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SOIL SURVEY

Montcalm County Michigan

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

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Montcalm County will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; it will assist engineers in selecting sites for roads, buildings, ponds, and other structures; it will help those who evaluate the land for different purposes; and it will add to soil scientists' fund of knowledge.

Finding information

Few readers will be interested in all of the report. The section, General Nature of the Area, which discusses climate and other subjects, will be of interest mainly to those not familiar with the county.

Use the index to map sheets to locate the map sheet that applies to the specific areas of the county in which you are interested. Numbered rectangles have been drawn on the index map to show the area covered by each map sheet at the back of the report. When the correct sheet is located, it will be seen that boundaries are outlined and that there is a symbol for each kind of soil. Suppose, for example, an area located on the map has the symbol Mc. The legend for the soil map shows that this symbol identifies Mancelona loamy sand, 2 to 6 percent slopes. This soil and all others mapped in the county are described in the subsection, Soil Types and Phases.

Farmers and those who work with farmers will want to learn about the soils in the subsection, Soil Types and Phases, and then go to the section, Use, Management, and Productivity. In this way they first identify the soils on their farms and then learn how these soils can be managed and what yields can be expected. The soils are grouped by soil management units; that is, soil units with similar properties that need similar management and respond in about the same way. For example, in the subsection, Soil Types and Phases, Mancelona loamy sand, 2 to 6 percent slopes, is shown to be in soil management unit 4aB (IIIS). The management needed for this soil is discussed in the section, Use, Management, and Productivity, under the heading, Soil Management Unit 4aB (IIIS).

Soil scientists will find information about how the soils were formed and how they are classified in the section, Genesis and Morphology.

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest, with the aid of the table of contents. Those interested in the broad soil areas in Montcalm County will want to read the section, General Soil Areas, and examine the general soil area map at the back of this report.

* * * * *

In making this survey soil scientists walked over the fields and woodlands. They dug holes and examined the surface soil, subsoil, and substratum; measured slopes with an Abney level; noticed differences in the growth of crops, weeds, and trees; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming, engineering, forestry, and related uses. The scientists plotted the boundaries between the soils on aerial photographs in the field. Then, cartographers prepared the detailed soil maps in the back of the report from those field sheets.

Fieldwork for this survey was completed in 1949. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time. Help in farm planning can be obtained from the Soil Conservation Service or the Cooperative Extension Service in the county, or from the Soil Science Department, Michigan State University, East Lansing, Michigan.

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SOIL SURVEY OF MONTCALM COUNTY, MICHIGAN

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH MICHIGAN AGRICULTURAL EXPERIMENT STATION

MONTCALM COUNTY is in the west-central part of the Lower Peninsula of Michigan (fig. 1). It is about 36 miles long and 24 miles wide and has an area of about 455,680 acres. In 1950 more than 31,000 people lived in the county. The climate of the county is suitable for the growth of most crops of the area. Agriculture is the most important enterprise in the county, and most of the farmed acreage is used to grow crops needed for dairying. The principal crops are corn, oats, alfalfa, wheat, dry beans, timothy-and-clover hay, and red clover. The chief cash crop is potatoes, and the most extensively grown fruit is apples.

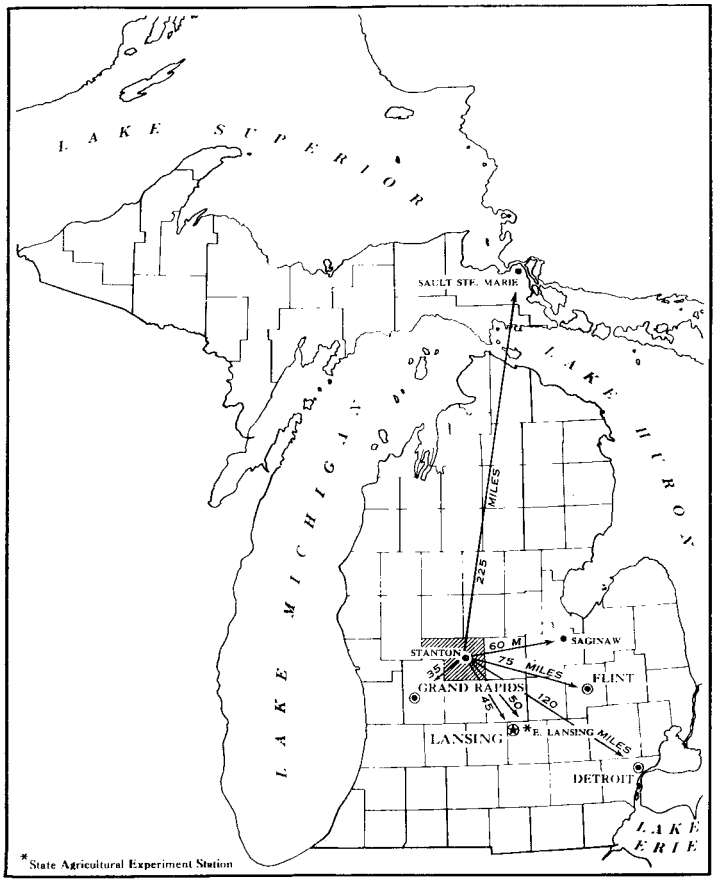

Figure 1.—**Location of Montcalm County in Michigan.**

[1] Fieldwork was done while Soil Survey was part of the Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. Soil Survey was transferred to the Soil Conservation Service on November 15, 1952.

Soil Survey Methods and Definitions

The soil scientist who makes a survey examines soils in the field, classifies the soils in accordance with facts that he observes, and draws their boundaries on an aerial photograph.

FIELD STUDY: The soil scientist bores or digs many holes to see what the soils are like. The holes are not spaced in a regular pattern but are located according to the lay of the land. Usually they are not more than a quarter of a mile apart, and commonly they are much closer. In most soils each boring or hole reveals several distinct layers, called horizons, which collectively are known as the soil profile. Each layer is studied to see how it differs from others in the profile and to learn the things about the soil that influence its capacity to produce plants.

Color in the surface layer is usually related to the content of organic matter. A dark-colored soil generally contains more organic matter than a light-colored one. Soils that have spots of gray, yellow, and brown in the lower layers are generally more poorly drained and more poorly aerated than those with more solid yellowish-brown or reddish-brown colors.

Texture, which is based on the proportions of sand, silt, and clay that make up a soil, is judged by the way the soil feels when rubbed between the fingers. Texture determines how well the soil retains moisture, natural plant nutrients, and fertilizer, and how easy or difficult it is to till.

Structure is the arrangement of the variously shaped soil particles into larger aggregates, or peds, and the amount and arrangement of pore space between these particles and peds. By observing structure, the soil scientist can judge permeability, or how easily moisture, air, and plant roots can penetrate the soil.

Consistence is a measure of the tendency of the soil particles and peds to crumble or stick together, or the resistance of the soil to deformation or rupture when dry, moist, or wet. Common terms for consistence are *friable, plastic, hard, sticky,* and *loose.* Consistence indicates how difficult it is to keep the soil open and porous during cultivation.

Other characteristics observed in the field and considered in classifying the soil include the following: The depth of the various soil layers; the presence of gravel or stones in amounts that will impede cultivation; the steepness of the slopes; the nature of the underlying parent material from which the soil has developed; and the acidity or alkalinity of the soil layers as measured by chemical tests.

CLASSIFICATION: On the basis of all soil characteristics observed by the soil scientists in the field, soils are classified in phases, types, and series. The soil phase is the basic classification unit. The soil type may consist of several phases, but all have the same texture in the surface layer. Types that resemble each other in profile characteristics beneath the surface layer are grouped into soil series.

Soil type.—Soils similar in kind, thickness, and arrangement of layers in the profile are classified as one soil type.

Soil phase.—Because of differences other than those of kind, thickness, and arrangement of layers, soil types are commonly divided into two or more phases. In Montcalm County the soil types are subdivided into phases only on the basis of variation in slope. In other places the soil type may be divided into phases on degree of stoniness, degree of erosion, or other surface characteristics.

The soil phase (or the soil type if it has not been subdivided) is the unit shown on the soil map. It is the soil unit that has the narrowest range of characteristics. Use and management, therefore, can be specified more precisely for soil phases than for soil types, soil series, or yet broader groups that contain more variation.

Soil series.—Two or more soil types that differ in surface texture but are otherwise similar in kind, thickness, and arrangement of soil layers, are normally designated as a soil series. Each series is named for a place near which it was first found. The Montcalm series was named after Montcalm County when the series was recognized in the soil survey of Kent County in 1926.

Miscellaneous land types.—Some areas are not classified as soil phases, types, or series but are identified by descriptive names, such as Made land and Alluvial land. These areas are called miscellaneous land types.

Soil associations.—A group of defined and named kinds of soils associated together in a characteristic geographic pattern is called a soil association. The Nester-Kawkawlin association is such a soil group in Montcalm County. The general soil map at the back of this report shows nine broad soil associations.

Soil complex.—This is a mapping unit that consists of two or more soils that are so intricately associated that it is not practical to show them separately on detailed soil maps. Melita-Iosco-Kawkawlin complex is an example in Montcalm County.

Soil correlation.—This is the process of assigning uniform names to soils of various areas in a cooperative nationwide system of mapping and classifying soils. The purpose of soil correlation is to show similarities and differences among the soils of each surveyed area and the rest of the United States. To do this the same combination of soil characteristics is given the same name, wherever found.

A more detailed discussion of the methods used in soil surveying can be found in the U. S. Department of Agriculture Soil Survey Manual (*5*).[2] Fuller definition of some of the foregoing terms and definitions of unfamiliar terms used in this report can be found in the Glossary.

Soils of Montcalm County

The various kinds of soils of Montcalm County differ from each other mainly because they have developed from different kinds of parent material, under different conditions of drainage, and for different lengths of time. The mineral soils were formed after the glaciers melted and the processes of soil formation began to alter the glacial debris. These soils are grouped by texture of parent material and natural drainage in table 1. Relationships among organic soils are shown in table 2.

Great Soil Groups

The well-drained and imperfectly drained soils commonly have two different kinds of subsoil developed, one above the other in their profiles. In one, humus and iron oxides moved down from the overlying layers to form a layer at depths of 1 to 12 inches below the surface. This layer is commonly mixed with the surface soil by plowing. Because iron oxides react with soluble phosphates to form insoluble compounds, phosphate fertilizer may be less effective in fields where the iron oxide and humus enriched subsoil has been mixed into the plow layer. In addition to the layer of iron oxides and humus, the Podzols of Montcalm County that developed from loamy sand to sandy clay loam parent material have a layer with an accumulation of clay lower in the profile. This subsoil is similar to that of the Gray Wooded soils of this region and also resembles that of the Gray-Brown Podzolic soils of the southern part of Michigan. The top of the clayey subsoil is at depths of 12 to 24 inches. For example, the McBride soils have developed from sandy loam parent material and have a sandy clay loam subsoil at depths of 18 to 24 inches. The brownish upper subsoil layer indicates that iron oxides and humus have accumulated.

The well-drained and imperfectly drained soils in the county formed from clay loam materials do not have an iron oxide and humus subsoil layer. Their subsoil has been enriched by clay washed down from the overlying layers. These soils are called Gray Wooded soils.

The well-drained and imperfectly drained soils formed from sand materials in Montcalm County have a subsoil enriched in iron oxides and humus in the upper parts of their profiles, but no fine-textured subsoil layer is found beneath them within 4 feet of the surface. These soils are called Brown Podzolic soils or Podzols, depending on whether or not a light-gray layer is evident above the subsoil layer.

Because the profile is better or more frequently aerated, the subsoil of the well-drained soils is more uniformly brown, red, and yellow than that of the imperfectly

[2] Italic numbers in parentheses refer to Literature Cited, p. 40.

TABLE 1.—*Natural drainage and parent material or underlying material of mineral soils*

Texture of parent material	Well drained or moderately well drained soils	Imperfectly drained soils	Poorly drained soils
Clay loam or silty clay loam	Nester	Kawkawlin	Sims.
Sandy clay loam	Isabella		
Sandy loam	McBride	Coral	Ensley.
Loamy sand	Montcalm		Edmore.
Fine sand to loamy sand	Rousseau [1]		
Sand	Grayling	Au Gres	Roscommon.
	Croswell [2]	Saugatuck [3]	
	Sparta		
Sandy loam or sandy clay loam 18 to 42 inches thick over gravel and sand.	Newaygo [4]	Palo [4]	Ronald.
Sand or loamy sand 18 to 42 inches thick over sand and gravel	Mancelona [5]	Gladwin [5]	Epoufette.
Sand or loamy sand 18 to 42 inches thick over loam to silty clay loam.		Iosco	Brevort.
Sand or loamy sand 42 to 66 inches thick over loam to clay	Melita		
Stratified or mixed mineral soil and muck			Kerston.
Stratified medium-textured mineral soil			Washtenaw.

[1] Some areas of Rousseau soils are imperfectly drained or poorly drained.
[2] Croswell soils are moderately well drained.
[3] Saugatuck soils have a B horizon strongly cemented with humus and iron oxides.
[4] These soils have a thick textural B horizon.
[5] These soils have a thin textural B horizon.

drained soils. The colors are fairly uniform to a depth of 42 inches or more. The imperfectly drained soils are mottled and contain splotches of gray, orange, or light brown in the subsurface soil or upper subsoil within 25 inches from the surface.

Poorly drained mineral soils have developed in low areas that had a dense swamp forest and a high water table. These areas were not covered by water for long periods. Under poor drainage and poor aeration, however, a dull-gray or mottled olive-gray layer was formed. The process of forming this kind of layer is called gleying, and the soils formed are called Humic Gley soils and Low-Humic Gley soils.

The youngest soils in the county lie on the flood plains of the Pine, Little Muskegon River, and Fish Creek. These soils are receiving deposits from the spring floods. They are similar to the deposited material because the material has not been in place long enough to have been appreciably altered by the processes of soil formation.

Organic, or Bog, soils are widely distributed and cover 12 percent of the land area of the county. They are mucks and peats, more than 12 inches deep, which formed under very poor drainage. In table 2 the organic soils are arranged according to the origin and nature of the organic material, their pH, and the depth to mineral materials in the profile.

General Soil Map

In mapping a county, or other large tract, it is fairly easy to see definite differences as one travels from place to place. There are many obvious differences in shape, gradient, and length of the slopes; in the course, depth, and speed of the streams; in the width of the bordering valleys or natural levees; in the kinds of native plants; and even in the kinds of agriculture. With these more obvious differences, there are less easily noticed differences in the pattern of the soils. The soils differ along with the other parts of the environment.

By drawing lines around the different patterns of soils on a small map, one may obtain a map of the general soil areas, or, as they are more frequently called, soil associa-

TABLE 2.—*Relationships of the organic (Bog) soils in Montcalm County, Mich.*

Origin	Organic material at depths of 12 to 42 inches	pH at depths of 12 to 24 inches	Organic material more than 42 inches deep	Organic material 12 to 42 inches deep over sands	Organic material 12 to 42 inches deep over marl
Woody:					
Deciduous and coniferous trees.	Black, granular, well-decomposed woody material over undecomposed brown fibrous material.	8. 3–7. 0			Edwards.
Deciduous trees	Dark-brown, slightly to moderately decomposed material over undecomposed fibrous material.	7. 0–5. 0	Carlisle	Tawas	
Coniferous and deciduous trees.	Brown to yellow undecomposed fibrous material.	6. 5–4. 5	Rifle	Tawas	
Fibrous:					
Marsh	Dark-brown to yellow finely fibrous material.	7. 0–5. 0	Houghton	Adrian	
Leatherleaf bogs	Yellow undecomposed fibrous material	5. 0–3. 0	Greenwood	Dawson	

tions. Such a map is useful to those who want only a general idea of the soils, or wish to compare different parts of the county, or want to locate large areas suitable for some particular kind of agriculture or other broad land use. The nine general soil areas, or kinds of soil patterns, in Montcalm County are shown in colors on the General Soil Map at the back of this report. Each of the areas shown on that map are described in the following numbered paragraphs.

Soil associations in Montcalm County

1. NESTER-KAWKAWLIN ASSOCIATION: This soil association consists mainly of light-colored Gray Wooded soils that were formed from loam, clay loam, or silty clay loam parent material. These soils are level to strongly sloping and moderately well drained to imperfectly drained. They are used on many farms for dairy and general farming; wheat is grown as a cash crop. The Nester and Kawkawlin soils are the dominant soils in this association; Sims soils make up about 10 percent of the acreage.

2. MCBRIDE-ISABELLA-NEWAYGO ASSOCIATION: This soil association consists of light-colored Podzols formed from sandy loam to sandy clay loam parent material; the Newaygo soils are underlain by stratified gravel and sand. The soils in the association are nearly level to sloping and well drained to moderately well drained. They are used for dairy and general farming. Many farms grow potatoes as a cash crop. McBride, Isabella, and Newaygo soils make up a large part of this association.

3. MONTCALM-MCBRIDE ASSOCIATION: This soil association consists mainly of light-colored Podzols that were formed from loamy sand to sandy loam parent material. They are nearly level to sloping and well drained to moderately well drained. They are used for dairy and general farming; potatoes are grown as a cash crop on many farms. The Montcalm and McBride soils are the dominant soils in this association.

4. MONTCALM-MANCELONA ASSOCIATION: This soil association consists mainly of light-colored, coarse-textured Podzols that were formed from loamy sand or from sand to gravel. They are moderately to strongly sloping and well drained to moderately well drained. They are used for dairy and general farming. A large acreage is in permanent pasture, and there is a considerable amount of second-growth forest. The Montcalm and Mancelona soils are the dominant soils in this association; Grayling soils make up less than 10 percent of the acreage.

5. GRAYLING ASSOCIATION: This soil association consists of light-colored, coarse-textured Podzols that were formed from sand parent material. These soils are nearly level to strongly sloping and well drained to moderately well drained. The association is used mostly for forestry and recreational purposes. Much of it has been planted to pines, and there are several large lakes. The principal soils are the Grayling, but Mancelona and Montcalm soils make up part of the acreage.

6. CORAL AND MCBRIDE ASSOCIATION: This soil association consists mainly of moderately light colored to light colored Podzols. These soils were formed from sandy loam parent material and are level to gently sloping. Most of the acreage is imperfectly drained to moderately well drained. The association is used for dairy and general farming. A considerable acreage is in permanent pasture, and some is in second-growth forest. The principal soils in this association are in the Coral and McBride series.

7. MELITA-IOSCO-KAWKAWLIN ASSOCIATION: This soil association consists mainly of sands that are 18 to 66 inches thick over clay loam to silty clay loam and of Gray Wooded soils that were formed from clay loam to silty clay loam parent material. The sands, which are Podzols, are moderately well drained to imperfectly drained. The Gray Wooded soils are imperfectly drained. Relief is nearly level to gently sloping. The association is used for dairy and general farming. Much of it is in permanent pasture and some is in second-growth forest. The principal soils are the Melita, Iosco, and Kawkawlin.

8. MANCELONA-GLADWIN-EPOUFETTE ASSOCIATION: This soil association consists mainly of light- to dark-colored, coarse-textured Podzols and Humic Gleys that developed on stratified sand and gravel. Organic soils make up from 10 to 20 percent of the acreage. The topography is nearly level to gently sloping. The association is used for general farming. More than half of the acreage is in permanent pasture and second-growth forest. The Mancelona, Gladwin, and Epoufette are the main soils in the association.

9. RIFLE-EPOUFETTE-ROSCOMMON ASSOCIATION: This soil association consists of organic soils that were formed from woody and fibrous parent material and from coarse- and medium-textured mineral soils. The soils are nearly level and poorly drained to very poorly drained. Large areas are in permanent pasture or second-growth forest. The cleared and drained areas are used for truck crops, onions, and field crops. The principal soils are the Rifle, Epoufette, and Roscommon.

Soil Types and Phases

This subsection is provided for those who want detailed information about the soils of the county. It describes the single soils, or mapping units, in this county; that is, the areas on the detailed soil map that are bounded by lines and identified by a letter symbol. For more general information about soils, the reader can refer to the preceding subsection, General Soil Map, in which the broad soil patterns are described.

An important part of this subsection is the description of the soil type and of a detailed soil profile for that type. Since all the mapping units of a given type have essentially the same kind of profile, it is not necessary to describe each soil in detail. For each soil only those characteristics that differentiate it from other closely related soils are emphasized.

In describing soils, the soil scientist frequently assigns a letter symbol and subscript, for example, "A_1," to the various layers, or horizons, of the soil profile. These letter symbols have a special meaning that concerns scientists and others who desire to make a special study of the soils. Most readers will need to remember only that all letter symbols beginning with "A" are surface or subsurface layers; those beginning with "B" are subsoil layers; those beginning with "C" are substratum, or parent material; and those beginning with "D" are underlying dissimilar materials.

The color of a soil can be described in words, such as yellowish brown, or can be stated in much more precise terms by giving symbols for hue, value, and chroma, such as 10YR 5/4. Precise symbols of this kind, called Munsell color notations, are given in the profile descrip-

tions along with descriptive words that tell the color of the soil horizons.

The location and distribution of the mapping units are shown on the map at the back of this report. Their acreage and proportionate extent are given in table 3. It will be helpful to refer to the section, Soil Survey Methods and Definitions, where "series," "types," "phases," and other special terms used in describing soils are listed. The Glossary at the end of the report defines many other special terms.

Alluvial land

Alluvial land occurs along streams and is poorly drained. It is nearly level except for a few hummocky or billowy areas. The soil ranges from loamy sand to silty clay loam, the coarser textures predominating. Its reaction is slightly acid to mildly alkaline. The native vegetation was largely elm, ash, red maple, willow, and a few swamp conifers. Included in this mapping unit are some areas of sandy muck.

Alluvial land (0 to 2 percent slopes) (Aa).[3]—Because this land occurs in narrow, poorly drained strips along meandering streams and is likely to be flooded, it is not suited to field crops. Cleared areas are used largely for unimproved pasture, and most of the wooded areas are pastured. The second-growth forest has not been managed for the purpose of producing timber. Soil management unit L3abc (VW).

Au Gres and Saugatuck sands

Au Gres and Saugatuck sands occur in small nearly level areas in association with the nearly level Grayling and Roscommon soils. These soils were developed from imperfectly drained sandy parent material. In drainage they are intermediate between the well-drained Grayling soils and the poorly drained Roscommon soils. The depth of the water table varies from 2 to 5 feet, depending on the season of the year. The original forest consisted of

[3] Symbol on soil map.

