesirable species, but sufficient quantities of desirable species generally are present to make management of the stands feasible.

Table 3 translates the terms used to indicate potential productivity into annual growth in board feet and cords per acre. The productivity ratings reflect, in part, the effects of soil, climate (particularly drought), insects, or disease that are associated with particular soils or are common to the area. They also reflect genetic influences and other common factors that affect the development of a stand of trees even under good management.

TABLE 3.—*Potential productivity ratings per acre per year for woodland types*

[<=less than]

Rating	Board feet	Cords
Very high	325–350	1. 5–1. 7
High	270–325	1. 0–1. 5
Medium	200–270	0. 6–1. 0
Low	125–200	0. 1–0. 6
Very low	<125	<0. 1

Species priority.—The information given on species priority for the different woodland suitability groups is based on the adaptability or tolerance, productivity, and commercial value of the predominant trees that grow on the soils of a particular group. The species are named in order of priority, the first species listed having the highest priority. The first species named for each of the woodland suitability groups should be given the most consideration when new plantings or improvement cuttings are made. The listings of species priorities do not reflect damages from diseases or insect infestations that have plagued certain localities.

Seedling mortality.—Unfavorable soil characteristics prevent the survival of some healthy natural or properly planted seedlings. A high water table, extreme acidity, droughtiness, and high soil temperature are some of the soil characteristics that cause some seedlings to die. A seedling mortality rating of *slight* indicates that ordinary losses from these causes are not more than 25 percent of the planted stock. A rating of *moderate* indicates that losses are between 25 and 50 percent of the planted stock. A rating of *severe* indicates that more than 50 percent of the trees in a planting are likely to die.

Plant competition.—When a site has been disturbed by fire, cutting, or other factors, and the soil is fertile and moist, undesirable species of brush, trees, and other plants may invade the site. This vegetation competes with and hinders the establishment and growth of desirable kinds of trees. A plant competition rating of *slight* indicates that invasion by undesirable trees does not impede the establishment or growth of natural or planted stands of the preferred kinds of trees. No special management to control competition is needed. A rating of *moderate* indicates that competing plants do not ordinarily prevent the establishment of adequate stands of desirable kinds of trees. Development of fully stocked stands may take longer. Establishment of seedlings is delayed, and early growth is slow. Management practices that eliminate or retard competition will speed up establishment and growth of seedlings. A rating of *severe* indicates that natural reestablishment of stands cannot be relied upon. Establishment of stands by tree planting is poor, unless competing vegetation is controlled.

Equipment limitations.—Some soil characteristics and topographic features, such as drainage, slope, number or size of stones, or soil texture, restrict or make impossible the use of equipment commonly used in woodland management and harvesting. Special equipment, special methods of equipment operation, or the use of equipment in only certain seasons may be necessary on some soils. An equipment limitation rating of *slight* indicates that there is no special problem in use of equipment. A rating of *moderate* indicates that not all types of equipment can be used; that there are short periods when equipment cannot be used, because of wetness or steep slopes; or that looseness of the soil makes hand planting and use of special logging techniques necessary. A rating of *severe* indicates that the type of equipment that can be used is very limited. Either the soil is so wet that equipment cannot be used for long periods of time, or the soil is so extremely steep or loose that the use of motorized equipment is dangerous and difficult. In some areas saw logs must be hauled from the slopes by a winch.

Erosion hazard.—It is possible to protect woodland from erosion and prevent excessive runoff by growing adapted species of trees, by adjusting the rotation age and cutting cycles, by laying out new plantings on the contour, and by careful construction and maintenance of roads, trails, and landings. When runoff is diverted from cultivated fields into wooded areas, the erosion hazard, the slope, and the ground cover in the woods should be such that gullies do not form. An erosion hazard rating of *slight* indicates that little or no erosion has taken place and can be prevented by normal management practices. A rating of *moderate* indicates that the soils are subject to some water or wind erosion, or both, and that excessive disturbance or removal of the forest litter should be avoided. A rating of *severe* indicates that the hazard of erosion is severe to very severe and that applicable erosion control measures, such as those already mentioned, should be used.

Windthrow hazard.—Soil characteristics, such as the presence of a high water table or a cemented subsoil layer, affect the development of tree roots, and in turn, determine the resistance of trees to the force of the wind. The degree of windthrow hazard is important in the choice of tree species for planting and in the planning of release or harvest cuttings. A windthrow hazard rating of *slight* indicates that the roots of the adapted species of trees develop normally and windthrow generally is not a problem. A rating of *moderate* indicates that the trees remain standing unless the wind velocity is high during the time the soil is excessively wet. A rating of *severe* indicates that the soil does not allow adequate rooting for stability of the trees or that the trees lack root firmness.

WOODLAND SUITABILITY GROUP A

Soils in this group are well drained or moderately well drained and are nearly level to sloping. They are in the Ubly series. Water moves through these soils moderately rapidly to moderately slowly. Available moisture capacity is moderate.

Northern hardwoods are best suited to this group of soils. Pines are next best suited. Fully stocked, well-managed stands of northern hardwoods normally grow more than 325 board feet per acre annually. Red pine is an excellent producer, but white pine was a more common component of the native vegetation. Aspen is well suited to the soils and responds well to management in well-stocked natural stands. Harvesting the aspen and converting the stands to hardwoods or pines generally is the most profitable plan of management in the long run.

White pine, red pine, and white spruce are the preferred species for planting. The preferred species in natural stands are sugar maple, basswood, red pine, and white pine.

Seedling mortality is slight, plant competition is moderate, equipment limitations are slight, erosion hazard is slight or moderate, and windthrow hazard is slight.

WOODLAND SUITABILITY GROUP B

This group consists of well drained or moderately well drained nearly level to very steep soils in the Nester and Ontonagon series. In most of these soils the subsoil and underlying material are moderately fine textured. The Nester, sandy substratum, soils are underlain by sandy material at a depth between 18 and 42 inches. In the Ontonagon soils the subsoil and underlying material are clayey. Water moves down through the soils at a moderately slow or very slow rate. Available moisture capacity is moderately high to high. Fertility is medium. Many of these soils have been cultivated in the past, and the degree of erosion ranges from slight to severe on them.

Northern hardwoods normally are better suited to these soils than other trees. Fully stocked, well-managed hardwoods generally have high or very high productivity. Aspen and white birch also have high or very high productivity, but pines have low productivity. Pines generally are not suited to this group of soils, and spruce trees do not grow naturally on them.

Conifers are the best trees for planting in open fields and for reestablishing a forest cover. Preferred species for planting are white spruce, Norway spruce, white pine, white-cedar, and Austrian pine. Preferred species for natural stands are sugar maple, basswood, white spruce, and yellow birch.

Seedling mortality is slight in native stands and moderate in planted stands, plant competition is moderate, equipment limitations are slight, erosion hazard is slight, and windthrow hazard is slight.

When planting seedlings or transplants, extra care is needed to pack the soil around the roots, to eliminate air pockets, especially when planting by machine. Plant competition generally does not prevent reestablishment of good hardwood stands, but the competition may delay and retard early growth.

On steep soils, hand planting is necessary. Gullied areas are difficult to plant unless the gullies are filled and the slopes stabilized. When trees are planted by machine, contour planting will help prevent erosion. Locating roads and skid trails on the contour in sloping areas also helps to prevent erosion. In sloping to steep areas excessive disturbance or removal of ground cover increases the erosion hazard. Logging is difficult on the steep soils.

WOODLAND SUITABILITY GROUP C

In this group are well drained or moderately well drained, level to steep soils in the Mancelona, Manistee, Menominee, Montcalm, Ocqueoc, Rousseau, and Rubicon series. In most of these soils, the surface layer, subsoil, and underlying material are coarse textured or moderately coarse textured. Manistee soils are underlain by clayey material, and Menominee soils are underlain by moderately fine textured material. Water moves through the soils at a moderately rapid to very rapid rate, but movement of water in the Menominee and Manistee soils is restricted by the finer textured underlying material. Available moisture capacity and fertility of the soils are moderate to low.

The productivity of pines and aspen growing on these soils is high or very high. Productivity of northern hardwoods is medium to high. An annual growth of approximately 300 board feet per acre can be expected on fully stocked, well-managed stands of red pine. Aspen is less valuable than pines or hardwoods.

Red pine has the highest priority for this group of soils. The preferred species in natural stands are red pine, sugar maple, and white pine. Preferred species for planting are white pine, red pine, and white spruce. Jack pine is preferred in areas that are severely eroded or gullied, or where erosion is a hazard.

Seedling mortality is slight in native or planted stands, plant competition is slight or moderate, equipment limitations are slight, erosion hazard is moderate, and windthrow hazard is slight.

On steep, stony, or gullied soils use of equipment is limited. Use of machine planters is not possible or practical in these areas, and hand planting is necessary. On the steep soils, the erosion hazard is moderate to severe. In such areas planting trees on the contour and locating logging and skid trails on the contour help to prevent erosion.

WOODLAND SUITABILITY GROUP E

Soils in this group are well drained or moderately well drained and are nearly level to steep. They are in the Chelsea and Croswell series. The surface layer, subsoil, and underlying material are coarse textured. Water moves down through the soils at a rapid or very rapid rate. Available moisture capacity and fertility are low. Soils in this group are among the most droughty and sandy in the county. Areas that have been farmed in the past are slightly to severely eroded and do not support natural stands of trees.

Productivity of hardwoods is low. Productivity of aspen, white birch, and pine is high.

Preferred species for planting on these soils are red pine, white pine, and jack pine. Preferred species in natural stands are white pine, red pine, and aspen.

Seedling mortality is slight in native and planted stands, plant competition is slight, erosion hazard is slight to moderate, and windthrow is slight.

Equipment limitations are slight for most of the soils, but use of equipment is restricted in some areas by steep slopes and the loose, sandy condition of the soils. Building roads and trails on the contour helps to control severe erosion and makes it easier to operate equipment.

WOODLAND SUITABILITY GROUP F

Soils in this group are somewhat poorly drained or poorly drained and are nearly level to gently sloping or undulating. They are the Au Gres; Belding, clayey subsoil variant; Gladwin; Ogemaw; Saugatuck; and Wainola. The Au Gres, loamy substratum, soils are underlain by medium-textured to fine-textured material at a depth of 42 to 66 inches. The Saugatuck and Ogemaw soils have a hardpan below the surface layer, and the Ogemaw and Belding, clayey subsoil variant, soils are underlain by fine-textured material at a depth of 18 to 42 inches. Water moves moderately to rapidly through the upper part of most of these soils but moderately slowly to very slowly through the finer textured material below. The hardpan of the Saugatuck and Ogemaw soils limits the growth of roots and the downward movement of water. Soils in this group formed under a fluctuating high water table, and as a result, they are saturated during spring and other wet periods.

Productivity of fully stocked, well-managed stands of pines and hardwoods is low or very low. Productivity of aspen, white birch, spruce, and fir is low or medium.

Tree plantings normally are not made on these soils. Plantings require special techniques, and considerable replanting is necessary. Preferred species for natural stands are aspen and spruce.

Seedling mortality is severe in native and planted stands, plant competition is severe, equipment limitations are severe, erosion hazard is slight, and windthrow hazard is moderate.

Natural regeneration will not always result in adequate restocking on these soils, and use of chemicals or girdling is needed to control the growth of undesired trees and brush. Plant competition often is severe. It slows the initial growth of desired species.

Aspen is severely affected by hypoxylon canker on the Au Gres and Arenac soils.

Use of equipment generally is restricted for less than 3 months each year by excessive wetness during spring and other wet periods. Tree roots are damaged in some areas by use of heavy equipment. Windthrow is a hazard on the Ogemaw and Saugatuck soils, especially when the removal of trees leaves openings in the tree canopy.

WOODLAND SUITABILITY GROUP G

This group consists of somewhat poorly drained, nearly level to sloping soils. These soils are in the Allendale, Belding, Brimley, Ingalls, Iosco, and Otisco series. They have a coarse textured or moderately coarse textured surface layer and subsoil. The Belding, Iosco, and Allendale soils are underlain by moderately fine textured or fine textured material. The Ingalls soils are underlain by stratified silt and very fine sand. Water moves through the upper part of the soil moderately rapidly to very rapidly, but it moves very slowly or moderately slowly through the finer textured material that underlies the Belding, Iosco, and Allendale soils. Available moisture capacity ranges from moderately low to moderately high. The soils in this group formed under a fluctuating water table and are saturated during spring and other wet periods.

Productivity of fully stocked and well-managed stands of pines and hardwoods is low. Productivity of aspen and white birch ranges from low to high, and productivity of spruce and fir ranges from medium to high.

Preferred species for planting in natural stands are white spruce, white pine, and yellow birch. If the site is drained, the preferred species for planting are white spruce, Norway spruce, white-cedar, and white pine.

Seedling mortality is slight to moderate in native stands, and moderate to severe in planted stands; plant competition is moderate or severe; equipment limitations are slight or moderate; and the erosion hazard is slight.

Removal of the overstory may prevent adequate stand establishment because of plant competition from brush and other plants. On some soils the competition may be so severe that natural regeneration does not provide adequate restocking. Maintenance planting is required on planted sites because of moderate or severe seedling mortality.

Use of heavy equipment is restricted or prevented during wet periods, which last for about 3 months each year. Erosion is seldom a hazard. The windthrow hazard generally is slight to moderate, but it is severe if large openings are left by harvesting. Controlled thinning in harvesting helps to prevent large openings and decreases the windthrow hazard.

WOODLAND SUITABILITY GROUP H

Soils of this group are well drained and are nearly level to steep. They are in the Rubicon series. The surface layer, subsoil, and underlying material are coarse textured. These soils are among the most droughty and sandy soils in the county. Water moves down through the soils very rapidly. Available moisture capacity is very low and fertility is low.

Productivity of pines on these soils is medium, productivity of hardwoods is very low, and productivity of aspen is low. Pines are best adapted to this group of soils. Annual growth of fully stocked, well-managed red pine stands is about 240 board feet per acre. Hardwoods are not so well suited as other trees, and their quality is very low. Annual growth of hardwoods is commonly less than 125 board feet per acre. Aspen is suited to these soils, but annual growth is only about 0.3 cord per acre.

Species priority of hardwoods and aspen is very low. If the soils are used for growing wood products, conversion of stands from hardwoods to pines eventually improves economic returns. Preferred species in natural stands and for planting are red pine, white pine, and jack pine.

Seedling mortality, plant competition, equipment limitations, erosion hazard, and windthrow hazard are all slight.

High soil temperatures, droughtiness, and cutting action of wind make establishment of planted seedlings somewhat difficult. Loss of seedlings, however, is less than 25 percent, and establishment is successful in most areas.

Use of equipment is restricted if the slope exceeds 18 percent. Placing roads and skid trails on the contour helps prevent erosion. Soil blowing is a potential hazard if the surface cover is removed from large areas of these soils.

WOODLAND SUITABILITY GROUP J

This group consists of very poorly drained soils of the Carbondale, Edwards, Houghton, Linwood, Loxley, Lupton, Markey, and Tawas series. In most places these soils are level, but in a few areas they are gently sloping or sloping. The soils are made up of organic material to a depth of 12 inches or more. Some of the soils are underlain by mineral material of various textures at a depth of 12 to 42 inches. Available moisture capacity is very high, and fertility is low. These soils formed under a high water table, and they are saturated most of the year.

No productivity ratings are available for these soils. Growth and species priority are governed mainly by depth to the water table and by the degree of saturation of the soil. Existing trees are lowland hardwoods and swamp conifers.

Seedling mortality is moderate in native stands, and severe in planted stands; plant competition and equipment limitations are severe; erosion hazard is slight; and windthrow hazard is severe.

On these soils timber production is extremely variable, and little information is available on potential productivity. Excessive moisture, severe plant competition, and the windthrow hazard make the planting of trees very difficult. Equipment limitations are severe because of the high water table and instability of the soils. Harvesting is limited to winter months when the soils are frozen. Because the soils are unstable and have a shallow rooting zone, windthrow is a severe hazard.

WOODLAND SUITABILITY GROUP N

Soils in this group are well drained, sandy, and nearly level to steep. They are in the Grayling series. Water moves through the soils rapidly. Available moisture capacity is very low and fertility is low. The soils in this group are the most droughty and sandy in the county.

Productivity for all tree species is very low because of high soil temperatures and low fertility and available moisture capacity. An annual growth of 0.1 cord of pine or aspen per acre and less than 125 board feet of pine per acre is typical for this group of soils. Jack pine and red pine seedlings have been planted successfully. Red pines are more thrifty than jack pines until they are 30 years old, but jack pines are more thrifty after 30 years.

Seedling mortality is severe because of high soil temperatures and droughtiness. Plant competition, equipment limitations, erosion hazard, and windthrow hazard are all slight, except that the use of equipment is restricted on slopes exceeding 18 percent. Disturbance of the surface litter by logging equipment can result in damage to the soil by soil blowing.

WOODLAND SUITABILITY GROUP O

This group consists of well drained to very poorly drained, nearly level soils on bottom lands along rivers. These soils are in the Ceresco, Cohoctah, Evart, and Winterfield series. They are subject to flooding for varying periods in spring and after a prolonged rain. These soils formed in stratified material that ranges from sand to clay loam in texture. Water moves through the soil at a rapid to moderate rate. Available moisture capacity and fertility range from low to high. Some of these soils have a flooding hazard, and some have a high water table and are saturated most of the year.

Productivity ratings are not available for this group of soils. Lowland hardwoods and swamp conifers commonly grow on the bottom lands in most places.

Seedling mortality is moderate in native stands, and severe in planted stands. Plant competition is severe, equipment limitations are moderate or severe, erosion hazard is slight, and windthrow hazard is severe.

Plant competition from brush and other plants is a moderate to severe limitation to regeneration of a stand if the overstory is removed. Natural regeneration is variable and sometimes results in scattered groups of trees. The amount and duration of flooding are major factors in the establishment of new stands.

Use of equipment is limited mainly by the hazard of flooding and by excessive wetness during wet periods. Equipment damages tree roots during wet periods.

WOODLAND SUITABILITY GROUP P

In this group are poorly drained or very poorly drained, nearly level soils of the Hettinger, Munuscong, Parkhill, Pickford, and Sims series. The subsoil and underlying material are moderately fine textured or fine textured in most of these soils. Water moves through the soil at a moderately rapid to very slow rate. Available moisture capacity ranges from moderate to high, and fertility ranges from medium to high. These soils are saturated much of the year because of a high water table. In some areas the water table has been lowered by artificial drainage, and the soils have better internal drainage as a result.

Productivity of fully stocked hardwood stands is low or very low. The annual growth rate is only 160 board feet or less per acre. Production of aspen, white birch, spruce, and fir ranges from low to medium. The annual growth of aspen and spruce is only about 0.3 to 0.8 cord per acre.

Trees generally are not planted on these soils. Species priority in natural stands is spruce, white-cedar, and balsam fir.

Seedling mortality, plant competition, equipment limitations, and windthrow hazard are all severe. The hazard of erosion is slight.

Plant competition prevents adequate immediate restocking of desired species by natural regeneration. Mortality of natural seedlings is severe, but seedlings are produced in large enough numbers to assure ultimate restocking.

The high water table restricts tree roots to the upper part of the soil, and this results in a severe hazard of windthrow. Use of equipment is limited for most of the year by wetness. Logging should be done during dry seasons or when the soil is frozen.

WOODLAND SUITABILITY GROUP Q

Soils of this group are poorly drained and very poorly drained and are in level areas or depressions. These soils are in the Kinross and Roscommon series. They formed in sandy material. Water moves very rapidly through the soils. Available moisture capacity is very low, and fertility is low. Because of a high water table, the soils are saturated for long periods.

Productivity of fully stocked, well-managed pines and hardwoods is very low. Annual growth is less than 125 board feet per acre. The annual growth of spruce, fir, and aspen is 0.1 cord per acre.

Trees commonly are not planted on these soils. Preferred species in natural stands are spruce, aspen, and red maple.

Seedling mortality is severe in native and planted stands, plant competition is moderate, equipment limitations are severe, erosion hazard is slight, and windthrow hazard is severe.

If tree plantings are made on these soils, they grow best if planted at the highest elevations or in areas that have been artificially drained. Roots are restricted to the upper layers of these soils because of a high water table, and a severe hazard of windthrow results.

Wetness of the soil restricts use of logging equipment, especially in spring and in other wet periods. Harvesting of trees is most practical during the driest periods or when the soils are frozen.

WOODLAND SUITABILITY GROUP W

This group consists of poorly drained or very poorly drained soils in the Breckenridge, Brevort, Bruce, Burleigh, Deford, Epoufette, Lacota, Pinconning, and Wheatley series. The subsoil and underlying material generally are coarse textured or moderately coarse textured, but the Breckenridge, Brevort, and Pinconning soils are underlain by moderately fine or fine textured material at a depth of 18 to 42 inches. Water moves very rapidly to moderately through most of these soils. It moves moderately slowly or very slowly, however, through the finer textured material of the Breckenridge, Brevort, and Pinconning soils. Available moisture capacity ranges from very low to moderately high. Fertility of most of the soils is low or moderately low but ranges to moderately high.

Pines are not suited to this group of soils, and productivity figures are not available. Productivity of hardwoods and aspen is very low or low, and annual growth is less than 125 board feet per acre. Aspen yields an average of 0.1 cord per acre per year. Productivity of swamp conifers, spruce, and white-cedar is low. Preferred

species in natural stands are white-cedar and spruce. Trees are seldom planted on these soils.

Seedling mortality, plant competition, equipment limitations, and windthrow hazard all are severe. The erosion hazard is slight.

Extensive site preparation is required before trees are planted on these soils. This includes lowering the water table and controlling plant competition. A high water table restricts the use of equipment in most areas. It also restricts the downward growth of tree roots and causes a severe windthrow hazard.