TABLE 3.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Alluvial land	2,439	0.5	McBride and Isabella sandy loams, 6 to 10 percent slopes	14,719	3.2
Au Gres and Saugatuck sands, 0 to 2 percent slopes	1,020	.2	McBride and Isabella sandy loams, 10 to 18 percent slopes	1,095	.2
Brevort loamy fine sand, 0 to 2 percent slopes	994	.2	McBride and Isabella sandy loams, 18+ percent slopes	177	(1)
Carlisle muck, 0 to 2 percent slopes	31,072	6.8	Melita loamy sand, 0 to 2 percent slopes	3,623	.8
Coral fine sandy loam, 0 to 2 percent slopes	2,784	.6	Melita loamy sand, 2 to 6 percent slopes	1,456	.3
Coral fine sandy loam, 2 to 6 percent slopes	2,515	.5	Melita-Iosco-Kawkawlin complex, 0 to 2 percent slopes	1,918	.4
Croswell and Melita loamy sands, 0 to 2 percent slopes	914	.2	Montcalm loamy sand and sandy loam, 6 to 10 percent slopes	48,992	10.7
Croswell and Melita loamy sands, 2 to 6 percent slopes	684	.2	Montcalm loamy sand and sandy loam, 10 to 18 percent slopes	4,327	.9
Croswell and Melita loamy sands, 6 to 15 percent slopes	55	(1)	Montcalm loamy sand and sandy loam, 18+ percent slopes	141	(1)
Edwards muck, 0 to 2 percent slopes	1,461	.3	Montcalm and McBride loamy sands and sandy loams, 0 to 2 percent slopes	6,490	1.4
Ensley loam and Edmore loamy fine sand, 0 to 2 percent slopes	9,037	2.0	Montcalm and McBride loamy sands and sandy loams, 2 to 6 percent slopes	52,758	11.6
Epoufette loamy sand and Ronald sandy loam, 0 to 2 percent slopes	10,441	2.3	Nester loam, 0 to 2 percent slopes	705	.2
Gladwin loamy sand and Palo sandy loam, 0 to 2 percent slopes	10,262	2.3	Nester loam, 2 to 6 percent slopes	24,423	5.4
Gladwin loamy sand and Palo sandy loam, 2 to 6 percent slopes	374	.1	Nester loam, 6 to 10 percent slopes	10,912	2.4
Grayling sand, 0 to 2 percent slopes	19,103	4.2	Nester loam, 10 to 18 percent slopes	843	.2
Grayling sand, 2 to 6 percent slopes	16,995	3.7	Nester loam, 18+ percent slopes	74	(1)
Grayling sand, 6 to 10 percent slopes	23,499	5.2	Newaygo loam, 0 to 2 percent slopes	403	.1
Grayling sand, 10 to 18 percent slopes	4,398	1.0	Newaygo loam, 2 to 6 percent slopes	48	(1)
Grayling sand, 18+ percent slopes	149	(1)	Newaygo sandy loam, 0 to 2 percent slopes	1,643	.4
Greenwood and Dawson peats, 0 to 2 percent slopes	4,913	1.1	Newaygo sandy loam, 2 to 6 percent slopes	5,402	1.2
Houghton and Adrian mucks and peats, 0 to 2 percent slopes	2,553	.6	Newaygo sandy loam, 6 to 10 percent slopes	1,362	.3
Iosco loamy sand, 0 to 2 percent slopes	1,391	.3	Newaygo sandy loam, 10 to 18 percent slopes	129	(1)
Kawkawlin loam, 0 to 2 percent slopes	6,608	1.5	Rifle and Tawas peats, 0 to 2 percent slopes	24,671	5.4
Kawkawlin loam, 2 to 6 percent slopes	438	.1	Roscommon sand, 0 to 2 percent slopes	3,601	.8
Kerston muck, 0 to 2 percent slopes	271	.1	Rousseau loamy fine sand, 0 to 2 percent slopes	728	.2
Made land	55	(1)	Sims loam, 0 to 2 percent slopes	6,099	1.3
Mancelona loamy sand, 0 to 2 percent slopes	10,260	2.3	Sparta loamy sand, 0 to 2 percent slopes	74	(1)
Mancelona loamy sand, 2 to 6 percent slopes	16,654	3.7	Washtenaw loam and silt loam, 0 to 2 percent slopes	579	.1
Mancelona loamy sand, 6 to 10 percent slopes	11,172	2.4	Washtenaw sandy loam and loamy sand, 0 to 2 percent slopes	909	.2
Mancelona loamy sand, 10 to 18 percent slopes	2,598	.6			
Mancelona loamy sand, 18+ percent slopes	169	(1)	Total	447,611	98.2
McBride and Isabella sandy loams, 0 to 2 percent slopes	6,776	1.5	Lakes	8,069	1.8
McBride and Isabella sandy loams, 2 to 6 percent slopes	27,256	6.0	Area of county	455,680	100.0

[1] Less than 0.1 percent.

white pine with some elm, red maple, and hemlock. After the forest was cleared or burned, the pine did not reproduce. The second growth is largely aspen.

Profile description for the Au Gres sand:

A_p 0 to 7 inches, very dark gray (7.5YR 3/1, moist) sand to loamy sand; weak fine granular structure; very friable when moist and loose when dry; slightly acid; 6 to 8 inches thick.

A_2 7 to 12 inches, light brownish-gray to light-gray and pinkish-gray (10YR 6/2 to 7/2 and 7.5YR 7/2, moist) sand; single grain (structureless); very friable to loose when moist and loose when dry; medium to strongly acid; 4 to 9 inches thick.

B_{2h} 12 to 15 inches, dark-brown to brown (7.5YR 4/4 to 5/4, moist) sand; weakly cemented in places; strongly acid; 2 to 6 inches thick.

B_{2hg} 15 to 30 inches, brown to reddish-yellow (7.5YR 5/4 to 6/6, moist) sand slightly to strongly mottled with strong-brown and light yellowish-brown streaks (7.5YR 5/8 and 10YR 6/4, moist); single grain (structureless); medium to strongly acid; 12 to 20 inches thick.

C_{1g} 30 inches+, light brownish-gray (10YR 6/2, moist) loose sand mottled with light yellowish brown and brownish yellow (10YR 6/4 and 6/6, moist); single grain (structureless); medium acid to neutral.

The Saugatuck soil is similar to the Au Gres soil, but at depths of 10 to 18 inches it has a well-developed B_{2h} layer that consists of strongly cemented iron oxide and organic matter, called ortstein.

Au Gres and Saugatuck sands, 0 to 2 percent slopes (Ab).—Because these soils commonly occur in small areas with Grayling or Roscommon soils, they are used in the same way as the associated soils. Most cleared areas are used for permanent pasture, but large areas remain in second-growth forest, largely aspen. The Au Gres and Saugatuck soils are not well suited to crops; their water-holding capacity and natural fertility are low. Unless there is enough well-distributed rainfall throughout the growing season, yields are very low. Frequently crops fail. Because these soils dry out sooner than the associated poorly drained soils, they are moderately well suited to spring pasture. The animal carrying capacity of these soils is low during summer. Soil management unit 5bA (IVW).

Brevort loamy fine sand

This level, dark-colored, poorly drained soil developed on layers of sand and loamy sand, 18 to 42 inches thick over limy loam to silty clay loam materials. The native vegetation consisted largely of elm, swamp oak, red maple, and ash. Areas that have not been cleared are mainly in second-growth aspen and, in the extremely wet spots, alder and willow.

This soil is a poorly drained member of the catena that includes the well drained to moderately well drained Menominee soils and the imperfectly drained Iosco soil. The Menominee soils are not mapped in Montcalm County. Brevort loamy fine sand is associated with the Sims soils, which were formed from clay loam to silty clay loam till.

Profile description for Brevort loamy fine sand:

A_p 0 to 7 inches, very dark gray to dark grayish-brown (10YR 3/1 to 4/2, moist) loamy fine sand; weak fine granular structure; very friable when moist and soft when dry; neutral; 6 to 10 inches thick.

G_1 7 to 12 inches, light-gray (10YR 7/2, moist) loamy fine sand; very weak fine granular structure; very friable when moist and soft when dry; neutral; 2 to 8 inches thick.

G_2 12 to 30 inches, light brownish-gray to light-gray (10YR 6/2 to 7/2, moist) loamy sand that is streaked and splotched with yellowish brown and brownish yellow (10YR 5/4 and 6/8, moist); weak medium granular structure; very friable when moist and loose when dry; neutral to mildly alkaline; 6 to 22 inches thick.

D 30 inches+, light brownish-gray to light-gray (10YR 7/2 to 6/2, moist) clay loam mottled with yellowish brown and yellow (10YR 5/6 and 7/8, moist); moderate medium to coarse angular blocky structure; sticky and plastic when wet and very firm when moist; limy.

Brevort loamy fine sand, 0 to 2 percent slopes (Ba).—This soil occurs in fairly small, irregularly shaped tracts, generally along drainways and in areas between mineral and organic soils.

Less than 20 percent of this soil is cropped. Most of it is in permanent pasture or woods. Second-growth forest usually occurs in places where this soil is associated with organic soil.

Because this soil occurs in small tracts along drainways and between organic and mineral soils, it is poorly suited to crops grown in rotations. Drainage is the main problem. In a few places where outlets are available, the soil is drained by shallow ditches, a practice that should improve permanent pasture. Artificial drainage is also needed if this soil is used for crops. Because of the sand in the upper part of the profile, care must be exercised to avoid clogging and overdraining if tile is used. Soil management unit 4cA (IIIW).

Carlisle muck

Carlisle muck consists of highly decomposed organic deposits that range from 3½ feet to as much as 50 feet in thickness. It occurs mostly in nearly level, irregularly shaped areas in stream valleys, and in basins where the water table is at or near the surface a considerable part of the time. The native forest consisted of dense stands of elm, red maple, and swamp white oak with some basswood and black ash.

Profile description for Carlisle muck:

O_1 0 to 16 inches, very dark brown to black (10YR 2/2 to 2/1, moist) muck containing a few recognizable fragments of wood; moderate fine granular structure; friable when moist and hard when dry; medium acid to neutral; 8 to 24 inches thick.

O_2 16 to 22 inches, yellowish-brown (10YR 5/8, moist) slightly decomposed woody and fibrous plant materials; much woody material in upper part; fibrous remains of plants easily distinguished in lower part; soft when moist; medium acid to neutral; 6 to 20 inches thick.

O_3 22 inches+, yellowish-brown to dark yellowish-brown (10YR 5/8 to 4/4, moist) fibrous peat that is mainly the remains of grasses and sedges; decomposition is less with increasing depth; medium acid to neutral.

The fairly well decomposed surface layer ranges from 8 to 24 inches in thickness. In places it is neutral to slightly alkaline. The layer underlying the surface layer varies considerably from place to place. In the shallower deposits, a layer of highly decomposed gelatinous materials occurs directly above the mineral material.

Carlisle muck, 0 to 2 percent slopes (Ca).—This soil, one of the most extensive organic soils, covers 31,072 acres, or 6.8 percent of the county. Its profile is similar to the one described for Carlisle muck. Included with this soil are areas of poorly drained mineral soils and patches of other kinds of organic soils. Also included are mixtures of dark-brown peat and muck. The character-

istics of this soil are likely to change much more rapidly than those of mineral soils.

More than 80 percent of this soil is still in native forest. The cleared areas are used largely for special crops. If installations for drainage and the control of the water table are made and enough lime and fertilizer are applied, onions, mint, sugar beets, potatoes, and truck crops can be successfully grown. Crops grown on this soil, however, are much more likely to be damaged by frost than those grown on adjacent mineral soils. Serious damage by frost is likely in almost any month of the growing season. Because early frost interferes with the proper ripening of grain, corn is usually harvested for silage. Bluegrass, alsike clover, and reed canarygrass are well suited to this soil and furnish good pasture in summer and fall.

If this soil is artificially drained and is cultivated, the surface layer decomposes faster than normal. Where the muck is less than 4 feet deep, rapid decomposition may decrease the thickness of the organic soil and make it much less suitable for special crops. The underlying mineral layer influences crop response and management needs in shallow areas. Many plants, however, benefit from the nutrients in the mineral soils. Soil management unit bM (IIIW).

Coral fine sandy loams

Coral fine sandy loams are imperfectly drained soils that were developed from calcareous sandy loam parent material. These soils are generally associated with the well-drained McBride and the poorly drained to very poorly drained Ensley soils. They are not so fine textured as the Kawkawlin soils, which were developed from clay loam to silty clay loam parent materials. Stones and cobbles are common on the surface, but normally not enough of them occur to interfere with tillage. The original vegetation consisted of mixed hardwoods and pines.

Profile description for Coral fine sandy loams:

A_p 0 to 7 inches, dark-gray to dark grayish-brown (10YR 4/1 to 4/2, moist) fine sandy loam; weak fine granular structure; friable when moist and soft when dry; medium organic-matter content; medium to slightly acid; 6 to 9 inches thick.

A_2 7 to 11 inches, light brownish-gray to light-gray (10YR 6/2 to 7/2, moist) coarse sandy loam mottled with yellowish brown (10YR 5/6, moist) and dark yellowish brown (10YR 4/4, moist); weak medium platy structure; friable when moist and soft when dry; medium acid; 3 to 7 inches thick.

B_{2hg} 11 to 16 inches, light yellowish-brown (10YR 6/4, moist) sandy loam mottled with strong brown (7.5YR 5/6 to 5/8, moist); weak fine platy structure; friable when moist and soft when dry; medium to strongly acid; 3 to 6 inches thick.

A_{2m} 16 to 20 inches, light-gray to pinkish-gray (10YR 7/2 to 7.5YR 7/2, moist) sandy loam; weakly to moderately developed fragipan; hard, brittle, and compact when dry; medium acid; 3 to 9 inches thick.

B_{2tg} 20 to 39 inches, yellowish-brown (10YR 5/4 to 5/6, moist) sandy clay loam with streaks and splotches of brownish yellow, yellow, and light gray (10YR 6/8, 7/8, and 7/2, moist); moderate medium subangular to angular blocky structure; plastic when wet, firm when moist, and hard when dry; medium to slightly acid; 12 to 25 inches thick.

C 39 inches+, light reddish-brown to light-brown (5YR 6/4 to 7.5YR 6/4, moist) sandy loam to sandy clay loam; massive (structureless); friable when moist and hard when dry; limy.

The depth to the limy materials varies from 27 to 50 inches. In some plowed areas the upper A_2 horizon has been mixed with the surface layer and cannot be identified. Some areas, particularly south and southwest of the village of Lakeview, have a loamy sand or sandy loam surface layer that is less than 18 inches deep.

Coral fine sandy loam, 0 to 2 percent slopes (Cb).—This soil is used for general crops, particularly those used in dairy farming. Corn, oats, wheat, and alfalfa are the main crops. A large acreage is in permanent pasture and small woodlots.

Obtaining adequate drainage is the most serious problem; outlets are not available in many places. Nevertheless, much of the soil is drained by tile or by open ditches. Because of the many sand pockets, the tile lines are likely to be filled with sand, which interferes with the efficiency of the drainage installation. If this soil is drained, fertilized, and otherwise well managed, it will produce good yields. Soil management unit 3bA (IIW).

Coral fine sandy loam, 2 to 6 percent slopes (Cc).—Except that it is more sloping, this soil is similar to Coral fine sandy loam, 0 to 2 percent slopes. It is used for the same kinds of crops. The dominant slopes have less than 4 percent gradient. The problem of drainage is less on this soil, but the soil should be tilled on the contour to reduce erosion. The removal of fences and the rearrangement of fields are needed in many places to increase the efficiency of contour tillage. Soil management unit 3bA (IIW).

Croswell and Melita loamy sands

These soils are mapped together because they are closely associated. They were formed from sand parent material—the Croswell soils in moderately well drained locations, and the Melita soils in well drained and moderately well drained locations. The Melita soils are underlain by medium- to fine-textured materials at depths of 42 to 66 inches. Croswell and Melita loamy sands are associated with Grayling sands. The Croswell soils differ from the Grayling soils in having developed under moderately well drained conditions that were caused by a water table closer to the surface than that of the Grayling soils. The original forest consisted of white and jack pines with some oak. Where the land has not been cleared, the present vegetation is largely oak and staghorn sumac, but there are many open areas that have only a sparse cover of native grasses, sweetfern, blueberries, and weeds.

A considerable part of the acreage was cleared and farmed at one time. More than half of this acreage is now idle or used for limited grazing. White, jack, and red pines have been planted in many places where farmland has been abandoned.

A profile representing the Melita soils is described for the Melita loamy sands elsewhere in this subsection. The upper horizons of the Croswell soils are similar to those described in that profile, but the underlying fine-textured material occurs at a depth of more than 66 inches. The depth to this fine-textured material varies within short distances, and the Croswell and Melita soils occur in the same fields. The fine-textured materials affect the natural water table and cause slightly better moisture-holding capacity in the Croswell soils than in the Grayling soils.

Croswell and Melita loamy sands have a low moisture-

holding capacity and are permeable to water and air. Their fertility is low, and they contain only a small amount of organic matter in the surface layer.

Croswell and Melita loamy sands, 0 to 2 percent slopes (Cd).—These nearly level soils are droughty and wind eroded. They are highly susceptible to further erosion by wind. If row crops are grown, they should not be grown more than once in 4 years. Because these soils are very droughty during summer, they are only fairly well suited to pasture. If they are farmed, deep-rooted crops and crops that make most of their growth during the wet seasons should be grown. These soils are suitable for new plantings of red and jack pines. Soil management unit 5aA (IVS).

Croswell and Melita loamy sands, 2 to 6 percent slopes (Ce).—These soils are more susceptible to water erosion than Croswell and Melita loamy sands, 0 to 2 percent slopes. They are poorly suited to field crops and only fairly well suited to pasture. They are well suited to plantings of red pine and jack pine. White pine can be grown in the moist areas. Soil management unit 5aB (IVS).

Croswell and Melita loamy sands, 6 to 15 percent slopes (Cg).—These soils occur in long, narrow, steep areas that are mostly in grasses and trees. Cleared areas have had considerable water erosion as well as wind erosion. Most of these areas have been abandoned and are now covered with grasses, shrubs, and second-growth trees. If row crops are used, they should be grown in a rotation only 1 out of 4 years. These soils are only fairly well suited to pasture. They are suitable for new plantings of red and jack pines. Soil management unit 5aC (IVS).

Edwards muck

Edwards muck occurs in poorly drained depressions and drainways. It consists of 12 to 42 inches of muck over marl. In the upper layers, this soil is similar to Carlisle muck, with which it is associated. Carlisle muck is more than 42 inches deep. The original vegetation was largely elm, ash, swamp white oak, and aspen.

Profile description for Edwards muck:

- O_1 0 to 7 inches, very dark grayish-brown to black (10YR 3/2 to 2/1, moist) well-decomposed muck with woody plant remains; moderate medium granular structure; friable when moist; neutral to moderately alkaline; 5 to 10 inches; thick.
- O_2 7 to 24 inches, very dark brown to very dark grayish-brown (10YR 2/2 to 3/2, moist) muck; well decomposed in the upper part and only moderately well decomposed in the lower part; woody material visible; neutral to moderately alkaline; 12 to 32 inches thick.
- D 24 inches+, gray (10YR 5/1, moist) marl; contains shells in most places; soft; limy.

Where the marl occurs at depths of 27 to 42 inches, a layer of dark-brown fibrous peat normally occurs above the marl.

Edwards muck, 0 to 2 percent slopes (Ea).—Because this organic soil is shallower to marl than Carlisle muck, 0 to 2 percent slopes, it is slightly less productive. Under cultivation it becomes alkaline as the organic surface layer decomposes and the underlying marl is mixed into the plow layer. Several areas grow excellent summer pasture. If this soil is used for special or field crops, the main management problems are poor drainage, frost, and wind erosion. In many places the marl provides a source for liming material. Soil management unit M/2 (IVW).

Ensley loam and Edmore loamy fine sand

These poorly drained soils developed from sandy materials in depressions and along natural drainways. The parent material of the Ensley soil is sandy loam and that of the Edmore soil is loamy sand. The native vegetation was mainly elm, ash, swamp white oak, silver maple, and red maple. The Edmore soil and the well-drained Montcalm soils are in the same catena.

Profile description for the Ensley loam:

- A_p 0 to 7 inches, very dark gray to very dark grayish-brown (10YR 3/1 to 3/2, moist) loam; moderate fine granular structure; friable when moist and soft when dry; medium to high in organic matter; neutral; 6 to 9 inches thick.
- AG_2 7 to 14 inches, light brownish-gray (10YR 6/2, moist) sandy loam mottled with strong brown and yellow (7.5YR 5/8 and 10YR 7/8, moist); weak coarse platy structure; friable when moist and slightly hard when dry; low in organic matter; neutral; 5 to 10 inches thick.
- BG_1 14 to 22 inches, light yellowish-brown to very pale brown (10YR 6/4 to 7/4, moist) sandy clay loam with reddish-yellow and pinkish-gray (7.5YR 6/8 to 7/8 and 7.5YR 7/2, moist) streaks and splotches; moderate medium subangular blocky structure; plastic when wet, firm when moist, and hard when dry; neutral to mildly alkaline; 6 to 16 inches thick.
- BG_2 22 to 38 inches, pinkish-gray to brown (7.5YR 6/2 to 5/4, moist) fine sandy loam mottled with strong brown, reddish yellow, and pinkish gray (7.5YR 5/8, 7/8, and 7/2, moist); weak to moderate medium subangular blocky structure; slightly plastic when wet, firm when moist, and slightly hard when dry; mildly alkaline; 10 to 20 inches thick.
- C 38 inches+, light brownish-gray to pale-brown (10YR 6/2 to 6/3, moist) sandy loam mottled with reddish yellow and olive gray (7.5YR 6/8 and 5Y 5/2, moist); massive (structureless); neutral to calcareous.

Profile description for the Edmore loamy fine sand:

- A_p 0 to 8 inches, very dark gray to very dark grayish-brown (10YR 3/1 to 3/2, moist) loamy fine sand; weak to moderate medium granular structure; very friable when moist; high in organic matter; slightly acid to neutral; 6 to 9 inches thick.
- AG_2 8 to 18 inches, light-gray to light brownish-gray (10YR 7/2 to 6/2, moist) loamy sand mottled with yellowish brown and yellow (10YR 5/8 and 7/6, moist); weak fine granular structure; very friable to loose when moist and loose when dry; neutral; 6 to 15 inches thick.
- BG_1 18 to 26 inches, light brownish-gray to light yellowish-brown (10YR 6/2 to 6/4, moist) sandy loam mottled with brownish yellow and light gray (10YR 6/8 and 7/2, moist); weak to moderate medium subangular blocky structure; friable when moist and slightly hard when dry; neutral to mildly alkaline; 4 to 16 inches thick.
- BG_2 26 to 44 inches, light-gray to light brownish-gray (10YR 7/2 to 2.5Y 6/2, moist) sand mottled with reddish yellow (7.5YR 6/8 to 7/8, moist); stratified with thin lenses of loamy sand and sandy loam; very friable to loose when moist; neutral to mildly alkaline; 15 to 30 inches thick.
- C 44 inches+, light-gray to light brownish-gray (10YR 7/2 to 2.5Y 6/2, moist) sands and loamy sands with lenses of sandy loam; stratified; very friable to loose when moist; neutral to mildly alkaline.

Ensley loam and Edmore loamy fine sand, 0 to 2 percent slopes (Eb).—Except during the summer, the water table of these poorly drained soils is at or near the surface. In spring the soils are cold and wet. Most of the cleared acreage is used for permanent pasture, but some small areas are cropped along with areas of associated imperfectly drained soils. These soils are difficult to drain because sand tends to be washed into the tile. Crops on

these soils are more likely to be damaged by early and late frost than are crops on the adjacent upland soils. Soil management unit 4cA (IIIW).

Epoufette loamy sand and Ronald sandy loam

These are poorly drained to very poorly drained, dark-colored soils that developed on deep stratified sandy and gravelly materials. They occur in fairly small bodies in association with the Gladwin loamy sands and Palo sandy loams.

The Ronald soil is a poorly drained member of the catena that includes the well-drained Newaygo and imperfectly drained Palo soils. The Epoufette soil is a poorly drained member of the catena that includes the well-drained Mancelona and the imperfectly drained Gladwin soils.

The native vegetation was largely elm and ash; there were some swamp conifers. The second growth is largely aspen.

Profile description for the Epoufette loamy sand:

A_p 0 to 8 inches, very dark gray to dark-gray (10YR 3/1 to 4/1, moist) loamy sand; weak fine granular structure; very friable when moist and soft when dry; organic-matter content varies from slight to enough to make the material mucky; neutral; 6 to 10 inches thick.

AG_2 8 to 26 inches, grayish-brown to light brownish-gray (10YR 5/2 to 2.5Y 6/2, moist) loose sand mottled with reddish yellow and light yellowish brown (7.5YR 6/8 and 10YR 6/4, moist); single grain (structureless); neutral; 8 to 22 inches thick.

BG_2 26 to 32 inches, grayish-brown to dark grayish-brown (10YR 5/2 to 4/2, moist) gravelly loamy sand to fine sandy loam mottled with reddish yellow and light gray (5YR 6/8 and 10YR 7/2, moist); friable when moist; somewhat coherent; neutral to mildly alkaline; 4 to 12 inches thick.

C 32 inches+, grayish-brown to light brownish-gray (10YR 5/2 to 2.5Y 6/2, moist) sand and gravel with a few thin lenses of loamy sand; stratified; loose; limy.

The surface texture varies from loamy sand to sandy loam. The BG_2 horizon varies considerably in depth below the surface and in thickness.

Ronald sandy loam has a color profile similar to that of the Epoufette soils, but it is finer textured throughout the solum. The BG_2 horizon is closer to the surface and thicker than that of the Epoufette soil. The texture of the Ronald subsoil is a sandy clay loam in most places.

Epoufette loamy sand and Ronald sandy loam, 0 to 2 percent slopes (Ec).—These soils have a moderate to moderately low moisture-holding capacity. Their supply of plant nutrients is low. They are used for permanent pasture or have never been cleared. Row crops can be grown in a rotation that has 2 years of legume-grass meadow and 2 years of small grain, but the maintenance of organic matter is a serious problem. These soils furnish fair to good sites for planting trees. Suitable species are white pine, Austrian pine, and Norway spruce. Suggestions on the planting of trees and shrubs can be found in the Michigan State University Extension Bulletin 264 (*6*).

If the coarser textured areas of this mapping unit are drained but are not protected by vegetation, they are likely to be eroded by wind. Many areas, particularly in Richland Township, are overdrained by large, deep county drains that have been constructed in the level, sandy, and gravelly plains and terraces. If control structures were placed in these deep drains, they would help maintain the natural water table and thus reduce the damage by drought and wind erosion. The use of tile for drainage normally is not satisfactory. Maintaining a grade in the sand and gravel is difficult. Furthermore, the sand often flows into the tile. Effective measures against wind erosion are the use of alternating strips that extend at right angles to the direction of the prevailing wind, and the planting of trees for windbreaks. Soil management unit 4cA (IIIW).

Gladwin loamy sand and Palo sandy loams

These moderately dark colored, coarse and moderately coarse textured soils are imperfectly drained. They developed on deep gravelly and sandy materials.

The Gladwin soils are imperfectly drained members of the catena that also includes the well-drained Mancelona soils and the poorly drained to very poorly drained Epoufette soils. In the same catena as the Palo soils are the well-drained Newaygo and the poorly drained Ronald soils.

The original forest largely consisted of sugar maple, ash, elm, beech, and white pine.

Profile description for the Gladwin loamy sand:

A_p 0 to 9 inches, very dark grayish-brown (10YR 3/2, moist) loamy sand; weak fine granular structure; very friable when moist and soft when dry; medium in organic matter; slightly acid to neutral; 7 to 11 inches thick.

B_{2hg} 9 to 14 inches, light yellowish-brown (10YR 6/4, moist) loamy sand with brownish-yellow (10YR 6/8, moist) streaks and splotches; weak fine platy structure; very friable when moist and slightly coherent when dry; slightly to medium acid; 4 to 8 inches thick.

A_2 14 to 28 inches, light brownish-gray (10YR 6/2, moist) loose sand mottled with light-gray and reddish-yellow (10YR 7/2 and 7.5YR 7/8, moist) streaks and splotches; single grain (structureless); medium to strongly acid; 6 to 18 inches thick.

B_{2tg} 28 to 32 inches, yellowish-brown (10YR 5/4 to 5/6, moist) gravelly sandy loam mottled with brownish yellow and light gray (10YR 6/6 to 6/8 and 10YR 7/2, moist); slightly plastic when wet, friable when moist, and hard when dry; slightly acid to neutral; 2 to 10 inches thick.

D_g 32 inches+, light-gray to very pale brown (10YR 7/2 to 7/3, moist) sands and gravel mottled with brownish yellow and yellowish brown (10YR 6/6 and 5/8, moist); stratified; loose; limy.

In depth, thickness, and clay content, the B_{2tg} horizon varies greatly from place to place.

The Palo soils are similar to the Gladwin soils in color but are finer textured throughout the solum. The B_{2tg} horizon is closer to the surface, thicker, and usually finer textured than that of the Gladwin soils. In most areas of the Palo soils, the B_{2tg} horizon is sandy clay loam instead of loamy sand.

These soils have a moderately low available water-holding capacity and supply of plant nutrients.

Gladwin loamy sand and Palo sandy loam, 0 to 2 percent slopes (Ga).—Most of the acreage of these soils has been cleared and cultivated. Some of the land has been abandoned, and in a few places trees have been planted. These soils are suited to the same kind of trees as are Epoufette loamy sand and Ronald sandy loam, 0 to 2 percent slopes. They are fair sites for planting trees. Included with this mapping unit are some areas that have a fine sandy loam surface soil.

If these soils are drained but are not protected by vegetation, they are likely to be eroded by the wind. Many areas, particularly in Richland Township, are over-

drained by large, deep county drains. The use of tile for drainage normally is not satisfactory, for coarse-textured material flows into the tile. Rotations should be used that will maintain organic matter. Soil management unit 4bA (IIIW).

Gladwin loamy sand and Palo sandy loam, 2 to 6 percent slopes (Gb).—Because these soils are more sloping than Gladwin loamy sand and Palo sandy loam, 0 to 2 percent slopes, they might be eroded by water as well as by wind. Soil management unit 4bA (IIIW).

Grayling sands

These soils developed from sand in well-drained locations. They are associated with the Montcalm and Mancelona soils but differ from them in that a clayey subsoil horizon has not formed. The parent material is coarser than that of the Montcalm soils and is free of lime to a depth of several feet. The original forest cover consisted of a sparse stand of jack pine or oak. The present vegetation is mainly oak, jack pine, and sumac, but large areas have only a sparse cover of native grasses, sweetfern, blueberries, and weeds.

Profile description for Grayling sands:

- A_0 1½ to 0 inches, dark grayish-brown (10YR 4/2, moist) litter of jack pine needles, oak leaves, twigs, and roots in all stages of decomposition.
- A_1 0 to 1½ inches, dark grayish-brown (10YR 4/2, moist) sand; loose; moderate content of organic matter; medium acid; ½ to 2 inches thick.
- A_2 1½ to 3 inches, light-gray to light brownish-gray (10YR 7/2 to 6/2, moist) sand, mainly quartz; single grain (structureless); loose; medium to strongly acid; 1 to 3 inches thick.
- B_{2h} 3 to 16 inches, light-brown to yellowish-brown (7.5YR 6/4 to 10YR 5/4, moist) sand; very weak fine granular structure; loose; medium to strongly acid; 10 to 15 inches thick.
- C_{11} 16 to 30 inches, light yellowish-brown to very pale brown (10YR 6/4 to 7/4, moist) sand; single grain (structureless); loose; medium acid; 10 to 18 inches thick.
- C_{12} 30 inches+, light brownish-gray (10YR 6/2, moist) sand with some lenses of gravel; loose; slightly acid to medium acid.

In the profile of some open, grassy areas, organic coatings or stains on the sand particles blot out the normal color of the A_2 horizon. The color of the B_{2h} horizon varies considerably from place to place and is lighter with increasing depth. In plowed areas the upper three layers and part of the fourth are mixed; consequently, the present surface layer is dark brown to dark grayish brown and very low in organic matter. The surface soil is gravelly in most places where these soils occur in association with the Mancelona soils.

Grayling sands are very low in plant nutrients and have a low available water-holding capacity. Cleared areas are likely to be eroded by the wind. Blowout areas are designated on the soil map by symbols.

The ruins of old farmsteads and the many abandoned clearings indicate the failure of early attempts at farming these dry sandy soils. Many abandoned farms are found in Eureka Township and the southern half of Fairplain Township. In these places, the Grayling sands comprise a large part of the State-owned Flat River Game Area. Large tracts of these soils are now best suited for recreational and forest use.

The forests of jack pine and oak furnish some pulpwood, fire wood, and fence posts. Extensive areas have been reforested by the State and Federal Governments and by private owners.

Grayling sand, 0 to 2 percent slopes (Gc).—This soil has little value for crops and pasture and only fair value for trees. It is susceptible to wind erosion.

Some of this soil in the vicinity of Greenville is used for potatoes, vegetables, and small fruits by part-time farmers who earn most of their income off the farm. Vegetables can be grown on a commercial scale on this soil, if it is irrigated and large amounts of manure, commercial fertilizer, and lime are applied. Although this soil is not well suited to pasture, in some places the native grasses can be grazed early in spring. Red and jack pines can be grown, but growth rates are low. Soil management unit 5.7a (VIIS).

Grayling sand, 2 to 6 percent slopes (Gd).—This soil is similar to Grayling sand, 0 to 2 percent slopes, except that it is more sloping. The two soils have about the same uses. Soil management unit 5.7a (VIIS).

Grayling sand, 6 to 10 percent slopes (Ge).—Like the other Grayling sands, this soil is likely to be eroded by the wind. It has little or no value for crops or pasture and should be kept in trees. Yields of forest products, however, will be low. Soil management unit 5.7a (VIIS).

Grayling sand, 10 to 18 percent slopes (Gg).—This soil is similar to Grayling sand, 6 to 10 percent slopes, but it is more strongly sloping. Soil management unit 5.7a (VIIS).

Grayling sand, 18+ percent slopes (Gh).—This soil is similar to Grayling sand, 10 to 18 percent slopes, but it is steeper. It should be kept in jack and red pines, but planting trees will be more difficult than on the less steep Grayling sands. Soil management unit 5.7a (VIIS).

Greenwood and Dawson peats

Greenwood and Dawson peats are the least decomposed organic soils in the county. They consist almost entirely of the fibrous material from sedges, mosses, and other nonwoody plants. The Dawson peat is shallower than Greenwood peat and is underlain by coarse-textured mineral materials at depths of less than 42 inches. In some places Greenwood peat extends 30 feet below the surface.

Greenwood and Dawson peats occupy basins that have the water table at or within a few inches of the surface throughout the year. In many places they are along the shores of lakes, and in a few places they occur over water as floating bogs. Consequently, they are referred to locally as "quaking bogs."

These peats support a native vegetation of leatherleaf, high-bush blueberry, sphagnum moss, hypnum moss, sedges, scattered shrubs, and dwarfed trees. The dwarfed trees are largely tamarack and black spruce. Leatherleaf, the characteristic cover, grows in a dense mat to a fairly uniform height over the entire bog. The mosses flourish under the leatherleaf, supported by its stems.

Profile description for the Greenwood peat:

- O_1 0 to 5 inches, dark grayish-brown to yellowish-brown (10YR 4/2 to 5/4, moist) sphagnum and hypnum mosses and fibrous peat; extremely acid; 4 to 9 inches thick.
- O_2 5 to 26 inches, brown to yellowish-brown (10YR 5/3 to 5/6, moist), undecomposed, fibrous peat; spongy and feltlike; extremely acid; 15 to 25 inches thick.
- O_3 26 inches+, light-brown to yellowish-brown (7.5YR 6/4 to 10YR 5/6, moist) fibrous peat, with little or no decomposition; very strongly acid to extremely acid.

The Greenwood peat ranges from 42 inches to as much as 30 feet in depth.

Profile description for the Dawson peat:

O_1 0 to 5 inches, dark grayish-brown to yellowish-brown (10YR 4/2 to 5/4, moist) slightly decomposed sphagnum and hypnum mosses and fibrous peat; extremely acid; 4 to 8 inches thick.

O_2 5 to 20 inches, brown to yellowish-brown (10YR 5/3 to 5/6, moist), undecomposed, fibrous peat; spongy and feltlike; extremely acid; 6 to 22 inches thick.

O_3 20 to 32 inches, light-brown to yellowish-brown (7.5YR 6/4 to 10YR 5/6, moist), undecomposed, fibrous peat; very strongly acid to extremely acid; 4 to 12 inches thick.

O_4 32 to 38 inches, black to very dark brown (10YR 2/1 to 2/2, moist), pasty, finely divided organic material; medium acid to strongly acid; 3 to 8 inches thick.

D 38 inches+, light-gray to very pale brown (10YR 7/2 to 7/3, moist) sand mottled with brown, yellowish brown, and strong brown (10YR 5/3, 10YR 5/4, and 7.5YR 5/6, moist); single grain (structureless); loose; neutral to mildly alkaline.

The depth of the Dawson peat over sand ranges from 12 to 42 inches.

Greenwood and Dawson peats, 0 to 2 percent slopes (Gk).—These organic soils are habitats for wildlife and probably are best for that purpose. The trees on these peats have little or no commercial value. Because the organic material is mostly undecomposed and is extremely acid, and because the water table is high, these soils probably have little value for agricultural use. Possibly they may have some value as a source of acid peat. Soil management unit aM (VIIIW).

Houghton and Adrian mucks and peats

These organic soils occur in small areas along the edges of lakes, in old lake basins, and in other moist, seepy locations. They are developing from fibrous peat that contains little or no woody material. The fibrous peat formed under marsh grasses, cattails, rushes, sedges, and other water-loving plants. This native marsh vegetation overgrew the depressions and filled them with its remains. These organic soils now support sedges, grasses, and a few scattered trees. The trees are mainly tamarack and willow.

Profile description for the Houghton muck and peat:

O_1 0 to 10 inches, black to dark-brown (10YR 2/1 to 4/3, moist) finely fibrous muck to undecomposed fibrous peat; consists almost entirely of a dense, tough matrix of grass roots; medium acid to neutral; 6 to 12 inches thick.

O_2 10 to 22 inches, dark grayish-brown to yellowish-brown (10YR 4/2 to 5/4, moist) fibrous peat; spongy and feltlike; slightly to very strongly acid; 8 to 20 inches thick.

O_3 22 inches+, yellowish-brown to dark yellowish-brown (10YR 5/8 to 4/4, moist) fibrous peat; very slightly decomposed; spongy and feltlike; slightly to strongly acid.

The Adrian soils are similar to the Houghton soils in the upper horizons, but the Adrian soils are underlain by coarse-textured mineral materials at depths of 12 to 42 inches.

Profile description for the Adrian muck and peat:

O_1 0 to 8 inches, black to dark-brown (10YR 2/1 to 4/3, moist) finely fibrous muck to almost undecomposed peat; consists almost entirely of a dense, tough matrix of grass roots; medium acid to neutral; 4 to 10 inches thick.

O_2 8 to 30 inches, yellowish-brown to dark yellowish-brown (10YR 5/8 to 4/4, moist) fibrous peat; very slightly decomposed; medium to strongly acid; 8 to 26 inches thick.

O_3 30 to 35 inches, very dark brown to dark grayish-brown (10YR 2/2 to 4/2, moist) gelatinous sedimentary peaty material; slightly to medium acid; 2 to 6 inches thick.

D 35 inches+, light-gray to very pale-brown (10YR 7/2 to 7/3, moist) sand; single grain (structureless); loose; neutral to mildly alkaline.

Houghton and Adrian mucks and peats, 0 to 2 percent slopes (Ha).—These soils are poorly suited to crops and forest and only fairly well suited to pasture. They are difficult and costly to drain and are susceptible to frost damage and wind erosion. Furthermore, they occur in small, irregularly shaped areas. Much of the acreage is used for pasture during the summer, but the quality and quantity of the pasture grasses depend on the extent of drainage. Unless these soils are well drained artificially, water-tolerant grasses should be used. The shallow Adrian soils, when drained and developed, usually decompose so rapidly that only the sandy mineral materials remain. Soil management unit bM (IIIW).

Iosco loamy sand

Iosco loamy sand consists of sands and loamy sands with loam to silty clay loam materials at depths of 18 to 42 inches. This soil formed under imperfect drainage conditions. The runoff is slow, but the coarser textured materials are sufficiently permeable to allow water to penetrate readily to the lower fine-textured materials.

Profile description for Iosco loamy sand:

A_p 0 to 7 inches, very dark brown, very dark gray, or very dark grayish-brown (10YR 2/2, 3/1, or 3/2, moist) loamy sand; weak fine granular structure; very friable when moist and soft when dry; medium in organic matter; slightly to medium acid; 6 to 10 inches thick.

A_{2g} 7 to 12 inches, light-gray to light brownish-gray (10YR 7/2 to 6/2, moist) sand mottled with reddish yellow and brownish yellow (7.5YR 6/8 and 10YR 6/8, moist); single grain (structureless); loose; very low in organic matter; slightly to strongly acid; 2 to 8 inches thick.

B_{2h} 12 to 20 inches, brown to dark-brown (7.5YR 5/4 to 4/4, moist) loamy sand; weakly cemented in some places by organic compounds and iron oxides; medium to strongly acid; 4 to 12 inches thick.

C_{1g} 20 to 34 inches, light brownish-gray to pinkish-gray (10YR 6/2 to 7.5YR 6/2, moist) sand to loamy sand; mottled with yellowish brown and reddish yellow (10YR 5/6 and 7.5YR 6/8, moist); single grain (structureless); loose; slightly acid; 6 to 16 inches thick.

D 34 inches+, light brownish-gray, brown, or light olive-brown (10YR 6/2, 5/3, or 2.5Y 5/4, moist) loam to silty clay loam; moderate medium angular blocky structure; plastic when wet, very firm when moist, and very hard when dry; limy.

In thickness the horizons vary according to the depth of the coarse-textured upper part of the soil profile. In many places the C_{1g} horizon contains lenses of yellowish-brown loamy sand or sandy loam. The loam to silty clay loam D horizon occurs at depths of 18 to 42 inches.

Iosco loamy sand, 0 to 2 percent slopes (Ia).—This soil includes some areas that have a sandy loam surface soil. Also included are small areas of Ogemaw soil, which has a strongly cemented layer in the subsoil (B_{2h} horizon). Ogemaw soils are not mapped separately in this county.

More than 60 percent of the Iosco soil is used for crops, and the rest is in permanent pasture or woodlots. If the wooded areas are well managed, the trees grow well. The crops generally grown are hay, wheat, oats, corn, and field beans. To increase crop yields, this soil should be drained by surface and tile installations. Soil management unit 3bA (IIW).

Kawkawlin loams

These loams are imperfectly drained soils developed on limy clay loam to silty clay loam materials. They are associated with the well-drained Nester and poorly drained Sims soils that formed on similar parent material. The native vegetation was mainly sugar maple, beech, and elm but included some ash, swamp white oak, basswood, and red maple.

Profile description for Kawkawlin loams:

A_p 0 to 6 inches, dark-gray to very dark-grayish brown (10YR 4/1 to 3/2, moist) loam; weak medium granular structure; friable when moist and slightly hard when dry; medium in organic matter; slightly acid to neutral; 5 to 8 inches thick.

A_{2g} 6 to 13 inches, light brownish-gray (10YR 6/2, moist) sandy loam that has reddish-yellow, pinkish-gray, and yellow (7.5YR 7/8, 7.5YR 7/2, and 10YR 7/8, moist) splotches and streaks; very weak fine to medium platy structure; friable when moist and hard when dry; slightly acid; 1 to 8 inches thick.

$B1_{tg}$ 13 to 16 inches, brown, dark-brown, or reddish-brown (7.5YR 5/4, 7.5YR 4/4, or 5YR 4/4, moist) sandy loam to loam mottled with light brown and pinkish gray (7.5YR 6/4 and 7/2, moist); weak fragipan in places; firm when moist and hard to brittle when dry; slightly to medium acid; 3 to 6 inches thick.

$B2_{tg}$ 16 to 28 inches, reddish-brown to brown (5YR 4/4 to 7.5YR 4/4, moist) sandy clay loam to clay loam mottled with pinkish gray and strong brown (7.5YR 7/2 and 5/8, moist); strong coarse subangular to angular blocky structure; plastic when wet, firm when moist, and very hard when dry; slightly acid to neutral; 8 to 18 inches thick.

C_g 28 inches+, brown to grayish-brown (7.5YR 5/2 to 10YR 5/2, moist) clay loam to silty clay loam mottled with strong brown and pink (7.5YR 5/8 and 7/4, moist); moderate medium to coarse angular blocky structure; plastic when wet, firm when moist, and hard to very hard when dry; limy.

The depth to the limy parent material ranges from 20 to 40 inches.

Kawkawlin loam, 0 to 2 percent slopes (Ka).—The downward movement of water through this imperfectly drained soil is slow, and areas that are used for crops need artificial drainage. Those areas associated with the poorly drained Sims soils need both surface and tile drainage.

This soil is difficult to work when wet, and warms up slowly in spring. More than 80 percent of the combined acreage of this soil and Kawkawlin loam, 2 to 6 percent slopes, is used for crops grown in rotation. The rest is used for permanent pasture or farm woodlots. This soil is suited to corn, wheat, oats, beans, and legume-grass mixtures. Included with this soil are areas with a fine sandy loam plow layer and a few areas of Iosco and Arenac soils. Arenac soils are not mapped separately in this county. Soil management unit 2bA (I).

Kawkawlin loam, 2 to 6 percent slopes (Kb).—This imperfectly drained soil is used for row crops, pasture, or trees. Dominant slopes have less than 4 percent gradient. Areas that are used for crops need artificial drainage. Because this soil is more sloping than Kawkawlin loam, 0 to 2 percent slopes, care must be taken to be sure that the tile is laid at the proper grade. Row crops should be grown in rotation with legume-grass mixtures. In order to maintain soil structure, only a minimum amount of tillage should be used. Included with this soil are areas that have a fine sandy loam surface soil. Soil management unit 2bA (I).

Kerston muck

Kerston muck occurs on wet bottom lands. It consists of a mixture of muck and mineral materials or alternate layers of organic and mineral alluvium.

Because this soil gradually merges with undifferentiated alluvial soils in many places, it cannot always be sharply delineated. Generally, the soil is mostly organic matter to depths of 2 or more feet. It is neutral to slightly acid and has a high water table.

The original vegetation was a fairly dense stand of tamarack, alder, willow, aspen, elm, and red maple.

Kerston muck, 0 to 2 percent slopes (Kc).—This soil is likely to be flooded at times. Most of the acreage is not cleared, but the naturally open areas provide fair to good pasture. A few small areas have been cleared and used for truck crops. Because this soil is in irregularly shaped areas and is poorly drained, and because crops may be damaged by frost and flooding, this soil can be used only for pasture and woodland. Trees, however, are seldom planted. Soil management unit L5c (VW).

Made land

Made land (Ma.)—This land consists of areas that have been covered by fill materials to such a depth that the physical characteristics of the natural soil profile cannot be identified. Areas of Made land are found in the industrial parts of Greenville.

Mancelona loamy sands

These well drained and moderately well drained soils have developed on stratified and nonstratified calcareous or neutral sands and gravel. The slopes range from nearly level to steep. The nearly level to gently sloping soils occur with Newaygo and Grayling soils in old glacial drainways and on terraces and outwash plains. The rolling, hilly, and steep soils are on moraines and eskers.

The Mancelona soils are intermediate in characteristics between the more sandy Grayling soils and the finer textured Newaygo soils. They are less acid than the Grayling soils, which are free of lime to depths of several feet. They are coarser in texture than the Newaygo soils, and their subsoil contains less clay, is thinner, and occurs at a greater depth than the Newaygo subsoil.

These soils are in the same catena as the imperfectly drained Gladwin and the poorly drained Epoufette soils. Runoff and internal drainage are rapid.

In the southern part of the county, the original vegetation consisted largely of oak and hickory. In the northern part it had a higher proportion of white pine. The present growth is largely oak and aspen.

The many abandoned clearings and old farmsteads, particularly in Eureka Township, indicate that early attempts to farm these dry sandy soils were seldom successful. Sassafras and staghorn sumac and a ground cover of bracken and sweetfern now grow on areas that were formerly cultivated.

Profile description for Mancelona loamy sands:

A_p 0 to 8 inches, dark-gray, dark grayish-brown, or very dark grayish-brown (10YR 4/1, 4/2, or 3/2, moist) loamy sand; weak fine granular structure; friable when moist and soft when dry; moderate to low in organic matter; slightly acid to medium acid; 7 to 10 inches thick.

B_{2h} 8 to 13 inches, dark yellowish-brown to light yellowish-brown (10YR 4/4 to 6/4, moist) loamy sand; very weak fine granular structure; very friable when moist and

soft when dry; medium to strongly acid; 3 to 10 inches thick.

A_{21} 13 to 34 inches, light brownish-gray to pale-brown (10YR 6/2 to 6/3, moist) sand or loamy sand with some gravel; very weak fine granular structure to single grain (structureless); very friable when moist and loose when dry; strongly acid to medium acid; 10 to 30 inches thick.

A_{22} 34 to 37 inches, light-gray (10YR 7/2, moist) loamy sand; very friable when moist and nearly loose when dry; slightly compact in places; medium acid; 2 to 6 inches thick.

B_{2t} 37 to 41 inches, brown, dark-brown, or yellowish-brown (7.5YR 4/4, 7.5YR 5/4, or 10YR 5/4, moist) fine sandy loam to sandy clay loam; weak medium subangular blocky structure; slightly plastic when wet, firm when moist, and hard when dry; slightly acid to neutral; 2 to 10 inches thick.

D 41 inches+, light-gray to light grayish-brown (10YR 7/2 to 6/2, moist) sands and gravel; loose; limy.

The plow layer ranges in texture from loamy sand to coarse sandy loam. The depth to the limy sand and gravel varies from 36 to 60 inches. The B_{2t} horizon ranges from a thin layer of slightly sticky, coarse sandy loam to a very sticky sandy clay loam as much as 10 inches thick. The upper part of the profile has a considerable range in color. Areas on many of the terraces along the Flat River are exceedingly stony and cobbly. In many places Mancelona soils are very gravelly on the surface and throughout the profile. A high percentage of the gravelly material in the D horizon is limestone.

These soils are low in available moisture-holding capacity and natural plant nutrients. They are very permeable to air and water. They are susceptible to wind and water erosion.

Mancelona loamy sand, 0 to 2 percent slopes (Mb).—More than 75 percent of this soil has been cleared and used for rotation crops. The main crops are corn, oats, and hay. Some truck crops are grown near Greenville. Yields of all crops are low. This soil generally does not grow productive pasture, but some of it can be grazed early in spring. This soil needs heavy applications of manure and the plowing under of green-manure crops. Because the soil is easy to work, only light implements are required for tillage. Wind strips and windbreaks are necessary.

Some pulpwood, firewood, and fence posts are obtained from the timbered areas. Extensive areas have been reforested by the State and Federal Governments and by private owners. Plantings of red, jack, Scotch, and white pines have been generally successful. The plantations need to be protected against fire and grazing. Additional information about tree plantations can be obtained from the Forestry Department of Michigan State University at East Lansing, Michigan (*6*). Soil management unit 4aA (IIIS).

Mancelona loamy sand, 2 to 6 percent slopes (Mc).—This soil can be used for crops, pasture, and trees, but yields will be low because of low fertility and low moisture-holding capacity. If row crops are grown, water and wind erosion should be controlled by stripcropping, terracing, or contour tillage. Soil management unit 4aB (IIIS).