WOODLAND SUITABILITY GROUP Z

In this group are somewhat poorly drained, level or gently sloping soils. These soils are in the Bowers, Kawkawlin, Londo, and Rudyard series. The subsoil and underlying material are medium textured to fine textured. Water moves through the soils at a moderately slow or very slow rate. Available moisture capacity and fertility are moderately high or high. These soils formed under a fluctuating high water table, and they are saturated during spring and other wet periods.

Generally only aspen and hardwoods grow on these soils, and productivity for both kinds of trees is medium. Aspen has a very low species priority because of competition from hardwoods. Fully stocked, well-managed northern hardwood stands have an annual growth rate of about 240 board feet per year.

Planting of trees on these soils generally is not recommended. If planting is desired, white spruce or Norway spruce generally is given first priority. Preferred priority in natural stands is spruce and sugar maple.

Seedling mortality is moderate in native and planted stands, plant competition is severe, equipment limitations are moderate, erosion hazard is slight, and windthrow hazard is moderate.

Because of a fluctuating high water table, some special site preparation is needed to insure full stands. Chemical and mechanical control of undesired plants is needed to insure adequate stands of trees. Use of heavy equipment is restricted during wet seasons because the soils are unstable when wet. In winter the soils seldom freeze under thick blankets of snow. Windthrow is a hazard if large areas are opened by logging operations.

Engineering Uses of the Soils

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for storing water, structures for controlling erosion, drainage systems, and systems for disposing of sewage. Among the soil properties most important to engineers are permeability, shear strength, compaction characteristics, drainage, shrink-swell characteristics, grain size, plasticity, and reaction. Also important are depth to water table, flooding hazard, and relief. Such information is made available in this subsection. Engineers can use it to—

1. Make studies of soil and land use that aid in selecting and developing sites for industries, businesses, residences, and recreational facilities.
2. Make estimates of engineering properties for use in planning agricultural drainage structures, dams, and other structures for conserving soil and water; in locating suitable routes for underground conduits and cables; and in locating sites for sewage disposal fields.
3. Make preliminary evaluations of soil conditions that will aid in selecting locations for highways, airports, pipelines, and sewage disposal fields, and in planning detailed surveys of the soils at the selected locations.
4. Locate sources of sand, gravel, and other material for use in construction.
5. Correlate pavement performance with the soil mapping units and thus develop information that will be useful in designing and maintaining the pavements.
6. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
7. Determine suitability of soils for movement of vehicles and construction equipment.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

It should be emphasized that the interpretations made in this soil survey are not a substitute for the sampling and testing needed at a site chosen for a specific engineering work that involves heavy loads or at a site where excavations are to be deeper than the depths of the layers here reported. Also, engineers should not apply specific values to the estimates for bearing capacity given in this survey. Nevertheless, by using this survey, an engineer can select and concentrate on those soil units most important for his proposed kind of construction, and in this manner reduce the number of soil samples taken for laboratory testing and complete an adequate soil investigation at minimum cost.

The soil mapping units shown on the maps in this survey may include small areas of a different soil material. These included soils may be as much as 2 acres in size. They are too small to be mapped separately and generally are not significant to the farming in the area but may be important in engineering planning.

Information of value in planning engineering work is given throughout the text, particularly in the sections "Descriptions of the Soils" and "Formation and Classification of Soils."

Some of the terms used by the scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, and sand—may have special meaning in soil science. These and other special terms used in the soil survey are defined in the Glossary at the back of this survey. Most of the information about engineering is given in tables 4, 5, 6, and 7.

Engineering classification systems

Agricultural scientists of the United States Department of Agriculture classify soils according to texture. In some ways this system of naming textural classes is comparable to the systems most commonly used by engineers for classifying soils; that is, the system of

the American Association of State Highway Officials (AASHO) and the Unified system.

Most highway engineers classify soil material in accordance with the system approved by the American Association of State Highway Officials (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1 (gravelly soils having high bearing capacity, the best soils for subgrade), to A–7 (clayey soils having low strength when wet, the poorest soils for subgrade). Within each group the relative engineering value of the soil material is indicated by a group index number. Group index numbers range from 0 for the best material to 20 for the poorest. The group index number is shown for the tested soils in parentheses following the soil group symbol in table 4.

Some engineers prefer to use the Unified soil classification system (*9*). In this system soil materials are identified according to their texture, plasticity, and performance as construction material. Soil materials are identified as coarse grained (GW, GP, GM, GC, SW, SP, SM, and SC), fine grained (ML, CL, OL, MH, CH, OH), and highly organic (Pt). The last column in table 4 gives the classification of the tested soils according to the Unified system.

Engineering test data

Engineering test data for three series sampled from six locations in Gladwin County are given in table 4. These data were obtained from tests performed in accordance with the standard procedures of the American Association of State Highway Officials, in the laboratories of the Bureau of Public Roads.

The soil samples represented in table 4 were taken from selected horizons of the soils at representative sites. They do not represent the entire range of soil properties in the county, or even those properties within the three series sampled.

Both the AASHO and Unified classifications are listed in table 4. These classifications are based on data obtained by mechanical analyses and by tests to determine the liquid limit and the plastic limit. The mechanical analyses were obtained by the combined sieve and hydrometer method. Percentages of silt and clay determined by the hydrometer method should not be used in naming textural classes for soil classification. The information is useful, however, in determining general engineering properties of the soils.

The terms for texture used by soil scientists have different meanings to engineers. For example, to soil scientists clay refers to mineral grains less than 0.002 millimeter in diameter, but engineers frequently define clay as less than 0.005 millimeter in diameter. These and other terms used by soils scientists are defined in the "Soil Survey Manual" (*7*) and in the Glossary.

The tests for liquid limit and for plastic limit measure the effect of water on the consistency of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from the plastic state to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material passes 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 the soil material is in a plastic condition.

Engineering properties of the soils

In table 5 the soil series and the symbol for each mapping unit are listed and estimates of properties significant in engineering are given. The estimated properties are those of the typical soil. Where test data are available, that information was used. Where tests were not performed, the estimates shown are based on comparisons with the soils that were tested in Gladwin County and with similar soils tested in other counties.

Depth to the seasonal high water table is the maximum height to which the water table rises during the year. The estimates are for soil material that has not been artificially drained. In general, the information in the table applies to a depth of 5 feet or less. Depth from the surface normally is given only for the major horizons. Other horizons are listed if they have engineering properties significantly different from adjacent horizons. Because bedrock is at a great depth in this county and is not significant to engineering, depth to bedrock is not given in table 5.

The estimated classification according to the textural classification of the U.S. Department of Agriculture and according to the AASHO and Unified classification systems is given for each important layer. The figures showing the percentages of material passing through sieves Nos. 4, 10, and 200 are rounded off to the nearest 5 percent. The percentage passing the No. 200 sieve approximates the combined amount of silt and clay in the soil.

In the column showing permeability are estimates of the rate at which water moves downward through undisturbed soil material. The estimates are based mainly on texture, structure, and consistence of the soils.

Available water capacity, expressed in inches per inch of soil depth, refers to the capacity of soils to store water available for use by most plants. It is commonly defined as the difference between the percentage of soil water at field capacity and the percentage at wilting point.

Reaction as shown in table 5 is the estimated range in pH values for each major horizon of the soils as determined in the field. It indicates the acidity or alkalinity of the soils. A pH of 7.0, for example, indicates a neutral soil; a lower pH indicates acidity; and a higher value indicates alkalinity.

Shrink-swell potential refers to the change in volume of the soil that results from a change in moisture content. The estimates are based mainly on the amount and kind of clay in the soil.

Engineering interpretations

Engineering interpretations in this survey are given in tables 6 and 7. The data in these tables apply to the typical profile described for the soil series in the section "Descriptions of the Soils."

Table 6 gives the suitability of the soils as a source of topsoil, sand, gravel, road fill, and impermeable material and lists features that affect the use of soils in locating highways, foundations for low buildings, and

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TABLE 4.—*Engineering*

[Tests performed by the Bureau of Public Roads in accordance with standard

Soil name and location	Parent material	Bureau of Public Roads report No.	Depth	Mechanical analysis[1]		
				Percentage passing sieve[2]		
				3-in.	¾-in.	No. 4 (4.7 mm.)
Iosco loamy sand:			*Inches*			
SE corner sec. 2, T. 17 N., R. 2 W. (Modal.)	Silty clay loam.	S–41478	0–7	----------	----------	----------
		S–41479	9–13	100	99	90
		S–41480	21–26	100	99	89
		S–41481	26–32	100	95	70
		S–41482	32–45	----------	100	98
SW¼NW¼ sec. 7, T. 19 N., R.1 W. (Finer textured than the modal profile.)	Silty clay loam.	S–41489	0–7	100	99	95
		S–41490	7–13	100	96	88
		S–41491	13–21	100	93	83
		S–41492	25–60	----------	----------	100
Iosco sand:						
SE corner sec. 26, T. 17 N., R. 2 W. (Coarser textured than the modal profile.)	Loam.	S–41483	0–9	----------	100	98
		S–41484	9–18	----------	100	96
		S–41485	18–24	----------	----------	99
		S–41486	33–36	----------	----------	99
		S–41487	36–42	100	99	78
		S–41488	42–60	----------	----------	100
Mancelona loamy sand:						
400 ft. E. and 75 ft. S., NW corner NW¼SE¼ sec. 32, T. 20 N., R. 2 W. (Modal.)	Sand and gravel.	S–41493	0–7	100	95	80
		S–41494	7–25	100	97	84
		S–41495	25–30	100	94	78
		S–41496	30–60	----------	95	76
SE¼NW¼ sec. 16, T. 20 N., R. 2 W. (Finer textured than the modal profile.)	Sand and gravel.	S–41497	0–6	100	99	92
		S–41498	6–24	[6] 95	87	72
		S–41499	24–33	[7] 90	79	58
		S–41500	33–60	[7] 90	70	50
Mancelona sand:						
SW corner SE¼SE¼ sec. 18, T. 20 N., R. 1 W. (Coarser textured than the modal profile.)	Sand and gravel.	S–41501	0–6	100	90	85
		S–41502	6–22	100	98	94
		S–41503	22–25	[8] 85	76	64
		S–41504	25–60	[6] 95	91	83
Rudyard silty clay loam:						
SW¼SE¼ sec. 15, T. 17 N., R. 1 W. (Modal.)	Silty clay.	S–41505	0–7	----------	----------	----------
		S–41506	7–18	----------	----------	----------
		S–41507	19–35	----------	----------	----------
Rudyard loam:						
NE¼NE¼ sec. 23, T. 17 N., R. 1 W. (Coarser textured than the modal profile.)	Silty clay.	S–41508	0–9	----------	----------	----------
		S–41509	9–22	----------	----------	----------
		S–41510	22–35	----------	----------	----------

[1] Mechanical analyses according to the AASHO Designation T 88. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

[2] Based on total material. Laboratory test data corrected for amount discarded in field sampling.

[3] Based on AASHO Designation M 145–49 (*1*).

test data

procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [1]—Continued							Liquid limit	Plasticity index	Classification	
Percentage passing sieve [2]—Con.			Percentage smaller than—[2]						AASHO [3]	Unified [4]
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	89	15	12	9	5	3	[5] NP	[5] NP	A-2-4(0)	SM
86	70	9	8	6	5	4	NP	NP	A-3(0)	SP-SM
80	50	9	9	8	6	6	NP	NP	A-1-b(0)	SP-SM
53	33	7	6	5	4	3	NP	NP	A-1-b(0)	SW-SM
96	91	64	62	54	39	30	27	14	A-6(7)	CL
92	83	26	23	15	8	6	NP	NP	A-2-4(0)	SM
85	75	18	17	12	7	5	NP	NP	A-2-4(0)	SM
77	55	16	15	12	10	8	NP	NP	A-2-4(0)	SM
99	98	90	88	81	63	50	36	19	A-6(12)	CL
96	87	13	12	8	5	3	NP	NP	A-2-4(0)	SM
93	82	6	6	5	4	2	NP	NP	A-3(0)	SP-SM
98	92	3	2	2	2	1	NP	NP	A-3(0)	SP
98	90	5	5	5	5	5	NP	NP	A-3(0)	SP-SM
68	47	5	4	2	1	1	NP	NP	A-1-b(0)	SW-SM
99	88	39	37	34	29	25	27	14	A-6(2)	SC
70	48	13	13	11	7	5	NP	NP	A-1-b(0)	SM
75	52	7	7	6	4	3	NP	NP	A-3(0)	SW-SM
67	47	9	9	7	7	5	NP	NP	A-1-b(0)	SP-SM
65	40	3	3	3	3	3	NP	NP	A-1-b(0)	SP
86	61	12	12	9	5	4	NP	NP	A-2-4(0)	SW-SM
64	37	9	8	7	5	4	NP	NP	A-1-b(0)	SW-SM
50	32	14	13	10	7	7	23	S	A-2-4(0)	SC
42	29	7	7	5	3	2	NP	NP	A-1-b(0)	SW-SM
82	66	7	7	5	2	2	NP	NP	A-3(0)	SP-SM
91	61	5	5	4	3	2	NP	NP	A-3(0)	SP-SM
54	28	6	6	5	3	3	NP	NP	A-1-b(0)	SP-SM
79	65	2	2	2	2	1	NP	NP	A-3(0)	SP
100	98	86	84	78	57	42	48	22	A-7-6(14)	ML-CL
100	99	96	96	94	82	66	70	40	A-7-5(20)	CH
----------	----------	----------	100	98	86	64	56	31	A-7-6(19)	CH
100	96	43	42	38	28	19	24	10	A-4(2)	SC
100	99	87	86	80	71	54	60	36	A-7-6(20)	CH
----------	100	98	98	94	72	49	50	29	A-7-6(18)	CL

[4] Based on the Unified Soil Classification System (*9*). The Soil Conservation Service and Bureau of Public Roads have agreed that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. Examples of borderline classification thus obtained are ML-CL, SP-SM, and SW-SM.

[5] NP=nonplastic.

[6] Five percent discarded in field sampling.

[7] Ten percent discarded in field sampling.

[8] Fifteen percent discarded in field sampling.

TABLE 5.—*Estimated*

Soil series and map symbols	Depth to seasonal high water table [1]	Depth from surface	Classification: USDA texture
		Inches	
Allendale: AlB, AP (For properties of Pinconning and Pickford soils in unit AP, refer to their respective series in this table.)	1 to 2 feet.	0–29 29–48	Sand Clay
Au Gres: ArA, AsA,[3] AU, AV,[3] AW (For properties of Kinross soil in units AU and AV and of Roscommon soil in unit AW, refer to their respective series in this table.)	1 to 2 feet.	0–9 9–60	Sand Sand
Belding: BeA, BeB	1 to 2 feet.	0–8 8–23 23–48	Sandy loam Sandy loam Clay loam
Belding, clayey subsoil variant: Bf	1 to 2 feet.	0–21 21–31 31–48	Sandy loam Sandy clay loam Clay
Bowers: BgB, Bl (For properties of Iosco and Hettinger soils in unit Bl, refer to their respective series in this table.)	1 to 2 feet.	0–11 11–22 22–48	Silt loam Stratified silty clay loam, clay loam, and silt. Stratified silty clay loam, clay loam, and silt.
Breckenridge: Bm	Less than 1 foot.	0–8 8–30 30–48	Sandy loam Sandy loam Clay loam
Brevort: Bn, Bo	Less than 1 foot.	0–10 10–30 30–48	Loamy sand Sand Silt loam
Brimley: BrB	1 to 2 feet.	0–11 11–25 25–48	Silt loam Loamy fine sand and silt loam Stratified silt, fine sand, very fine sand, and some silty clay loam.
Bruce: Bs, BU (For properties of Brimley and Burleigh soils in unit BU, refer to their respective series in this table.)	Less than 1 foot.	0–13 13–26 26–48	Very fine sandy loam and fine sandy loam. Stratified fine sand, fine sandy loam, and silt loam. Stratified silt, fine sandy loam, loamy fine sand, and fine sand.
Burleigh: Bv	Less than 1 foot.	0–9 9–32 32–48	Loamy sand Sand Stratified very fine sand and silt
Carbondale: Ca	Water table at the surface.	0–48	Muck over peat
Ceresco: Cc	1 to 2 feet; subject to flooding.	0–8 8–40	Loam Stratified loam, silt loam, and sandy loam.
Chelsea: CdB, CdC, CdD, CG, CHB, CHC (For properties of Au Gres soil in unit CG and of Rubicon soil in CHB and CHC, refer to their respective series in this table.)	4 feet or more.	0–44 44–60 60–66	Sand Sand banded with loamy sand Sand
Cohoctah: Co	Less than 1 foot; subject to flooding.	0–18 18–40	Loam Stratified loam and fine sandy loam.
Croswell: CrB, CsB, CT, CU, CW (For properties of Au Gres soil in units CT, CU, and CW, of Kinross soil in CU, and of Roscommon soil in CW, refer to their respective series in this table.)	2 to 3 feet.	0–8 8–60	Sand Sand

See footnotes at end of table.

engineering properties

Classification—Continued		Percent passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH*	
SP or SM	A–3 or A–2	100	100	0–15	5. 0–10. 0	0. 03	5. 6–6. 5	Low.
CH	A–7	100	100	75–95	<0. 05	. 17	[2] 6. 6	High.
SP or SP–SM	A–3 or A–2	100	100	0–30	5. 0–10. 0	. 04	5. 6–6. 0	Low.
SP or SP–SM	A–3	100	100	0–10	5. 0–10. 0	. 03	5. 6–6. 5	Low.
SM	A–2	90–100	80–100	25–35	2. 5–5. 0	. 13	6. 1–6. 5	Low.
SM	A–2 or A–4	95–100	90–100	20–45	2. 5–5. 0	. 12	5. 6–6. 5	Low.
ML or CL	A–6	95–100	95–100	55–85	0. 2–0. 8	. 17	[2] 6. 1	Moderate.
SM, ML	A–2, A–4	95–100	90–100	25–55	2. 5–5. 0	. 13	6. 1–6. 5	Low.
SC	A–6	95–100	90–100	40–50	0. 8–2. 5	. 18	6. 6–7. 3	Moderate.
CH	A–7	100	95–100	70–95	<0. 05	. 17	(2)	High.
ML	A–4	100	100	70–90	0. 8–2. 5	. 17	6. 1–6. 5	Low.
CL or CH	A–6	100	100	70–95	0. 2–0. 8	. 2	6. 6–7. 3	Moderate to high.
CL	A–6	100	100	80–95	0. 2–0. 8	. 2	(2)	Moderate to high.
SM	A–2	95–100	90–100	25–35	2. 5–5. 0	. 13	6. 1–6. 5	Low.
SM	A–2 or A–4	95–100	90–100	25–40	2. 5–5. 0	. 12	6. 6–7. 3	Low.
CL or ML	A–6 or A–4	95–100	90–100	55–90	0. 2–0. 8	. 17	(2)	Moderate.
SM	A–2	95–100	90–100	15–25	5. 0–10. 0	. 06	6. 1–6. 5	Low.
SP or SM	A–3 or A–2	95–100	90–100	0–15	5. 0–10. 0	. 03	6. 6–7. 3	Low.
ML	A–4	95–100	90–100	65–90	0. 2–0. 8	. 2	(2)	Low.
ML	A–4	100	100	70–90	0. 8–2. 5	. 2	6. 1–6. 5	Low.
ML or SM	A–4	100	100	40–90	0. 8–2. 5	. 18	6. 1–6. 5	Low.
ML and SM	A–4 and A–2	100	100	20–80	0. 8–2. 5	. 16	(2)	Low.
SM	A–2 or A–4	100	100	15–45	0. 8–2. 5.	. 18	7. 4–7. 8	Low.
ML and SM	A–4 and A–2	100	100	25–70	0. 8–2. 5	. 18	7. 4–7. 8	Low.
ML and SM	A–4 and A–2	100	100	25–70	0. 8–2. 5	. 16	(2)	Low.
SM	A–2	100	100	15–25	5. 0–10. 0	. 06	6. 1–7. 8	Low.
SP or SM	A–3 or A–2	100	100	0–15	5. 0–10. 0	. 03	6. 1–7. 8	Low.
SM and ML	A–4	100	100	40–80	2. 5–5. 0	. 21	(2)	Low.
Pt	----------	----------	----------	----------	2. 5–5. 0	. 25	5. 6–7. 3	Variable.
ML	A–4	100	100	55–80	0. 8–2. 5	. 15	6. 6–7. 3	Low.
ML and SM	A–4 and A–2	95–100	90–100	30–75	0. 8–2. 5	. 2	7. 4–7. 8	Low.
SP, SP–SM	A–3 or A–2	100	95–100	0–15	5. 0–10. 0	. 03	5. 1–6. 0	Low.
SP with bands of SP–SM	A–2	100	95–100	10–35	5. 0–10. 0	. 07	5. 6–6. 0	Low.
SP	A–3	100	100	0–5	5. 0–10. 0	. 03	(2)	Low.
ML	A–4	100	95–100	55–80	0. 8–2. 5	. 15	7. 4–7. 8	Low.
ML and SM	A–4 or A–2	100	95–100	25–65	0. 8–2. 5	. 2	7. 4–7. 8	Low.
SP or SM	A–3 or A–1	100	100	0–15	>10	. 04	5. 1–5. 5	Low.
SP	A–3	100	100	0–5	>10	. 02	5. 6–6. 0	Low.