Mancelona loamy sand, 6 to 10 percent slopes (Md).—This soil is suited to small grains, hay, and pasture. It needs to be protected against both wind and water erosion. If it is used for row crops, strip cropping or terraces are needed in combination with a rotation that provides small grains and a legume-grass mixture. Many cleared areas have been planted to red and jack pines. Soil management unit 4aC (IIIS).

Mancelona loamy sand, 10 to 18 percent slopes (Me).—In cultivated areas the original upper layers have been removed by water erosion; consequently, the gravelly, brown to dark-brown sandy clay loam subsoil is exposed, and the limy sand and gravel are near the surface. Many areas are extremely gravelly. Row crops should not be grown. The soil is fairly well suited to pasture, but pastures are poor during dry summers. Soil management unit 4aD (IVS).

Mancelona loamy sand, 18+ percent slopes (Mg).—This droughty, erosive soil is not suited to field crops. It can be used for pasture, but yields will be moderately low, even if the soil is limed and fertilized. The fields that have been cropped are severely eroded and have many gullies. This soil is best suited to trees. Red, jack, and white pines are suggested for planting. Soil management unit 4aE (VIS).

McBride and Isabella sandy loams

These well-drained soils were mapped together as undifferentiated units because they occur together in an intricate pattern. They occur on level, gently to moderately sloping, hilly, and very steep areas. The McBride soils have formed from sandy loam material, and the Isabella soils have formed from sandy clay loam material. These soils are associated with the Montcalm soils.

The native vegetation was a forest of mixed hardwoods and conifers, largely sugar maple, beech, hickory, and white pine. Hickory, however, did not grow in the northern part of the county. White pine flourished on the sandier soils.

Profile description for the McBride sandy loams:

A_p 0 to 6 inches, very dark grayish-brown to dark grayish-brown (10YR 3/2 to 4/2, moist) sandy loam; weak fine granular structure; friable when moist and soft when dry; moderate to low in organic matter; slightly to medium acid; 6 to 10 inches thick.

B_{2h} 6 to 10 inches, strong-brown to dark-brown (7.5YR 5/6 to 10YR 4/3, moist) sandy loam; weak medium granular structure; very friable when moist and soft when dry; slightly to medium acid; 3 to 6 inches thick.

A_2 10 to 14 inches, light yellowish-brown to brownish-yellow (10YR 6/4 to 6/6, moist) loamy sand to sandy loam; weak very thin platy structure; relatively compact, but slight pressure causes breakage into poorly defined irregularly shaped aggregates; slightly to medium acid; 2 to 8 inches thick.

A_{2m} 14 to 25 inches, brown, pinkish-gray, or light brownish-gray (7.5YR 5/2, 7.5YR 6/2, or 10YR 6/2, moist) sandy loam; compact; weakly to moderately developed fragipan; slightly to medium acid; 5 to 14 inches thick.

B_{2t} 25 to 44 inches, reddish-brown, dark-brown, or brown (5YR 4/4, 7.5YR 4/4, or 7.5YR 5/4, moist) sandy clay loam; moderate medium subangular to angular blocky structure; plastic when wet, firm when moist, and hard when dry; slightly to medium acid; 12 to 24 inches thick.

C 44 inches+, light-brown, brown, reddish-brown, or light reddish-brown (7.5YR 6/4, 7.5YR 5/4, 5YR 5/4, or 5YR 6/4, moist) sandy loam; contains lenses and pockets of sandy clay loam and gravelly loamy sand; massive (structureless); firm when moist and hard when dry; limy.

The surface soil of this mapping unit ranges from sandy loam to loam. The fragipan (A_{2m}) horizon is weakly to moderately developed. In timbered areas where grass has not invaded, a gray bleached layer occurs between the dark-colored surface layer and the strong-brown to dark-

brown B_{2h} horizon. In some eroded areas this B_{2h} horizon may not be present.

Profile description for the Isabella sandy loams:

- A_p 0 to 7 inches, very dark grayish-brown to dark grayish-brown (10YR 3/2 to 4/2, moist) sandy loam; moderate medium granular structure; friable when moist and slightly hard when dry; slightly acid to medium acid; 6 to 9 inches thick.
- B_{2h} 7 to 9 inches, brown to yellowish-brown (7.5YR 5/4 to 10YR 5/4, moist) sandy loam; very friable when moist and soft when dry; slightly acid to medium acid; 1 to 5 inches thick.
- A_2 9 to 13 inches, light yellowish-brown, very pale brown, or pale-brown (10YR 6/4, 7/3, or 6/3, moist) sandy loam; very weak thin platy structure; very friable when moist and slightly hard when dry; slightly acid to medium acid; 3 to 7 inches thick.
- A_{2m} 13 to 17 inches, light-gray to light brownish-gray (10YR 7/2 to 6/2, moist) sandy loam; weak fragipan development; medium acid; 3 to 9 inches thick.
- B_1 17 to 22 inches, brown or dark-brown (7.5YR 5/4 or 4/4, moist) sandy loam; strong medium subangular blocky structure; firm when moist and hard when dry; slightly acid to medium acid; 4 to 6 inches thick.
- B_{2t} 22 to 30 inches, reddish-brown, dark-brown, or brown (5YR 4/4, 7.5YR 4/4, or 7.5YR 5/4, moist) sandy clay loam to sandy clay; strong medium to coarse angular blocky structure; plastic when wet, firm when moist, and hard to very hard when dry; slightly acid to neutral; 7 to 20 inches thick.
- C 30 inches+, light reddish-brown to light-brown (5YR 6/4 to 7.5YR 6/4, moist) sandy clay loam; moderate to strong coarse angular blocky structure; plastic when wet, very firm when moist, and very hard when dry; limy.

The subsoil varies from sandy clay loam to sandy clay. In timbered areas where grass has not invaded, a gray bleached layer occurs between the dark-colored surface layer and the brown to yellowish-brown B_{2h} horizon. In some eroded areas this B_{2h} horizon may not be present.

McBride and Isabella sandy loams, 0 to 2 percent slopes (Mh).—Most of this mapping unit is used for crops grown in rotations. A small part is used for permanent pasture and woodlots. If these soils are well managed, they are excellent for growing potatoes. Generally, crop yields on the sandier and deeper McBride soils are less than those on the Isabella soils. Included with this mapping unit are areas of McBride soil that have a surface layer of fine sandy loam, very fine sandy loam, or loam. Also included are areas of Isabella soil that have a plow layer of loamy sand, fine sandy loam, very fine sandy loam, or loam. Soil management unit 3aA (IIS).

McBride and Isabella sandy loams, 2 to 6 percent slopes (Mk).—These soils are similar to McBride and Isabella sandy loams, 0 to 2 percent slopes, but they are more susceptible to water erosion. They are suited to the same uses but need more exacting management. Erosion can be controlled by growing crops in rotation and using soil conserving practices. Pastures grow slowly during extended dry periods. These soils are suitable for planting white, Austrian, red, and Scotch pines. Soil management unit 3aB (IIS).

McBride and Isabella sandy loams, 6 to 10 percent slopes (Mm).—In most places the limy parent material is closer to the surface than that of McBride and Isabella sandy loams, 0 to 2 percent slopes. In eroded areas the dark-brown to reddish-brown subsoil is exposed. Some gullies have formed in the natural waterways. These soils are well suited to row crops, pasture, and trees. If row crops are used, however, they should be grown in rotations, as water erosion must be controlled. Soil management unit 3aC (IIIS).

McBride and Isabella sandy loams, 10 to 18 percent slopes (Mn).—In eroded areas, the moderately fine textured subsoil is usually mixed with the plow layer. In many places, the surface layer is a reddish sandy clay loam that absorbs rainfall slowly.

These soils generally are best suited to pasture and trees. Red, white, Austrian, and Scotch pines are suitable for planting. Soil management unit 3aD (IVS).

McBride and Isabella sandy loams, 18+ percent slopes (Mo).—These soils are similar to McBride and Isabella sandy loams, 10 to 18 percent slopes, but they have a much smaller cleared acreage. In cultivated areas, erosion is moderate to severe and many gullies have formed. If suitable legumes and grasses are planted, yields are moderately high. The yields of forest products from managed woodlands are among the highest in the county. White, red, Scotch, and Austrian pines are suitable for planting. Soil management unit 2aE (VIE).

Melita loamy sands

These soils occur in old lake plains and glaciofluvial areas. They consist of 42 to 66 inches of well drained to moderately well drained sands and loamy sands over materials that range from loam to clay. The upper part of the profile is very permeable to water and air. The native vegetation consisted of sugar maple, beech, hemlock, and white pine.

Profile description for Melita loamy sand:

- A_p 0 to 6 inches, dark-gray to dark grayish-brown (10YR 4/1 to 4/2, moist) loamy sand; weak fine granular structure; very friable when moist and soft when dry; low in organic matter; slightly to medium acid; 5 to 10 inches thick.
- A_2 6 to 8 inches, light-gray to light brownish-gray (10YR 6/2 to 7/2, moist) loamy sand; single grain (structureless); loose; very low in organic matter; medium to strongly acid; 1 to 5 inches thick.
- B_{2h} 8 to 17 inches, light yellowish-brown and yellowish-brown (10YR 6/4 and 5/4, moist) sand; weak fine granular structure to single grain (structureless); very friable to loose; medium to strongly acid; 5 to 12 inches thick.
- B_{3h} 17 to 36 inches, pale-brown (10YR 6/3, moist) sand; single grain (structureless); loose; medium to strongly acid; 10 to 28 inches thick.
- C_{11} 36 to 48 inches, light brownish-gray (10YR 6/2, moist) sand that is mottled in the lower part; single grain (structureless); loose; medium to slightly acid; 10 to 24 inches thick.
- C_{12} 48 to 54 inches, light brownish-gray (10YR 6/2, moist) sand mottled with brownish yellow (10YR 6/6 to 6/8, moist); single grain (structureless); very friable to loose; slightly acid; 3 to 9 inches thick.
- D 54 inches+, grayish-brown to brown (10YR 5/2 to 5/3, moist) silty clay loam; moderate medium angular blocky structure; plastic when wet, firm when moist, and hard when dry; limy.

The texture of the D horizon ranges from loam to silty clay. This horizon occurs at depths of 42 to 66 inches.

Melita loamy sand, 0 to 2 percent slopes (Mp).—About three-fourths of the combined acreage of this soil and Melita loamy sand, 2 to 6 percent slopes, is used for crops, and the rest is in permanent pasture and woodland. Cultivated areas are susceptible to wind erosion and should be kept in a legume-grass mixture as much of the time as practical. This soil is low in natural fertility and in moisture-holding capacity. The maintenance of organic matter is very important and can be done by plowing

under stands of legumes and grasses and reseeding before the ground cover becomes thin. Yields are low, even in stripcropped areas and where cultivated crops are planted in rotations that keep the soil in a legume-grass mixture much of the time. Fair yields of timber can be obtained if the woodlots are well managed. Red, white, and jack pines are recommended for planting.

Included with this mapping unit are areas that have a surface soil of loamy fine sand, loamy very fine sand, and coarse loamy sand. Also included are areas of Croswell, Au Gres, Arenac, Iosco, and Kawkawlin soils. The Arenac soils are not mapped separately in this county. In the Croswell and Au Gres inclusions, the finer textured D horizon occurs at a depth greater than 66 inches. The Au Gres and Arenac inclusions are imperfectly drained. The Iosco and Kawkawlin inclusions occur in Crystal Township. Soil management unit 5aA (IVS).

Melita loamy sand, 2 to 6 percent slopes (Mr).—This soil occurs in long, narrow strips along streams in Pierson and Douglas Townships. Cultivated areas are susceptible to water erosion as well as wind erosion. Considerable erosion has already occurred on the cleared areas, but most of these areas have been abandoned and are now covered with grass, shrubs, or second-growth forest. These narrow strips should remain in grass or trees. Soil management unit 5aB (IVS).

Melita-Iosco-Kawkawlin complex

This complex consists of Melita loamy sand, 0 to 2 percent slopes; Iosco loamy sand, 0 to 2 percent slopes; and Kawkawlin loam, 0 to 2 percent slopes. These soils were mapped together because they occur in such an intricate pattern that it was not possible to delineate them separately on a map of the scale used. They have developed from a variable thickness of sandy materials that overlie loam to silty clay loam till. The Melita soil has the thickest layer of sandy material, whereas the Kawkawlin soil has a thin sandy upper layer, or no sandy layer. Each of these soils is described elsewhere in this subsection under its name.

Melita-Iosco-Kawkawlin complex, 0 to 2 percent slopes (Ms).—About 80 percent of the acreage of these soils is cleared. Most of the cleared acreage is used for cultivated crops, but some is in permanent pasture. Corn, wheat, oats, field beans, and legume-grass mixtures are the principal crops. Yields of timber in the woodlands are fair. These soils are suitable for new plantings of red, jack, and Scotch pines. In some places white pine can also be planted.

These soils have different natural drainage and are difficult to manage because they occur together in many fields. Generally the management suggested for the Iosco soil is best suited to this complex as a whole. However, in areas where one of the other soils predominates, the suggestions for the predominant soil are best. More fertilizer, lime, and manures are needed on the Melita and Iosco soils than on the Kawkawlin soil. Tile drains are used in many areas of Kawkawlin soil. Many farmers plow this soil in fall. If fields that consist of all three soils are plowed in fall, the areas of the Melita and Iosco soils are susceptible to wind erosion. Soil management unit 4aA (IIIS).

Montcalm loamy sand and sandy loams

These soils occur on outwash plains and moraines. The steeper soils are along the edges of the stream terraces. The loamy sands and sandy loams are so closely intermingled that it is impractical to map them separately. In many places the upper horizons of these soils have been washed away by the rapid to very rapid runoff. Internal drainage is also rapid to very rapid.

These soils are associated with Mancelona, Grayling, and McBride soils. They differ from the Mancelona soils, which have limy, coarse sand, very coarse sand, and gravel within 42 inches of the surface. They are finer textured than the Grayling soils and have a light reddish-brown subsoil that is not present in the Grayling soils.

The native vegetation was mainly white pine, and there were lesser amounts of sugar maple, beech, and oak.

Profile description for the Montcalm loamy sands:

A_p	0 to 7 inches, dark grayish-brown (10YR 4/2, moist) loamy sand; weak fine granular structure; very friable when moist and soft when dry; moderately low in organic matter; slightly to medium acid; 6 to 10 inches thick.
A_2	7 to 9 inches, pale-brown to light-gray (10YR 6/3 to 7/2, moist) loamy sand; weak fine granular structure; very friable when moist and loose when dry; low in organic matter; medium acid; 1 to 5 inches thick.
B_{2h}	9 to 15 inches, brown to yellowish-brown (7.5YR 5/4 to 10YR 5/4, moist) loamy sand; weak fine granular structure; very friable when moist and soft when dry; medium acid; 3 to 8 inches thick.
A_2	15 to 26 inches, pinkish-gray to pale-brown (7.5YR 6/2 to 10YR 6/3, moist) loamy sand; very weak thin platy structure; very friable when moist and hard when dry; medium to strongly acid; 7 to 16 inches thick.
A_{2m}	26 to 29 inches, pinkish-gray to light brownish-gray (7.5YR 6/2 and 7/2 to 10YR 6/2, moist) loamy sand; weak to moderately developed fragipan; friable when moist and very hard and brittle when dry; medium to strongly acid; 2 to 8 inches thick.
B_{2t}	29 to 35 inches, brown, dark-brown, or strong-brown (7.5YR 5/4, 4/4, or 5/6, moist) sandy loam to sandy clay loam; weak to moderate coarse subangular to angular blocky structure; plastic when wet, firm when moist, and hard when dry; strongly acid; 3 to 10 inches thick.
A_2–B_{2t}	35 to 60 inches, light brownish-gray (10YR 6/2, moist) medium and coarse sand; contains a series of lenses or thin layers of reddish-brown to dark-brown (5YR 4/4 to 7.5YR 4/4, moist) loamy sand to sandy loam; slightly to medium acid.
C	60 inches+, light yellowish-brown to pale-brown (10YR 6/4 to 6/3, moist) sand; single grain (structureless); loose; slightly acid to alkaline; limy in many places.

The texture of the surface soil varies from loamy sand to sandy loam. The fragipan (A_{2m}) horizon varies from weakly to moderately developed. In timbered areas where grass has not invaded, a gray, bleached horizon is present between the dark-colored surface layer and the brown to yellowish-brown B_{2h} layer. In severely eroded areas, the B_{2h} layer may not occur below the plow layer.

Montcalm loamy sand and sandy loam, 6 to 10 percent slopes (Mt).—More of the acreage of these soils is used for permanent pasture and woodlots than of the more nearly level Montcalm and McBride loamy sands. Many

areas that were formerly in pasture now are in sassafras and sumac with a ground cover of bracken and sweetfern. Other areas that were formerly farmed are now planted to red and jack pines.

These soils can be used for row crops if water and wind erosion are controlled. They are easy to till and are suited to small grains and to legume-grass mixtures. Areas used for pasture should be limed, fertilized, and properly seeded. Organic matter can be maintained by plowing under good stands of grass. Overgrazing, which is common in dry summers, subjects the soil to severe water erosion that includes severe gullying.

Included in this mapping unit are areas that have had their upper horizons removed by erosion. Also included are areas of Grayling, Mancelona, and McBride soils. Soil management unit 4aC (IIIS).

Montcalm loamy sand and sandy loam, 10 to 18 percent slopes (Mu).—These soils are similar to Montcalm loamy sand and sandy loam, 6 to 10 percent slopes, but, because they are steeper, they are more susceptible to wind and water erosion. Soil management unit 4aD (IVS).

Montcalm loamy sand and sandy loam, 18+ percent slopes (Mv).—These droughty soils are low in natural fertility and are not suited to rotation crops. They have limited value for pasture. They are best suited to forestry. The steepest parts of these soils are almost entirely in second-growth forest that consists largely of aspen and oaks. Soil management unit 4aE (VIS).

Montcalm and McBride loamy sands and sandy loams

The loamy sands and sandy loams of the Montcalm and McBride series occur together in an intricate pattern. They occur on level to undulating till plains in association with Isabella soils. The Montcalm soils have developed from loamy sand materials, and the McBride soils have developed from sandy loam materials. The native vegetation was a mixture of hardwoods and conifers. Sugar maple, beech, hickory, and white pine were the main species, but the hickory did not grow in the northern part of the county.

A profile description for the Montcalm loamy sands is given under the heading Montcalm loamy sand and sandy loams elsewhere in this subsection. One for the McBride sandy loams is given under McBride and Isabella sandy loams.

Montcalm and McBride loamy sands and sandy loams, 0 to 2 percent slopes (Mw).—Most of the acreage of these soils is used for crops grown in rotations. A very small acreage is in permanent pasture and woodlots. Corn, field beans, wheat, oats, and legume-grass mixtures are commonly grown. Potatoes are especially well suited to these soils. Crop yields on the Montcalm soils, which are sandier than the McBride soils, are less than those on the McBride soils.

Using legume-grass mixtures in the rotation much of the time helps to maintain organic matter and fertility. Applications of commercial fertilizers and manure also increase crop yields. Lime or marl generally should be applied before legumes are seeded. Soil management unit 4aA (IIIS).

Montcalm and McBride loamy sands and sandy loams, 2 to 6 percent slopes (Mx).—Because these soils are more sloping than Montcalm and McBride loamy sands and sandy loams, 0 to 2 percent slopes, they are more susceptible to erosion. Contour tillage will help reduce losses through water erosion. Soil management unit 4aB (IIIS).

Nester loams

These soils are well drained to moderately well drained. They occur in association with the imperfectly drained Kawkawlin and the poorly drained Sims soils. They have developed from clay loam to silty clay loam parent materials. In a few places there are enough stones and boulders to interfere with tillage. The native forest consisted mainly of sugar maple and beech, and there were lesser amounts of basswood, elm, and ash.

Nester loams are among the most productive soils in the county for field crops.

Profile description for Nester loams:

- A_p 0 to 7 inches, dark-gray to dark grayish-brown (10YR 4/1 to 4/2, moist) loam; moderate medium granular structure; friable when moist and soft when dry; medium to low in organic matter; slightly to medium acid; 5 to 8 inches thick.
- A_2 7 to 12 inches, pinkish-gray to light-brown (7.5YR 6/2 to 6/4, moist) fine sandy loam to loam; moderate thin platy structure; friable when moist and slightly hard when dry; slightly to medium acid; 2 to 7 inches thick.
- B_{2t} 12 to 32 inches, dark-brown, reddish-brown, or dark reddish-brown (7.5YR 4/4, 5YR 4/4, or 5YR 3/4, moist) clay loam to silty clay loam; strong medium angular blocky structure; sticky and plastic when wet, firm when moist, and hard to very hard when dry; slightly acid to medium acid; 12 to 28 inches thick.
- C 32 inches+, brown, reddish-brown, or light reddish-brown (7.5YR 5/4, 5YR 5/4, or 5YR 6/4, moist) clay loam to silty clay loam; strong medium to coarse angular blocky structure; sticky and plastic when wet, firm when moist, and hard to very hard when dry; limy.

The depth to the limy parent material varies from 26 to 40 inches. The individual structural aggregates in the subsoil are coated with a thin, clayey material that is darker in color than the interior of the aggregates. Plant roots penetrate the more or less permanent spaces between the aggregates. The larger roots develop in the larger cracks, and the smaller roots in the smaller cracks. In many places the roots concentrate in the cracks in this zone of clay accumulation. Because of the many cracks, crevices, and channels in the subsoil when the soil is dry, the subsoil is fairly permeable for the downward movement of water.

Nester loam, 0 to 2 percent slopes (Na).—Nearly all of the acreage of this soil has been cleared and used for crops and pasture. Because dairying is the main type of farming, much of the acreage is in corn, wheat, oats, and a mixture of alfalfa and bromegrass. Row crops can be grown satisfactorily in rotations that provide sod crops or frequent green-manure crops. Yields will be increased if manure and commercial fertilizer are applied. Because this soil is level or nearly level and medium textured, the risk of wind and water erosion is slight. If it is worked when wet, the soil clods on drying and the surface layer is hard to till. Soil management unit 2aA (I).

Nester loam, 2 to 6 percent slopes (Nb).—This soil is well suited to crops, pasture, and trees. Much of it has been cleared and farmed. Because it is more sloping than Nester loam, 0 to 2 percent slopes, this soil is more susceptible to water erosion. Included with this soil are areas where water erosion has removed the original surface layer and the plow layer is a clay loam, sandy clay loam, or silty clay loam.

If water erosion is to be reduced and fertility main-

tained, this soil should be tilled on the contour, stripcropped, or terraced. Natural waterways should be kept in grass and rotations used that provide a legume-grass mixture. The woodlots generally produce high yields of forest products if they are properly managed. Soil management unit 2aB (IIE).

Nester loam, 6 to 10 percent slopes (Nc).—Many of the slopes of this soil are short and complex, and cultivated areas are moderately to severely sheet eroded. On many slopes the finer textured, reddish-brown subsoil has been exposed by water erosion. Some of the drainways are gullied.

If this soil is used for row crops, it should be tilled on the contour, stripcropped, and, in some places, terraced. Row crops should be grown in rotations that provide a legume-grass mixture. This soil can produce medium to high yields of forest products. Soil management unit 2aC (IIIE).

Nester loam, 10 to 18 percent slopes (Nd).—This soil has many short complex slopes. Many cultivated areas have been severely eroded, and the clay loam subsoil occurs at the surface. In some places the limy substratum occurs at depths of 10 to 15 inches.

This soil is best suited to pasture and forest. If it is used for row crops, it should be stripcropped and row crops should be grown only once in 5 years. If seeded across the slope and adequately limed and fertilized, legumes and grasses grow well. Trees suitable for new plantings are white, Austrian, and red pines and, in some places, Scotch pine. Soil management unit 2aD (IVE).

Nester loam, 18+ percent slopes (Ne).—This soil is steeper than Nester loam, 10 to 18 percent slopes. It is used mostly for pasture and trees. Along the streams, many of the steeper slopes remain in shrubs or woody vegetation. Soil management unit 2aE (VIE).

Newaygo sandy loams

Newaygo sandy loams are well-drained soils that occur on outwash plains and terraces along old glacial drainageways. They have developed on limy, stratified loamy sands, sands, and gravel. They are associated with the level to undulating Mancelona soils. Their subsoil is finer textured, thicker, and generally nearer the surface than that of the Mancelona soils. Newaygo sandy loams are the well-drained members of the catena that includes the imperfectly drained Palo and the poorly drained Ronald soils. The original vegetation was a forest of mixed hardwoods and white pine, but oak is now predominant.

Profile description for Newaygo sandy loams:

A_p 0 to 7 inches, very dark grayish-brown to dark grayish-brown (10YR 3/2 to 4/2, moist) sandy loam; weak to moderate fine granular structure; friable when moist and slightly hard when dry; medium to low in organic matter; slightly to medium acid; 6 to 9 inches thick.