TABLE 5.—*Estimated*

Soil series and map symbols	Depth to seasonal high water table [1]	Depth from surface	Classification: USDA texture
		Inches	
Deford	Less than 1 foot.	0–18	Fine sand
(Mapped only in association with Roscommon or Wainola soil.)		18–28	Fine sand and loamy fine sand
		28–48	Fine sand
Edwards: Ed	Water table at the surface.	0–24	Muck
		24–50	Marl
Epoufette: Ep, ET	Less than 1 foot.	0–9	Sandy loam
(For properties of Tawas soil in unit ET, refer to Tawas series in this table.)		9–26	Loamy sand and gravelly sandy loam.
		26–48	Stratified gravel and sand
Evart: Ev, EW	Less than 1 foot; subject to flooding.	0–12	Loamy sand
(For properties of Winterfield soil in unit EW, refer to Winterfield series in this table.)		12–48	Sand
Gladwin: GhA, GlA [4], GE, GPB	1 to 2 feet.	0–8	Loamy sand
(For properties of Epoufette soil in GE and GPB and of Croswell soil in GPB, refer to their respective series in this table.)		8–18	Sand
		18–28	Gravelly sandy loam
		28–48	Stratified sand and gravel
Grayling: GrB, GSB, GSC, GU	4 feet or more.	0–48	Sand
(For properties of Au Gres and Croswell soils in unit GU, refer to their respective series in this table.)			
Hettinger: Hg, HB	Less than 1 foot.	0–8	Loam
(For properties of Brevort and Burleigh soils in unit HB, refer to their respective series in this table.)		8–18	Silty clay loam and silt loam
		18–48	Stratified silty clay loam, silt loam, and some clay and clay loam.
Houghton: Hu	Water table at the surface.	0–48	Muck and peat
Ingalls: IcA	1 to 2 feet.	0–30	Sand
		30–45	Stratified very fine and fine sand and silt.
Iosco: IdA, IoA, IoB, IA, IB, II, IK, IM	1 to 2 feet.	0–12	Loamy sand
(For properties of Au Gres soil in unit IA, of Brevort soil in IB, II, IK, and IM, of Ingalls soil in IA and II, of Kawkawlin soil in IK, and of Menominee soil in IM, refer to their respective series in this table.)		12–30	Sand and loamy sand
		30–60	Silty clay loam
Kawkawlin: KaA KaB	1 to 2 feet.	0–16	Loam
		16–26	Heavy clay loam
		26–48	Clay loam
Kinross: Kr [5]	Less than 1 foot.	0–2	Peaty sand
		2–42	Sand
Lacota: La	Less than 1 foot.	0–9	Sandy loam
		9–28	Clay loam
		28–50	Sand
Linwood: Lm	Water table at the surface.	0–23	Muck and peat
		23–48	Clay loam
Londo: LoA, LoB	1 to 2 feet.	0–12	Loam and sandy loam
		12–22	Light clay loam
		22–48	Loam
Loxley: Lr	Water table at the surface.	0–20	Muck and peat
		20–48	Sand
Lupton: Lu	Water table at the surface.	0–48	Muck and peat

See footnotes at end of table.

engineering properties—Continued

Classification—Continued		Percent passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH*	
SM	A-2	100	100	15-25	5. 0-10. 0	0. 25	6. 1-6. 5	Low.
SM	A-2	100	100	15-35	5. 0-10. 0	. 07	6. 6-7. 3	Low.
SP-SM and SM	A-3 and A-2	100	95-100	5-25	5. 0-10. 0	. 06	(2)	Low.
Pt					2. 5-5. 0	. 25	7. 4-7. 8	Variable.
					<0. 05	. 23	(2)	Variable.
SM	A-2	95-100	90-100	15-35	2. 5-5. 0	. 13	6. 6-7. 3	Low.
SM	A-2	75-85	75-80	15-35	2. 5-5. 0	. 12	6. 6-7. 8	Low.
SP or SP-SM	A-1	55-80	50-70	0-10	>10. 0	. 02	(2)	Low.
SM	A-2	90-100	80-100	15-30	2. 5-5. 0	. 09	6. 1-6. 5	Low.
SP or SP-SM	A-3	95-100	80-100	0-10	5. 0-10. 0	. 03	6. 6-7. 3	Low.
SM	A-2	95-100	90-100	10-20	5. 0-10. 0	. 08	6. 6-7. 3	Low.
SP or SP-SM	A-3	95-100	90-100	0-10	5. 0-10. 0	. 02	6. 6-7. 3	Low.
SM	A-2	75-90	70-80	15-30	2. 5-5. 0	. 12	7. 4-7. 8	Low.
SP	A-1	55-80	50-70	0-5	>10. 0	. 02	(2)	Low.
SP or SP-SM	A-3	100	95-100	0-10	5. 0-10. 0	. 03	5. 1-6. 0	Low.
ML	A-4	100	100	60-80	0. 8-2. 5	. 18	6. 6-7. 3	Low.
CL	A-6	100	100	80-95	0. 2-0. 8	. 2	7. 4-7. 8	Moderate.
CL	A-6	100	100	80-95	0. 2-0. 8	. 2	(2)	Moderate.
Pt					2. 5-5. 0	. 25	5. 6-6. 5	Variable.
SP or SM	A-3 or A-2	100	100	0-15	5. 0-10. 0	. 05	5. 6-6. 5	Low.
Layers of SP or ML	A-4 and A-2	100	100	25-70	2. 5-5. 0	. 21	7. 4-7. 8	Low.
SM	A-2	95-100	90-100	15-25	5. 0-10. 0	. 08	5. 6-6. 0	Low.
SP or SM	A-3 or A-2	95-100	90-100	0-15	5. 0-10. 0	. 05	5. 6-6. 5	Low.
CL	A-6	95-100	90-100	75-90	0. 2-0. 8	. 2	(2)	Moderate.
ML	A-4	90-100	80-100	55-80	0. 8-2. 5	. 18	5. 6-6. 0	Low.
CL	A-6 or A-7	95-100	90-100	70-85	0. 2-0. 8	. 18	6. 1-6. 5	Moderate.
CL	A-6	95-100	90-100	65-80	0. 2-0. 8	. 18	(2)	Moderate.
SP or SM	A-3 or A-2	100	100	0-15	>10. 0	. 16	4. 5-5. 0	Low.
SP	A-3	100	100	0-5	>10. 0	. 02	4. 5-5. 5	Low.
SM	A-2	95-100	85-100	25-35	2. 5-5. 0	. 18	7. 4-7. 8	Low.
CL	A-6	95-100	85-100	60-80	0. 2-0. 8	. 18	7. 4-7. 8	Moderate.
SP or SP-SM	A-3 or A-2	95-100	80-100	0-10	5. 0-10. 0	. 05	7. 4-7. 8	Low.
Pt					2. 5-5. 0	. 25	5. 6-6. 5	Variable.
CL	A-6	95-100	95-100	60-85	0. 2-0. 8	. 15	7. 4-7. 8	Moderate.
ML and SM	A-4	95-100	90-100	35-70	0. 8-2. 5	. 16	6. 1-6. 5	Low.
CL	A-6	90-100	85-100	70-80	0. 2-0. 8	. 18	6. 6-7. 3	Moderate.
ML-CL	A-4	85-95	85-90	60-70	0. 2-0. 8	. 16	(2)	Low.
Pt					2. 5-5. 0	. 25	<4. 5	Variable.
SP or SP-SM	A-3	95-100	90-100	0-10	5. 0-10. 0	. 04	<4. 5	Low.
Pt					2. 5-5. 0	. 25	6. 6-7. 8	Variable.

TABLE 5.—*Estimated*

Soil series and map symbols	Depth to seasonal high water table [1]	Depth from surface	Classification
			USDA texture
		Inches	
Mancelona: MaA, MaB, MaC, MaE, McA,[6] McB[6]	4 feet or more.	0–8	Loamy sand
		8–32	Loamy sand and gravelly sandy loam.
		32–60	Stratified sand and gravel
Manistee: MdB	3 feet or more.	0–12	Sand
		12–31	Sand
		31–48	Clay
Markey: Me	Water table at the surface.	0–26	Muck
		26–48	Loamy sand
Menominee: MnA, MnB, MnD, MrA, MrB	3 feet or more.	0–27	Sand
		27–48	Clay loam, loam
Montcalm: MtA, MtB, MtC, MtE	4 feet or more.	0–30	Loamy sand and sand
		30–55	Sand and thin bands of light sandy loam.
		55–60	Sand
Munuscong: Mu	Less than 1 foot.	0–30	Sandy loam
		30–48	Clay
Nester: NbB,[7] NeA, NeB, NeC, NeC2, NeD, NeD2, NeE, NeE2.	3 feet or more.	0–9	Loam
		9–25	Clay loam
		25–48	Clay loam
Ocqueoc: OcA	3 feet or more.	0–32	Sand
		32–84	Stratified very fine sand, fine sand, and silt.
Ogemaw: Og	1 to 2 feet.	0–10	Sand
		10–19	Sand-ortstein
		19–30	Sand
		30–48	Silty clay loam
Ontonagon: OnA, OnB	3 feet or more.	0–9	Loam
		9–48	Clay
Otisco: OtA	1 to 2 feet.	0–30	Loamy sand and sand
		30–40	Light sandy loam
		40–60	Loamy sand
Parkhill: Pa	Less than 1 foot.	0–8	Loam
		8–28	Sandy clay loam that contains pockets of loam and sandy loam.
		28–48	Sandy clay loam
Pickford: Pc, Pm	Less than 1 foot.	0–7	Silty clay loam
		7–48	Clay
Pinconning: Ps	Less than 1 foot.	0–14	Loamy sand
		14–28	Sand
		28–48	Clay
Roscommon: Rc, RB, RD, RT (For properties of Brevort soil in unit RB, of Deford soil in RD, and of Tawas soil in RT, refer to their respective series in this table.)	Less than 1 foot.	0–4	Loamy sand
		4–42	Sand
Rousseau: RoC	4 feet or more.	0–15	Fine sand
		15–66	Fine sand and very fine sand

See footnotes at end of table.

engineering properties—Continued

Classification—Continued		Percent passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH*	
SM	A-2	95-100	90-100	15-25	5. 0-10. 0	0. 04	6. 1-6. 5	Low.
SM	A-2	75-85	70-80	15-30	2. 5-5. 0	. 12	6. 1-7. 3	Low.
SP or SP-SM	A-1	60-80	55-75	0-10	>10. 0	. 02	(2)	Low.
SM	A-2	100	95-100	10-15	5. 0-10. 0	. 03	5. 6-6. 0	Low.
SP or SM	A-3 or A-2	100	95-100	0-15	5. 0-10. 0	. 03	5. 1-6. 0	Low.
CH	A-7	100	100	80-100	<0. 05	. 17	[2] 6. 1	High.
Pt					2. 5- 5. 0	. 25	7. 4-7. 8	Variable.
SM	A-2	100	90-100	15-25	5. 0-10. 0	. 04	7. 4-7. 8	Low.
SP or SP-SM	A-3 or A-2	95-100	90-100	0-15	5. 0-10. 0	. 05	5. 6-6. 5	Low.
CL	A-6	95-100	90-100	60-85	0. 2- 0. 8	. 2	[2] 6. 1	Moderate.
SM	A-2	95-100	90-100	10-25	5. 0-10. 0	. 05	5. 6-6. 0	Low
SP with bands of SM	A-2	95-100	90-100	10-35	2. 5- 5. 0	. 12	5. 6-6. 0	Low.
SP or SM	A-3 or A-2	95-100	90-100	0-25	5. 0-10. 0	. 04	(2)	Low.
SM	A-2	95-100	90-100	25-35	2. 5- 5. 0	. 13	6. 1-7. 3	Low.
CH	A-7	100	95-100	80-100	<0. 05	. 16	(2)	High.
ML	A-4	95-100	90-100	55-80	0. 8- 2. 5	. 17	6. 1-6. 5	Low.
CL	A-6	95-100	90-100	70-85	0. 2- 0. 8	. 18	5. 6-6. 5	Moderate.
CL	A-6	95-100	90-100	65-80	0. 2- 0. 8	. 18	(2)	Moderate.
SP or SM	A-3 or A-2	100	100	0-15	5. 0-10. 0	. 05	5. 1-6. 5	Low.
Layers of SM and ML	A-4	100	100	40-80	2. 5- 5. 0	. 21	7. 4-7. 8	Low.
SP or SM	A-2 or A-3	100	95-100	0-15	5. 0-10. 0	. 04	5. 1-6. 0	Low.
SP or SM	A-3 or A-2	100	95-100	0-15	<0. 05	. 02	5. 1-5. 5	Low.
SP or SP-SM	A-3	100	95-100	0-10	5. 0-10. 0	. 03	6. 1-6. 5	Low.
CL	A-6	100	100	80-95	0. 2- 0. 8	. 17	(2)	Moderate.
ML	A-4	95-100	90-100	60-80	2. 5-5. 0	. 16	6. 1-6. 5	Low.
CH	A-7	100	100	80-100	<0. 05	. 16	[2] 6. 6	High.
SM	A-2	95-100	90-100	10-25	5. 0-10. 0	. 06	5. 1-5. 5	Low.
SM	A-2	95-100	90-100	25-35	2. 5-5. 0	. 12	5. 6-6. 0	Low.
SM	A-2	90-100	80-100	10-25	5. 0-10. 0	. 03	6. 6-7. 3	Low.
ML	A-4	95-100	90-100	55-80	0. 8-2. 5	. 18	6. 1-6. 5	Low.
SC	A-2 or A-6	90-100	85-100	20-45	0. 8-2. 5	. 17	6. 1-6. 5	Moderate.
SC or CL	A-2 or A-6	90-100	85-100	20-55	0. 8-2. 5	. 18	(2)	Moderate.
CL	A-6	100	95-100	80-100	0. 2-2. 5	. 21	6. 6-7. 3	Moderate.
CH	A-7	100	100	80-100	<0. 05	. 16	[2] 6. 6	High.
SM	A-2	100	95-100	15-25	5. 0-10. 0	. 05	6. 1-7. 3	Low.
SP or SM	A-3 or A-2	100	95-100	0-15	5. 0-10. 0	. 04	6. 6-7. 3	Low.
CH	A-7	100	100	80-100	<0. 05	. 17	(2)	High.
SM	A-2	100	95-100	15-25	5. 0-10. 0	. 1	6. 1-6. 5	Low.
SP	A-3	100	95-100	0-5	>10. 0	. 02	6. 6-7. 3	Low.
SM	A-2	100	100	10-25	5. 0-10. 0	. 06	5. 6-6. 0	Low.
SM	A-2	100	100	10-25	5. 0-10. 0	. 06	5. 6-6. 0	Low.

TABLE 5.—*Estimated*

Soil series and map symbols	Depth to seasonal high water table [1]	Depth from surface	Classification
			USDA texture
		Inches	
Rubicon: RsB, RsC, RsE, RtB,[8] RUB, RVB, RWB (For properties of Croswell soil in unit RUB, of Menominee soil in RVB, and of Ocqueoc and Ingalls soils in RWB, refer to their respective series in this table.)	4 feet or more.	0–9 9–48	Sand Sand
Rudyard: RyA, RyB	1 to 2 feet.	0–7 7–48	Loam Heavy clay
Saugatuck: Sc	Less than 1 foot.	0–12 12–28 28–48	Sand Sand-ortstein Sand
Sims: Sn	Less than 1 foot.	0–7 7–27 27–48	Loam Clay loam Clay loam
Tawas: Ta	Water table at the surface.	0–26 26–48	Muck Loamy sand
Ubly: UlA, UlB, UlC	3 feet or more.	0–22 22–30 30–48	Sandy loam Sandy clay loam Clay loam
Wainola: WD (For properties of Deford soil in this unit; refer to Deford series in this table.)	1 to 2 feet.	0–12 12–30 30–48	Fine sand and loamy fine sand Fine sand and very fine sand Fine sand
Wheatley: Wh	Less than 1 foot.	0–8 8–24 24–42	Loamy sand Sand Stratified gravel and coarse sand
Winterfield (Mapped only in association with Evart soil.)	1 to 2 feet; subject to flooding.	0–8 8–42	Sand Sand

[1] Assumes that no artificial drainage practices are in use.
[2] Calcareous.
[3] Au Gres loamy substratum phase is underlain by loam to clay at a depth between 42 and 66 inches.
[4] Gladwin loamy substratum phase is underlain by clay loam or silty clay loam at a depth between 42 and 66 inches.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—				
	Topsoil [1]	Sand	Gravel	Road fill	Impermeable material
Allendale: AlB, AP (For interpretations of Pinconning and Pickford soils in unit AP, refer to their respective series in this table.)	Very poor: Thin; sandy; droughty.	Fair to not suitable: Poorly graded sand to a depth of 29 inches, and material below not suitable.	Not suitable	Fair to good to a depth of 29 inches, low volume change, good to fair bearing capacity; poor below a depth of 29 inches, high volume change, difficult to work when wet.	Not suitable to a depth of 29 inches, good below; very slow permeability.

See footnotes at end of table.

engineering properties—Continued

Classification—Continued		Percent passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH*	
SP or SP–SM	A–3	100	100	0–10	5. 0–10. 0	0. 04	5. 1–5. 5	Low.
SP	A–3	100	100	0–5	5. 0–10. 0	. 02	5. 6–6. 5	Low.
ML	A–4	95–100	90–100	55–80	0. 8–2. 5	. 17	6. 1–6. 5	Low.
CH	A–7	100	100	80–100	<0. 05	. 17	[2] 6. 6	High.
SP or SM	A–3 or A–2	100	100	0–15	5. 0–10. 0	. 04	4. 5–5. 0	Low.
SP or SM	A–3 or A–2	100	100	0–15	<0. 05	. 02	4. 5 5. 0	Low.
SP or SP–SM	A–3	100	95–100	0–10	>10. 0	. 03	5. 1–5. 5	Low.
ML	A–4	95–100	90–100	55–80	0. 8–2. 5	. 19	6. 6–7. 3	Moderate.
CL	A–6	95–100	90–100	65–80	0. 2–0. 8	. 18	7. 4–7. 8	Moderate.
CL	A–6	95–100	90–95	55–75	0. 2–0. 8	. 17	(2)	Moderate.
Pt					2. 5–5. 0	. 25	6. 1–6. 5	Variable.
SM	A–2	100	90–100	15–25	5. 0–10. 0	. 04	7. 4–7. 8	Low.
SM	A–2	95–100	90–100	25–35	2. 5–5. 0	. 13	5. 6–6. 5	Low.
SC or CL	A–2 or A–6	95–100	90–100	30–55	0. 8–2. 5	. 16	6. 1–6. 5	Moderate.
CL	A–6	95–100	85–95	55–85	0. 2–0. 8	. 17	[2] 6. 6	Moderate.
SM	A–2	100	100	15–30	5. 0–10. 0	. 07	5. 6–6. 0	Low.
SM	A–2 or A–4	100	100	20–45	5. 0–10. 0	. 08	5. 6–6. 5	Low.
SP–SM and SM	A–3 or A–2	100	95–100	5–25	5. 0–10. 0	. 06	6. 1–6. 5	Low.
SM	A–2	95–100	80–100	15–25	5. 0–10. 0	. 06	6. 6–7. 3	Low.
SP	A–3	95–100	80–100	0–5	5. 0–10. 0	. 02	7. 4–7. 8	Low.
SP	A–1	55–80	50–70	0–5	>10. 0	. 02	(2)	Low.
SP or SP–SM	A–3	100	100	0–10	5. 0–10. 0	. 6	6. 1–6. 5	Low.
SP or SP–SM	A–3	95–100	90–100	0–10	5. 0–10. 0	. 4	6. 5–7. 3	Low.

[5] The Kinross component of the Au Gres-Kinross loamy substratum association is underlain by loamy material at a depth between 42 and 66 inches.
[6] Mancelona loamy substratum phase is underlain by loam to clay at a depth between 42 and 66 inches.
[7] Nester sandy substratum phase is underlain by sandy material at a depth of 42 inches.
[8] Rubicon loamy substratum phase is underlain by loam to clay at a depth between 42 and 66 inches.

interpretations for nonfarm uses

Soil features affecting—			Limitations for septic tank disposal fields	Corrosion potential for conduits	
Highway location	Foundations for low buildings	Winter grading		Uncoated steel	Concrete
Periodic high water table; good to fair bearing capacity to a depth of 29 inches; high volume change below a depth of 29 inches.	Periodic high water table; fair to poor bearing capacity below a depth of 29 inches; high volume change; high compressibility.	High moisture content in many places hinders operations; poor stability on thawing.	Severe: Seasonal high water table, clayey material has very slow permeability.	High	Low.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—				
	Topsoil [1]	Sand	Gravel	Road fill	Impermeable material
Au Gres: ArA, AsA, AU, AV, AW. (For interpretations of Kinross soil in units AU and AV and for Roscommon soil in unit AW, refer to their respective series in this table.)	Poor to very poor: Sandy; droughty; subject to soil blowing.	Good: Poorly graded medium sand; seasonal high water table may make excavation difficult.	Not suitable: Dominantly sand.	Fair to good: Very low compressibility; low volume change; good to fair bearing capacity; periodic high water table.	Not suitable.
Belding: BeA, BeB	Fair: Low content of organic matter; seasonal high water table.	Not suitable: Source of binder material in places.	Not suitable.	Fair to good in the upper 23 inches; low volume change; fair to good bearing capacity; fair to poor below a depth of 23 inches, moderate volume change, periodic high water table.	Fair to a depth of 23 inches, good below.
Belding, clayey subsoil variant: Bf.	Fair in surface: Low content of organic matter; seasonal high water table.	Not suitable.	Not suitable.	Fair to good in the upper 31 inches, low compressibility, low volume change; poor below a depth of 31 inches, high compressibility, high volume change.	Fair to a depth of 31 inches, good below: Very slow permeability.
Bowers: BgB, Bl (For intrepretations of Iosco and Hettinger soils in unit Bl, refer to their respective series in this table.)	Good to fair: Low content of organic matter; erodes readily.	Not suitable.	Not suitable.	Poor to fair: Medium compressibility; moderate to high volume change; poor workability when wet; fair to poor bearing capacity.	Good: Moderately slow permeability; difficult to work and compact when wet.
Breckenridge: Bm	Good: Low content of organic matter; high water table; difficult to excavate.	Not suitable: High water table.	Not suitable: Dominantly sandy loam.	Fair to good in the upper 30 inches, low volume change, fair to good bearing capacity; fair to poor below a depth of 30 inches, moderate volume change, difficult to work when wet.	Fair to a depth of 30 inches, good below: High water table.
Brevort: Bn, Bo	Fair to a depth of 10 inches: High water table.	Fair to not suitable: Poorly graded sand and some fines to a depth of 30 inches; not suitable below.	Not suitable.	Poor to good to a depth of 30 inches, low volume change, good to fair bearing capacity; poor to fair below a depth of 30 inches, low volume change, difficult to work when wet, high water table.	Not suitable to a depth of 30 inches, good below: Moderately slow permeability; high water table.
Brimley: BrB	Good to fair: Low content of organic matter; seasonal high water table.	Not suitable.	Not suitable.	Poor: Low volume change; poor bearing capacity; high frost hazard; periodic high water table.	Good to fair to a depth of 25 inches, fair to not suitable below: Flows readily when wet.
Bruce: Bs, BU (For interpretations of Brimley and Burleigh soils in unit BU, refer to their respective series in this table.)	Good: Low content of organic matter; high water table makes excavating difficult.	Not suitable.	Not suitable.	Poor: Low volume change; poor bearing capacity; high water table.	Good to a depth of 26 inches, fair to not suitable below.