B_h 7 to 18 inches, brown to pale-brown (10YR 4/3 to 6/3, moist) loamy sand; in places slightly compact with a weak thin platy structure; very friable when moist and soft to loose when dry; very low in organic matter; medium to strongly acid; 6 to 12 inches thick.

A_2 18 to 24 inches, light brownish-gray to pale-brown (10YR 6/2 to 6/3, moist) loamy sand; weak fine granular structure; very friable when moist and soft when dry; medium to strongly acid; 4 to 12 inches thick.

B_{2t} 24 to 38 inches, dark-brown to reddish-brown (7.5YR 4/4 to 5YR 5/4, moist) sandy loam to sandy clay loam; contains some gravel; moderate medium subangular blocky structure; plastic when wet, firm when moist, and hard when dry; medium acid; 10 to 24 inches thick; extends in tonguelike projections into the loose sand and gravel below.

D 38 inches+, pinkish-gray, light-brown, or light yellowish-brown (7.5YR 6/2, 7.5YR 6/4, or 10YR 6/4, moist) sands and gravel; stratified; loose; limy.

The thickness of the subsoil ranges from 10 to 24 inches, and the depth from the surface to the limy sand and gravel ranges from 24 to 42 inches. The amount of gravel on the surface and in the profile varies from place to place. As the depth of the D horizon increases, the thickness of the various horizons also increases. In timbered areas where grass has not invaded, a gray, bleached layer occurs between the dark-colored surface layer and the brown to pale brown subsoil (B_h) horizon.

These soils have a low to medium available moisture-holding capacity. The plow layer and subsoil are slightly acid to medium acid, but the underlying sand and gravel are calcareous.

Newaygo sandy loam, 0 to 2 percent slopes (Nk).—Much of this soil has been farmed. Wheat, corn, oats, field beans, and alfalfa are the main crops. Because of the low to medium moisture-holding capacity, most crops do not grow well during periods of low rainfall. Some lime should be applied so that the plants can establish good roots that can utilize the lime available at lower depths. To maintain high yields, the soil needs frequent heavy applications of manure and complete fertilizers, the plowing under of crop residues, and the growing of sod crops. Wind erosion is also a problem in unprotected areas. This soil is suitable for tree planting. White, Austrian, red, and Scotch pines are recommended. Soil management unit 3aA (IIS).

Newaygo sandy loam, 2 to 6 percent slopes (Nm).—This soil is similar to Newaygo sandy loam, 0 to 2 percent slopes, but is more susceptible to water erosion. Unprotected areas may also be eroded by the wind. The use of crop rotations and supporting conservation practices will help reduce erosion. Soil management unit 3aB (IIS).

Newaygo sandy loam, 6 to 10 percent slopes (Nn).—This soil occurs on the sloping edges of terraces and around small depressions. In many areas plowing has exposed the reddish-brown to dark-brown sandy clay loam subsoil. The limy sands and gravel are nearer the surface in these eroded areas than they are in the uneroded areas. This soil is less productive than the Newaygo soils that are less sloping. Soil management unit 3aC (IIIS).

Newaygo sandy loam, 10 to 18 percent slopes (No).—This soil is shallower to the underlying sands and gravel than the less sloping Newaygo sandy loams. Included in the mapping unit are many eroded areas and some areas that have slopes greater than 18 percent. In many places the limy, loose, stratified sands and gravel occur at depths as shallow as 10 to 15 inches. Except in the wooded areas, wind and water erosion have removed much of the upper part of the soil. Many of these eroded inclusions are gravelly.

This soil should be kept in small grains, permanent pasture, or trees. Legume-grass mixtures are suitable for pasture. Overgrazing should be avoided, especially in dry summers. Many areas that were formerly farmed are now planted to white, red, Austrian, and Scotch pines. The slopes greater than 18 percent are now in a second-growth forest, largely aspen and oak. The best use for these steep inclusions is for forest and recreation. Soil management unit 3aD (IVS).

Newaygo loams

These well-drained, light-colored soils occur on outwash plains and terraces along old glacial drainageways. They have developed on stratified, limy loamy sands and gravel. Their subsoil is finer textured, thicker, and generally closer to the surface than that of the Newaygo sandy loams. In some places the subsoil is yellowish brown rather than dark brown or reddish brown. In most other characteristics these soils are similar to the Newaygo sandy loams.

Newaygo loam, 0 to 2 percent slopes (Ng).—Much of this soil is cultivated. It is suited to crops, pasture, and trees. Row crops should be grown in rotations that provide legume-grass mixtures. Lime and fertilizer, in sufficient amounts, need to be applied if satisfactory yields are to be obtained. Windbreaks and stripcropping may be needed to reduce wind erosion. The growth of plants is affected during dry periods. This soil is suitable for new plantings of white, Austrian, red, and Scotch pines. Soil management unit 3aA (IIS).

Newaygo loam, 2 to 6 percent slopes (Nh).—This soil is similar to Newaygo loam, 0 to 2 percent slopes, but, because it is more sloping, it is susceptible to water erosion. The use of rotations and supporting soil conservation practices will help reduce erosion. Soil management unit 3aB (IIS).

Rifle and Tawas peats

These very poorly drained organic soils are composed of woody and fibrous plant remains. Rifle peat is more than 42 inches deep. Tawas peat is underlain by coarse-textured mineral materials at depths of 12 to 42 inches.

These soils are slightly acid to strongly acid. They are intermediate in reaction between Carlisle muck and Greenwood and Dawson peats. In a few burned-over areas, the surface layer is neutral to mildly alkaline.

The native vegetation was mostly tamarack but included some red maple and red-osier dogwood. Areas where these trees have been destroyed by burning, cutting, or flooding are covered by a dense growth of sedges and grasses, mainly wiregrass and bluejoint. These areas have a surface layer that in time will be similar to that of Houghton muck, except that trunks and roots of trees will be found at depths of 6 to 18 inches.

Profile description for the Rifle peat:

O_1 0 to 8 inches, dark-brown (10YR 4/3, moist) peat that contains woody fragments or roots; slightly acid to medium acid; 6 to 10 inches thick.

O_2 8 to 16 inches, dark yellowish-brown (10YR 4/4, moist) woody and fibrous peat; medium acid to slightly acid; 5 to 15 inches thick.

O_3 16 inches+, brownish-yellow through yellowish-brown to dark yellowish-brown (10YR 6/6, 5/8 to 3/4, moist) fibrous reed and sedge peat with some woody material; medium to slightly acid.

The water table is near the surface in spring but drops to 30 inches or more below the surface in summer. Many woody roots are above this water table. In some places a sandy and silty overwash from the adjacent eroded slopes partly covers small areas of this soil.

Rifle and Tawas peats, 0 to 2 percent slopes (Ra).—In many places these soils are surrounded by areas of Carlisle muck and poorly drained mineral soils. They are poorly drained and at times have a high water table. During dry periods, however, the cleared, tilled areas are susceptible to wind erosion. Crops planted on these soils are more likely to be damaged by frost than are crops planted on adjacent upland mineral soils.

These soils need about the same management as Carlisle muck, and respond to management in about the same way. Deep plowing in these soils is harmful because raw, brown, fibrous material is brought up by the plowing and mixed with the more decomposed mucky plow layer. Drainage and control of the water table are important when field crops and special crops are grown. Furthermore, larger applications of fertilizers high in phosphate and potash are needed. Windbreaks should be used to reduce wind erosion. Soil management unit bM (IIIW).

Roscommon sand

Roscommon sand is a poorly drained dark-colored soil that occurs on deep sands, largely on outwash plains and in old glacial drainageways. It is associated in small tracts with imperfectly drained Au Gres soils and very poorly drained organic soils. Most of the time the water table is at or near the surface. The native vegetation was largely elm, ash, and swamp conifers. The second growth is mostly aspen, alder, and swamp conifers.

Profile description for Roscommon sand:

A_p 0 to 5 inches, black to very dark gray (10YR 2/1 to 3/1, moist) sand; weak fine granular structure; very friable when moist and loose when dry; high in organic matter; neutral to slightly alkaline; 5 to 10 inches thick.

BG_2 5 to 30 inches, light brownish-gray to light-brown (10YR 6/2 to 7.5YR 6/4, moist) sand; single grain (structureless); loose; slightly acid to neutral; 15 to 30 inches thick.

C 30 inches+, gray and grayish-brown (10YR 5/1 and 5/2, moist) sand mottled with light yellowish brown and strong brown (10YR 6/4 and 7.5YR 5/8, moist); single grain (structureless); loose; neutral to mildly alkaline.

Roscommon sand, 0 to 2 percent slopes (Rb).—This soil has a low moisture-holding capacity and a low supply of plant nutrients. It is poorly suited to crops. Most of the cleared areas are used for hay and pasture. Stumps have been removed from many pastures. Most of the acreage remains in second-growth forest. Many of these areas are pastured. Some areas with a loamy sand surface layer are included in this mapping unit. Soil management unit 5cA (IVW).

Rousseau loamy fine sand

This inextensive soil occurs in the northwestern part of Reynolds Township on the benches 5 to 30 feet above the Little Muskegon River. These benches are separated from the surrounding area by slopes that were cut by streams. A few areas on the lower benches are likely to be flooded periodically. This soil also occurs in the southwestern and southern part of Reynolds Township along Tamarack Creek. Most of this soil is well drained or moderately well drained, but some is imperfectly or poorly drained. The vegetation is mostly second-growth hardwoods and aspen, and there is some hemlock. A few small inaccessible areas have an almost undisturbed cover of hemlock, red maple, white pine, aspen, and elm.

Profile description for Rousseau loamy fine sand:

A_1 0 to 6 inches, very dark grayish-brown to dark grayish-brown (10YR 3/2 to 4/2, moist) loamy fine sand; weak fine granular structure; friable when moist and soft when dry; fair to low in organic matter; slightly acid to neutral; 2 to 8 inches thick.

B_h 6 to 11 inches, dark-brown to brown (7.5YR 4/4 to 10YR 4/3, moist) fine sand; single grain (structureless); low in organic matter; slightly acid to neutral; 4 to 9 inches thick.

C 11 inches+, light yellowish-brown (10YR 6/4, moist) sand; contains a variable amount of stratified very fine sands and silts; finer textured layers are darker colored than the sand; slightly acid to mildly alkaline.

The intensity of the brown color of this soil and the degree of cementation in the subsoil vary considerably from place to place. Some subsoil horizons are loose, and others are weakly to strongly cemented. The texture of the underlying stratified horizons varies from dominantly fine sand to very fine sand and silt.

Rousseau loamy fine sand, 0 to 2 percent slopes (Rc).—This soil has fair fertility. Its capacity for holding water for plants is higher than that of the Grayling soils. Agricultural uses are limited, however, because this soil occurs on terraces in small, irregular, isolated tracts, many of which are inaccessible. Furthermore, the soil on the lower terraces is periodically flooded. Included with this soil are some loamy sand and sandy loam areas and some narrow bands of wet, gray fine sand. Soil management unit 4aA (IIIS).

Sims loam

Sims loam has developed from clay loam to silty clay loam parent materials under poor drainage. It occurs in rounded depressions or in irregular, elongated drainageways. Sims is the poorly drained member of the catena that includes the well drained to moderately well drained Nester soils and the imperfectly drained Kawkawlin soils. The native forest consisted of elm, ash, swamp white oak, silver maple, and a scattering of basswood.

Profile description for Sims loam:

A_p 0 to 8 inches, very dark gray to very dark brown (10YR 3/1 to 2/2, moist) loam; moderate medium granular structure; friable when moist and hard when dry; high in organic matter; slightly acid to neutral; 5 to 9 inches thick.

BG_{21} 8 to 12 inches, grayish-brown to light brownish-gray (10YR 5/2 to 6/2, moist) clay loam mottled with reddish yellow to yellowish brown (7.5YR 7/8 to 10YR 5/8, moist); weak fine subangular blocky structure; firm when moist and slightly hard when dry; neutral; 2 to 6 inches thick.

BG_{22} 12 to 30 inches, grayish-brown to light brownish-gray (2.5Y 5/2 to 6/2, moist) fine clay loam to silty clay loam mottled with yellow, yellowish brown, and pinkish gray (10YR 7/8, 10YR 5/6, and 7.5YR 7/2, moist); moderate medium angular blocky structure; very sticky when wet, very firm when moist, and hard when dry; neutral to mildly alkaline; 15 to 28 inches thick.

C_g 30 inches+, pinkish-gray (7.5YR 7/2, moist) clay loam to silty clay loam mottled with yellow, reddish yellow, and strong brown (10YR 7/8, 7.5YR 7/8, and 7.5YR 5/8, moist); moderate medium angular blocky structure; very sticky when wet, firm when moist, and very hard when dry; limy.

The depth to the limy parent material varies from 26 to 44 inches. Where this soil is associated with Brevort loamy fine sand, the wet, grayish, gleyed horizon directly below the dark-colored surface soil is a compact loamy fine sand to fine sandy loam, 4 to 10 inches thick. In some places, particularly in Bushnell and Bloomer Townships, the substratum lacks the pinkish-gray colors that are common in Pierson Township.

Sims loam, 0 to 2 percent slopes (Sa).—In this county, Sims loam, 0 to 2 percent slopes, occurs in fairly small tracts, normally in depressions or along narrow drainageways. The value for crops is limited by the size of these areas. Included with this soil are areas that have a surface layer that ranges from loamy sand to clay loam. The loamy sand inclusions are the result of a thin deposition of sandy material.

This soil is used mainly for permanent pasture and woodlots. Because most of the wooded areas are grazed, they are not fully utilized for forest products. In fields where this soil occurs in small patches with Kawkawlin loam, 0 to 2 percent slopes, and Kawkawlin loam, 2 to 6 percent slopes, it is used for the same crops as these Kawkawlin soils.

Sims loam, 0 to 2 percent slopes, seldom needs lime, but fertilizer should be applied as indicated by soil tests (*4*). Tile and surface drainage are needed in cropped areas. The frequent use of sod or green-manure crops in rotations helps to maintain good soil structure that improves drainage and increases the growth of plants. Soil management unit 2cA (I).

Sparta loamy sand

Sparta loamy sand has developed from well-drained sands that were derived mainly from quartz. It occurs on nearly level sandy plains that are an extension of a large prairie area in Croton Township in Newaygo County. Because the original vegetation was grass, the surface layer of this soil is darker colored and thicker than that of the adjacent Grayling soils, which developed under trees.

Profile description for Sparta loamy sand:

A_p 0 to 8 inches, very dark grayish-brown (10YR 3/2, moist) loamy sand and finely divided, well-decomposed organic matter; weak fine granular structure; very friable when moist and soft when dry; medium to strongly acid; 8 to 11 inches thick.

A_{12} 8 to 11 inches, brown (10YR 4/3, moist) sand; weak fine granular structure; very friable when moist and loose when dry; medium to strongly acid; 2 to 6 inches thick.

A_3 11 to 14 inches, brown (10YR 5/3, moist) sand; single grain (structureless); loose; strongly acid; 2 to 6 inches thick.

C_1 14 to 25 inches, pale-brown to light yellowish-brown (10YR 6/3 to 6/4, moist) sand; single grain (structureless); loose; strongly acid; 8 to 22 inches thick.

C_2 25 inches+, very pale brown to yellow (10YR 7/3 to 7/6, moist) medium and coarse sand; single grain (structureless); loose; medium to slightly acid.

The depth of the darker colored surface layer ranges from 6 to 18 inches. From place to place, the content of organic matter varies. In some large fields wind erosion has removed the surface soil and exposed the lighter colored subsoil.

Sparta loamy sand, 0 to 2 percent slopes (Sb).—This soil was one of the first to be farmed in the county. Because it was covered with grass and the land did not have to be cleared, the sandy soil was easy to cultivate. It was farmed continuously by the pioneers, and much of the dark-colored surface layer has blown away. Most of the farms failed because of the low available water-holding capacity, wind erosion, and low natural fertility of the soil.

Wind blowout areas are shown on the map by special symbols.

Although native grasses furnish some grazing early in spring, this soil generally is not suited to pasture. It can be best used to produce forest products. Tree planting projects of the United States Forest Service indicate that red and jack pines grow fairly rapidly. Planted areas need

to be protected from grazing and fire. Additional information on planting trees and shrubs can be obtained in Michigan State University Extension Bulletin 264 (*6*). Soil management unit 5aA (IVS).

Washtenaw loam and silt loam

Washtenaw loam and silt loam are medium- to dark-colored moist soils that occur in depressions, basins, and swales. Some areas of these soils are so small that they cannot be shown on the soil map. Some of the basins and depressions do not have outlets. Others, however, occur in intermittent drainways. Many spots of these soils occur with the moderately sloping to steep phases of Nester, Isabella, and McBride soils. The Washtenaw soils developed from an accumulation of medium-textured materials that were washed from adjacent slopes.

Washtenaw loam and silt loam, 0 to 2 percent slopes (Wa).—This mapping unit has many variations in depth, color, texture, and amount of organic matter in the surface layer. The texture of the surface layer is a loam or silt loam resulting from a 12- to 48-inch stratified accumulation of fine sand, very fine sand, silts, and clays that have been washed from adjacent slopes. In some places the underlying material is muck or peat.

These soils contain a medium to large amount of plant nutrients and have a high water-holding capacity. They are likely to be flooded at times, and crops may be damaged by frost late in spring and early in fall. The use of these soils is restricted because the areas are small and irregularly shaped.

Included with these soils are areas of alluvium of various textures other than loam and silt loam.

Many areas of these soils are suited to most crops commonly grown in the county, but on these soils crops do not mature so quickly as on the associated upland soils. Grain crops are likely to lodge. Plowing is often delayed in spring because these soils are wet longer than are the adjacent upland soils. Normally artificial drainage is impractical. Some areas too wet for crops or pastures should be used only to provide cover for wildlife. Soil management unit 2cA (I).

Washtenaw sandy loam and loamy sand

This sandy loam and loamy sand consists of materials that have been washed mainly from the adjacent sandy Grayling and Montcalm soils. A 12- to 48-inch layer of light- and medium-colored materials has accumulated over dark-colored mineral materials. Washtenaw soils occur in depressions and narrow drainageways, generally in small areas. Some areas have no outlets. Many of these soils cannot be shown separately on the soil map because of their complex pattern of distribution or their small extent.

Washtenaw sandy loam and loamy sand, 0 to 2 percent slopes (Wb).—This mapping unit has many variations in depth, color, texture, and amount of organic matter in the surface layer. Cultivation of soils on adjacent slopes, particularly the cultivation up and down hill, accelerates erosion and results in deposits of materials that are low in organic matter. In some areas the underlying material is muck or peat instead of mineral materials.

These soils are not so productive as are Washtenaw loam and silt loam, 0 to 2 percent slopes. Generally, they have a lower content of organic matter than the loam and silt loam and a lower water-holding capacity. The drier, shallow spots are used with the associated upland soils for many kinds of crops. Many of the wetter spots are not cropped. Suitability for crops depends on the length of time the soils remain wet during the growing season, the size and shape of the areas, and the suitability of the surrounding soils for crops. Farm operations are delayed because the time for plowing is seldom the same as that for the adjacent upland. In many places artificial drainage is impractical, and at times frost injures crops late in spring and early in fall. Soil management unit 2cA (I).

Genesis and Morphology of Soils

Soil is formed in part by the forces of weathering and soil development acting on parent material that was deposited or accumulated by geologic processes. At any given point the characteristics of the soil depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the parent material.

Factors of Soil Formation

The five factors of soil formation are independent; but each may modify the effects of the others. Climate and vegetation are the active forces of soil genesis, and the effects of these forces are influenced by relief. Relief affects surface drainage, the amount of water that percolates through the soil, erosion, and the vegetation on the soil. The kind of soil that develops is influenced by the parent material, which also modifies the effects of climate and vegetation. In some places the kind of profile that forms is determined almost entirely by the nature of the parent material. Finally, time is required for the development of all soils. The length of time during which the forces of soil formation have worked is reflected in the degree that the soil has developed into a body with well-defined horizons.

The factors of soil genesis are so closely interrelated in their effects that few generalizations can be made about one factor unless conditions are specified for the other four factors.

PARENT MATERIAL: Montcalm County, located in the west-central part of the Lower Peninsula of Michigan, was entirely covered by the Lake Michigan ice lobe of the Cary substage of the Wisconsin glacial age (*2*). Consequently, the parent material of the soils of the county is largely of glacial origin. Because the glacial deposit is from 100 to 300 feet thick, the underlying bedrock did not directly affect the development of the soil. The glacial material was high in lime and contained other mineral plant food elements except nitrogen. The differences in the soils of the county are mainly the result of differences in the texture and mineralogical composition of the parent material and differences in natural drainage (see table 1).

CLIMATE: The soils of Montcalm County developed in a cool, moist climate that is somewhat affected by Lake Michigan (*2*). These soils differ from those that developed in other climates, such as the warmer, dry climate of western Kansas or the warm, humid climate of Alabama. The average annual precipitation in Montcalm County is about 30 inches. Precipitation is quite uniform in all

seasons, although it is somewhat less in winter than in summer. Winter is fairly long and cold, and summer is fairly short and mild. Because of the uniformity of climate throughout the county, climate is not responsible for the differences among the various soils.

VEGETATION: The native vegetation in the county was affected by the kind of soil on which it grew, and the soil, in turn, was influenced by the vegetation. The physical and chemical characteristics of the organic matter in the surface layers are directly related to the original vegetation. The kind of vegetation affected not only the nature of the organic accumulation on the surface but also the depth and color of the leached mineral layer directly beneath the organic accumulation.

Except for small areas of grasslands and marshes, Montcalm County was originally covered by forest. The well-drained sites supported (1) dense stands of northern hardwoods on the more fertile, moisture-retaining, fine-textured soils; (2) mixed hardwoods and white pine on the medium-textured soils; and (3) pine and oak on the coarse-textured soils.

The Sparta soils were covered by native grasses. They have a dark surface layer, 8 to 14 inches deep, that consists of finely divided organic matter mixed with loamy sand. Grasses normally add more organic matter to soils than do forests, partly because the grasses have a dense, fibrous root system, and also because much of the leaf litter of forests is decomposed completely and is not added to the soil.

RELIEF: The relief of an area largely determines the natural drainage under which the soils develop. Under different conditions of drainage, different kinds of mineral soils are formed from the same kind of parent material. Organic soils—peats and mucks—formed in low, very poorly drained areas where more than 1 foot of organic matter accumulated over the mineral materials (see table 2).

AGE: After the glaciers melted about 15,000 years ago, the processes of soil development started to alter the glacial debris. Many different kinds of soils have developed: (1) Mature mineral soils that have well-defined horizons; (2) young, weakly developed alluvial soils that are very much like the parent materials from which they are forming; and (3) organic soils that formed in poorly drained areas having a large accumulation of organic materials.

Great Soil Groups

Soil scientists have arranged the different soil series in great soil groups. A great soil group consists of soils that have several characteristics in common, but the soils within a group may differ greatly in some characteristics, such as relief or thickness of profile. The soil series of Montcalm County have been placed in the great soil groups as follows:

Podzols	
Au Gres	Iosco
Croswell	*Melita
Grayling	Rousseau
Podzols (intergrading to Gray Wooded soils)	
Coral	McBride
*Gladwin	Montcalm
Isabella	*Newaygo
Mancelona	*Palo
Ground-Water Podzols	
Saugatuck	
Gray Wooded soils	
Kawkawlin	Nester
Regosols (intergrading to Brunizems)	
Sparta	
Humic Gley soils	
Edmore	*Ronald
Ensley	Sims
Epoufette	
Low-Humic Gley soils	
Brevort	Roscommon
Bog (organic) soils	
Adrian	Houghton
Carlisle	Kerston
Dawson	Rifle
Greenwood	Tawas
Alluvial soils	
Washtenaw	

In the foregoing list the following series, indicated by an asterisk, are tentative: Gladwin, Melita, Newaygo, Palo, and Ronald.

Podzols

The Podzols in this county have developed on well-drained or imperfectly drained sandy material. They have a very thin, dark-colored, mineral A_1 layer that is underlain by an eluviated, leached, ash-gray A_2 layer. The B_h horizon contains an accumulation of brown iron oxides and humus that has been leached out of the overlying horizons. The practical significance of this kind of subsoil has not been completely evaluated, but it is known that iron oxides react with phosphates to form insoluble compounds. Phosphate fertilizers, therefore, will be less effective on soils that have iron oxides from the subsoil mixed into the plow layer.

The Podzols that are intergrading to Gray Wooded soils have developed in loamy sand to sandy clay loam materials on well-drained and imperfectly drained sites. In the profiles of these soils, the A_1, A_2, and B_h Podzol horizons near the surface are underlain by A_2 and B_t horizons which are similar to those of the Gray Wooded soils or the Gray-Brown Podzolic soils. If the second A_2 horizon occurs, it is gray and extends as coating on the aggregates or as wedged-shaped projections into the upper part of the underlying B_t horizon. This A_2 horizon is thickest in the soils that developed from the coarse materials. It is thin or discontinuous in soils that developed from finer textured materials. The B_t horizon is enriched either by clay washed down from the overlying horizons or by clay developed in place, or by both. These subsoil layers, therefore, are finer textured than the overlying or underlying layers. In soils formed from the loamy sand or coarser textured materials, there commonly exists more than one A_2, B_t sequence in the profile. Only one sequence occurs in the soils formed from sandy loam or finer-textured material.