See footnote at end of table.

interpretations for nonfarm uses—Continued

Soil features affecting—			Limitations for septic tank disposal fields	Corrosion potential for conduits	
Highway location	Foundations for low buildings	Winter grading		Uncoated steel	Concrete
Loose sand hinders construction in many places; good to fair bearing capacity; loses stability and flows when wet; drainage needed.	Good to fair bearing capacity; low volume change and compressibility; seasonal high water table.	Wetness hinders operations in many places.	Severe: Seasonal high water table, rapid percolation of effluent may pollute ground water.	Low	Moderate.
Seasonal high water table; fair to poor bearing capacity; low volume change above substratum; substratum has moderate volume change and is difficult to work when wet.	Seasonal high water table; fair to poor bearing capacity; moderate volume change; medium compressibility and shear strength.	Moisture content too high in many places for good compaction; poor stability on thawing.	Severe: Seasonal high water table, moderately slow permeability; onsite investigation needed.	High	Low.
Seasonal high water table; plastic clayey layer at a depth of 18 to 42 inches; unsuitable and slippery when wet; fair to poor bearing capacity.	Seasonal high water table; fair to poor bearing capacity; high volume change; high compressibility; low shear strength.	High moisture content in many places hinders operations; poor stability on thawing.	Severe: Seasonal high water table; very slowly permeable below a depth of 18 to 42 inches; onsite investigation needed.	High	Low.
Fair to poor bearing capacity; medium to high frost action; periodic high water table; needs drainage.	Periodic high water table; fair to poor bearing capacity; moderate to high volume change; medium compressibility.	Moisture content too high in many places for good compaction; poor stability on thawing.	Severe: Seasonal high water table; moderately slow permeability; onsite investigation needed.	High	Low.
High water table, fair to poor bearing capacity, low volume change above substratum; substratum has moderate volume change, difficult to work when wet.	High water table; fair to poor bearing capacity; moderate volume change; medium compressibility and shear strength.	Wetness hinders operations; poor stability on thawing.	Severe: High water table; subject to ponding; moderately slow permeability.	High	Low.
High water table; fair to good bearing capacity to a depth of 30 inches, low volume change below.	High water table; fair to poor bearing capacity below a depth of 30 inches, low volume change.	High water table; poor stability on thawing.	Severe: High water table; subject to ponding; moderately slow permeability.	High	Low to moderate, depending on acidity.
Periodic high water table; poor bearing capacity; low volume change; subject to frost hazard.	Periodic high water table; poor bearing capacity; silt and fine sand below a depth of 25 inches; loses stability when wet.	Moisture content too high in many places for good compaction; poor stability on thawing.	Severe: Seasonal high water table; moderate permeability; onsite investigation needed.	Moderate	Low.
High water table; poor bearing capacity; low volume change.	High water table; poor bearing capacity; low volume change below a depth of 26 inches; silty and sandy material loses stability when wet.	High water table; poor stability on thawing.	Severe: High water table; filter field saturated during wet periods.	High	Low.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—				
	Topsoil [1]	Sand	Gravel	Road fill	Impermeable material
Burleigh: Bv	Fair to poor: Sandy; high water table.	Fair to a depth of 32 inches, poor below; high water table.	Not suitable	Fair to good in the upper 32 inches, low volume change, good to fair bearing capacity; poor below a depth of 32 inches, poor bearing capacity, high water table; difficult to work.	Not suitable to a depth of 32 inches, fair to not suitable below.
Carbondale: Ca	Poor when used alone, oxidizes readily, erodible; fair to good if mixed with mineral material.	Not suitable	Not suitable	Not suitable: Organic material; unstable and compressible.	Not suitable: Organic material; unstable and compressible.
Ceresco: Cc	Good: Loamy; thick.	Not suitable	Not suitable	Poor: Subject to frost hazard; poor bearing capacity.	Good to fair: Moderate permeability.
Chelsea: CdB, CdC, CdD, CG, CHB, CHC. (For interpretations of Au Gres soil in unit CG and for Rubicon soils in units CHB and CHC, refer to their respective series in this table.)	Very poor: Thin; sandy; droughty; subject to soil blowing.	Good: Poorly graded medium sand; some layers contain fines.	Not suitable	Fair to good: Very low compressibility; low volume change; good to fair bearing capacity.	Not suitable: Rapid permeability.
Cohoctah: Co	Good in surface layer, fair below; subject to flooding.	Not suitable	Not suitable	Poor: Low volume change; poor bearing capacity; high water table.	Good to fair: Moderate permeability; high water table.
Croswell: CrB, CsB, CT, CU, CW. (For interpretations of Au Gres soil in unit CT, CU, CW, of Kinross soil in unit CU, and of Roscommon soil in unit CW, refer to their respective series in this table.)	Very poor: Thin; sandy; droughty; subject to soil blowing.	Good: Poorly graded medium sand.	Not suitable: Dominantly sand.	Fair to good: Very low compressibility; low volume change; no frost hazard.	Not suitable: Very rapid permeability; subject to piping.
Deford (Mapped only in association with Roscommon and Wainola soils.)	Fair in surface: Sandy; droughty; difficult to excavate.	Fair: Poorly graded fine sands.	Not suitable	Poor to good: Low compressibility; low volume change; good to fair bearing capacity; high water table.	Not suitable: Rapid permeability.
Edwards: Ed	Poor when used alone, oxidizes readily, erodible; fair to good if mixed with mineral material.	Not suitable	Not suitable	Not suitable: Organic material unstable.	Not suitable: Organic material unstable.
Epoufette: Ep, ET (For interpretations of Tawas soil in unit ET, refer to the Tawas series in this table.)	Fair to good	Good: Poorly graded sand and gravel; contains fines in places.	Good to fair: Poorly graded sand and gravel; contains fines in places; thickness of gravelly layer is variable.	Poor to good in upper 26 inches, fair to good below: Low compressibility; low volume change; good bearing capacity; high water table.	Fair to not suitable in upper 26 inches, not suitable below.

See footnote at end of table.

interpretations for nonfarm uses—Continued

Soil features affecting—			Limitations for septic tank disposal fields	Corrosion potential for conduits	
Highway location	Foundations for low buildings	Winter grading		Uncoated steel	Concrete
High water table, good to fair bearing capacity to a depth of 32 inches; below this depth, poor bearing capacity, low volume change.	High water table; poor bearing capacity below a depth of 32 inches; low volume change; loses stability when wet.	High water table; poor stability on thawing.	Severe: High water table; filter field saturated during wet periods.	High	Low.
Deep organic soil; unstable; must be replaced with suitable subgrade material.	Deep organic soil; unstable; very high compressibility.	High water table; poor stability.	Severe: High water table; subject to ponding; unstable; high compressibility.	High	Low to moderate.
Seasonal high water table; subject to stream overflow; poor bearing capacity.	Seasonal high water table; fair bearing capacity; low volume change.	High moisture content hinders operations in many places.	Severe: Seasonal high water table; moderate permeability; subject to stream overflow.	High	Low.
Loose sandy soil easily excavated but hinders hauling in places; good to fair bearing capacity; cuts and fills needed in many places.	Fair to good bearing capacity; low volume change; low compressibility; hazard of soil blowing.	Sandy; low moisture content; good drainage.	Slight: Possible pollution of ground water by effluent; slopes of more than 10 percent hinder installation and operation of filter fields.	Low	Low.
High water table; poor bearing capacity; low volume change; medium compressibility; high frost action.	High water table; subject to flooding; poor bearing capacity; low volume change.	High water table; poor stability on thawing.	Severe: High water table; subject to flooding.	High	Low.
Loose sand often hinders hauling operations in many places; good to fair bearing capacity; subject to soil blowing.	Good to fair bearing capacity; low volume change.	Good stability on thawing; generally low content of moisture.	Slight to moderate: Unfiltered sewage may pollute water supplies; water table within 3 feet of surface during wet periods; onsite investigation needed.	Low	Low.
Fine sands; good to fair bearing capacity; high water table; drainage needed; tends to flow if not confined.	High water table; fair bearing capacity; low volume change; low compressibility; tends to flow if not confined.	High water table; wetness hinders operations.	Severe: High water table; filter fields saturated during wet periods.	High	Low.
Organic material and marl; unstable; high water table; must be replaced with suitable subgrade material.	Organic and marl material; unstable; pilings needed.	High water table; poor stability.	Severe: High water table; subject to ponding; unstable.	High	Low.
High water table; wetness hinders construction.	High water table; low volume change; very low compressibility; good bearing capacity.	High water table; wetness hinders operations.	Severe: High water table; subject to ponding.	High	Low.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—				
	Topsoil [1]	Sand	Gravel	Road fill	Impermeable material
Evart: Ev, EW (For interpretations of Winterfield soil in unit EW, refer to Winterfield series in this table.)	Poor: Sandy; droughty; subject to soil blowing; difficult to excavate.	Fair: Poorly graded sand; some layers have fines; high water table.	Not suitable	Poor to good: Low compressibility; low volume change; fair workability; high water table.	Not suitable: Rapid permeability.
Gladwin: GhA, GIA, GE, GPB. (For interpretations of Epoufette soil in units GE and GPB, and of Croswell soil in unit GPB, refer to their respective series in this table.)	Poor: Sandy; contains gravel in places; droughty; subject to soil blowing.	Good: Poorly graded sand; in places contains gravel and fines.	Good to fair: Poorly graded sand; gravelly layer is variable in thickness; in places contains gravel and fines.	Fair to good: Very low compressibility; low volume change; good to fair bearing capacity; periodic high water table.	Fair to not suitable to a depth of 28 inches, not suitable below: Very rapid permeability.
Grayling: GrB, GSB, GSC, GU. (For interpretations of Croswell and Au Gres soils in unit GU, refer to their respective series in this table.)	Very poor: Thin; sandy; droughty; low fertility; subject to soil blowing.	Good: Poorly graded, medium sand.	Not suitable	Fair to good: Very low compressibility; low volume change; good to fair bearing capacity; subject to soil blowing.	Not suitable: Rapid permeability.
Hettinger: Hg, HB (For interpretations of Brevort and Burleigh soils in unit HB, refer to their respective series in this table.)	Good to fair: High water table.	Not suitable	Not suitable	Poor to fair: Medium compressibility; moderate volume change; poor workability when wet; fair to poor bearing capacity; medium frost action.	Good: Slowly permeable.
Houghton: Hu	Poor when used alone, oxidizes readily, erodible; fair to good if mixed with mineral material.	Not suitable	Not suitable	Not suitable: Organic material; unstable.	Not suitable: Organic material; unstable.
Ingalls: IcA	Very poor to poor: Sandy; droughty.	Fair to not suitable: Poorly graded sand to a depth of 30 inches, not suitable below.	Not suitable	Fair to good in the upper 30 inches, very low compressibility, low volume change; poor below a depth of 30 inches, poor bearing capacity, periodic high water table.	Not suitable to a depth of 30 inches, fair to not suitable below.
Iosco: IdA, IoA, IoB, IA, IB, II, IK, IM. (For interpretations of Au Gres soil in unit IA, of Brevort soil in IB, II, IK, and IM, of Ingalls soil in IA and II, of Kawkawlin soil in IK, and of Menominee soil in IM, refer to their respective series in this table.)	Very poor to fair: Droughty; sandy.	Fair to not suitable: Poorly graded sand to a depth of 30 inches, not suitable below; periodic high water table.	Not suitable	Poor to good to a depth of 30 inches, low volume change, good to fair bearing capacity; poor to fair below, moderate volume change, difficult to work when wet, periodic high water table.	Not suitable to a depth of 30 inches, good below: Moderately slow to moderate permeability.
Kawkawlin: KaA, KaB	Fair to good	Not suitable	Not suitable	Poor to fair: Medium compressibility; moderate volume change; poor workability when wet; fair to poor bearing capacity.	Good: Slowly permeable.

See footnote at end of table.

interpretations for nonfarm uses—Continued

Soil features affecting—			Limitations for septic tank disposal fields	Corrosion potential for conduits	
Highway location	Foundations for low buildings	Winter grading		Uncoated steel	Concrete
Sand; fair to good bearing capacity; high water table; subject to frequent flooding; drainage needed.	Subject to overflow; high water table; good to fair bearing capacity; low volume change.	High water table; wetness hinders operations.	Severe: High water table; subject to flooding.	High	Low.
Sandy soil that contains some fines and gravel; good to fair bearing capacity; periodic high water table may hinder construction.	Seasonal high water table; good bearing capacity; low volume change; very low compressibility; high shear strength.	High moisture content in places hinders operations.	Severe: Seasonal high water table; rapid seepage rate.	Moderate	Low.
Loose sand hinders hauling operations; good to fair bearing capacity.	Good to fair bearing capacity; low volume change; low compressibility; subject to soil blowing.	Sandy; moisture content generally is low; good stability on thawing.	Slight: Possible pollution of ground water by effluent; slopes of more than 10 percent hinder installation and operation of filter fields.	Low	Low.
Plastic clayey soils; fair to poor bearing capacity; medium frost action; high water table; drainage needed.	High water table; fair to poor bearing capacity; moderate volume change; medium compressibility.	High water table; wet conditions hinder operations; poor stability on thawing.	Severe: High water table; moderately slow permeability.	High	Low.
Deep organic soil; unstable; must be replaced with suitable subgrade material.	Deep organic soil; unstable; pilings needed.	High water table; poor stability.	Severe: High water table; subject to ponding.	High	Low.
Seasonal high water table; good to fair bearing capacity to a depth of 30 inches; poor bearing capacity below a depth of 30 inches; low volume change.	Seasonal high water table; poor bearing capacity below a depth of 30 inches; low volume change; loses stability when wet.	Moisture content in many places too high for good compaction; poor stability on thawing.	Severe: Seasonal high water table; onsite investigation needed.	Moderate	Low.
Periodic high water table; fair to good bearing capacity to a depth of 30 inches; moderate volume change below a depth of 30 inches.	Periodic high water table; fair to poor bearing capacity below a depth of 30 inches; moderate volume change.	Seasonal high water table; moisture content too high in many places for good compaction; poor stability on thawing.	Severe: Seasonal high water table; moderately slow permeability; onsite investigation needed.	High	Low.
Plastic clayey soil; fair to poor bearing capacity; medium to high frost action; periodic high water table; drainage needed.	Periodic high water table; fair to poor bearing capacity; moderate volume change; medium compressibility.	Moisture content too high in many places for good compaction; poor stability on thawing.	Severe: Seasonal high water table; moderately slow permeability; onsite investigation needed.	High	Low.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—				
	Topsoil [1]	Sand	Gravel	Road fill	Impermeable material
Kinross: Kr	Poor: Sandy; droughty; low fertility; acid; subject to soil blowing; high water table.	Good: Poorly graded, medium sand; high water table.	Not suitable: Dominantly sand.	Fair to good: Very low compressibility; low volume change; fair to good bearing capacity; high water table.	Not suitable: Very rapid permeability; high water table.
Lacota: La	Good: High water table.	Not suitable to a depth of 28 inches, fair below; poorly graded sand and in places contains some fines; high water table.	Not suitable	Poor to fair in upper 28 inches, moderate volume change, fair to poor bearing capacity; fair to good below a depth of 28 inches; sandy; high water table.	Good to a depth of 28 inches; clay loam has moderately slow permeability; fair to poor below a depth of 28 inches; sandy; rapid permeability.
Linwood: Lm	Poor when used alone, oxidizes readily, erodible; fair to good if mixed with mineral material.	Not suitable	Not suitable	Not suitable: Organic material; unstable.	Not suitable: Organic material; unstable.
Londo: LoA, LoB	Good to fair: Medium content of organic matter; seasonal high water table.	Not suitable: Suitable for binder material in places.	Not suitable	Poor to fair: Medium compressibility; moderate volume change; poor workability when wet; fair to poor bearing capacity.	Good: Slow permeability when compacted.
Loxley: Lr	Very poor when used alone, extremely acid, oxidizes readily, erodible; fair if mixed with mineral material and lime.	Not suitable to a depth between 12 and 42 inches, fair to good below: Muck and peat; high water table.	Not suitable	Not suitable: Organic material; unstable.	Not suitable: Organic material; unstable.
Lupton: Lu	Poor when used alone, oxidizes readily, erodible; fair to good if mixed with mineral material.	Not suitable	Not suitable	Not suitable: Organic material; unstable.	Not suitable: Organic material; unstable.
Mancelona: MaA, MaB, MaC, MaE, McA, McB.	Very poor: Sandy; gravel in some places; low content of organic matter.	Good: Poorly graded sand and gravel.	Good to fair: Poorly graded sand and gravel.	Good to a depth of 32 inches, low compressibility, low volume change; excellent below a depth of 32 inches, low volume change; good bearing capacity.	Fair to not suitable to a depth of 32 inches, not suitable below.
Manistee: MdB	Very poor: Thin; sandy; droughty.	Fair to not suitable to a depth of 31 inches; poorly graded sand that contains some fines; not suitable below a depth of 31 inches clayey.	Not suitable	Fair to good to a depth of 31 inches, low volume change, fair to good bearing capacity; poor below a depth of 31 inches, high volume change.	Not suitable to a depth of 31 inches, good below; very slow permeability.

See footnote at end of table.

interpretations for nonfarm uses—Continued

Soil features affecting—			Limitations for septic tank disposal fields	Corrosion potential for conduits	
Highway location	Foundations for low buildings	Winter grading		Uncoated steel	Concrete
Sandy soil; fair to good bearing capacity; loses stability and flows when wet; high water table.	High water table; fair to good bearing capacity; low volume change; low compressibility tends to flow when wet.	High water table; wetness hinders operations.	Severe: High water table.	High	High.
Plastic clayey soils to a depth of 28 inches or more; nonplastic below; high water table; subject to frost action.	Sandy underlying material has fair to good bearing capacity; low volume change; low compressibility.	High water table; wetness hinders operations.	Severe: High water table.	High	Low.
High moisture content; soft peat and muck over clay loam; loses stability when saturated.	High water table; fair to poor bearing capacity; moderate volume change; medium compressibility.	High water table; poor stability.	Severe: High water table; subject to ponding.	High	Low.
Fair to poor bearing capacity; hard when dry; periodic high water table; drainage needed.	Periodic high water table; fair to poor bearing capacity; low volume change; low compressibility.	Moisture content too high in many places for good compaction; poor stability on thawing.	Severe: Seasonal high water table; moderately slow permeability.	Moderate	Low.
Organic soil; unstable; must be replaced with suitable subgrade material.	Organic soil; unstable; pilings needed.	High water table; poor stability; sand substratum.	Severe: High water table; subject to ponding.	High	High.
Deep organic soil; unstable; must be replaced with suitable subgrade material.	Deep organic soil; unstable; pilings needed.	High water table; poor stability.	Severe: High water table; subject to ponding.	High	Low.
Sandy soil that has fines and gravel in places; good to fair bearing capacity.	Good bearing capacity; low volume change; very low compressibility; high shear strength.	Moisture content generally low to medium; fair stability on thawing.	Slight: Possible pollution of ground water by effluent; slopes of more than 10 percent hinder installation and operation of filter fields.	Low	Low.
Good to fair bearing capacity to a depth of 31 inches; high volume change and compressibility below a depth of 31 inches; subject to frost hazard.	Fair to poor bearing capacity below a depth of 31 inches; high volume change and compressibility; low shear strength.	Moisture content of clayey substratum too high in many places for good compaction.	Severe: Slowly permeable clayey material at a depth of 18 to 42 inches; onsite investigation needed.	High	Low.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—				
	Topsoil [1]	Sand	Gravel	Road fill	Impermeable material
Markey: Me	Poor when used alone, oxidizes readily; erodible; fair to good if mixed with mineral material.	Fair: High water table; difficult to excavate; organic material must be removed.	Not suitable	Not suitable: Organic material is unstable.	Not suitable: Organic material is unstable.
Menominee: MnA, MnB, MnD, MrA, MrB.	Very poor: Thin; sandy; droughty.	Fair to not suitable to a depth of 27 inches; poorly graded sand that contains some fines; not suitable below a depth of 27 inches.	Not suitable	Poor to good to a depth of 27 inches, low volume change, good to fair bearing capacity; poor to fair below a depth of 27 inches, moderate volume change, difficult to work when wet.	Not suitable to a depth of 27 inches, good below: Moderately slow permeability.
Montcalm: MtA, MtB, MtC, MtE.	Poor to very poor: Sandy; droughty.	Fair: Some layers contain fines.	Not suitable	Fair to good: Low volume change; fair to good bearing capacity; erodible.	Fair to not suitable.
Munuscong: Mu	Good	Not suitable: High water table.	Not suitable: Dominantly sandy loam in upper layers, clay below.	Fair to good in the upper 30 inches, low compressibility, low volume change; poor below a depth of 30 inches, high volume change, very difficult to work when wet.	Fair to a depth of 30 inches, good below: Very slow permeability; high water table.
Nester: NbB, NeA, NeB, NeC, NeC2, NeD, NeD2, NeE, NeE2.	Fair	Not suitable	Not suitable	Poor to fair: Medium compressibility; moderate volume change; poor workability when wet; fair to poor bearing capacity.	Good: Moderately slow permeability; difficult to work and compact when wet.
Oequeoc: OcA	Very poor: Sandy; droughty.	Fair to a depth of 32 inches, poor below.	Not suitable	Fair to good in the upper 32 inches, low volume change, fair to good bearing capacity; below a depth of 32 inches, poor bearing capacity, low volume change.	Not suitable to a depth of 32 inches, fair to not suitable below a depth of 32 inches.
Ogemaw: Og	Poor to fair to a depth of 10 inches: Sandy; droughty.	Poor: Poorly graded sand to a depth of 30 inches, cemented layer difficult to excavate; not suitable below a depth of 30 inches, fines, periodic high water table.	Not suitable	Poor to good to a depth of 30 inches, low volume change, good to fair bearing capacity; poor to fair below a depth of 30 inches, moderate volume change, cemented layer difficult to excavate.	Not suitable to a depth of 30 inches; good below: Moderately slow permeability; seasonal high water table; cemented layer may be difficult to excavate.
Ontonagon: OnA, OnB	Good to fair	Not suitable	Not suitable	Poor: High compressibility and volume change; poor workability; difficult to compact.	Good: Very slow permeability when compacted; cracks when dry.

See footnote at end of table.

interpretations for nonfarm uses—Continued

Soil features affecting—			Limitations for septic tank disposal fields	Corrosion potential for conduits	
Highway location	Foundations for low buildings	Winter grading		Uncoated steel	Concrete
Organic material is unstable and must be removed; high water table; fills needed.	Fair to poor bearing capacity; high water table.	High water table; poor stability.	Severe: High water table; subject to ponding.	High	Low.
Good to fair bearing capacity to a depth of 27 inches; moderate volume change below a depth of 27 inches; medium compressibility; cuts and fills are often needed.	Fair to poor bearing capacity below a depth of 27 inches; moderate volume change; medium shear strength.	Moisture content too high in many places for good compaction; poor stability on thawing.	Moderate: Moderately slow permeability at a depth of 18 to 42 inches; onsite investigation needed.	Moderate	Low.
Cuts and fills needed in many places; loose sandy material is easily excavated but hinders hauling in places.	Good to fair bearing capacity; low volume change on wetting or drying; low compressibility; becomes quick and flows when wet in places.	Sandy; low moisture content; good drainage and stability.	Slight: Possible pollution of water supplies by effluent; slopes of more than 10 percent hinder installation and operation of filter fields.	Low	Low.
High water table; plastic clayey material below a depth of 18 to 42 inches; unstable and slippery when wet; fair to poor bearing capacity.	High water table; fair to poor bearing capacity; high volume change and compressibility; low shear strength.	High water table; clayey; poor stability on thawing.	Severe: High water table; subject to ponding; very slow permeability in lower part.	High	Low.
Plastic clayey soils; fair to poor bearing capacity; moderately high frost action; cuts and fills needed in many places.	Fair to poor bearing capacity; moderate volume change; medium compressibility.	Moisture content generally too high for good compaction; poor stability on thawing.	Severe: Moderately low permeability; effluent seeps to surface on slopes; slopes of more than 10 percent hinder installation and operation of filter fields.	Moderate	Low.
Fair to good bearing capacity to a depth of 32 inches; low volume change below a depth of 32 inches; poor bearing capacity.	Poor bearing capacity below a depth of 32 inches; sandy and silty material; loses stability when wet.	Medium to high moisture content, poor stability on thawing.	Slight: When wet, soil material may flow into tile and filter beds and plug them.	Moderate	Low.
Periodic high water table; good to fair bearing capacity to a depth of 30 inches; moderate volume change below.	Seasonal high water table; cemented layer difficult to excavate; fair to poor bearing capacity below a depth of 30 inches.	Seasonal high water table; loose sand over cemented sand, underlain by loose sand; underlying clayey material has poor stability on thawing.	Severe: Seasonal high water table; moderately slow permeability in fine-textured underlying material; layers of cemented sand must be removed.	High	High.
Plastic clayey soil; poor bearing capacity; medium to high frost action; very plastic and slippery when wet.	Poor bearing capacity; high volume change and compressibility; low shear strength.	Moisture content too high in many places for good compaction; poor stability on thawing.	Severe: Very slowly permeable; clay.	High	Low.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—				
	Topsoil [1]	Sand	Gravel	Road fill	Impermeable material
Otisco: OtA	Poor: Sandy; droughty.	Fair: Some layers have fines.	Not suitable	Fair to good: Low volume change; fair to good bearing capacity; periodic high water table.	Fair to not suitable.
Parkhill: Pa	Good: High water table.	Not suitable	Not suitable	Poor to fair: Moderate volume change; fair to poor bearing capacity; difficult to work when wet.	Good in layers below surface soil: High water table; slow permeability when compacted.
Pickford: Pc, Pm	Fair: High water table.	Not suitable	Not suitable	Poor: High compressibility and volume change; poor workability and bearing capacity; high water table; medium to high frost action.	Good: Very slow permeability when compacted.
Pinconning: Ps	Fair to poor: Sandy; droughty; high water table.	Fair to not suitable: Poorly graded sand, some fines to a depth of 28 inches; not suitable below a depth of 28 inches, high water table.	Not suitable	Poor to good to a depth of 28 inches, low volume change; fair to good bearing capacity; poor below to a depth of 28 inches, high volume change.	Not suitable to a depth of 28 inches, good below: Very slow permeability; high water table.
Roscommon: Rc, RB, RD, RT. (For interpretations of Brevort soil in unit RB, of Deford soil in unit RD, and of Tawas soil in units RB and RT, refer to their respective series in this table.)	Poor: Sandy; droughty; difficult to excavate.	Good: Poorly graded sand; fine sand in places below a depth of 42 inches; high water table makes excavating difficult in places.	Not suitable: Dominantly sand.	Fair to good: Very low compressibility; low volume change; fair to good bearing capacity; high water table.	Not suitable: Very rapid permeability; high water table.
Rousseau: RoC	Very poor: Thin; sandy; droughty; subject to soil blowing.	Fair: Poorly graded fine sand.	Not suitable	Poor to good: Low compressibility and volume change; fair workability and bearing capacity; subject to soil blowing.	Not suitable: Rapid permeability.
Rubicon: RsB, RsC, RsE, RtB, RUB, RVB, RWB. (For interpretations of Croswell soil in unit RUB, of Menominee soil in unit RVB, and Ocqueoc and Ingalls soils in unit RWB, refer to their respective series in this table.)	Very poor: Sandy; droughty; low fertility; subject to soil blowing.	Good: Poorly graded sand.	Not suitable: Dominantly sand.	Fair to good: Very low compressibility; low volume change; good to fair bearing capacity; subject to soil blowing.	Not suitable: Very rapid permeability.
Rudyard: RyA, RyB	Good to fair	Not suitable	Not suitable	Poor: High compressibility and volume change; poor workability and bearing capacity.	Good: Very slow permeability when compacted; cracks when dry.

See footnote at end of table.

interpretation for nonfarm uses—Continued

Soil features affecting—			Limitations for septic tank disposal fields	Corrosion potential for conduits	
Highway location	Foundations for low buildings	Winter grading		Uncoated steel	Concrete
Seasonal high water table; fair to good bearing capacity; low volume change and compressibility; loses stability if not confined.	Seasonal high water table; fair to good bearing capacity; low volume change and compressibility.	Wetness hinders operations in many places.	Severe: Seasonal high water table; onsite investigation needed; rapid permeability in substratum; ground water may be polluted by effluent.	Low	Moderate.
Fair to poor bearing capacity; wetness hinders construction; high susceptibility to frost hazard; drainage needed.	High water table; fair to poor bearing capacity; moderate volume change; low to medium compressibility.	High moisture content; poor stability on thawing.	Severe: High water table; moderate permeability.	High	Low.
Plastic clayey soil; poor bearing capacity; medium to high frost action; very plastic and slippery when wet; drainage needed.	Plastic clayey soil; poor bearing capacity; high compressibility; high water table; low shear strength.	High water table; clayey; poor stability on thawing.	Severe: High water table; very slow permeability.	High	Low.
High water table; fair to good bearing capacity to a depth of 28 inches; high volume change and compressibility below a depth of 28 inches.	High water table; fair to poor bearing capacity below a depth of 28 inches; high volume change and compressibility.	High water table; clayey substratum; poor stability on thawing.	Severe: High water table; very slow permeability in clayey substratum.	High	Low.
Sandy soils; fair to good bearing capacity; loses stability and flows when wet; high water table.	High water table; fair to good bearing capacity; low volume change; low compressibility; tends to flow if not confined.	High water table; wetness hinders operations.	Severe: High water table; very rapid permeability.	High	Low.
Fine sand; fair bearing capacity; extremely susceptible to soil blowing if cover is removed.	Fair bearing capacity; low volume change; low compressibility; extremely susceptible to soil blowing.	Sandy; moisture content generally is low.	Slight: Possible pollution of ground water by effluent.	Low	Low.
Loose sand hinders hauling operations; good to fair bearing capacity; subject to soil blowing.	Good to fair bearing capacity; low volume change; low compressibility; subject to soil blowing.	Moisture content generally is low; good stability on thawing.	Slight: Possible pollution of ground water by effluent; slopes of more than 10 percent hinder installation and operation of filter fields.	Low	Low.
Plastic clayey soil; poor bearing capacity; medium to high frost action; very plastic and slippery when wet; drainage needed.	Plastic clayey soil; poor bearing capacity; high volume change; high compressibility; seasonal high water table.	Moisture content high in many places and hinders operations and prevents good compaction; poor stability on thawing.	Severe: Seasonal high water table; very slow permeability; clayey material.	High	Low.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—				
	Topsoil [1]	Sand	Gravel	Road fill	Impermeable material
Saugatuck: Sc	Very poor: Sandy; droughty.	Fair: Poorly graded, medium sand; cemented layer makes excavating difficult in places.	Not suitable: Dominantly sand.	Fair to good: Very low compressibility; low volume change; good to fair bearing capacity; periodic high water table.	Not suitable: Very rapid permeability when disturbed.
Sims: Sn	Good to fair: High water table; high content of organic matter.	Not suitable	Not suitable	Poor to fair: Medium compressibility; moderate volume change; poor workability when wet; fair to poor bearing capacity; medium to high frost action.	Good: Slow permeability; high water table.
Tawas: Ta	Poor when used alone, oxidizes readily, crodible; fair to good if mixed with mineral material.	Fair: High water table; difficult to excavate; organic material must be removed.	Not suitable	Not suitable: Organic material; unstable.	Not suitable: Organic material; unstable.
Ubly: UlA, UlB, UlC	Poor: Low content of organic matter.	Not suitable	Not suitable: Dominantly sandy loam or finer textured.	Fair to good in the upper 30 inches, low to moderate volume change, fair to good bearing capacity; fair to poor below a depth of 30 inches, moderate volume change.	Fair to a depth of 30 inches, good below.
Wainola: WD (For interpretations of Deford soil in this unit, refer to the Deford series in this table.)	Poor to very poor: Sandy; droughty.	Poor to a depth of 30 inches, some fines; fair below a depth of 30 inches, poorly graded sand and fine sand.	Not suitable	Fair to good: Low volume change; fair to good bearing capacity.	Fair to not suitable: Rapid permeability.
Wheatley: Wh	Fair: Sandy; droughty; difficult to excavate.	Good: Poorly graded sand and gravel; high water table.	Good to fair: Poorly graded sand and gravel; gravelly layers are variable in thickness.	Fair to good: Very low compressibility; low volume change; fair workability; fair to good bearing capacity; high water table.	Not suitable: Rapid to very rapid permeability.
Winterfield (Mapped only in association with Evart soils.)	Very poor: Sandy; droughty; subject to stream overflow.	Good: Layers of fine material.	Not suitable	Fair to good: Low volume change; good to fair bearing capacity.	Not suitable: Sandy; rapid permeability.

[1] Unless otherwise stated, only the surface layer was considered in rating the suitability of the soils as a source of topsoil.

interpretations for nonfarm uses—Continued

Soil features affecting—			Limitations for septic tank disposal fields	Corrosion potential for conduits	
Highway location	Foundations for low buildings	Winter grading		Uncoated steel	Concrete
Loose sand hinders hauling operations; good to fair bearing capacity; cemented layer difficult to work; drainage needed.	Periodic high water table; cemented layers difficult to excavate; good to fair bearing capacity; low volume change.	Wetness hinders operations in many places.	Severe: Seasonal high water table; effluent may seep into ground water; onsite investigation needed; cemented layer must be removed.	Low	High.
Plastic clayey soil; fair to poor bearing capacity; medium to high frost action; high water table; drainage needed.	High water table; fair to poor bearing capacity; moderate volume change; medium compressibility.	High water table; poor stability on thawing; moisture content too high in many places for good compaction.	Severe: High water table; moderately slow permeability.	High	Low.
Organic material must be removed.	Fair to poor bearing capacity; subject to ponding.	High water table; poor stability.	Severe: High water table; subject to ponding.	High	Low.
Cuts and fills needed in many places; substratum has fair to poor bearing capacity; subject to frost hazard.	Fair to poor bearing capacity; moderate volume change; medium shear strength and compressibility.	Medium to high moisture content hinders operations; poor stability on thawing.	Slight: Moderately slow permeability below a depth of 18 to 42 inches; slopes of more than 10 percent hinder installation and operation of filter fields.	Low	Moderate.
Seasonal high water table; fair to good bearing capacity; low volume change; loses stability when wet.	Seasonal high water table; fair to good bearing capacity; fair to poor stability.	Moisture content too high in many places for good compaction; poor stability on thawing.	Severe: Seasonal high water table; onsite investigation needed.	Low	Moderate.
Sandy soil that contains some gravel; high water table hinders construction in places; fair to good bearing capacity.	High water table; fair to good bearing capacity; low volume change; very low compressibility; good shear strength; flows when wet.	High water table; wetness hinders operations.	Severe: High water table.	High	Low.
Seasonal high water table; subject to stream overflow; fair to good bearing capacity.	Seasonal high water table; fair to good bearing capacity; low volume change and compressibility.	High moisture content in places hinders excavation.	Severe: Seasonal high water table; subject to stream overflow; contamination of shallow water supplies possible.	Moderate	Low.

TABLE 7.—*Engineering*

Soil series and map symbols	Soil features affecting—	
	Agricultural drainage	Irrigation
Allendale: AlB, AP (For interpretations of Pinconning and Pickford soils in unit AP, refer to their respective series in this table.)	Surface and subsurface drainage needed; seasonal high water table; very slowly permeable clayey material below a depth of 18 to 42 inches.	Low available moisture capacity; very rapid intake rate; very slow permeability in clays.
Au Gres: ArA, AsA, AU, AV, AW (For interpretations of Kinross soils in units AU and AV and of Roscommon soils in AW, refer to their respective series in this table.)	Drainage needed; material flows when wet; unstable if not confined; readily overdrained.	Low available moisture capacity; rapid intake rate; frequent applications of water required during dry periods.
Belding: BeA, BeB	Subsurface drainage needed; moderately slow permeability below a depth of 18 to 42 inches; seasonal high water table.	Moderate available moisture capacity; rapid intake rate.
Belding, clayey subsoil variant: Bf	Subsurface drainage needed; seasonal high water table; very slow permeability below a depth of 18 to 42 inches.	High available moisture capacity; moderately rapid intake rate.
Bowers: BgB, Bl (For interpretations of Iosco and Hettinger soils in unit Bl, refer to their respective series in this table.)	Generally needed; moderately slow permeability; seasonal high water table; wet depressions need surface drainage.	High available moisture capacity; moderate intake rate.
Breckenridge: Bm	Surface and subsurface drainage needed; high water table; moderately slow permeability below a depth of 18 to 42 inches.	Moderate available moisture content; rapid intake rate; drainage needed.
Brevort: Bn, Bo	Drainage needed; moderately slow permeability below a depth of 18 to 42 inches; high water table.	Low available moisture capacity; rapid intake rate; drainage needed.
Brimley: BrB	Drainage needed; high water table; silt and very fine sand in the substratum may flow into and plug tile; ditchbanks unstable.	Moderately high available moisture capacity and intake rate.
Bruce: Bs, BU (For interpretations of Brimley and Burleigh soils in unit BU, refer to their respective series in this table.)	Drainage needed; high water table; silt and fine sand in the substratum may flow into and plug tile; ditchbanks unstable.	Moderately high available moisture capacity; rapid intake rate; drainage needed.
Burleigh: Bv	Drainage needed; high water table; silt and very fine sand substratum make tiling questionable; ditchbanks unstable.	Sandy; low available moisture capacity; rapid intake rate; drainage needed.
Carbondale: Ca	Drainage needed; high water table; organic material subsides if overdrained.	Very high available moisture capacity; rapid intake rate; drainage needed.
Ceresco: Cc	Seasonal high water table; subject to stream overflow.	High available moisture capacity, rapid intake rate; subject to stream overflow.
Chelsea: CdB, CdC, CdD, CG, CHB, CHC (For interpretations of Au Gres soil in unit CG and of Rubicon soil in CHB and CHC, refer to their respective series in this table.)	Not needed	Low available moisture capacity; very rapid intake rate; frequent irrigation required; subject to soil blowing.
Cohoctah: Co	Drainage needed; high water table; fine sandy loam in the substratum may flow into and plug tile.	High available moisture capacity; rapid intake rate; drainage needed.
Croswell: CrB, CsB, CT, CU, CW (For interpretations of Au Gres soil in units CT, CU, and CW, of Kinross soil in unit CU, and of Roscommon soil in unit CW, refer to their respective series in this table.)	Not needed	Low available moisture capacity; very rapid permeability; rapid intake rate; frequent applications of water required in dry periods.

interpretations for farm uses

Soil features affecting—Continued			
Terraces and diversions	Grassed waterways	Farm ponds	
		Reservoir area	Embankment
Not needed; sandy; slow runoff.	Not needed; sandy; slow runoff.	Seasonal high water table; rapid seepage in sandy part, slow seepage in substratum.	Sandy part has fair stability, rapid seepage; substratum has high volume change, slow seepage.
Generally not needed; nearly level to gently sloping; slow runoff.	Generally not needed; nearly level to gently sloping; slow runoff.	Rapid permeability; rapid seepage; seal blanket required.	Rapid seepage; subject to piping.
Not needed; nearly level to gently sloping; slow runoff.	Not needed; nearly level; seasonal high water table; can be used for disposal of surface water.	Seasonal high water table; slow seepage.	Seasonal high water table; fair to good stability and compaction; slow seepage in substratum.
Not needed; nearly level to gently sloping; slow runoff.	No important limitations; seasonal high water table; can be used for disposal of surface water.	Slow seepage in clayey materials.	Seasonal high water table; fair stability; high volume change; fair to poor compaction; slow seepage.
Generally not needed; nearly level and gently sloping; slow runoff.	No important limitations; can be used for disposal of surface water.	Slow seepage	Fair to good stability and compaction; slow seepage.
Not needed; nearly level; slow runoff.	Not needed; can be used for disposal of surface water.	High water table; slow seepage; suited to pit ponds.	High water table; fair to good stability and compaction; slow seepage.
Not needed; nearly level; slow runoff.	Not needed; nearly level; high water table; can be used for disposal of surface water.	High water table; rapid seepage in sandy part, slow seepage below; suited to pit ponds.	High water table; sandy part has fair stability and rapid seepage; substratum has fair to good stability, slow seepage.
Generally not needed; gently sloping; little runoff.	No important limitations; seasonal high water table.	Medium to slow seepage; sides of ponds unstable when wet.	Subsoil has fair stability and compaction, slow seepage; substratum has poor stability, medium seepage, subject to piping.
Terraces not needed; nearly level; high water table; diversions reduce overflow of water from adjacent areas.	Generally not needed; high water table; nearly level or depressional.	High water table; medium seepage; suited to pit ponds; sides of ponds unstable when wet.	High water table; subsoil has fair to poor stability, slow seepage; substratum has poor stability, medium seepage, subject to piping.
Terraces not needed; nearly level; high water table; diversions reduce overflow of water from adjacent areas.	Generally not needed; wet; sandy; nearly level or depressional.	High water table; sandy part has rapid seepage; substratum has medium seepage; suited to pit ponds.	High water table; poor stability; fair compaction; medium seepage; subject to piping.
Not needed; nearly level; high water table.	Not needed; nearly level; slow runoff.	Very poorly drained; high water table; suited to pit ponds; organic material likely to float or cave in.	High water table; poor stability.
Nearly level; terraces seldom needed; diversions reduce overflow of water from adjacent soils.	Generally not needed; nearly level; seasonal high water table.	Seasonal high water table; medium seepage.	Seasonal high water table; medium to slow seepage; substratum subject to piping.
Not needed; sandy; slow runoff; difficult to vegetate.	Generally not needed; sandy; slow runoff on gentle slopes; steep slopes erode readily; difficult to vegetate.	Rapid seepage; too sandy and porous to hold water unless seal blanket is used.	Rapid seepage; fair stability and compaction; subject to piping; low volume change.
Terraces not needed, level, high water table; diversions reduce overflow of water from adjacent areas.	Generally not needed; high water table; nearly level or depressional.	High water table; medium seepage; suited to pit ponds; sides of ponds unstable when wet.	High water table; subsoil has fair to poor stability, slow seepage; substratum has poor stability, medium seepage, subject to piping.
Not needed; gently sloping; slow runoff.	Not needed; gently sloping; slow runoff.	Rapid seepage; seal blanket required.	Rapid seepage; good compaction; subject to piping.