Gardner and Whiteside (*1*) studied profiles of Podzols with and without underlying textural B horizons that had developed from different textured parent materials. They found that the upper horizons of the Podzols are more strongly expressed in coarser textured materials, and that the clayey B horizons are best developed in the more calcareous and argillaceous (clayey) materials. They concluded that all horizons are genetic and are the result of either the simultaneous development of all horizons or the succession of the younger Podzol profile in the A_2 horizon

of an older, deeper soil. They called this arrangement and sequence of horizons a "double profile."

Ground-Water Podzols

If, at times, the water table rises in sandy materials to a level of 2 or 3 feet from the surface, Ground-Water Podzols may develop. These soils have a very white, ashy, leached layer that is underlain by a hard, cemented, dark-brown to reddish-brown layer. This cemented layer is called ortstein.

Gray Wooded soils

These soils developed from moderately fine textured materials in the region dominated by Podzols. They have a clayey subsoil horizon (B_t), but iron oxide and humus have not accumulated. The clayey subsoil horizon is similar to that of the Gray-Brown Podzolic soils of Southern Michigan. The A_2 horizon of the Gray Wooded soils is commonly grayer than the A_2 horizon of the Gray-Brown Podzolic soils that occur in southern Michigan, Indiana, and Ohio.

Regosols (intergrading to Brunizems)

These soils have developed from well-drained, very sandy materials under an original vegetative cover of native grasses. They are grouped with the Regosols because of their generally weakly expressed profiles and lack of B horizons. They also have some characteristics of the Brunizems (Prairie soils), such as the thickness and the dark color of surface horizons, that result from the original grassland vegetation.

Humic Gley soils

These soils are poorly and very poorly drained mineral soils that have developed in low depressional areas. The native vegetation was swamp forest, but organic soils did not form because the ground was not covered by water for long periods. The organic matter in the Humic Gley soils has been better preserved than that in the well-drained, associated upland soils. Humic Gley soils have a thicker and darker organic-mineral horizon than have the better drained Podzols and Gray Wooded soils with which they are associated.

Beneath the organic-mineral horizons, the Humic Gley soils are either dull gray or have an olive-gray layer that has orange, rust-brown, or yellow splotches or streaks. The dull-gray or olive-gray (G) horizon is a result of the effects of the organic matter that is poorly drained and poorly aerated. If the gray colors are less prevalent than normal in a horizon, their presence is indicated by a small "g" in a profile description.

Where developed from the same textured parent materials as the associated Podzols and Gray Wooded soils, Humic Gley soils are less acid than the Podzols and Gray Wooded soils and contain more plant nutrients. If the parent material is calcareous, they are generally neutral to mildly alkaline from the surface downward.

Low-Humic Gley soils

These are poorly drained mineral soils that have developed in the level or nearly level depressional areas similar to those where the Humic Gley soils occur. They closely resemble the Humic Gley soils in mode of formation and in the general kinds and arrangement of horizons in the soil profiles. In the Low-Humic Gley soils, however, the undisturbed organic-mineral surface horizons are thinner than those in the Humic Gley soils; as a result, the upper parts of the underlying olive-gray (G) horizons are commonly mixed into the surface soil in cultivated areas.

Bog (organic) soils

These very poorly drained organic soils occupy more than 12 percent of the land area of the county. They occur in areas where more than 12 inches of organic matter has accumulated over the mineral materials. Nearly all the organic deposits have accumulated in marshes and lakes. In places, the organic soils are more than 40 feet deep.

The organic matter was preserved because the water prevented rapid oxidation. Even in submerged areas, however, some of the material was decomposed by bacteria that are active where there is no free oxygen. The degree of decomposition partly depended on the nature of the vegetation and the height of the water table. Organic accumulations of sphagnum moss and leatherleaf are very slightly decomposed, and, in areas with these accumulations, the original plant material can be recognized even at the surface.

Alluvial soils

Alluvial soils developed on flood plains of streams and are the youngest soils of the county. They are still receiving deposits during spring floods. Alluvial soils are similar to the deposited material because they have not been in place long enough for the deposits to have been greatly altered by the processes of soil formation. Most areas of these soils are likely to be flooded at times and are poorly drained.

In flood plains where recent stream deposits are subject to frequent changes due to overflow, additional deposition, and channel cutting, Alluvial soils occur in close association with small bodies of organic soils, open water, and river sands and gravels; such areas are not classified into soil series but are combined into a single miscellaneous land type, Alluvial land.

Use, Management, and Productivity

This section is divided into three main parts. In the first part, the Soil Conservation Service's nationwide system of capability grouping is described. In the second part, the soils of the county are placed in soil management groups and units. After each group or unit is briefly described, suggestions on the use and management are presented. In the third part, estimated average yields of important crops are given for each soil under two levels of management—ordinary management and the improved management suggested in the second part of this section

Capability Grouping of the Soil Conservation Service [4]

Capability grouping is a system of classification used to show the relative suitability of soils for crops, grazing,

[4] This subsection was prepared by C. A. ENGBERG, State Soil Scientist of the Soil Conservation Service, U.S.D.A. The other parts of this report were prepared cooperatively by the Soil Conservation Service and the Michigan Agricultural Experiment Station.

forestry, and wildlife. It is a practical grouping based on the needs and limitations of the soils, the risks of damage to them and to the crops growing on them, and also their response to management. There are three levels above the soil mapping unit in this grouping. They are the capability unit, subclass, and class.

The capability unit, which also can be called a soil management unit, is the lowest level of the capability grouping. A capability unit is made up of soils similar in kind of management they need, in risk of damage, and in general suitability for use.

The next broader grouping, the subclass, is used to indicate the dominant kind of limitation. The letter symbol "E" indicates that the main limiting factor is risk of water erosion if the plant cover is not maintained; "W" means that excess water retards plant growth or interferes with cultivation unless the soils have been artificially drained; and "S" shows that the soils are shallow, droughty, or usually low in fertility. In some areas there is another subclass, "C", for the soils that are limited chiefly by a climate that is too cold or too dry.

The broadest grouping, the capability class, is identified by Roman numerals. All the soils in one capability class have limitations and management problems of about the same degree, but of different kinds, as shown by the subclass. All the land capability classes except class I may have one or more subclasses.

In classes I, II, and III are soils that are suitable for annual or periodic cultivation of annual or short-lived crops.

Class I soils are those that have the widest range of use and the least risk of damage. They are level, or nearly level, productive, either well drained or easily drained, and easy to work. They can be cultivated with almost no risk of erosion and will remain productive if managed with normal care.

Class II soils can be cropped regularly but do not have quite so wide a range of suitability as class I soils. Some class II soils are gently sloping; consequently, they need moderate care to prevent erosion. Other soils in class II may be slightly droughty, or slightly wet, or somewhat limited in depth.

Class III soils can be cropped regularly but have a narrower range of use than class II soils. They need even more careful management.

In class IV are soils that should be cultivated only occasionally or only under very careful management.

In classes V, VI, and VII are soils that normally should not be cultivated for annual or short-lived crops, but they can be used for pasture or range, as woodland, or for wildlife.

Class V soils are nearly level and gently sloping but are droughty, wet, low in fertility, or otherwise unsuitable for cultivation.

Class VI soils are not suitable for crops because they are steep, or droughty, or otherwise limited, but they give fair yields of forage or forest products. Some soils in class VI can, without damage, be cultivated enough so that fruit trees or forest trees can be set out or pasture crops seeded.

Class VII soils provide only poor to fair yields of forage or forest products and have characteristics that limit them severely for these uses.

In class VIII are soils that have practically no agricultural use. Some of them have value as watersheds, as wildlife habitats, or for scenery.

The capability class and subclass designation of the Soil Conservation Service is shown in parentheses following each soil management unit or group designation. The meaning of the additional symbols, such as 2aA and 2aB, which differ from those used in the national system, are explained in the second part of this section.

These soil management unit and group designations have been worked out cooperatively by the Soil Conservation Service, the Michigan Agricultural Experiment Station, and the Cooperative Extension Service in Michigan.

Class I.—Deep, nearly level, productive soils that have few or no permanent limitations that restrict their use.
- 2aA (I).—Nearly level, light-colored, medium-textured, well-drained soil.
- 2bA (I).—Nearly level to gently sloping, moderately dark colored, medium-textured soils formed under imperfect drainage.
- 2cA (I).—Nearly level, dark or moderately dark colored, medium-textured soils developed under poor drainage.

Class II.—Soils that have some limitations that reduce the choice of plants or require some conservation practices.

Subclass IIE.—Soils that are likely to erode if not protected.
- 2aB (IIE).—Gently sloping, light-colored, medium-textured, well-drained soil.

Subclass IIW.—Soils in which excess water may restrict the choice of crops or require some corrective measures.
- 3bA (IIW).—Nearly level, moderately dark colored, moderately coarse textured soils formed under imperfect drainage.

Subclass IIS.—Soils that have moderate limitations of moisture-holding capacity or an erosion hazard.
- 3aA (IIS).—Nearly level, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.
- 3aB (IIS).—Gently sloping, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.

Class III.—Soils that have severe limitations that require special conservation practices.

Subclass IIIE.—Soils that will erode if not protected.
- 2aC (IIIE).—Moderately sloping, light-colored, medium-textured, well-drained soil.

Subclass IIIW.—Soils that may be severely limited by excess water.
- 4bA (IIIW).—Nearly level to gently sloping, moderately dark colored, coarse-textured soils formed under imperfect drainage.
- 4cA (IIIW).—Nearly level, dark-colored, moderately coarse to coarse textured soils formed under poor drainage.
- bM (IIIW).—Level, very poorly drained, deep, organic soils, well supplied with bases.

Subclass IIIS.—Soils that have severe limitations because of low fertility, or low moisture-holding capacity, or wind and water erosion hazard, or a combination of these.
3aC (IIIS).—Moderately sloping, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.
4aA (IIIS).—Nearly level, light-colored, coarse-textured, well-drained, droughty soils.
4aB (IIIS).—Gently sloping, light-colored, coarse-textured, well-drained, droughty soils.
4aC (IIIS).—Moderately sloping, light-colored, coarse-textured, droughty soils.

Class IV.—Soils that have very severe limitations that require very careful management to control erosion and to maintain the soils.
Subclass IVE.—Soils that will erode if not protected.
2aD (IVE).—Strongly sloping, light-colored, medium-textured, well-drained soil.
Subclass IVW.—Soils that have very severe limitations because of excess water.
5bA (IVW).—Nearly level, light- to dark-colored sand developed under imperfect drainage.
5cA (IVW).—Nearly level, dark-colored sand formed under poor drainage.
M/2 (IVW).—Level, dark-colored, poorly drained, organic soil with marl at 12 to 42 inches.
Subclass IVS.—Soils that have very severe limitations of low fertility, low moisture-holding capacity, erosion problems, or a combination of these.
3aD (IVS).—Strongly sloping, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.
4aD (IVS).—Strongly sloping, light-colored, coarse-textured, well-drained, droughty soils.
5aA (IVS).—Nearly level, light-colored or dark-colored, well-drained, very droughty sands.
5aB (IVS).—Gently sloping, light-colored, well-drained, deep, very droughty sands.
5aC (IVS).—Moderately sloping, light-colored, well-drained, very droughty sands.

Class V.—Soils that have limitations that make them generally unsuitable for cultivation and limit their use to pasture, woodland, or wildlife cover.
Subclass VW.—Soils that are permanently wet or highly subject to flooding.
L3abc (VW).—Level, light-colored, well-drained to poorly drained soils on bottoms along streams.
L5c (VW).—Level, dark-colored alluvial soil with alternate layers of mineral and organic materials.

Class VI.—Soils that have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture, woodland, or wildlife cover.
Subclass VIE.—Soils that are highly susceptible to erosion.
2aE (VIE).—Steep, light-colored, medium-textured, well-drained soils.
Subclass VIS.—Soils that have severe limitations of low fertility and moderately low moisture-holding capacity.
4aE (VIS).—Steep, light-colored, coarse-textured, well-drained, droughty soils.

Class VII.—Soils unsuitable for cultivation and with very severe limitations that restrict their use largely to pasture, woodland, or wildlife.
Subclass VIIS.—Soils that have very severe limitations of low fertility and low moisture-holding capacity.
5.7a (VIIS).—Nearly level to steep, light-colored, well-drained, extremely droughty sands.

Class VIII.—Soils not suitable for the commercial production of crops, grasses, or trees.
Subclass VIIIW.—Soils not suited to grow plants in commercial quantity because of excess water.
aM (VIIIW).—Level, poorly drained, raw, acid peats.

Soil Management Groups and Units

The soils of Montcalm County are placed in soil management groups and soil management units on the basis of local differences among the soils. These local differences are related chiefly to variations in parent material and variations in the natural drainage under which the soils developed. The mineral soils of the county, therefore, are placed in management groups mainly on the basis of the texture of their parent material and natural drainage. Some of the management groups are subdivided, on the basis of slope, into management units.

Table 4 shows the relations among soil management groups in Montcalm County. It also shows the meaning of the symbols that are used to designate the management groups. In table 4, the parent materials are arranged according to their texture from finest to coarsest. The texture is designated by arabic numbers. The drainage classes are arranged horizontally and are designated by small letters. The arabic numbers and the small letters are combined to show the management groups in the county. For lowland soils, this combination of a number and a letter or letters is preceded by the letter "L".

Relations among the management groups can be visualized if the symbols representing the management groups are understood. Thus, soil management group 2a consists of soils formed under well-drained conditions from loam or clay loam parent materials. Similarly, soil management group L3abc consists of lowland soils formed under well-drained to poorly drained conditions from stratified, moderately coarse to moderately fine textured parent materials.

The organic soils of the county are placed in three management groups on the basis of their depth, underlying material, or acidity. Because all the organic soils were originally very poorly drained, it is not necessary to use a symbol for drainage. The letters "a" and "b" are used with the letter "M" (muck) to show whether the organic soils are acidic or basic. Thus, management group aM consists of acid organic soils. The shallow organic soils are underlain by marl at depths of 12 to 42 inches.

The well-drained management groups are subdivided into soil management units, or capability units, according to the slope of the soils. The ranges of slope are designated by the capital letters, "A" through "E". These ranges and their corresponding letters are given in the subsection, Relative Productiveness of Cropping Systems. Each management unit consists of soils that have similar properties, management needs, and productive capacities.

TABLE 4.—*Relations among soil management groups in Montcalm County*

MINERAL SOILS

Parent material	Natural drainage		
	Good (a) [2]	Imperfect (b)	Poor (c)
Upland soils:			
Loam or clay loams (2) [1]	[3] 2a	2b	2c
Sandy loams (3)	[3] 3a	3b	
Loamy sands (4)	[3] 4a	4b	4c
Sands, very droughty (5)	[3] 5a	5b	5c
Sands, extremely droughty (5.7)	[3] 5.7a		
Lowland soils (L): [4]			
Stratified; moderately coarse to moderately fine textured (3)		[5] L3abc	
Stratified; organic and mineral layers (5)			L5c

ORGANIC SOILS (M)

Depth	Over marl	Acidic	Basic
Shallow	M/2		
Deep		[6] aM	[6] bM

[1] Number in parentheses designates textural class.
[2] Letter in parentheses designates drainage class.
[3] Management group is subdivided, on the basis of slope, into units.
[4] Management groups consisting of lowland soils designated by "L".
[5] Good to poor drainage.
[6] The letters "a" and "b" stand for acidic and basic, respectively, when they precede the letter "M".

Soils that have different natural drainage and different ranges of slope commonly occur in association on the same kind of parent material. Therefore, the system used for grouping soils in Montcalm County is suitable for presenting management suggestions for associated soils.

SOIL MANAGEMENT GROUPS AND UNITS OF SOILS IN THE COUNTY

The following list gives the soil management group or unit and, in parentheses, the capability class and subclass for each mapping unit.

Map symbol	*Soil management group or unit*	*Map symbol*	*Soil management group or unit*	*Map symbol*	*Soil management group or unit*
Aa	L3abc (VW)	Ia	3bA (IIW)	Mw	4aA (IIIS)
Ab	5bA (IVW)	Ka	2bA (I)	Mx	4aB (IIIS)
Ba	4cA (IIIW)	Kb	2bA (I)	Na	2aA (I)
Ca	bM (IIIW)	Kc	L5c (VW)	Nb	2aB (IIE)
Cb	3bA (IIW)	Ma		Nc	2aC (IIIE)
Cc	3bA (IIW)	Mb	4aA (IIIS)	Nd	2aD (IVE)
Cd	5aA (IVS)	Mc	4aB (IIIS)	Ne	2aE (VIE)
Ce	5aB (IVS)	Md	4aC (IIIS)	Ng	3aA (IIS)
Cg	5aC (IVS)	Me	4aD (IVS)	Nh	3aB (IIS)
Ea	M/2 (IVW)	Mg	4aE (VIS)	Nk	3aA (IIS)
Eb	4cA (IIIW)	Mh	3aA (IIS)	Nm	3aB (IIS)
Ec	4cA (IIIW)	Mk	3aB (IIS)	Nn	3aC (IIIS)
Ga	4bA (IIIW)	Mm	3aC (IIIS)	No	3aD (IVS)
Gb	4bA (IIIW)	Mn	3aD (IVS)	Ra	bM (IIIW)
Gc	5.7a (VIIS)	Mo	2aE (VIE)	Rb	5cA (IVW)
Gd	5.7a (VIIS)	Mp	5aA (IVS)	Rc	4aA (IIIS)
Ge	5.7a (VIIS)	Mr	5aB (IVS)	Sa	2cA (I)
Gg	5.7a (VIIS)	Ms	4aA (IIIS)	Sb	5aA (IVS)
Gh	5.7a (VIIS)	Mt	4aC (IIIS)	Wa	2cA (I)
Gk	aM (VIIIW)	Mu	4aD (IVS)	Wb	2cA (I)
Ha	bM (IIIW)	Mv	4aE (VIS)		

The soil management group or unit designation and the capability subclass designation, for example, 5bA (IVW), is the capability unit designation used to identify the management units that are discussed later in this section. In this county the capability subclass designation used by the Soil Conservation Service follows the soil management group or unit designation, for example, 5bA (IVW).

RELATIVE PRODUCTIVENESS UNDER DIFFERENT CROPPING SYSTEMS

In controlling water erosion and maintaining tilth and productivity, the effectiveness of a cropping system varies with the completeness that the soil is covered by crops and the proportion of the time that cover remains on the soil. Forage crops provide more complete cover than small grains, and small grains provide more complete cover than row crops. Crop rotations are less protective than continuous sod or forest cover because, in crop rotations, the crops must be changed and the soil is unprotected while a new crop is being established.

In the following list the relative protectiveness of different cropping systems is given in values that range from 20 for the least protective system to 99 for the most protective.

Cropping system	*Relative protectiveness*	*Cropping system*	*Relative protectiveness*
R	20	AARWgmRW	78
RgmR	28	ARO	78
Rgm	36	AROW	79
RRO	39	AARgmRO	79
RRW	42	ARORgmW	80
RWRRO	44	AARgmRW	80
RO	48	AAARRO	80
RgmROgm	50	ARW	81
RW	53	AAWRO	82
RgmRWgm	53	AAROO	84
RWgmRgmROgm	55	AAWgmRO	84
ROO	55	AARORgmO	85
ROgm	57	AAROW	85
RWgm	61	AARO	86
ROgmOgm	64	AARORgmW	86
ARORO	66	AARW	87
ARORW	68	AAAROW	88
ARROW	69	AWO	88
AROgmRO	69	AAARO	88
ARWRW	70	AAARW	90
AROgmRW	71	AAAARO	91
ARWgmRW	72	AAAARW	91
ARgmROgmW	72	AAWO	92
AARORO	73	AO	92
AARORW	75	AAOW	93
AAROgmRO	76	AAAWO	93
AARRO	77	AW	94
AROO	77	AAO	96
AARROW	77	AAW	97
AAROgmRW	77	AA(fc)O	98
AROgmO	78	AA(fc)W	98
AARRW	78	A	99

The values in the foregoing list are based on ready references prepared by the Soil Conservation Service. The symbols used in the list to designate the cropping systems are: A, legume-grass; gm, green manure; O, spring grains; R, row crops; and W, winter grains. The symbol (fc) means that a field cultivator is used.

Erosion losses will be decreased if a green-manure crop is used with a row crop or if a field cultivator is used in preparing the soil for seeding legume-grasses with a small grain.

The soil groups in Montcalm County that consist of the coarser textured, well-drained soils need a more pro-

tective cropping system than groups with finer textured soils. This is because wind erosion as well as water erosion needs to be controlled. The sandier soils generally have a lower content of organic matter than finer textured soils and a lower moisture-holding capacity. This relation between the finer and coarser textured soils is shown on 0 to 2 percent slopes where water-control practices are not used. On these slopes, the least protective rotations that are suggested for the well-drained soil management groups, from the groups with the finest soils to those with the coarsest soils, and their protective values, are: 2a, ROgm (57); 3a, ARgmROgmW (72); 4a, AAROW (85); and 5a, AARW (87). These differences in soil profiles are less important on the steeper slopes.

Soil management group 2a

This group consists of light-colored, medium-textured, well-drained soils. The group is divided into management units according to the slope ranges of the soils. The slope ranges of the soils in the different units are designated by capital letters as follows:

A	0 to 2 percent slopes.
B	2 to 6 percent slopes.
C	6 to 10 percent slopes.
D	10 to 18 percent slopes.
E	18+ percent slopes.

A more protective cropping system generally should be used for soils that have the steeper, longer slopes. Length of slope refers to the distance that water ordinarily flows over the surface before entering a drainageway.

The cropping systems listed in table 5 for the soil management units in group 2a are the least protective that can be safely used under the conditions stated. More protective rotations, which have values of relative protectiveness greater than the ones given in this table, would also be satisfactory. Table 5 shows that, without erosion control practices, a rotation that has a value of relative protectiveness less than 57 (see p. 25) should not be used for soils in management unit 2aA. Similarly, a rotation that has a value less than 81 should not be used for soils in unit 2aB if there are no erosion control practices.

SOIL MANAGEMENT UNIT 2aA (I)

Nearly level, light-colored, medium-textured, well-drained soil

(Na) Nester loam, 0 to 2 percent slopes.

This well-drained soil is suited to row crops, small grains, legume-grasses, and trees. Rotations consisting of one-half row crop and one-half small grain seeded to a green-manure crop are satisfactory if crop residues are returned to the soil (see table 5). If row crops, small grains, or legume-grasses are grown, lime and fertilizer should be applied in the amounts indicated by soil tests (*4*).

Trees are generally not planted on this soil.

SOIL MANAGEMENT UNIT 2aB (IIE)

Gently sloping, light-colored, medium-textured, well-drained soil

(Nb) Nester loam, 2 to 6 percent slopes.

This soil is well suited to row crops, small grains, legume-grasses, and trees. Some water erosion has occurred in places. If erosion control practices are not used, a suitable rotation is 1 year of legume-grass, 1 year of a row crop, and 1 year of a small grain (see table 5). If stripcropping is used, an adequate rotation will keep legume-grass on the soil half of the time. With terraces, a suitable rotation is 1 year of a row crop and 1 year of a small grain seeded to a green-manure crop. If contour tillage alone is used, a suitable rotation is 2 years each of a legume-grass, of a row crop, and of a small grain seeded to a legume-grass mixture. All crop residues should be returned to the soil. Waterways can be protected from erosion by seeding them to a mixture of grass and legumes and keeping them in sod. Associated small wet spots can be drained by a random system of tile.

Under good management, excellent pasture can be grown. Lime and fertilizer applied in the amounts indicated by soil tests are needed if yields of forage or field crops are to be good (*4*).

White pine, red pine, Scotch pine, and Norway spruce grow well on this soil. This soil, however, is seldom used for tree plantations.

TABLE 5.—*Suggested crop rotations that give the least amount of protection that can be safely used, under named practices of water control, for the soil management units in group 2a*

Soil management unit	Slope	Water erosion control practices			
		None	Contour tillage	Stripcropping	Terracing
	Percent				
2aA (I)	0–2	ROgm [1] (57)[2]	Not used	Not used	Not used.
2aB (IIE)	2–6	ARW (81)	AARRO (77)	AAARRO (80)	ROgm (57).
2aC (IIIE)	6–10	AAO (96)	AAAARO (91)	AARO (86)	ARWgmRW (72).
2aD (IVE)	10–18	AA(fc)O (98)	AA(fc)O (98)	AAARW (90)	Not recommended.
2aE (VIE)	18+	Permanent vegetation (grass or trees).			