TABLE 7.—*Engineering*

Soil series and map symbols	Soil features affecting—	
	Agricultural drainage	Irrigation
Deford (Mapped only in association with Roscommon or Wainola soil.)	Drainage needed; high water table; fine sand flows readily when wet.	Low available moisture capacity; rapid intake rate; drainage needed.
Edwards: Ed	Drainage needed; high water table.	Very high available moisture capacity; very rapid intake rate.
Epoufette: Ep, ET (For interpretations of Tawas soil in unit ET, refer to Tawas series in this table.)	Subsurface drainage needed; moderately rapid to very rapid permeability; sandy material flows.	Moderate available moisture capacity; rapid intake rate; drainage needed.
Evart: Ev, EW (For interpretations of Winterfield soil in unit EW, refer to Winterfield series in this table.)	Drainage needed; high water table; very sandy material; ditchbanks unstable.	Low available moisture capacity; rapid intake rate; drainage needed.
Gladwin: GhA, GIA, GE, GPB (For interpretations of Epoufette soil in units GE and GPB and of Croswell soil in unit GPB, refer to their respective series in this table.)	Subsurface drainage needed; moderately rapid to very rapid permeability; sandy material flows when wet.	Moderate available moisture capacity; very rapid intake rate; drainage needed.
Grayling: GrB, GSB, GSC, GU (For interpretations of Au Gres and Croswell soils in unit GU, refer to their respective series in this table.)	Not needed	Very low available moisture capacity; very rapid intake rate; frequent irrigation required; subject to soil blowing.
Hettinger: Hg, HB (For interpretations of Brevort and Burleigh soils in unit HB, refer to their respective series in this table.)	Subsurface and surface drainage needed; high water table; moderately slow permeability.	High available moisture capacity; moderate intake rate; drainage needed.
Houghton: Hu	Drainage needed; high water table; organic material subsides if overdrained.	Very high available moisture capacity; very rapid intake rate; drainage needed.
Ingalls: IcA	Generally needed; seasonal high water table; silt and very fine sand flows; ditchbanks unstable.	Low available moisture capacity; very rapid intake rate.
Iosco: IdA, IoA, IoB, IA, IB, II, IK, IM (For interpretations of Au Gres soil in unit IA, of Brevort soil in IB, II, IK, and IM, of Ingalls soil in IA and II, of Kawkawlin soil in IK, and of Menominee soil in IM, refer to their respective series in this table.)	Drainage needed; moderately slow permeability below a depth of 18 to 42 inches.	Low available moisture capacity; rapid intake rate.
Kawkawlin: KaA, KaB	Drainage needed; moderately slow permeability; seasonal high water table; wet depressions need surface drainage.	High available moisture capacity; moderate water intake rate.
Kinross: Kr	Extremely acid; wet; presently not used for farming.	Very low available moisture capacity; rapid intake rate; drainage needed.
Lacota: La	Drainage needed; high water table; rapid permeability below the water table; sandy material may flow into and plug tile.	High available moisture capacity and intake rate; drainage needed.
Linwood: Lm	Drainage needed; organic material subsides if overdrained.	Very high available moisture capacity; very rapid intake rate.
Londo: LoA, LoB	Drainage needed; seasonal high water table; moderately slow permeability.	High available moisture capacity; moderate intake rate.
Loxley: Lr	High water table; extremely acid; low fertility.	Very high available moisture capacity; very rapid intake rate.
Lupton: Lu	Drainage needed; high water table; organic material subsides if overdrained; controlled drainage required.	Very high available moisture capacity; very rapid intake rate; drainage needed.

interpretations for farm uses—Continued

Soil features affecting—Continued			
Terraces and diversions	Grassed waterways	Farm ponds	
		Reservoir area	Embankment
Generally not needed; nearly level; poorly drained; high water table.	Generally not needed; nearly level; high water table.	High water table; medium to rapid seepage; suited to pit ponds; banks unstable when wet.	High water table; poor stability; fair compaction; medium to rapid seepage; subject to piping.
Not needed; nearly level; slow runoff.	Not needed; nearly level; high water table.	Very poorly drained; high water table; organic material unstable.	High water table; poor stability and compaction.
Not needed; nearly level; slow runoff.	Not needed; nearly level; high water table.	High water table; rapid seepage; suited to pit ponds.	High water table; fair stability; fair to good compaction; medium to rapid seepage; subject to piping.
Terraces not needed; wet; sandy; nearly level.	Generally not needed; wet; sandy; nearly level.	High water table; rapid seepage; suited to pit ponds; subject to overflow.	High water table; fair stability and compaction; rapid seepage; subject to piping.
Not needed; nearly level to gently sloping; slow runoff.	Not needed; nearly level to gently sloping; slow runoff.	Too porous to hold water; seal blanket required.	Fair stability; fair to good compaction; medium to rapid seepage.
Not needed nor applicable; sandy; slow runoff; difficult to vegetate; slopes too steep in places.	Generally not needed; sandy; slow runoff; difficult to vegetate.	Rapid seepage; too sandy and porous to hold water unless seal blanket is used.	Rapid seepage; fair stability and compaction; subject to piping; low volume change.
Not needed; nearly level; wet	Can be used for disposal of surface water.	High water table; slow seepage; suited to dug ponds.	High water table; fair to good stability and compaction; slow seepage.
Not needed; nearly level; slow runoff.	Not needed; nearly level; high water table.	Very poorly drained; high water table; suited to pit ponds; organic material likely to float.	High water table; poor stability.
Generally not needed; sandy; gently sloping; little runoff.	Generally not needed; gently sloping; little runoff.	Rapid seepage; sides of ponds unstable when wet.	Poor stability; fair compaction; medium seepage; subject to piping.
Not needed; nearly level to gently sloping; slow runoff.	Not needed; normally can be used for disposal of surface water.	Seasonal high water table; rapid seepage in sandy part; slow seepage in substratum.	Sandy part has fair stability; rapid seepage; substratum has fair to good stability; slow seepage.
Generally not needed; nearly level and gently sloping; slow runoff.	No important limitations; can be used for disposal of surface water.	Slow seepage	Fair to good stability and compaction; slow seepage.
Terraces not needed; nearly level; high water table.	Generally not needed; wet; sandy; nearly level.	High water table; fair to good bearing capacity; low volume change and compressibility; tends to flow when wet.	High water table; rapid seepage; suited to pit ponds; acid; difficult to vegetate.
Not needed; nearly level	Can be used for disposal of surface water.	High water table; suited to pit ponds; rapid seepage in substratum.	High water table; upper 18 to 42 inches has fair to good stability and slow seepage; material below has fair stability, rapid seepage, and piping hazard.
Not needed; nearly level; slow runoff.	Not needed; nearly level; high water table.	Very poor drainage; high water table; organic material in upper part unstable, clay loam below.	High water table; organic material unstable; underlying material has fair to poor stability.
Generally not needed; nearly level; somewhat poorly drained.	Not needed because of topography; can be used for disposal of surface water.	Medium to slow seepage; seasonal high water table.	Fairly stable; can be used for impervious core; good compaction; slow seepage.
Not needed; nearly level; high water table.	Not needed; nearly level; slow runoff.	Very poor drainage; high water table; suited to pit ponds; organic material likely to float.	High water table; organic material unstable; extremely acid; sand substratum.
Not needed; nearly level; slow runoff.	Not needed; nearly level; high water table.	Very poorly drained; high water table; suited to pit ponds; organic material likely to float.	High water table; organic material unstable.

TABLE 7.—*Engineering*

Soil series and map symbols	Soil features affecting—	
	Agricultural drainage	Irrigation
Manceiona: MaA, MaB, MaC, MaE, McA, McB	Not needed	Moderate available moisture capacity; very rapid intake rate; subject to soil blowing.
Manistee: MdB	Not needed; in places random tile needed for draining small wet spots.	Low available moisture capacity; very rapid intake rate.
Markey: Me	Sand likely to flow into and plug tile; poor stability of ditchbanks.	Very high available moisture capacity; very rapid water intake rate.
Menominee: MnA, MnB, MnD, MrA, MrB	Not needed; in places random tile needed for draining small wet spots.	Low available moisture capacity; very rapid intake rate; sloping soils erode readily.
Montcalm: MtA, MtB, MtC, MtE	Not needed	Moderate available moisture capacity; very rapid intake rate; frequent applications of water needed in dry periods; subject to soil blowing.
Munuscong: Mu	Surface and subsurface drainage needed; slowly permeable material below a depth of 18 to 42 inches.	Moderate available moisture capacity; moderately rapid intake rate; drainage needed.
Nester: NbB, NeA, NeB, NeC, NeC2, NeD, NeD2, NeE, NeE2.	Not needed; in places random tile needed for draining small wet spots.	High available moisture capacity; moderate intake rate; sloping to steep soils subject to rapid runoff and erosion.
Oequeoc: OcA	Not needed	Low available moisture capacity; very rapid intake rate.
Ogemaw: Og	Seasonal high water table needs drainage; infertile.	Low available moisture capacity; very rapid intake rate; cemented layer restricts water movement.
Ontonagon: OnA, OnB	In places random tile needed for draining small wet areas; very slow permeability.	Moderately high available moisture capacity; moderate to slow intake rate.
Otisco: OtA	Generally needed; seasonal high water table; rapid permeability; sandy substratum; special binding required for tile.	Low available moisture capacity; rapid intake rate.
Parkhill: Pa	Moderate permeability; high water table if adequate outlets are available; subsurface drainage is satisfactory; soil becomes hard during dry periods.	High available moisture capacity and moderate intake rate; requires infrequent application of water.
Pickford: Pc, Pm	Surface and subsurface drainage needed; high water table; very slow permeability.	Moderately high available moisture capacity; moderate to slow intake rate; drainage needed.
Pinconning: Ps	Surface and subsurface drainage needed; very slowly permeable substratum; high water table.	Low available moisture capacity; rapid intake rate.
Roscommon: Rc, RB, RD, RT (For interpretations of Brevort soil in unit RB, of Deford soil in RD, and of Tawas soil in RB and RT, refer to their respective series in this table.)	Drainage needed; high water table; very sandy material makes use of tile drains questionable; ditchbanks unstable.	Very low available moisture capacity; rapid intake rate; drainage needed.
Rousseau: RoC	Not needed	Sandy; low available moisture capacity; very rapid intake rate; frequent irrigation needed; subject to soil blowing.

interpretations for farm uses—Continued

Soil features affecting—Continued			
Terraces and diversions	Grassed waterways	Farm ponds	
		Reservoir area	Embankment
Erodible; slopes more than 12 percent in places.	Sandy; slow to medium runoff; difficult to vegetate.	Too porous to hold water; seal blanket required.	Fair stability; fair to good compaction; medium to rapid seepage.
No important limitations; slopes short or irregular in places.	Sandy; erodible; difficult to vegetate.	Very slow seepage rate below a depth of 18 to 42 inches; rapid above.	Fairly stable; rapid seepage to a depth between 18 and 42 inches, very slow seepage above.
Not needed; level; very slow runoff.	Not needed	High water table; normally suited to shallow dug ponds; organic material likely to float.	High water table; organic material unstable; rapid permeability.
Sandy part is highly erodible; construction difficult on slopes.	Erodes readily; difficult to vegetate.	Rapid seepage to a depth of 27 inches, slow below.	Fair stability; rapid seepage to a depth of 27 inches, slow seepage below.
Not needed or not suitable; sandy; slow runoff; difficult to vegetate; slopes too steep in places.	Generally not needed; sandy; slow runoff on gentle slopes; steep slopes erode readily; difficult to vegetate.	Rapid seepage; too sandy and porous to hold water unless seal blanket is used.	Rapid to medium seepage; fair stability and compaction; subject to piping; low volume change on wetting or drying.
Not needed; nearly level; slow runoff.	Not needed; nearly level; can be used for disposal of surface water.	High water table; slow seepage; suited to pit ponds.	High water table; fair stability in upper 18 to 42 inches, medium seepage; substratum has fair stability, high volume change; slow seepage.
No important limitations; in places slopes exceed 12 percent.	Sloping and steep areas subject to rapid runoff and erosion; clayey layers below surface layer difficult to vegetate.	Slow seepage	Fair stability and compaction; slow seepage; can be used for impervious core in places.
Not needed; nearly level; difficult to vegetate.	Sandy; difficult to vegetate	Rapid seepage; seal blanket generally required; sides of ponds unstable if substratum is exposed.	Fair to poor stability; medium seepage; fair to poor compaction; subject to piping.
Not needed; nearly level; slow runoff.	Not needed; nearly level	Sandy upper part too porous to hold water; impervious material below suitable for dug ponds.	Rapid seepage in sandy upper part; difficult to vegetate; slow seepage in lower part, fair to good stability.
Dense clay material; difficult to construct and vegetate.	Dense clay material; difficult to construct and vegetate; rapid runoff on slopes.	Slow seepage; clayey material	Fairly stable; slow seepage; fair to poor compaction; high volume change.
Generally not needed; sandy; gently sloping; little runoff.	Generally not needed; sandy soil; gently sloping; slow runoff.	Rapid seepage; seal blanket required.	Fair stability; fair to good compaction; medium to slow seepage; subject to piping.
Not needed; nearly level	Not needed because of topography; can be used for disposal of surface water.	Slow seepage; high water table; suitable for dug ponds.	Fairly stable; can be used for impervious core; good compaction; slow seepage.
Not needed; nearly level; wet; slow runoff.	Can be used to improve surface drainage; clayey material and high water table hinder construction.	High water table; slow seepage; suited to pit ponds.	High water table; fair stability; poor compaction; slow seepage; high volume change.
Not needed; nearly level; slow runoff.	Not needed; nearly level; slow runoff.	High water table; rapid seepage in sandy part, slow seepage in substratum; suitable for pit ponds.	High water table; sandy part has fair stability and rapid seepage; substratum has high volume change, slow seepage.
Terraces not needed; nearly level; high water table.	Generally not needed; wet; sandy; nearly level.	High water table; rapid seepage; suited to pit ponds.	High water table; fair stability and compaction; rapid seepage; subject to piping.
Not needed nor applicable; sandy; slow runoff; difficult to vegetate.	Generally not needed; sandy; slow runoff on gentle slopes; steep slopes erode readily; difficult to vegetate.	Rapid seepage; seal blanket generally required; unstable if ground cover is removed.	Fair to poor stability; rapid seepage; fair compaction; subject to excessive piping.

TABLE 7.—*Engineering*

Soil series and map symbols	Soil features affecting—	
	Agricultural drainage	Irrigation
Rubicon: RsB, RsC, RsE, RtB, RUB, RVB, RWB—(For interpretations of Croswell soil in unit RUB, of Menominee soil in RVB, and of Ocqueoc and Ingalls soils in RWB, refer to their respective series in this table.)	Not needed	Very low available moisture capacity; very rapid intake rate; subject to soil blowing; frequent irrigation needed; low fertility.
Rudyard: RyA, RyB	Seasonal high water table; very slow permeability; surface and subsurface drainage needed.	Moderately high available moisture capacity; moderate to slow intake rate; very slow permeability.
Saugatuck: Sc	Seasonal high water table; sandy material flows when wet; ditchbanks unstable.	Very low available moisture capacity; rapid intake rate; frequent irrigation needed; low fertility.
Sims: Sn	Surface and subsurface drainage needed; moderately slow permeability; water likely to be ponded in depressions.	High available moisture capacity; moderate intake rate; drainage needed.
Tawas: Ta	Sand likely to flow into and plug tile lines; ditchbanks unstable.	Very high available moisture capacity; very rapid intake rate.
Ubly: UlA, UlB, UlC	Not needed; in places random tile needed for draining small wet spots.	Moderate available moisture capacity; rapid intake rate.
Wainola: WD—(For interpretations of Deford soil in this unit, refer to Deford series in this table.)	Generally needed; seasonal high water table; tiling questionable because of fine sand substratum; ditchbanks unstable.	Low available moisture capacity; very rapid intake rate; frequent applications of water required.
Wheatley: Wh	Drainage needed; high water table; very sandy material makes tiling questionable; ditchbanks unstable.	Very low available moisture capacity; rapid intake rate; drainage needed.
Winterfield—(Mapped only in association with Evart soil.)	Generally not suited to crops because of flooding hazard and sandy material.	Low available moisture capacity; very rapid intake rate; subject to stream overflow.

interpretations for farm uses—Continued

Soil features affecting—Continued			
Terraces and diversions	Grassed waterways	Farm ponds	
		Reservoir area	Embankment
Not needed nor applicable; slow runoff; difficult to vegetate; slopes too steep in places.	Generally not needed; slow runoff; difficult to vegetate; steep slopes erode readily.	Rapid seepage; too sandy and porous to hold water unless seal blanket is used.	Rapid seepage; fair stability and compaction; subject to piping; low volume change; subject to soil blowing.
Not needed; seasonal high water table; clayey material; difficult to vegetate.	Cuts expose clayey material; difficult to vegetate.	Slow seepage	Seasonal high water table; fair stability; high volume change; fair to poor compaction; slow seepage.
Not needed; nearly level; slow runoff.	Not needed; nearly level; slow runoff.	Material too porous to hold water; seal blanket required.	Seasonal high water table; fair stability and compaction; rapid seepage; subject to piping
Not needed; nearly level; wet	Can be used for disposal of surface water.	High water table; slow seepage; suited to pit ponds.	High water table; fair to good stability and compaction; slow seepage.
Not needed; nearly level; slow runoff.	Not needed	Very poorly drained; high water table; normally suited to dug ponds; organic material likely to float.	High water table; organic material unstable; rapid permeability in sandy part.
No important limitations; slopes are short and irregular.	No important limitations; sloping areas are erodible.	Medium to rapid seepage to a depth of 18 to 42 inches; slow below.	Upper part has fair stability, medium seepage, and good compaction; substratum has fair to good compaction and slow seepage.
Not needed; sandy soil; gently sloping; slow runoff.	Not needed; sandy; gently sloping; slow runoff.	Rapid seepage; sides of ponds unstable when wet.	Poor stability; fair compaction; medium seepage; subject to piping.
Terraces not needed; nearly level; high water table.	Generally not needed; wet; sandy; nearly level or depressional.	High water table; rapid seepage; suited to pit ponds.	High water table; fair stability and compaction; rapid seepage; subject to piping.
Not needed; nearly level; slow runoff.	Not needed; nearly level; slow runoff.	Subject to stream overflow; rapid seepage.	Seasonal high water table; fair stability; fair to good compaction; medium seepage; subject to piping.

winter grading. Also given in table 6 are limitations for septic tank disposal fields and ratings for the corrosive potential for conduits.

The ratings for suitability as a source of topsoil were based largely on texture and content of organic matter. Topsoil is material, preferably material rich in organic matter, that is used to topdress back slopes, embankments, lawns, gardens, and the like. Unless otherwise indicated, only the surface layer was considered in making these ratings.

Ratings of suitability of the soil as a source of sand and gravel apply only to material within a depth of 5 feet. Some soils that are rated "not suited" in table 6 may have sand and gravel at a depth of more than 5 feet. In some of the soils, sand and gravel is at a depth of less than 5 feet and extends to a depth greater than 5 feet. Where suitability is questionable, the availability of the sand and gravel can be determined by digging test pits.

Ratings of the suitability of the soil as a source of road fill are based on performance of soil material used as borrow for subgrade. Both the subsoil and substratum are rated if they have contrasting characteristics. The most suitable material is sand; the least suitable is clay.

In table 6 the ratings of suitability of the soils as a source of impermeable material are based on the permeability of the soil material when compacted. Permeability affects uses of soil material as linings for reservoirs and sewage lagoons and as fill for embankments.

Also listed in table 6 are soil features affecting locations for highways. The soil features considered were those that affect the overall performance of the soil, such as a high water table or steep slopes. The entire soil profile, undisturbed and without artificial drainage, was evaluated. Seepy areas and small wet spots are common in most areas of the Ontonagon, Nester, and Ubly soils, even though these soils are dominantly well drained or moderately well drained. In many of these areas, random tile lines are needed to provide drainage. Good materials for road subbase are well distributed throughout the county in the sandy and gravelly soils. Additional information can be obtained from the State Highway Department of Michigan, which has rated the major soil series in the State for their suitability for highway construction. This information is in the "Field Manual of Soil Engineering" (*3*).

Of special concern to engineers involved with highway locations are the silty soils of the county, particularly the Bowers and Brimley soils. These soils consist of stratified silt and very fine sand that is soft and very unstable and has low bearing capacity and is highly susceptible to frost action.

The soils are also rated in table 6 as to their suitability for foundations for buildings that are no more than three stories high. The suitability of the soils as a base for low buildings depends mainly on characteristics of the substratum, which generally provides the base for foundations. Ratings are therefore for the substratum. Important factors considered in determining the suitability of the soils as foundations for low buildings are susceptibility to frost heaving, bearing capacity, and shrink-swell potential. Engineers and others should not apply specific values to the estimates given for bearing capacity of soils.

The poor bearing capacity of the Brimley and Ontonagon soils is likely to result in cracks in basement walls and settling of foundations, particularly in buildings of more than one story. Frost heaving is a relatively high hazard on the somewhat poorly drained and poorly drained, finer textured soils, such as the Kawkawlin, Londo, Pickford, and Sims. Paved sidewalks, driveways, and garage or carport floors on these soils are likely to be damaged by frost heaving unless a foot or more of coarse-textured material is placed below the paving. Soils that have a high shrink-swell potential are severely limited for foundations and structures.

Among the soil features that affect winter grading are those that, in winter, affect the crossing of areas of soil and the handling of soil material with ordinary construction equipment. Important factors considered are texture of the soil material, natural content of water, and depth to water table.

Limitations of the soils for use as disposal fields for septic tanks and soil features that affect their use for this purpose are also shown in table 6. Some of the limiting factors are permeability, depth to water table, flooding hazard, and relief. Soils that have somewhat poor or poor drainage, a seasonal high water table, or slow or very slow permeability are poor sites. A sewage disposal system does not function properly in such soils. A percolation rate of 60 minutes per inch or less is required for a septic tank disposal field. This is equivalent to a permeability rate of 1 inch per hour. Permeability rates for the soils in Gladwin County are given in table 5.

The soils are also rated in table 6 according to the degree that they encourage the corrosion of conduits laid in them. Ratings are given for uncoated steel conduits and concrete conduits. The texture and natural drainage of a soil affect this potential through their influence on aeration, content of water, and movement of water. The pH of the soil also may be important.

Table 7 lists features that affect the use of the soils for agricultural drainage, irrigation, terraces and diversions, grassed waterways, and farm ponds.

Listed under agricultural drainage are features that affect the installation and performance of surface and subsurface drainage systems. Such features are texture, permeability, relief, restricting layers, and depth to water table.

Artificial drainage is needed in areas that have been cleared for farmland. Many wet areas in the county that are used for pasture would be suited to crops if adequately drained and managed. Less than one-third of the total acreage of the Kawkawlin, Breckenridge, Bowers, Bruce, and Sims soils is used for cropland. Tile drains are suitable for draining these soils, but adequate outlets are lacking in many areas. In many places drainage ditches can be installed, however, as outlets for tile. The Pickford soils are slowly to very slowly permeable. In these soils closer spacing of tile is needed for adequate drainage than on more permeable soils.

Few of the organic soils in the county are drained and used for farming. Drainage of organic soils is best accomplished in two phases. First, outlet ditches should be dug to lower the water table to a depth of about 3 feet.

Then, after a year or two, tile drains can be installed. The time between digging the ditches and installing the tile drains is needed to allow initial subsidence without interfering with the grade in the tile lines.

The major features affecting suitability of the soils for irrigation are water-holding capacity and rate of water intake. Also important are relief, depth to the water table, and depth to soil material that restricts growth of roots. Little irrigation is now done in the county, though many of the soils are suitable for irrigation. If irrigated, the large acreage of sandy soils in the county would be suitable for many crops, including many specialty crops that are suited to the climate but presently are not grown. In many areas water for irrigation can be obtained from shallow wells or lakes.

Important features that affect the layout and construction of terraces and diversions are relief, texture of the soil material, and depth to material that restricts growth of roots. All of the sloping soils on uplands in the county have properties that are suitable for the construction of terraces and diversions. In some places, however, the slopes are too irregular for terraces. On the Ontonagon and the Nester soils, cuts into the lower part of the subsoil expose material that is low in productivity and difficult to till.

The success of grassed waterways depends on soil features that affect the construction and maintenance of the waterways and the growth of plants in them. Important features are fertility, water-holding capacity, and susceptibility to erosion. Establishing a good, dense sod that is resistant to erosion is needed for well-constructed waterways, and this is fairly easy on most soils in the county. The lack of high-intensity rainfalls of the kind common in states to the south and west also helps to make these soils suitable for construction of waterways.

Establishing grassed waterways on the limy glacial till of the Nester and Ontonagon soils is possible, even though these soils have poor soil structure and are low in organic matter. On these soils liberal applications of manure are needed for establishing seedlings.

The seepage rate of undisturbed soil material is the most important feature affecting the reservoir area of a farm pond. Features affecting embankments are compaction properties, stability, permeability, seepage, and the piping hazard. Because of the slow seepage rate, the soils that formed in sandy clay loam, clay loam, and silty clay to clay are favorable for construction of farm ponds. The soils that formed in sandy loam materials have a rapid seepage rate, and this results in wide fluctuations in the water level. Successful ponds can be constructed on these soils, however, by careful selection of materials from the subsoil for use in blanketing the reservoir area and by compacting the material. The soils that formed in sand and loamy sand have an excessive seepage rate and are not suitable sites for ponds. Springs in many low areas in the county provide a good flow of water. Good ponds can be constructed in these areas, even though the seepage rate is rapid. Careful study of the areas is needed before constructing the ponds.

Residential development.—Some features important to development as sites for residences already have been discussed, such as suitability of the soils for domestic sewage disposal systems. Further information that needs to be considered is discussed in the paragraphs that follow.

Important factors to consider in using the soils for residential development are soil drainage, permeability, and stability and the frequency of flooding. Soils that are somewhat poorly drained or poorly drained, that have a seasonal high water table, or that have slow or very slow permeability are poor construction sites for residential use.

On wet and slowly permeable soils, basements are difficult to keep dry. The best soils in the county for residential uses are the well-drained soils that formed in sandy loam and loamy sand material. The most favorable soils are those of the Mancelona, Montcalm, and Rousseau series. The very sandy, well-drained Grayling and Rubicon soils also are suited except for droughtiness. On these soils good lawns and shrubs can be established and maintained if they are watered regularly. Blanketing the areas with a loamy topsoil makes them less droughty.

The alluvial soils in the county on the flood plains of streams are severely limited for use as residential developments because of the hazard of flooding.

Formation and Classification of Soils

This section first discusses the five major factors of soil formation and the four important processes that are involved in the differentiation of soil horizons in terms of their effect on the soils of Gladwin County. Then the current system of classifying soils is explained briefly. More information about the soils, as well as a profile typical of each soil series, is given in the section "Descriptions of the Soils."

Factors of Soil Formation

Soil is the product of the interaction of the five major factors of soil formation. These factors are parent material, climate, living organisms (especially vegetation), relief, and time. The kind of soil at any place depends on the influence of these factors.

Parent material is the unconsolidated mass from which soil forms. It determines the limits of the chemical and mineralogical composition of the soil. Much of the parent material in Gladwin County was deposited by glaciers and consists of such mineral materials as gravel, sand, sand and gravel, loam, and clay. These materials were deposited on outwash plains, in valley drainageways, and on till plains, moraines, and flood plains. Some of the soils, however, formed in recent alluvium along the streams, and the organic soils consist of remains of plants that accumulated under water in shallow lakes or swamps.

The *climate* of Gladwin County is cool and humid and is presumably similar to the climate that existed at the time the soils formed. Climate is fairly uniform throughout the county, but its affect is modified in some areas by runoff. Differences among the soils in the county therefore are not because of the climate.

Among the *living organisms* that affect soils are green plants, animals, insects, bacteria, and fungi. These organisms cause gains in the content of organic matter and

nitrogen, gains or losses in the content of plant nutrients, and changes in the structure and porosity of the soil.

Vegetation has had a greater effect on the formation of soils in the county than other living organisms. Hardwoods and conifers were dominant in the vegetation much of the time while the soils were being formed.

Relief affects formation of soils through its influence on drainage, erosion, plants, and temperature of the soils. The county has extremely variable relief, and the surface features range from closed depressions to steep hills. In some places the local differences in elevation are as much as 150 to 200 feet. In others there are large, nearly level plains that have slopes of less than 2 percent. Many small areas of level soils are interspersed throughout areas of undulating and hilly soils. The areas of level soils receive runoff from the slopes. In depressions and in some level areas, the water table is at or near the surface, and the soils are somewhat poorly drained or poorly drained. Examples of somewhat poorly drained or poorly drained soils are those of the Sims, Kawkawlin, and Roscommon series.

Time, generally hundreds or thousands of years, is required for formation of soils that have distinct horizons. The differences in length of time that parent materials have been in place or that have been subjected to the processes of soil formation are commonly reflected in the degree of development of the soil profile.

The soils in Gladwin County range from young to old. The young soils show very little profile development, but the old soils have well-expressed soil horizons. Ceresco soils are an example of young soils that lack a developed profile. Except for the darkening of their surface layer, Ceresco soils retain most of the characteristics of their parent material. Londo soils are an example of older soils that have developed soil horizons.

Differentiation of Soil Horizons

Four main processes that are involved in the formation of soil horizons are (1) accumulation of organic matter, (2) leaching of calcium carbonate and of other bases, (3) reduction and transfer of iron, and (4) formation and translocation of silicate clay minerals. In most soils more than one of these processes have been active in the formation of soil horizons.

In many soils organic matter accumulates in the upper profile to form a dark-colored horizon of mineral soil that is called the A1 horizon. The soils of Gladwin County range from high to very low in their content of organic matter.

Leaching of carbonates and other bases has occurred in nearly all of the soils of the county. Soil scientists generally agree that leaching of bases in soils usually precedes the translocation of silicate clay minerals. Most soils in the county are moderately to strongly leached, and the leaching has contributed to the formation of soil horizons.

Reduction of iron compounds, a process called gleying, is evident in the poorly drained and very poorly drained soils of the county. Gray color in the subsoil horizons indicates that iron compounds have been reduced and moved by leaching. Some horizons contain reddish-brown mottles and concretions, which indicates that iron compounds have been segregated and oxidized.

In some soils of the county, translocation of clay minerals has contributed to the formation of soil horizons. The eluviated A2 horizon above the B horizon has platy structure, is lower in content of clay, and generally is lighter in color than the B horizon. The B horizon in many soils contains accumulated clay in the form of clay films in pores and on the surfaces of peds. Soils that have one or more horizons in which clay has accumulated probably were leached of most of their carbonates and soluble salts before the translocation of silicates took place. Nester soils have in them translocated silicate clay minerals that have accumulated in the B horizon in the form of clay films.

In some soils of the county, iron compounds and humus have moved from the surface layer and accumulated in the B horizon. Such a B horizon ranges from dark reddish brown to yellowish brown in color. The Rousseau, Rubicon, and Grayling soils are examples of soils in which translocated iron compounds and humus have accumulated.

Classification of Soils

Soils are classified so that we may more readily remember their significant characteristics. 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 specific fields and other tracts of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and later revised (*6*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study (*5, 8*). Therefore, readers interested in developments of the current system should search the latest literature available. In table 8 the soil series of Gladwin County are placed in some categories of the current system.

The current system 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 origin are grouped together. The classes of the current system are briefly defined in the following paragraphs.

ORDERS. Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols,

TABLE 8.—*Soil series of Gladwin County classified according to the current system of classification*[1]

Series	Family	Subgroup	Order
Allendale	Sandy over clayey, mixed, frigid	Aqualfic Haplorthods	Spodosols.
Au Gres	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Belding	Coarse-loamy, mixed, frigid	Alfic Haplaquods	Spodosols.
Belding, clay subsoil variant [2]	Coarse-loamy over clayey, mixed, frigid	Alfic Haplaquods	Spodosols.
Bowers	Fine, mixed	Aquic Eutroboralfs	Alfisols.
Breckenridge	Coarse-loamy, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Brevort	Sandy over loamy, mixed, nonacid, frigid	Mollic Haplaquents	Entisols.
Brimley [3]	Fine-loamy, mixed, frigid	Alfic Haplaquods	Spodosols.
Bruce	Fine-loamy, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Burleigh	Sandy over loamy, mixed, nonacid, frigid	Mollic Haplaquents	Entisols.
Carbondale	(4)	(4)	Histosols.
Ceresco [3]	Coarse-loamy, mixed, mesic	Aquic Fluventic Hapludolls	Mollisols.
Chelsea	Mixed, mesic	Alfic Udipsamments	Entisols.
Cohoctah	Coarse-loamy, mixed, noncalcareous, mesic	Fluventic Haplaquolls	Mollisols.
Croswell	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Deford	Mixed, frigid	Mollic Psammaquents	Entisols.
Edwards	(4)	(4)	Histosols.
Epoufette	Sandy, mixed, frigid	Mollic Haplaquents	Entisols.
Evart [3]	Sandy, mixed, frigid	Fluventic Haplaquolls	Mollisols.
Gladwin	Sandy, mixed, frigid	Alfic Haplaquods	Spodosols.
Grayling	Mixed, frigid	Typic Udipsamments	Entisols.
Hettinger	Fine-loamy, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Houghton	(4)	(4)	Histosols.
Ingalls [3]	Sandy over loamy, mixed, frigid	Entic Haplaquods	Spodosols.
Iosco	Sandy over loamy, mixed, frigid	Aqualfic Haplorthods	Spodosols.
Kawkawlin [2]	Fine, mixed	Aquic Eutroboralfs	Alfisols.
Kinross	Sandy, mixed, frigid	Typic Haplaquods	Spodosols.
Lacota	Fine-loamy over sandy or sandy skeletal, mixed, nonacid, frigid.	Mollic Haplaquepts	Inceptisols.
Linwood	(4)	(4)	Histosols.
Londo [2]	Fine-loamy, mixed, mesic	Aeric Glossaqualfs	Alfisols.
Loxley, coarse substratum	(4)	(4)	Histosols.
Lupton	(4)	(4)	Histosols.
Mancelona	Sandy, mixed, frigid	Alfic Haplorthods	Spodosols.
Manistee	Sandy over clayey, mixed, frigid	Alfic Haplorthods	Spodosols.
Markey	(4)	(4)	Histosols.
Menominee	Sandy over loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Montcalm	Sandy, mixed, frigid	Alfic Haplorthods	Spodosols.
Munuscong	Coarse-loamy over clayey, mixed, nonacid, frigid.	Mollic Haplaquepts	Inceptisols.
Nester	Fine, mixed	Typic Eutroboralfs	Alfisols.
Ocqueoc	Sandy over loamy, mixed, frigid	Entic Haplorthods	Spodosols.
Ogemaw	Sandy over loamy, mixed, frigid, ortstein	Aquic Haplorthods	Spodosols.
Ontonagon	Very fine, illitic	Typic Eutroboralfs	Alfisols.
Otisco [3]	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Parkhill	Fine-loamy, mixed, nonacid, mesic	Mollic Haplaquepts	Inceptisols.
Pickford	Fine, mixed, nonacid, frigid	Aeric Haplaquepts	Inceptisols.
Pinconning	Sandy over clayey, mixed, nonacid, frigid	Mollic Haplaquents	Entisols.
Roscommon	Mixed, frigid	Mollic Psammaquents	Entisols.
Rousseau	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Rubicon	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Rudyard [2]	Very fine, illitic	Aquic Eutroboralfs	Alfisols.
Saugatuck [3]	Sandy, mixed, frigid, ortstein	Aeric Haplaquods	Spodosols.
Sims	Fine, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Tawas	(4)	(4)	Histosols.
Ubly	Coarse-loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Wainola [3]	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Wheatley	Mixed, frigid	Mollic Psammaquents	Entisols.
Winterfield [3]	Mixed, frigid	Aquic Udipsamments	Entisols.

[1] Classification given is as of January 1970. Placement of some soil series in the current system of classification, particularly in families, may change as more information becomes available.

[2] This series in Gladwin County is wetter than is typical for the series.

[3] This series in Gladwin County is less wet than is typical for the series.

[4] The classification of Histosols at the subgroup and family levels was omitted because that classification was provisional at the time the survey was sent to the printer.

Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad, climatic groupings of soils. Two exceptions, the Entisols and Histosols, occur in many different kinds of climate. The six orders in Gladwin County are Entisols, Inceptisols, Alfisols, Mollisols, Spodosols, and Histosols.

Entisols are young mineral soils that do not have genetic horizons or have only the beginning of such horizons.

Inceptisols are mineral soils in which horizons have definitely started to develop. They generally are on young, but not recent, land surfaces.

Alfisols are soils that have a clay-enriched B horizon that has high base saturation. These soils formed in marshes and swamps in materials that were little affected by weathering.

Mollisols have a thick, friable, dark-colored surface layer. Base saturation is more than 50 percent.

Spodosols are mineral soils in which organic colloids and iron and aluminum compounds have accumulated in some part of the B horizon.

Histosols are highly organic soils that formed in marshes and swamps where organic matter from decaying plants accumulated, and their classification has not been completed beyond the order.

SUBORDERS. Each order is subdivided into groups (suborders) that are based mostly on soil characteristics that seem to produce classes having the greatest similarity from the standpoint of their genesis. Suborders narrow the broad climatic range of soils that are in the orders.

Soil characteristics used to separate suborders mainly reflect either the presence or absence of waterlogging or soil differences produced through the effects of climate or vegetation. The names of suborders have two syllables, the last syllable of which indicates the order. An example is Psamments (Psamm, meaning sandy, and ent, from Entisol).

GREAT GROUPS. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and other features. The horizons used as a basis for distinguishing between great groups are those in which (1) clay, iron, or humus has accumulated; (2) a pan has formed that interferes with growth of roots, movement of water, or both; or (3) a thick, dark-colored surface horizon has formed. The other features commonly used are the self-mulching properties of clay, the base of the soil, major differences in chemical composition (mainly the bases calcium, magnesium, sodium, and potassium), or the dark-red or dark-brown colors associated with soils formed in material weathered from basic rocks.

Names of the great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Aquipsamment (Aqui, meaning wet; psamm, for sandy; and ent, from Entisol.)

SUBGROUPS. Great groups are subdivided into subgroups. One of these represents the central, or typic, segment of the group. Other subgroups have properties of the group but have one or more properties of another great group, suborder, or order, and these are called intergrades. The names of subgroups are formed by placing one or more adjectives before the name of the great group. An example is Typic Aquipsamment (a typical Aquipsamment.)

FAMILIES. Families are separated within a subgroup, primarily on the basis of properties that are important to the growth of plants or to the behavior of soils when used for engineering. The main properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives that precedes the name of the subgroup. The adjectives used are the class names for texture, mineralogy, and so on. An example is the sandy, mixed, frigid family of Typic Haplaquods.

SERIES. The series consists of a group of soils that formed from a particular kind of parent material and that have genetic horizons that, except for texture of surface layer, are similar in important characteristics and in arrangement in the profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

General Nature of the County

In this section the climate and outstanding features of farming in Gladwin County are discussed. The statistics used in the discussion of farming are mainly from reports published by the U.S. Census of Agriculture.

Climate [4]

Gladwin County has a continental climate that is modified by the Great Lakes. Winds that cross Lake Michigan from the west and Lake Huron from the east make the county somewhat warmer in winter and cooler in summer than areas at the same latitude in the western part of the State.

Annual temperature and precipitation, compiled from records of the U.S. Weather Station at Gladwin, are shown in table 9. Shown in this table, in addition to the average monthly temperature and precipitation, are the probabilities of very high and very low temperatures and the amounts of precipitation. Temperatures in the county vary widely. In July, for example, an average of 2 years in 10 will have at least 4 days with temperatures of 92° F. or higher at the Gladwin weather station. On an average of 10 days each summer, the temperature reaches 90° or higher. In January, on the other hand, temperatures of 8° below zero or colder occur on at least 4 days on an average of 2 years in 10. Temperatures of zero or lower occur on an average of 15 days in winter.

The highest temperature ever recorded in the county was 105°, on July 13, 1936, and the lowest was 39° below zero on February 20, 1929. The average highest temperature, however, is 95°, and the average lowest is 14° below zero.

In table 10 the probabilities of last freezing temperatures in spring and first freezing temperatures in fall are shown. These figures are also from the U.S. Weather Station at Gladwin. They show that in 1 year in 10

[4] By NORTON P. STROMMAN, climatologist for Michigan, National Weather Service, U.S. Department of Commerce.

TABLE 9.—*Temperature and precipitation, Gladwin County, Mich.*

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average monthly total	One year in 10 will have—		Days with snow cover	Average depth of snow on days with snow cover of 1 inch or more
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Number	Inches
January	28. 5	12. 2	41	−8	1. 68	0. 6	3. 0	26	5. 7
February	30. 0	11. 5	42	−7	1. 53	. 5	2. 9	24	7. 2
March	38. 9	20. 1	59	3	1. 92	. 9	3. 1	16	5. 0
April	54. 7	31. 6	75	19	2. 67	1. 3	4. 5	1	1. 7
May	67. 3	42. 0	82	31	2. 97	1. 5	4. 6	0	0
June	77. 4	51. 9	90	40	3. 41	1. 5	5. 5	0	0
July	82. 0	55. 8	92	45	2. 94	1. 2	5. 6	0	0
August	80. 2	54. 6	91	43	3. 11	1. 1	5. 9	0	0
September	71. 3	46. 8	85	33	3. 19	1. 5	5. 7	0	0
October	60. 2	37. 3	77	22	2. 70	. 6	5. 2	(1)	1. 0
November	43. 9	27. 5	61	14	2. 49	1. 2	3. 6	3	2. 7
December	32. 1	17. 5	48	0	1. 87	. 7	3. 5	17	3. 4
Year	55. 5	34. 1			30. 48	23. 4	37. 8	87	5. 4

[1] Less than 0.5 day.

temperatures as low as 32° occur as late as June 4 in spring and as early as September 9 in fall.

The average date of the last killing frost in spring is May 20, and the average date of the first killing frost in fall is September 25. The average frost-free season therefore is 128 days. Length of the growing season varies, depending upon the air drainage. In low depressions that lack air drainage, the heavier cold air tends to settle. In such areas frost generally occurs later in spring and earlier in fall than on sloping areas where air drainage is good.

Most of the rain comes during the growing season. On an average, about 60 percent of the yearly precipitation falls in the 6-month period from April through September. June is the wettest month, when the average total precipitation is 3.41 inches, and February is the driest, when the average total precipitation is 1.53 inches. In 1 year in 2, as much as 1.1 inches of precipitation comes in 1 hour, 1.4 in 2 hours, and 2.3 in 24 hours. In 1 year in 10, 3.4 inches of rain falls in a 24-hour period, and in 1 year in 50, 4.1 inches falls in the same period.

Precipitation during the growing season is suitable for many kinds of crops. It generally is well distributed throughout the season, and long periods of drought are rare. Short periods of drought are common in summer, and hinder growth of crops even on the medium-textured soils.

The greatest number of cloudy days occurs late in fall and early in winter. The nearest 24-hour weather station is at Flint in Genesee County. Records at this station show that on the average December has 22 cloudy days, 7 partly cloudy days, and 2 clear days. In contrast, July has 10 cloudy days, 13 partly cloudy days, and 8 clear days.

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall, Gladwin County, Mich.*

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 11	April 19	May 7	May 20	June 4
2 years in 10 later than	April 6	April 14	May 2	May 15	May 30
5 years in 10 later than	March 27	April 4	April 22	May 5	May 20
Fall:					
1 year in 10 earlier than	November 7	October 25	October 8	September 23	September 9
2 years in 10 earlier than	November 12	October 30	October 13	September 28	September 14
5 years in 10 earlier than	November 23	November 9	October 23	October 8	September 24

Evaporation and transpiration are relatively low in the county because of the cool temperatures, high humidity, and the relatively high percentage of cloudy or partly cloudy days. The low evapotranspiration rate, coupled with the well-distributed rainfall, results in less severe and less frequent droughty periods than in States to the south and west.