[1] Rotation symbols: A, legume-grass; gm, green manure; O, spring grains; R, row crops; W, winter grains; (fc), field cultivator. These symbols are the same as those in the list of relative protective values (p. 25).

[2] Numbers in parentheses refer to the relative protectiveness of the cropping system. A cropping system that has a value of relative protectiveness less than the ones given should not be used.

SOIL MANAGEMENT UNIT 2aC (IIIE)

Moderately sloping, light-colored, medium-textured, well-drained soil

(Nc) Nester loam, 6 to 10 percent slopes.

Under suggested soil-management practices, this soil is suited to crops or trees. The crop yields are lower on the areas that have been eroded by water. In most areas the control of water erosion and the growing of sod crops in rotation are required. For adequate control of water erosion, most slopes should be tilled on the contour, and a rotation that consists of 4 years of a legume-grass mixture, 1 year of a row crop, and 1 year of a small grain should be used (see table 5). With terracing, a satisfactory 5-year rotation consists of legume-grass, a row crop, a winter grain seeded to a green-manure crop, and a row crop followed by a winter grain seeded to legume-grass. If erosion control practices are not used, 1 year of small grain and 2 years of legume-grass can be grown, but row crops are not suggested.

Return all crop residues to the soil and apply lime and fertilizer in the amounts indicated by soil tests (*4*). Keep waterways in sod.

If lime and fertilizer are applied in adequate amounts, all of the grasses and legumes commonly grown in the area can be used for pasture.

Although these soils are generally not used for forest plantations, they are well suited to white pine, Norway spruce, and red pine. These trees produce good yields.

SOIL MANAGEMENT UNIT 2aD (IVE)

Strongly sloping, light-colored, medium-textured, well-drained soil

(Nd) Nester loam, 10 to 18 percent slopes.

Many areas of this soil are badly eroded, particularly those that have been used for row crops. Many bald clay knobs are evident in eroded fields.

This soil is best suited to pasture and trees. If it is used for crops, plant in contour strips and use a rotation in which row crops are not grown more often than once in 5 years (see table 5). This rotation should have at least 3 years of legume-grass and 1 year of a small grain seeded to legume-grass. This soil is too steep to be terraced effectively. Use contour tillage and keep the soil in grasses and legumes as much of the time as possible. Keep all waterways in sod.

This soil is well suited to the grasses and legumes commonly grown in the county. Apply lime and fertilizer to crops and pasture in amounts indicated by soil tests (*4*).

Trees grow fairly well. For new plantings, use white, Austrian, red, or Scotch pines.

SOIL MANAGEMENT UNIT 2aE (VIE)

Steep, light-colored, medium-textured, well-drained soils

(Mo) McBride and Isabella sandy loams, 18+ percent slopes.
(Ne) Nester loam, 18+ percent slopes.

Both sheet and gully erosion have occurred where these soils have been cropped.

The best use is for pasture and trees. The soils are not suitable for intertilled crops. If it is necessary to reestablish a pasture, break the ground, fertilize, and seed legumes and grasses with a nurse crop of small grain. Suitable legumes and grasses used for pasture produce moderately good to high yields. Apply lime and fertilizer to crops and pasture in the amounts indicated by soil tests (*4*).

Yield of wood products from established stands on these soils are good. For new plantings, use white, red, or Austrian pines.

Soil management groups 2b and 2c

SOIL MANAGEMENT UNIT 2bA (I)

Nearly level to gently sloping, moderately dark colored, medium-textured soils formed under imperfect drainage

(Ka) Kawkawlin loam, 0 to 2 percent slopes.
(Kb) Kawkawlin loam, 2 to 6 percent slopes.

If adequately drained, these soils are well suited to crops, legume-grasses, and trees. If used for rotation crops, supplementary drainage is needed in most areas. Tile lines placed at depths of 36 to 48 inches and spaced 4 to 6 rods apart provide adequate drainage. Because of the slope, care is needed to provide the right grade for the tile lines. Some areas contain only local seepy spots that can be drained by random tile lines. In some places no supplementary drainage is needed.

If these soils are adequately drained, a 3-year rotation of a row crop, a small grain, and legume-grass is suitable. A suitable 4-year rotation consists of a row crop, a small grain seeded to a green-manure crop, a row crop, and legume-grass.

Return all crop residues, and, on cropland and pasture, apply lime and fertilizer in amounts indicated by soil tests (*4*). Keep tillage at a minimum to help maintain good soil structure.

Most of the legumes and grasses common to the county grow well on this soil if drainage is adequate. Consult local representatives of the Soil Conservation Service or the Cooperative Extension Service for suggestions on kinds of grasses and legumes to use in inadequately drained fields.

Yields of wood products on the more poorly drained sites are medium to low.

SOIL MANAGEMENT UNIT 2cA (I)

Nearly level, dark or moderately dark colored, medium-textured soils developed under poor drainage

(Sa) Sims loam, 0 to 2 percent slopes.
(Wa) Washtenaw loam and silt loam, 0 to 2 percent slopes.
(Wb) Washtenaw sandy loam and loamy sand, 0 to 2 percent slopes.

These soils are well suited to rotation crops and trees. Supplementary drainage is needed if rotation crops are grown. Tile laid at depths of 36 to 48 inches and spaced 4 to 6 rods apart is satisfactory. A satisfactory rotation consists of a row crop followed by a small grain seeded to a green-manure crop. Also satisfactory is 1 year of alfalfa, 1 year of a row crop, and 1 year of a small grain seeded to alfalfa. Either of these rotations can be used if crop residues are returned, tillage is kept to a minimum to help maintain good soil structure, and fertilizer is applied to maintain good yields (*4*).

Some of these fertile soils, particularly the Washtenaw, are likely to be flooded by runoff from adjacent soils on stronger slopes. Since these soils are in small areas and are farmed with adjacent soils, suggestions for their use and management are not given separately.

These soils can grow excellent pasture. If adequately drained, they are suited to most of the legumes and

grasses grown in the county. If supplementary drainage is not installed, the selection of legumes and grasses depends on the degree of wetness of the soil. Consult local representatives of either the Soil Conservation Service or the Cooperative Extension Service concerning suitable legumes and grasses.

Trees do not grow well on these soils; consequently, few areas are planted to trees.

Soil management group 3a

This management group consists of light-colored, moderately coarse textured, well-drained, somewhat droughty soils. The units within this management group are designated by capital letters, which stand for the same ranges of slopes as the capital letters in the unit names of soil management group 2a.

The cropping systems listed in table 6 for the soil management units in group 3a are the least protective that can be safely used under the conditions stated. More protective rotations, which have values of relative protectiveness (see p. 25) greater than the ones given, would also be satisfactory under the conditions given in table 6. Less protective cropping systems are needed on the less strongly sloping areas, as the protectiveness of the associated erosion control practices increases.

SOIL MANAGEMENT UNIT 3aA (IIS)

Nearly level, light-colored, moderately coarse textured, well-drained, somewhat droughty soils

(Mh) McBride and Isabella sandy loams, 0 to 2 percent slopes.
(Nk) Newaygo sandy loam, 0 to 2 percent slopes.
(Ng) Newaygo loam, 0 to 2 percent slopes.

These light-colored, well-drained soils are suited to crops grown in rotations, to pasture, and to trees. If all crop residues are returned to the soil, a suitable 5-year rotation consists of a legume-grass, a row crop seeded to a green-manure crop, a row crop, a small grain seeded to a green-manure crop, and a winter grain crop seeded to legume-grass (see table 6).

Return all crop residues and apply manure to improve soil structure and fertility. Apply lime and fertilizer to crops and pastures in amounts indicated by soil tests (*4*). Windbreaks and wind stripcropping should be used to control wind erosion.

The animal carrying capacity of pastures ranges from fair to moderately good, depending on the kinds of legumes and grasses grown and the amounts of fertilizer and lime applied.

White, Austrian, red, and Scotch pines grow well on these soils.

SOIL MANAGEMENT UNIT 3aB (IIS)

Gently sloping, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.

(Mk) McBride and Isabella sandy loams, 2 to 6 percent slopes.
(Nh) Newaygo loam, 2 to 6 percent slopes.
(Nm) Newaygo sandy loam, 2 to 6 percent slopes.

These light-colored, well-drained soils have some eroded areas. If properly managed, these soils are suited to crops, pasture, and trees. Some erosion control practices are needed if row crops are grown. If there are no supporting practices for conserving soil, a rotation that provides legumes and grasses at least 2 years in 4 is suggested (see table 6). If stripcropping is used, the rotation should provide grasses and legumes half of the time. If these soils are tilled on the contour, a satisfactory 4-year rotation consists of legume-grass, a row crop, a small grain seeded to a green-manure crop, and wheat seeded to legume-grass. If terraces are used, a suggested 5-year rotation consists of legume-grass, corn followed by a cover crop, a row crop, a small grain seeded to a green-manure crop, and wheat seeded to legume-grass. Return all crop residues to the soil, and keep waterways protected by sod. Apply fertilizer and lime according to needs shown by soil tests (*4*).

The local representatives of either the Soil Conservation Service or the Cooperative Extension Service can suggest legumes and grasses suitable for these soils. Yields of pasture will be low in long dry periods.

These soils are well suited to white, Austrian, red, and Scotch pines.

SOIL MANAGEMENT UNIT 3aC (IIIS)

Moderately sloping, light-colored, moderately coarse textured, well-drained, somewhat droughty soils

(Mm) McBride and Isabella sandy loams, 6 to 10 percent slopes.
(Nn) Newaygo sandy loam, 6 to 10 percent slopes.

These soils are susceptible to water erosion and some wind erosion. If stripcropping is used, the soils should be kept in sod crops half of the time (see table 6). When contour tillage alone is used, row crops can be grown 1

TABLE 6.—*Suggested crop rotations that give the least amount of protection that can be safely used, under named practices of water control, for the soil management units in group 3a*

Soil management unit	Slope	Water erosion control practices			
		None	Contour tillage	Stripcropping	Terracing
	Percent				
3aA (IIS)	0–2	ARgmROgmW [1] (72).[2]	Not used	Not used	Not used.
3aB (IIS)	2–6	AARO (86)	AROgmW (80)	AAARRO (80)	ARgmROgmW (72).
3aC (IIIS)	6–10	AW (94)	AAOW (93)	AARO (86)	AAROgmRO (76).
3aD (IVS)	10–18	AAW (97)	AAW (97)	AAWO (92)	Not recommended.

[1] Rotation symbols: A, legume-grass; gm, green manure; O, spring grains; R, row crops; W, winter grains. These symbols are the same as those in the list of relative protective values (p. 25).

[2] Numbers in parentheses refer to relative protectiveness of the cropping system. A cropping system that has a value of relative protectiveness less than the ones given should not be used.

year out of 4 if an alfalfa-grass mixture is grown the other 3 years in the rotation. If terraces are used, an adequate rotation consists of 2 years of legume-grass and 1 year each of a row crop, a small grain seeded to a green-manure crop, a row crop, and a small grain seeded to legume-grass. If no water erosion control practices are used, the rotation should keep sod crops on the soils at least half of the time. Sod waterways should be maintained to prevent gullying. Apply lime and fertilizer in the amounts indicated by soil tests (*4*).

All grasses and legumes commonly used in the county grow well on these soils. Pastures produce fair to good yields if lime and fertilizer are applied in the amounts indicated by soil tests. Yields of forage will be somewhat depressed during the dry summers.

White, Austrian, red, and Scotch pines grow well on these soils and produce moderately high yields.

SOIL MANAGEMENT UNIT 3aD (IVS)

Strongly sloping, light-colored, moderately coarse textured, well-drained, somewhat droughty soils

(Mn) McBride and Isabella sandy loams, 10 to 18 percent slopes.
(No) Newaygo sandy loam, 10 to 18 percent slopes.

These light-colored soils are eroded in most areas that have been cropped. They have limited use for growing intertilled crops (see table 6). Ordinarily, row crops should not be grown. If these soils are cropped and water erosion control practices are not used, a rotation consisting of 2 years of legume-grass and 1 year of a small grain, preferably wheat, can be used.

These soils are fairly well suited to legume and grasses, but yields will be low during dry summers. If lime and fertilizer are added in the amounts indicated by soil tests, most legumes and grasses common to the county grow well (*4*).

These soils are well suited to trees. Use red, white, Austrian, and Scotch pines for new plantings.

Soil management group 3b

SOIL MANAGEMENT UNIT 3bA (IIW)

Nearly level, moderately dark colored, moderately coarse textured soils formed under imperfect drainage

(Cb) Coral fine sandy loam, 0 to 2 percent slopes.
(Cc) Coral fine sandy loam, 2 to 6 percent slopes.
(Ia) Iosco loamy sand, 0 to 2 percent slopes.

Many areas of these soils need artificial drainage if crops are grown in rotations. Tile works well if it is spaced 6 or 7 rods apart and covered with topsoil, straw, or other suitable materials that keep out the sand. Only random tile are needed in some areas.

If these soils are adequately drained, a satisfactory 5-year rotation consists of a legume-grass mixture, corn with a cover crop, a row crop, a small grain followed by a green-manure crop, and wheat. Yields are higher if fewer row crops are grown. Control of wind erosion, which can be obtained by wind stripcropping, is needed in the Iosco soil areas. To maintain fertility, crop residues should be returned and lime and fertilizer applied in amounts indicated by soil tests (*4*).

Legumes and grasses can be grown on these soils if they are adequately drained. The kinds of grasses and legumes that are grown depend on the wetness of the soils. The local representatives of either the Soil Conservation Service or the Cooperative Extension Service can suggest suitable grasses and legumes.

Although farm woodlots are common, trees are generally not planted on these soils. White, red, or Scotch pines, or Norway spruce grow satisfactorily in drained areas.

Soil management group 4a

This management group consists of light-colored, coarse-textured, well-drained droughty soils. The soil management units within the group are designated by capital letters, which stand for the same ranges of slopes as the capital letters in the unit names of group 2a.

The cropping systems listed in table 7 for the soil management units in group 4a are the least protective that can be safely used under the conditions stated. More protective cropping systems, which have values of relative protectiveness (see p. 25) greater than the ones given, would also be satisfactory under the conditions given in table 7.

SOIL MANAGEMENT UNIT 4aA (IIIS)

Nearly level, light-colored, coarse-textured, well-drained, droughty soils

(Mb) Mancelona loamy sand, 0 to 2 percent slopes.
(Ms) Melita-Iosco-Kawkawlin complex, 0 to 2 percent slopes.
(Mw) Montcalm and McBride loamy sands and sandy loams, 0 to 2 percent slopes.
(Rc) Rousseau loamy fine sand, 0 to 2 percent slopes.

If these soils are improperly managed, the organic matter burns out of surface layers. Then much of the soil is blown away. Crop yields are too low to give an adequate return on the investment. Under proper management, these soils are suited to rotation crops, pasture, and trees. If they are used for crops, control of wind erosion is required. Windbreaks will reduce erosion. Erosion can also be reduced by wind stripcropping if rotations are used that provide adequate amounts of sod crops. A satisfactory rotation is 2 years of legume-grass, 1 year of a row crop, and 2 years of small grain. Another is 1 year of a row crop, 1 year of a small grain seeded to legume-grass, and 2 years of legume-grass (see table 7). Wind erosion could be reduced by a cover of green-manure crops seeded in corn and other row crops and small grains. For good yields, apply lime and fertilizer in the amounts indicated by soil tests (*4*). Use random tile lines to drain the wet spots that occur in the Melita-Iosco-Kawkawlin complex.

These soils produce only fair pasture, especially in summer, because they have moderately low moisture-holding capacity. Deep-rooted, drought-resistant legumes and grasses yield the best. These plants grow well in spring because the sandy soils warm up quickly.

White, red, jack, and Scotch pines grow well in new plantings on these soils.

SOIL MANAGEMENT UNIT 4aB (IIIS)

Gently sloping, light-colored, coarse-textured, well-drained, droughty soils

(Mc) Mancelona loamy sand, 2 to 6 percent slopes.
(Mx) Montcalm amd McBride loamy sands and sandy loams, 2 to 6 percent slopes.

These well-drained soils can be used for rotation crops, pasture, or trees. Crop yields are only fair because the soils have low fertility and low capacity to hold available moisture.

TABLE 7.—*Suggested crop rotations that give the least amount of protection that can be safely used, under named practices of water control, for the soil management units in group 4a*

Soil management unit	Slope	Erosion control practices			
		None	Contour tillage	Stripcropping	Terracing
	Percent				
4aA (IIIS)	0–2	AAROW [1] (85)[2]	Not used	Not used	Not used.
4aB (IIIS)	2–6	AAROW (85)	AAROW (85)	AARW (87)	AAROW (85).
4aC (IIIS)	6–10	AW (94)	AAARW (90)	AARW (87)	AAROW (85).
4aD (IVS)	10–18	AA (fc) W (98)	AA (fc) W (98)	AAAARW (91)	Not recommended.
4aE (VIS)	18+	Permanent vegetation (grass or trees).			

[1] Rotation symbols: A, legume-grass; gm, green manure; O, spring grains; R, row crops; W, winter grains; (fc), field cultivator. These symbols are the same as those in the list of relative protective values (p. 25).

[2] Numbers in parentheses refer to the relative protectiveness of the cropping system. A cropping system that has a value of relative protectiveness less than the ones given should not be used.

The soils are suited to crops only if wind and water erosion are controlled. Wind erosion can be reduced by windbreaks, wind stripcropping, or a combination of these practices. If stripcropping is used, keep the soils in legume-grass at least half of the time (see table 7). If water control practices are not used, a suitable 5-year rotation consists of 2 years of legume-grass, a row crop, a spring grain, and a winter grain seeded to legume-grass. This rotation will reduce erosion and maintain soil productivity. Keep waterways in sod. Apply lime and fertilizer in amounts indicated by soils tests (*4*). Return all crop residues to the soil.

These droughty soils produce only fair pasture. If adequate amounts of lime and fertilizer are applied, all of the legumes and grasses common to the county can be grown.

Trees grow well on these soils. Use white pine, red pine, jack pine, or Scotch pine for new plantings.

SOIL MANAGEMENT UNIT 4aC (IIIS)

Moderately sloping, light-colored, coarse-textured, droughty soils

(Md) Mancelona loamy sand, 6 to 10 percent slopes.
(Mt) Montcalm loamy sand and sandy loam, 6 to 10 percent slopes.

These droughty soils are low in fertility and are susceptible to both wind and water erosion. In places considerable erosion has occurred. If properly managed, these soils can be used for crops, pasture, or trees, but yields will be lower than on most other soils in the county. If these soils are used for crops, control of wind and water erosion is necessary. Wind erosion can be reduced by windbreaks or wind stripcropping if crop rotations are adequate.

With wind stripcropping, use a rotation that keeps the soil in legume-grass half of the time and do not grow a row crop more often than once in 4 years (see table 7). More protective rotations should be used if contour tillage alone is used or if there are no supporting practices of erosion control. Terraces generally are not appropriate where stripcropping adequately controls erosion. An adequate rotation on terraces consists of 2 years of legume-grass, a row crop, and 2 years of small grain. Where erosion control practices are not used, a rotation that excludes row crops and provides legume-grass half of the time will reduce erosion. For all rotations, return crop residues to the soil and apply lime and fertilizer in amounts indicated by soil tests (*4*). Prevent gullying by keeping the waterways in sod.

These droughty soils produce only fair pasture. Yields are low in dry summers. If adequate amounts of lime and fertilizer are applied, all of the legumes and grasses common to the county can be grown.

Trees grow well on these soils. Use white, red, jack, and Scotch pines for new plantings.

SOIL MANAGEMENT UNIT 4aD (IVS)

Strongly sloping, light-colored, coarse-textured, well-drained, droughty soils

(Me) Mancelona loamy sand, 10 to 18 percent slopes.
(Mu) Montcalm loamy sand and sandy loam, 10 to 18 percent slopes.

These light-colored, coarse-textured, hilly soils are droughty, low in fertility, and susceptible to both wind and water erosion. Areas that have been cultivated have been moderately to severely eroded. In many places, the subsoil is exposed.

These soils are not well suited to intertilled crops. If contour tillage is used, a rotation of 2 years of legumes and grasses with winter grain every third year is suitable. If these soils are stripcropped and wind erosion is controlled, an occasional row crop can be grown (see table 7). Keep waterways in sod. Apply fertilizer and lime in amounts indicated by soil tests (*4*). Return all crop residues to the soil.

These soils are well-suited to trees. Red, white, and jack pines are suitable for new plantings.

SOIL MANAGEMENT UNIT 4aE (VIS)

Steep, light-colored, coarse-textured, well-drained, droughty soils

(Mg) Mancelona loamy sand, 18+ percent slopes.
(Mv) Montcalm loamy sand and sandy loam, 18+ percent slopes.

These droughty soils are commonly low in fertility. They are not suited to rotation crops. Cropped areas have been severely gullied in places. Wind erosion is a major problem unless cover is maintained. These soils

can be used for pasture, but yields will be only fair, even if lime and fertilizer are applied according to soil tests (*4*).

These soils are suited to trees. Red, white, and jack pines do well in new plantings.

Soil management groups 4b and 4c

SOIL MANAGEMENT UNIT 4bA (IIIW)

Nearly level to gently sloping, moderately dark colored, coarse-textured soils formed under imperfect drainage

(Ga) Gladwin loamy sand and Palo sandy loam, 0 to 2 percent slopes.
(Gb) Gladwin loamy sand and Palo sandy loam, 2 to 6 percent slopes.

These moderately dark soils, though wet part of the time, have only a moderately low capacity for holding moisture that plants can use. They are moderately low in fertility. Apply fertilizer and lime as indicated by soil tests (*4*).

Supplementary artificial drainage is needed for rotation crops. Open ditches or tile spaced 6 to 8 rods apart is suitable. If tile is used, sand will likely be encountered at the depth where the tile is to be laid. The sand makes it difficult to maintain a proper grade in the tile line. In areas that have slopes greater than 2 percent, more care will be needed to maintain a proper grade than in more nearly level areas. To keep the tiles from filling with sand, cover them with topsoil, straw, or similar materials that will filter out the sand.

An adequate rotation consists of 2 years of legume-grass, 1 year of a row crop, 1 year of a small grain, and 1 year of a small grain seeded to legume-grass. Either windbreaks or wind stripcropping will reduce wind erosion, but a combination of these two practices will be more effective.

If adequately drained, these soils are good for pasture. The kinds of legumes and grasses selected will depend on the degree of wetness. Local representatives of either the Soil Conservation Service or the Cooperative Extension Service can suggest legumes or grasses suitable for these soils.

These soils are fair to poor for trees; consequently, trees are seldom planted. Use white pine, Austrian pine, or Norway spruce for new plantings. In the existing woodlots most of the yields are low and the species undesirable.

SOIL MANAGEMENT UNIT 4cA (IIIW)

Nearly level, dark-colored, moderately coarse to coarse textured soils formed under poor drainage

(Ba) Brevort loamy fine sand, 0 to 2 percent slopes.
(Eb) Ensley loam and Edmore loamy fine sand, 0 to 2 percent slopes.
(Ec) Epoufette loamy sand and Ronald sandy loam, 0 to 2 percent slopes.

The Brevort loamy fine sand is underlain by medium to moderately fine textured materials at depths of 18 to 42 inches.

If properly managed, these soils are suitable for crops and pasture. Where adequately drained, they produce moderate yields if suggested rotations are used. Random tile lines, surface ditches, or a combination of the two provide satisfactory drainage. Lime and fertilizer should be applied in amounts indicated by soil tests (*4*). All crop residues should be returned to the soil.

Control of wind erosion is needed in some areas. Either windbreaks or wind stripcropping or a combination of the two practices can be used.

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If adequately drained, these soils are good for pasture. All of the legumes and grasses grown in the county are suitable. Local representatives of either the Soil Conservation Service or the Cooperative Extension Service can suggest the best legumes and grasses for these soils.

Most areas of these soils are not suited to trees. On the wet sites, new tree plantings are not suggested.

Soil management group 5a

This group consists of light- and dark-colored, well-drained, very droughty sands. The group is divided into management units according to the slope ranges of the soils. The slope ranges of the soils in the different units are designated by capital letters as follows:

A	0 to 2 percent slopes.
B	2 to 6 percent slopes.
C	6 to 15 percent slopes.

The cropping systems listed in table 8 for the soil management units in group 5a are the least protective that can be safely used under the conditions stated. More protective rotations (see p. 25), which have values of relative protectiveness greater than the ones given, would also be satisfactory under the conditions given in table 8. Generally, less protective cropping systems are needed on the less sloping soil and in places that have more protective erosion control.

SOIL MANAGEMENT UNIT 5aA (IVS)

Nearly level, light-colored or dark-colored, well-drained, very droughty sands

(Cd) Croswell and Melita loamy sands, 0 to 2 percent slopes.
(Mp) Melita loamy sand, 0 to 2 percent slopes.
(Sb) Sparta loamy sand, 0 to 2 percent slopes.