Snowfall in the county averages about 43.8 inches a year, but it varies considerably from year to year. Total snowfall has been as much as 102.4 inches in the season of 1951–52 and as little as 16.0 inches in the season of 1936–37. Measurable amounts of snow generally fall during each month in the period of November through April.

The length of growing season and relatively cool summer temperatures are near the minimum requirements for growing corn for grain. Some corn, however, is grown for grain in this county. Varieties that require 110 days to mature will mature in most seasons if corn is planted around the last killing frost date of May 20. In fields that have depressions where air drainage is poor, varieties that mature in 90 days offer better assurance against the greater frost hazard in the colder depressions.

Most soils are near the saturation point in spring after the snow melts. Subsequent rainfall often results in a large amount of runoff and possible erosion on sloping soils that are cultivated.

Cool daytime temperatures and relatively high soil moisture during the bloom stage help give good yields of oats. The yields of hay and pasture are favored by the cool, moist growing seasons, and they generally are good on well-fertilized soils that are not too sandy. Soil moisture conditions are quite favorable during most fall months for seedbed preparation and germination of fall-seeded grain. Snow cover protects winter grain crops from excessive cold during most of the winter.

Wind velocities of sufficient strength to cause erosion of unprotected muck soils and sandy soils occur on several days during the year.

Farming

Farming developed slowly in Gladwin County. The first crops grown were in family gardens of the early settlers. As the land was cleared, the soils were found to be productive for farm crops.

Until the turn of the century, farming in the county continued to expand. Since that time, however, the total acreage in farms and the number of farms have declined. Records of the U.S. Census Bureau show that 665 farms were in the county in 1964, and that 116,675 acres were in farms. Though the number and acreage of farms has gradually decreased, the trend is toward larger farming units. In 1964, 36.2 percent of the county was in farms, and the average size of the farms was 175.5 acres.

In 1964 there were 197 dairy farms in the county, 93 farms where livestock other than dairy cattle provided the chief income, 48 general farms, 32 cash grain farms, 1 other farm with other types of field crops predominating, and 4 poultry farms. In addition 290 farms were listed as miscellaneous and unclassified.

Crops.—Hay, corn, and small grains are the chief crops grown in the county, and these crops are used mostly to feed livestock. The following gives the acreage of the main crops grown in 1964:

Crop:	*Acreage*
All hay	20,820
Corn for all purposes	8,679
Small grains harvested:	
Wheat	3,490
Oats	3,723
Barley, rye, and buckwheat	417

Yields of the chief crops grown in the county have increased in the last 30 years. This increase has come partly through the use of improved varieties of seed and partly because of better management.

Livestock.—Dairying is the chief livestock enterprise in the county. In 1964 there were 17,966 cattle and calves in the county, of which 4,095 were milk cows. Cows and heifers that calved numbered 6,019; heifers and heifer calves, 5,175; and steers, bulls, and calves, 6,772. In addition there were 2,996 sheep and lambs and 3,216 hogs and pigs. The number of chickens was 13,490. Because of increased mechanization and more efficient farming, few horses remain on the farms.

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Glossary

Acidity. See Reaction, soil.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkalinity. See Reaction, soil.

Available moisture capacity. The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Calcareous. Containing enough calcium carbonate to effervesce (fizz) when treated with dilute hydrochloric acid.

Clay. As a soil separate, the normal 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 clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour or are parallel to terraces or diversions. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production.

Depression. A low-lying area that lacks surface outlets for removal of water or has only poorly developed ones.

Diversion. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course, and thus, to protect areas downslope from the effects of such runoff.

Drainage, artificial. The removal of excess water on or within the soil by means of surface or subsurface drains.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flood plain. Nearly level land, consisting of stream sediment, that borders a stream and is subject to flooding unless protected artificially.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Mineral soil. Soil composed mainly of inorganic (mineral) material and low in organic matter. Its bulk density is greater than that of an organic soil.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Muck. An organic soil consisting of fairly well decomposed organic material that is relatively high in mineral content, finely divided, and dark in color.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Natural soil drainage. Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and in Podzolic soils commonly have mottlings below 6 to 16 inches in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic material is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Organic soil. A general term applied to a soil or to a soil horizon that consists primarily of organic matter, such as peat soils, muck soils, and peaty soil layers.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability

are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0		
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher
Neutral	6.6 to 7.3		

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff. The part of precipitation upon a drainage area that is discharged from the area in stream channels. 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. In this publication runoff is used in the sense of surface runoff.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that 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 variant. A soil having properties sufficiently different from those other known soils to suggest establishing a new soil series, but a soil of such limited known area that creation of a new series is not believed to be justified.

Solum. The upper part of a soil profile, above the parent material in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

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. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tile drain. Concrete or pottery pipe placed at suitable spacing and depths in the soil or subsoil to provide water outlets from the soil.

Till plains. A level or undulating land surface covered by till, which is unstratified glacial drift consisting of clay, sand, gravel, and boulders intermingled.

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Well-graded soil. A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Weathering. The physical and chemical disintegration and decomposition of rocks and minerals. Soil is the result of weathering and other chemical, physical, and biological alterations that have changes in the upper part of the earth's crust through various periods of time.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. In referring to a capability unit or woodland group, read the introduction to the section it is in for general information about its management. Other information is given in tables as follows:

Acreage and extent, table 1, p. 9.
Predicted yields, table 2, p. 63.

Engineering use of the soils, tables 4, 5, 6, and 7 pp. 72 through 103.

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
AlB	Allendale sand, 0 to 4 percent slopes	10	IIIw-7 (4/1b)	58	G	68
AP	Allendale-Pinconning-Pickford association	10				
	Allendale	--	IIIw-7 (4/1b)	58	G	68
	Pinconning	--	IIIw-8 (4/1c)	58	W	69
	Pickford	--	IIIw-2 (1c)	57	P	69
ArA	Au Gres sand, 0 to 2 percent slopes	11	IVw-2 (5b)	61	F	67
AsA	Au Gres sand, loamy substratum, 0 to 2 percent slopes	11	IVw-2 (5b)	61	F	67
AU	Au Gres-Kinross association	11				
	Au Gres part	--	IVw-2 (5b)	61	F	67
	Kinross part	--	IIIw-11 (5c)	59	Q	69
AV	Au Gres-Kinross loamy substratum association	11				
	Au Gres part	--	IVw-2 (5b)	61	F	67
	Kinross part	--	IIIw-11 (5c)	59	Q	69
AW	Au Gres-Roscommon association	12				
	Au Gres part	--	IVw-2 (5b)	61	F	67
	Roscommon part	--	IIIw-11 (5c)	59	Q	69
BeA	Belding sandy loam, 0 to 2 percent slopes	12	IIw-8 (3/2b)	56	G	68
BeB	Belding sandy loam, 2 to 6 percent slopes	13	IIw-8 (3/2b)	56	G	68
Bf	Belding sandy loam, clayey subsoil variant	13	IIw-8 (3/2b)	56	F	67
BgB	Bowers silt loam, 0 to 4 percent slopes	14	IIw-2 (1.5b)	55	Z	70
BI	Bowers-Iosco-Hettinger association	14				
	Bowers part	--	IIw-2 (1.5b)	55	Z	70
	Iosco part	--	IIIw-9 (4/2b)	59	G	68
	Hettinger part	--	IIw-2 (1.5c)	55	P	69
Bm	Breckenridge sandy loam	15	IIw-8 (3/2c)	56	W	69
Bn	Brevort loamy sand	15	IIIw-10 (4/2c)	59	W	69
Bo	Brevort sandy loam	15	IIIw-10 (4/2c)	59	W	69
BrB	Brimley silt loam, 0 to 4 percent slopes	16	IIw-6 (3b)	56	G	68
Bs	Bruce very fine sandy loam	17	IIw-6 (3c)	56	W	69
BU	Bruce-Brimley-Burleigh association	17				
	Bruce part	--	IIw-6 (3c)	56	W	69
	Brimley part	--	IIw-6 (3b)	56	G	68
	Burleigh part	--	IIIw-6 (4c)	58	W	69
Bv	Burleigh loamy sand	17	IIIw-6 (4c)	58	W	69
Ca	Carbondale muck	18	Vwc-1 (Mc)	61	J	68
Cc	Ceresco loam	18	Vw-3 (L-2c)	61	O	69
CdB	Chelsea sand, 0 to 6 percent slopes	19	IVs-4 (5a)	61	E	67
CdC	Chelsea sand, 6 to 12 percent slopes	19	VIs-1 (5a)	62	E	67
CdD	Chelsea sand, 12 to 18 percent slopes	19	VIIs-1 (5a)	62	E	67
CG	Chelsea-Au Gres association	19				
	Chelsea part	--	IVs-4 (5a)	61	E	67
	Au Gres part	--	IVw-2 (5b)	61	F	67
CHB	Chelsea-Rubicon association, undulating	19				
	Chelsea part	--	IVs-4 (5a)	61	E	67
	Rubicon part	--	VIIs-1 (5.3a)	62	H	68
CHC	Chelsea-Rubicon association, rolling	20				
	Chelsea part	--	VIIs-1 (5a)	62	E	67
	Rubicon part	--	VIIs-1 (5.3a)	62	H	68

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
Co	Cohoctah loam	20	Vw-3 (L-2c)	61	O	69
CrB	Croswell sand, 0 to 6 percent slopes	21	IVs-4 (5a)	61	E	67
CsB	Croswell stony sand, 0 to 6 percent slopes	21	IVs-4 (5a)	61	E	67
CT	Croswell-Au Gres association	21				
	Croswell part	--	IVs-4 (5a)	61	E	67
	Au Gres part	--	IVw-2 (5b)	61	F	67
CU	Croswell-Au Gres-Kinross association	21				
	Croswell part	--	IVs-4 (5a)	61	E	67
	Au Gres part	--	IVw-2 (5b)	61	F	67
	Kinross part	--	IIIw-11 (5c)	59	Q	69
CW	Croswell-Au Gres-Roscommon association	21				
	Croswell part	--	IVs-4 (5a)	61	E	67
	Au Gres part	--	IVw-2 (5b)	61	F	67
	Roscommon part	--	IIIw-11 (5c)	59	Q	69
Ed	Edwards muck	22	Vwc-1 (M/Mc)	61	J	68
Ep	Epoufette sandy loam	23	IIIw-6 (4c)	58	W	69
ET	Epoufette-Tawas association	23				
	Epoufette part	--	IIIw-6 (4c)	58	W	69
	Tawas part	--	Vwc-1 (M/4c)	61	J	68
Ev	Evart loamy sand	24	Vw-3 (L-4c)	61	O	69
EW	Evart-Winterfield association	24				
	Evart part	--	Vw-3 (L-4c)	61	O	69
	Winterfield part	--	Vw-3 (L-4c)	61	O	69
GhA	Gladwin loamy sand, 0 to 2 percent slopes	24	IIIw-5 (4b)	57	F	67
GlA	Gladwin loamy sand, loamy substratum, 0 to 2 percent slopes	25	IIIw-5 (4b)	57	F	67
GE	Gladwin-Epoufette association	25				
	Gladwin part	--	IIIw-5 (4b)	57	F	67
	Epoufette part	--	IIIw-6 (4c)	58	W	69
GPB	Gladwin-Epoufette-Croswell association, undulating	25				
	Gladwin part	--	IIIw-5 (4b)	57	F	67
	Epoufette part	--	IIIw-6 (4c)	58	W	69
	Croswell part	--	IVs-4 (5a)	61	E	67
GrB	Grayling sand, 0 to 6 percent slopes	26	VIIs-1 (5.7a)	62	N	68
GSB	Grayling association, undulating	26	VIIs-1 (5.7a)	62	N	68
GSC	Grayling association, rolling	26	VIIs-1 (5.7a)	62	N	68
GU	Grayling-Croswell-Au Gres association	26				
	Grayling part	--	VIIs-1 (5.7a)	62	N	68
	Croswell part	--	IVs-4 (5a)	61	E	67
	Au Gres part	--	IVw-2 (5b)	61	F	67
Hg	Hettinger loam	27	IIw-2 (1.5c)	55	P	69
HB	Hettinger-Brevort-Burleigh association	27				
	Hettinger part	--	IIw-2 (1.5c)	55	P	69
	Brevort part	--	IIIw-10 (4/2c)	59	W	69
	Burleigh part	--	IIIw-6 (4c)	58	W	69
Hu	Houghton muck	28	Vwc-1 (Mc)	61	J	68
IcA	Ingalls sand, 0 to 2 percent slopes	28	IIIw-5 (4b)	57	G	68
IdA	Iosco stony sand, 0 to 2 percent slopes	29	IIIw-9 (4/2b)	59	G	68
IoA	Iosco loamy sand, 0 to 2 percent slopes	29	IIIw-9 (4/2b)	59	G	68
IoB	Iosco loamy sand, 2 to 6 percent slopes	29	IIIw-9 (4/2b)	59	G	68
IA	Iosco-Au Gres-Ingalls association	29				
	Iosco part	--	IIIw-9 (4/2b)	59	G	68
	Au Gres part	--	IVw-2 (5b)	61	F	67
	Ingalls part	--	IIIw-5 (4b)	57	G	68
IB	Iosco-Brevort association	30				
	Iosco part	--	IIIw-9 (4/2b)	59	G	68
	Brevort part	--	IIIw-10 (4/2c)	59	W	69

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
II	Iosco-Brevort-Ingalls association	30				
	Iosco part	--	IIIw-9 (4/2b)	59	G	68
	Brevort part	--	IIIw-10 (4/2c)	59	W	69
	Ingalls part	--	IIIw-5 (4b)	57	G	68
IK	Iosco-Kawkawlin-Brevort association	30				
	Iosco part	--	IIIw-9 (4/2b)	59	G	68
	Kawkawlin part	--	IIw-2 (1.5b)	55	Z	70
	Brevort part	--	IIIw-10 (4/2c)	59	W	69
IM	Iosco-Menominee-Brevort association	31				
	Iosco part	--	IIIw-9 (4/2b)	59	G	68
	Menominee part	--	IIIs-3 (4/2a)	59	C	67
	Brevort part	--	IIIw-10 (4/2c)	59	W	69
KaA	Kawkawlin loam, 0 to 2 percent slopes	31	IIw-2 (1.5b)	55	Z	70
KaB	Kawkawlin loam, 2 to 6 percent slopes	31	IIw-3 (1.5b)	55	Z	70
Kr	Kinross sand	32	IIIw-11 (5c)	59	Q	69
La	Lacota sandy loam	33	IIw-6 (3c)	56	W	69
Lm	Linwood muck	33	Vwc-1 (M/3c)	61	J	68
LoA	Londo loam, 0 to 2 percent slopes	34	IIw-4 (2.5b)	56	Z	70
LoB	Londo loam, 2 to 6 percent slopes	34	IIw-4 (2.5b)	56	Z	70
Lr	Loxley muck, coarse substratum	34	Vwc-1 (M/4c)	61	J	68
Lu	Lupton muck	35	Vwc-1 (Mc)	61	J	68
MaA	Mancelona sand, 0 to 2 percent slopes	35	IIIs-3 (4a)	59	C	67
MaB	Mancelona sand, 2 to 6 percent slopes	36	IIIs-4 (4a)	60	C	67
MaC	Mancelona sand, 6 to 12 percent slopes	36	IIIe-9 (4a)	57	C	67
MaE	Mancelona sand, 12 to 25 percent slopes	36	IVe-9 (4a)	60	C	67
McA	Mancelona loamy sand, loamy substratum, 0 to 2 percent slopes	36	IIIs-3 (4a)	59	C	67
McB	Mancelona loamy sand, loamy substratum, 2 to 6 percent slopes	36	IIIs-4 (4a)	60	C	67
MdB	Manistee sand, 0 to 4 percent slopes	37	IIIs-3 (4/2a)	59	C	67
Me	Markey muck	37	Vwc-1 (M/4c)	61	J	68
MnA	Menominee sand, 0 to 2 percent slopes	38	IIIs-3 (4/2a)	59	C	67
MnB	Menominee sand, 2 to 6 percent slopes	38	IIIs-4 (4/2a)	60	C	67
MnD	Montcalm loamy sand, 0 to 2 percent slopes	38	IIIe-9 (4/2a)	57	C	67
MrA	Menominee loamy sand, 0 to 2 percent slopes	38	IIIs-3 (4/2a)	59	C	67
MrB	Menominee loamy sand, 2 to 6 percent slopes	38	IIIs-4 (4/2a)	60	C	67
MtA	Montcalm loamy sand, 0 to 2 percent slopes	39	IIIs-4 (4a)	60	C	67
MtB	Montcalm loamy sand, 2 to 6 percent slopes	39	IIIs-4 (4a)	60	C	67
MtC	Montcalm loamy sand, 6 to 12 percent slopes	39	IIIe-9 (4a)	57	C	67
MtE	Montcalm loamy sand, 12 to 25 percent slopes	39	IVe-9 (4a)	60	C	67
Mu	Munuscong sandy loam	40	IIw-8 (3/1c)	56	P	69
NbB	Nester sandy loam, sandy substratum, 0 to 6 percent slopes	42	IIs-1 (1.5a)	56	B	66
NeA	Nester loam, 0 to 2 percent slopes	40	IIs-1 (1.5a)	56	B	66
NeB	Nester loam, 2 to 6 percent slopes	40	IIe-1 (1.5a)	55	B	66
NeC	Nester loam, 6 to 12 percent slopes	41	IIIe-4 (1.5a)	57	B	66
NeC2	Nester loam, 6 to 12 percent slopes, eroded	41	IIIe-4 (1.5a)	57	B	66
NeD	Nester loam, 12 to 18 percent slopes	41	IVe-1 (1.5a)	60	B	66
NeD2	Nester loam, 12 to 18 percent slopes, eroded	41	IVe-1 (1.5a)	60	B	66
NeE	Nester loam, 18 to 30 percent slopes	41	VIe-1 (1.5a)	62	B	66
NeE2	Nester loam, 18 to 30 percent slopes, eroded	41	VIe-1 (1.5a)	62	B	66
OcA	Ocqueoc sand, 0 to 2 percent slopes	42	IIIs-3 (4a)	59	C	67
Og	Ogemaw sand	43	IVw-2 (5b-h)	61	F	67
OnA	Ontonagon loam, 0 to 2 percent slopes	43	IIs-1 (1a)	56	B	66
OnB	Ontonagon loam, 2 to 6 percent slopes	43	IIIe-4 (1a)	57	B	66
OtA	Otisco loamy sand, 0 to 2 percent slopes	44	IIIw-5 (4b)	57	G	68
Pa	Parkhill loam	45	IIw-4 (2.5c)	56	P	69

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
Pc	Pickford loam	45	IIIw-2 (1c)	57	P	69
Pm	Pickford silty clay loam	45	IIIw-2 (1c)	57	P	69
Ps	Pinconning loamy sand	46	IIIw-8 (4/1c)	58	W	69
Rc	Roscommon soils	46	IIIw-11 (5c)	59	Q	69
RB	Roscommon-Brevort-Tawas association	46				
	Roscommon part	--	IIIw-11 (5c)	59	Q	69
	Brevort part	--	IIIw-10 (4/2c)	59	W	69
	Tawas part	--	Vwc-1 (M/4c)	61	J	68
RD	Roscommon-Deford association	46				
	Roscommon part	--	IIIw-11 (5c)	59	Q	69
	Deford part	--	IIIw-6 (4c)	58	W	69
RT	Roscommon-Tawas association	47				
	Roscommon part	--	IIIw-11 (5c)	59	Q	69
	Tawas part	--	Vwc-1 (M/4c)	61	J	68
RoC	Rousseau fine sand, 2 to 12 percent slopes	47	IIIs-4 (4a)	60	C	67
RsB	Rubicon sand, 0 to 6 percent slopes	48	VIIs-1 (5.3a)	62	H	68
RsC	Rubicon sand, 6 to 12 percent slopes	48	VIIs-1 (5.3a)	62	H	68
RsE	Rubicon sand, 12 to 25 percent slopes	48	VIIs-1 (5.3a)	62	H	68
RtB	Rubicon sand, loamy substratum, 0 to 6 percent slopes	48	IVs-4 (5/2a)	61	C	67
RUB	Rubicon-Croswell association, undulating	48				
	Rubicon part	--	VIIs-1 (5.3a)	62	H	68
	Croswell part	--	IVs-4 (5a)	61	E	67
RVB	Rubicon-Menominee association, undulating	49				
	Rubicon part	--	VIIs-1 (5.3a)	62	H	68
	Menominee part	--	IIIs-3 (4/2a)	59	C	67
RWB	Rubicon-Ocqueoc-Ingalls association, undulating	49				
	Rubicon part	--	VIIs-1 (5.3a)	62	H	68
	Ocqueoc part	--	IIIs-3 (4a)	59	C	67
	Ingalls part	--	IIIw-5 (4b)	57	G	68
RyA	Rudyard loam, 0 to 2 percent slopes	50	IIIw-2 (1b)	57	Z	70
RyB	Rudyard loam, 2 to 6 percent slopes	50	IIIw-2 (1b)	57	Z	70
Sc	Saugatuck sand	50	IVw-2 (5b-h)	61	F	67
Sn	Sims loam	51	IIw-2 (1.5c)	55	P	69
Ta	Tawas muck	51	Vwc-1 (M/4c)	61	J	68
UlA	Ubly sandy loam, 0 to 2 percent slopes	52	IIe-3 (3/2a)	55	A	66
UlB	Ubly sandy loam, 2 to 6 percent slopes	52	IIe-3 (3/2a)	55	A	66
UlC	Ubly sandy loam, 6 to 12 percent slopes	52	IIIe-4 (3/2a)	57	A	66
WD	Wainola-Deford association	53				
	Wainola part	--	IIIw-5 (4b)	57	F	67
	Deford part	--	IIIw-6 (4c)	58	W	69
Wh	Wheatley loamy sand	53	IIIw-6 (4c)	58	W	69

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