These very droughty soils are low in fertility. If a plant cover is not maintained, the risk of wind erosion is high.

If these soils are used for intertilled crops, yields are relatively low. Wind stripcropping should be used with crop rotations to protect the soils from erosion. A suggested rotation consists of 2 years of a legume-grass mixture, 1 year of a row crop, and 1 year of a winter grain seeded to legume-grass. Return all crop residues to the soil and use green-manure and cover crops. Apply lime and fertilizer in the amounts indicated by soil tests (*4*).

These soils are not well suited to pasture; they are too droughty during dry summers. Nevertheless, they produce good pasture early in spring and late in fall. If these soils are used for pasture, seed deep-rooted legumes and grasses that withstand drought.

These soils are suitable for new plantings of trees. Use red pine and jack pine in most areas. White pine is suitable for the lower, less exposed moist areas.

SOIL MANAGEMENT UNIT 5aB (IVS)

Gently sloping, light-colored, well-drained, deep, very droughty sands

(Ce) Croswell and Melita loamy sands, 2 to 6 percent slopes.
(Mr) Melita loamy sand, 2 to 6 percent slopes.

These soils are low in fertility and highly susceptible to wind erosion. They are of limited use for intertilled crops. If intertilled crops are grown, plant the crops in strips or on the contour and keep half the area in forage crops. Use no more than one row crop every 4 years.

TABLE 8.—*Suggested crop rotations that give the least amount of protection that can be safely used, under named practices of water control, for the soil management units in group 5a*

Soil management unit	Slope	Erosion control practices			
		None	Contour tillage	Stripcropping	Terracing
	Percent				
5aA (IVS)	0–2	AARW [1] (87) [2]	AARW (87)	AARW (87)	Not used.
5aB (IVS)	2–6	AARW (87)	AARW (87)	AARW (87)	AARW (87).
5aC (IVS)	6–15	AAAARW (91)	AARW (87)	AARW (87)	AARW (87).

[1] Crop symbols: A, legume-grass; R, row crops; W, winter grains.

[2] Numbers in parentheses refer to the relative protectiveness of the cropping system. A cropping system that has a value of relative protectiveness less than the ones given should not be used (see p. 25).

Return crop residues to the soil, grow green-manure crops and cover crops, and apply lime and fertilizer in amounts indicated by soil tests (*4*).

These soils are only fair for pasture because yields are low during dry summers. Plant deep-rooted legumes and grasses that are drought resistant.

Trees are well suited to these soils. For new plantings, use red pine, jack pine, and a limited number of white pine in the better protected, moist sites.

SOIL MANAGEMENT UNIT 5aC (IVS)

Moderately sloping, light-colored, well-drained, very droughty sands

(Cg) Croswell and Melita loamy sands, 6 to 15 percent slopes.

These are very droughty soils that are low in fertility and somewhat eroded by wind and water. Since yields are low and the risk of erosion is great, these soils are not well suited to intertilled crops. If they are used for rotation crops, grow legume-grass at least half of the time and row crops not more than once every 4 years (see table 8). Return all crop residues to the soil, and, whenever possible, grow green-manure and cover crops in the rotation. Apply lime and fertilizer in the amounts indicated by soil tests (*4*).

Although using these soils for pasture will keep erosion to a minimum, they are only fair for legumes and grasses because of their low fertility and low moisture-holding capacity. Grasses and legumes that have deep roots and are resistant to drought should be grown on these soils.

These soils are well suited to trees. Use red pine and jack pines, along with limited numbers of white pine on more moist sites, for new plantings.

Soil management groups 5b, 5c, and 5.7a

SOIL MANAGEMENT UNIT 5bA (IVW)

Nearly level, light- to dark-colored sands developed under imperfect drainage

(Ab) Au Gres and Saugatuck sands, 0 to 2 percent slopes.

These light- to dark-colored sands have only limited value for crops. They require some drainage before they can be cropped. Most of the drainage is by open ditches, but some tile lines are used. Both types of drainage are of limited effectiveness. The ditch banks are likely to cave in, and the tile lines may be filled with sand.

Where drainage is adequate, follow a rotation that provides legume-grass half of the time and use wind stripcropping and windbreaks to reduce wind erosion. For both crops and pasture, apply lime and fertilizer in the amounts indicated by soil tests (*4*).

Where these soils are not very wet, they provide fair to good pasture. Local representatives of either the Soil Conservation Service or the Cooperative Extension Service can suggest legumes and grasses satisfactory for the degree of wetness of the soil.

These soils are fair to poor for trees. Only a few areas have been planted.

SOIL MANAGEMENT UNIT 5cA (IVW)

Nearly level, dark-colored sand formed under poor drainage

(Rb) Roscommon sand, 0 to 2 percent slopes.

This soil has only limited use for crops and pasture. It is low in fertility. In some parts of most growing seasons, it is dry. If used for crops, it produces low to fair yields. Most of the areas are wet in the spring, but they supply some good pasture in summer.

This soil requires drainage before crops can be grown. Open ditches are used in most drained areas. These ditches need careful maintenance because they are filled by blowing sand and caving ditchbanks. Plant in strips to control wind erosion, and use a rotation that keeps the soil in legume-grass half the time. Return all crop residues to the soil, and apply fertilizer in amounts indicated by soil tests (*4*).

This soil produces fair pasture if the water table is not too near the surface and adequate fertilizer is used.

This soil is poorly suited to trees because the water table is too high. New plantings are generally not made on this soil.

SOIL MANAGEMENT UNIT 5.7a (VIIS)

Nearly level to steep, light-colored, well-drained, extremely droughty sands

(Gc) Grayling sand, 0 to 2 percent slopes.
(Gd) Grayling sand, 2 to 6 percent slopes.
(Ge) Grayling sand, 6 to 10 percent slopes.
(Gg) Grayling sand, 10 to 18 percent slopes.
(Gh) Grayling sand, 18+ percent slopes.

These soils are not well suited to crops or pasture because they are very low in fertility and in moisture-holding capacity. Small, level or gently sloping areas are cropped although yields are very low. The soils are extremely droughty; the wind erosion hazard is high in the exposed areas.

Even native trees grow very slowly. These soils are

best suited for trees and wildlife. Use jack pine or red pine on the moist sites for plantings. Planting is difficult on the steeper slopes. On these slopes, planting on the contour is desirable so that the washing out of trees during rain storms will be prevented.

Soil management groups L3abc and L5c

SOIL MANAGEMENT UNIT L3abc (VW)

Level, light- to dark-colored, well-drained to poorly drained soils on bottoms along streams

(Aa) Alluvial land.

These areas are coarse to moderately fine textured. Because they are commonly poorly drained, irregularly shaped, difficult to reach, and likely to flood, most areas are used for pasture or remain in second-growth forest. If adequately fertilized, this land produces excellent pasture. The second-growth forest has not been managed for the purpose of producing timber.

SOIL MANAGEMENT UNIT L5c (VW)

Level, dark-colored alluvial soil with alternate layers of mineral and organic materials

(Kc) Kerston muck, 0 to 2 percent slopes.

This soil occurs on flood plains. Because of its position and wetness, it has little value for crops. If it can be drained, yields will be moderately high. In areas that are cleared and properly fertilized, the best use is for pasture. This soil has little value for trees, but native species furnish some posts, firewood, and cover for wildlife.

Soil management groups aM, bM, and M/2

SOIL MANAGEMENT UNIT aM (VIIIW)

Level, poorly drained raw, acid peats

(Gk) Greenwood and Dawson peats, 0 to 2 percent slopes.

This mapping unit produces little vegetation and is not suited to crops, pasture, or trees. Most of the areas are covered with leatherleaf and sphagnum moss and are best suited to wildlife.

SOIL MANAGEMENT UNIT bM (IIIW)

Level, very poorly drained, deep, organic soils, well supplied with bases

(Ca) Carlisle muck, 0 to 2 percent slopes.
(Ha) Houghton and Adrian mucks and peats, 0 to 2 percent slopes.
(Ra) Rifle and Tawas peats, 0 to 2 percent slopes.

If adequately drained, these soils are suitable for crops and pasture. Tile, open ditches, or both can be used to drain the soils. These organic soils provide an unsuitable foundation for tile lines; therefore, tile drainage is hazardous. Truck crops are particularly well suited to these soils, but the risk of damage by frost is greater than on the associated better drained soils in higher positions.

These soils are also susceptible to severe wind erosion, which can be controlled either by keeping the water table high or by planting windbreaks. Apply fertilizer in the amounts indicated by soil tests and to meet the needs of the special crops grown (*4*).

The quality and quantity of pasture grown on these soils depend on the extent of drainage, the kind of plants present, and fertilization. Plant only water-loving grasses, such as Reed canarygrass, unless the soils are artificially drained.

These soils are poorly suited to trees, but some posts and some firewood are harvested from the wooded areas.

SOIL MANAGEMENT UNIT M/2 (IVW)

Level, dark-colored, poorly drained, organic soil with marl at 12 to 42 inches

(Ea) Edwards muck, 0 to 2 percent slopes.

The use suitability of this soil depends on the depth to the marl. Where the organic soil is less than 18 inches deep, its use for growing crops is questionable. Deeper areas can be cropped, but the muck may decompose rapidly under cropping. In areas where the soil is shallow to marl, adequate drainage is difficult. With drainage, the soil is suitable for truck crops. Control of wind erosion is a serious problem. If this soil is cultivated, windbreaks and wind stripcropping should be used to reduce erosion.

This soil is fair to good for pasture if properly drained. It is not suitable for new plantings of trees.

Estimated Yields

Table 9 gives, for each soil, estimated average yields to be expected from the principal crops grown in Montcalm County. In columns A are yields that are expected under common management, or the management that is generally used in the county. In columns B are the yields that are expected under improved management.

The management that generally is used provides some legume-grass in the crop rotation. Barnyard manure that is produced on the farms is returned to the soil. Lime is applied, although in many places in insufficient amounts. Some commercial fertilizer is applied In most places a fairly regular rotation is used, but row crops are grown much of the time. Poorly drained areas are artificially drained, in most places by the use of tile. On the more rolling or sandy soils, the rotations include a larger proportion of legume-grass than do those on the more nearly level finer textured soils, where more row crops or small grains are grown.

The yields in columns B are expected if management is improved. Under improved management, the quantity of lime that is used is determined by soil tests. Fertilization is based on the amount and kind of plant food required by the crops grown. Where needed, an adequate system of artificial drainage is installed. Improved varieties of plants and seeds of high quality are planted. Other conservation practices are used, where needed, to control erosion and to improve moisture content. These are contour tillage, minimum tillage, stripcropping, terracing, and the construction of diversion ditches.

Because the soils differ from place to place and management differs from farm to farm, the yields given in columns A and columns B cannot be expected every year on every farm. Varying rainfall and varying lengths of the growing season will also cause varying yields. The yields given in table 9, however, indicate the relative productivity of the soils of Montcalm County. By comparing the average yields on a certain farm with the estimated yields given in table 9, the management on the farm can be evaluated.

TABLE 9.—*Estimated average acre yields of principal crops under two levels of management*

[Average yields in columns A are to be expected under common management; yields in columns B are to be expected under improved management. Dashed lines indicate that crop is not ordinarily grown on the particular soil]

Soil	Corn		Wheat		Oats		Rye		Timothy and clover hay		Alfalfa		Field beans		Potatoes		Relative productivity [1]
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	
Alluvial land									0.5	0.9							4
Au Gres and Saugatuck sands, 0 to 2 percent slopes									.4	.8							5
Brevort loamy fine sand, 0 to 2 percent slopes	20	40	10	20	15	25	10	20	1.2	2.0	1.2	2.0	14	20	80	200	4
Carlisle muck, 0 to 2 percent slopes	30	65													80	250	
Coral fine sandy loam, 0 to 2 percent slopes	40	60	20	30	40	55	20	30	1.4	2.0	2.0	3.0	15	25	80	200	2
Coral fine sandy loam, 2 to 6 percent slopes	35	60	18	30	38	55	18	30	1.4	2.0	2.0	3.0	15	25	80	200	2
Croswell and Melita loamy sands, 0 to 2 percent slopes	15	25	5	15	15	25	10	20	.7	1.0	1.0	1.5	10	15	80	150	4
Croswell and Melita loamy sands, 2 to 6 percent slopes	15	25	5	15	15	25	10	20	.7	1.0	1.0	1.5	10	15	80	150	4
Croswell and Melita loamy sands, 6 to 15 percent slopes																	5
Edwards muck, 0 to 2 percent slopes	30	55															
Ensley loam and Edmore loamy fine sand, 0 to 2 percent slopes	20	35	10	20	15	25	10	20	1.2	2.0	1.2	2.0					3–4
Epoufette loamy sand and Ronald sandy loam, 0 to 2 percent slopes	20	35	10	20	15	25	10	20	1.2	2.0	1.2	2.0					3–4
Gladwin loamy sand and Palo sandy loam, 0 to 2 percent slopes	20	35	12	20	20	30	15	25	1.6	2.0	1.2	2.0	14	20	80	200	3–4
Gladwin loamy sand and Palo sandy loam, 2 to 6 percent slopes	20	35	12	20	20	30	15	25	1.6	2.0	1.2	2.0	14	20	80	200	3–4
Grayling sand, 0 to 2 percent slopes																	5
Grayling sand, 2 to 6 percent slopes																	5
Grayling sand, 6 to 10 percent slopes																	5
Grayling sand, 10 to 18 percent slopes																	5
Grayling sand, 18+ percent slopes																	5
Greenwood and Dawson peats, 0 to 2 percent slopes																	5
Houghton and Adrian mucks and peats, 0 to 2 percent slopes	30	65													80	250	
Iosco loamy sand, 0 to 2 percent slopes	25	40	15	25	25	40	15	25	1.6	2.4	1.8	2.6	15	20	80	200	3
Kawkawlin loam, 0 to 2 percent slopes	45	65	25	35	40	55			1.6	2.4	2.4	3.2	15	25			1
Kawkawlin loam, 2 to 6 percent slopes	45	65	25	35	40	55			1.6	2.4	2.4	3.2	15	25			1
Kerston muck, 0 to 2 percent slopes									.5	.9							4–5
Mancelona loamy sand, 0 to 2 percent slopes	15	25	7	15	15	25	10	20	.6	1.2	1.0	1.5	10	15	80	140	4
Mancelona loamy sand, 2 to 6 percent slopes	15	25	7	15	15	25	10	20	.6	1.2	1.0	1.5	10	15	80	140	4
Mancelona loamy sand, 6 to 10 percent slopes	10	20	5	15	12	20	10	20	.6	1.2	1.0	1.5					4
Mancelona loamy sand, 10 to 18 percent slopes									.6	1.2	1.0	1.5					4
Mancelona loamy sand, 18+ percent slopes																	5
McBride and Isabella sandy loams, 0 to 2 percent slopes	35	50	20	30	30	45	20	30	1.0	1.8	2.0	3.0	12	20	100	350	2
McBride and Isabella sandy loams, 2 to 6 percent slopes	30	50	18	30	30	45	18	30	1.0	1.8	2.0	3.0	12	20	100	350	2
McBride and Isabella sandy loams, 6 to 10 percent slopes	20	40	12	20	20	35	10	25	1.0	1.8	2.0	3.0	10	18	80	200	3
McBride and Isabella sandy loams, 10 to 18 percent slopes									1.0	2.0	2.0	3.0					3
McBride and Isabella sandy loams, 18+ percent slopes																	4
Melita loamy sand, 0 to 2 percent slopes	15	25	5	15	15	25	10	20	.6	1.0	1.0	1.5	10	15	80	140	4
Melita loamy sand, 2 to 6 percent slopes	15	25	5	15	15	25	10	20	.6	1.0	1.0	1.5	10	15	80	140	4
Melita-Iosco-Kawkawlin complex, 0 to 2 percent slopes	35	60	18	30	30	50			1.6	2.4	2.4	3.2	15	25			2
Montcalm loamy sand and sandy loam, 6 to 10 percent slopes	15	25	5	15	15	25	10	20	.6	1.0	1.0	1.5					3–4
Montcalm loamy sand and sandy loam, 10 to 18 percent slopes									.6	1.0	1.0	1.5					4
Montcalm loamy sand and sandy loam, 18+ percent slopes																	5
Montcalm and McBride loamy sands and sandy loams, 0 to 2 percent slopes	25	50	15	25	25	40	15	25	1.0	2.0	1.5	2.5	12	18	100	350	2–3
Montcalm and McBride loamy sands and sandy loams, 2 to 6 percent slopes	25	50	15	25	25	40	15	25	1.0	2.0	1.5	2.5	12	18	100	350	2–3

See footnote at end of table.

TABLE 9.—*Estimated average acre yields of principal crops under two levels of management*—Continued

Soil	Corn		Wheat		Oats		Rye		Timothy and clover hay		Alfalfa		Field beans		Potatoes		Relative productivity [1]
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	
Nester loam, 0 to 2 percent slopes	40	55	25	35	40	50	----	----	1. 6	2. 4	2. 4	3. 2	15	25	----	----	1
Nester loam, 2 to 6 percent slopes	40	55	25	35	40	50	----	----	1. 6	2. 4	2. 4	3. 2	15	25	----	----	1
Nester loam, 6 to 10 percent slopes	30	45	20	30	35	40	----	----	1. 6	2. 4	2. 4	3. 2	15	20	----	----	2
Nester loam, 10 to 18 percent slopes	----	----	----	----	----	----	----	----	1. 6	2. 4	2. 4	3. 2	----	----	----	----	2
Nester loam, 18+ percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3
Newaygo loam, 0 to 2 percent slopes	35	50	15	25	30	40	20	30	1. 6	2. 2	2. 0	2. 8	12	20	100	350	2
Newaygo loam, 2 to 6 percent slopes	35	50	15	25	30	40	20	30	1. 6	2. 2	2. 0	2. 8	12	20	100	350	2
Newaygo sandy loam, 0 to 2 percent slopes	25	40	15	25	25	35	15	25	1. 2	1. 8	1. 4	2. 2	10	18	80	200	3
Newaygo sandy loam, 2 to 6 percent slopes	25	40	15	25	25	35	15	25	1. 2	1. 8	1. 4	2. 2	10	18	80	200	3
Newaygo sandy loam, 6 to 10 percent slopes	20	35	12	20	20	30	15	25	1. 2	1. 8	1. 4	2. 2	10	15	80	200	3
Newaygo sandy loam, 10 to 18 percent slopes	----	----	----	----	----	----	----	----	1. 2	1. 8	1. 4	2. 2	----	----	----	----	3
Rifle and Tawas peats, 0 to 2 percent slopes	10	50	----	----	----	----	----	----	----	----	----	----	----	----	50	250	----
Roscommon sand, 0 to 2 percent slopes	----	----	----	----	----	----	----	----	. 6	1. 0	----	----	----	----	----	----	5
Rousseau loamy fine sand, 0 to 2 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3
Sims loam, 0 to 2 percent slopes	40	60	20	30	35	50	----	----	1. 6	2. 4	2. 4	3. 2	15	20	----	----	1
Sparta loamy sand, 0 to 2 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	5
Washtenaw loam and silt loam, 0 to 2 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	Variable
Washtenaw sandy loam and loamy sand, 0 to 2 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	Variable

[1] Productivity ranges from 1 for the most productive soils to 5 for the least productive soils.

Engineering Applications

This soil survey report contains information that can be used by engineers. The most detailed information that is useful for engineering is in the section, Soils of Montcalm County. The subsection on soil management units points out some of the needs of the soils for drainage, terracing, irrigation, and other engineering works.

Some of the terms used by the soil scientists may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, sand, and granular—have special meaning in soil science. These terms and others that have special meanings to the agriculturalist are defined in the Glossary. The Field Manual of Soil Engineering published by the Michigan State Highway Department (*3*) gives information on soils that is useful to engineers.

The term "soil" may be particularly confusing. Agriculturalists think of a soil as a natural body made up of different horizons that have some different characteristics. Engineers are more likely to single out each horizon as a different kind of soil; they often refer to the unconsolidated material at the earth's surface, such as glacial drift, as soil.

In the following list of engineering uses, for which this report will be helpful, the publications designated by italicized numbers give further information on the engineering operations listed. The publications are named in Literature Cited. The information in this report is useful for—

1. Making reconnaissance surveys of soils for the purpose of planning the location of highways and airports, and for planning more detailed soil surveys at these locations (*3*).
2. Relating soil features, by use of the soil map, to other land features and to cultural features.
3. Locating sand, gravel, and clay for construction purposes (*3*).
4. Correlating pavement performance with the kinds of soil so that an economical and effective design for foundations and pavements can be made (*3*).
5. Determining the suitability of soils for cross-country movement of vehicles and construction equipment under various conditions of soil and climate (*3*).
6. Supplementing information from other published maps and reports so that engineering soil maps and reports can be made.
7. Selecting and developing industrial, business, residential, and recreational sites.
8. Estimating runoff and erosion so that effective structures for soil and water conservation can be made (*7*).
9. Designing drainage systems.
10. Designing irrigation systems.
11. Establishing plants to stabilize or beautify an area.

General Nature of the Area

In this section are brief descriptions of the climate, vegetation, settlement and population, and other subjects that should be helpful to those readers who are not familiar with the county.

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Climate

The climate of Montcalm County is favorable for the growth of most farm crops cultivated in Michigan. Summer is mild and pleasant and has only a few extremely hot days. Winter is moderately long and cold. Temperatures as high as 108° F. and as low as −25° F. have been recorded, but these extremes are rare (table 10).

The length of the growing season varies considerably from place to place. At Greenville, in the southwestern corner of the county, the average frost-free period of 148 days extends from May 12 to October 7. This is long enough for most crops to mature. At Howard City, in the northwestern corner of the county, the average frost-free period is about 34 days shorter than it is at Greenville. Killing frost has been recorded at Howard City as early as August 2 and as late as June 23.

At Greenville, the average annual precipitation is fairly well distributed throughout the year; but precipitation is greater in summer, when it is needed by crops, than it is in winter. The average yearly snowfall is 43.4 inches. Every winter enough snow covers the ground to protect fall-sown crops. In some places, as much as 3 feet of snow accumulates. Enough rain to be measured falls at Greenville on an average of 108 days a year.

In spring and fall the precipitation is usually a slow, drizzly rain; thundershowers are frequent in summer. Hailstorms are rare and seldom cause serious damage to crops. Most cloudy days occur in winter and spring. Summer has a large number of clear days with a high percentage of sunshine.

Generally, there is enough rain to supply the needs of the crops commonly grown. The growth of crops on the sandy soils, however, may be impaired by a scarcity of moisture during the hottest part of the summer and during periods of infrequent rains.

The prevailing winds are westerly. The wind is seldom strong enough to damage crops, but wind erosion is a serious problem on the sandier soils and mucks.

TABLE 10.—*Temperature and precipitation at Greenville, Montcalm County, Michigan*

[Elevation, 802 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1930)	Wettest year (1921)	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December	27.5	62	−16	1.86	0.72	3.30	9.6
January	23.5	64	−21	1.55	1.94	.56	10.9
February	23.7	67	−25	1.47	3.02	.99	9.0
Winter	24.9	67	−25	4.88	5.68	4.85	29.5
March	32.8	80	−12	2.05	.94	5.44	7.9
April	45.8	88	7	2.51	1.67	5.11	1.5
May	57.1	92	23	3.38	3.08	.58	.3
Spring	45.2	92	−12	7.94	5.69	11.13	9.7
June	67.2	101	35	3.39	3.20	7.21	0
July	72.2	108	42	2.50	.50	.53	0
August	69.7	104	39	2.90	.49	5.96	0
Summer	69.7	108	35	8.79	4.19	13.70	0
September	62.0	96	27	3.29	1.27	4.67	[3]
October	51.5	87	12	2.48	2.34	4.45	.2
November	38.1	80	−3	2.30	1.13	3.43	4.0
Fall	50.5	96	−3	8.07	4.74	12.55	4.2
Year	47.6	108	−25	29.68	20.30	42.23	43.4

[1] Average temperature based on a 43-year record, through 1955; highest and lowest temperatures, on a 38-year record, through 1952.

[2] Average precipitation based on a 43-year record, through 1955; wettest and driest years based on a 38-year record, in the period 1914–55; snowfall based on a 35-year record, through 1952.

[3] Trace.

Vegetation

Virgin forest covered the entire county except for small areas of grassland on the dry plains in the northwestern corner of Reynolds Township and a few small areas of marsh. The early settlers found five groupings of trees on the uplands: (1) Extensive stands of white and red pines with some oak and aspen; (2) hardwoods that were mostly sugar maple, beech, and yellow birch; (3) oak and hickory in the southern part of the county; (4) jack pine and oak with a ground cover of grass and shrubs; and (5) mixed stands of white pine, hemlock, yellow birch, and elm.

After the stands of white and red pines were logged and burned several times, the pines did not reproduce. The second growth is oak, aspen, and red maple and a ground cover of sweetfern and grass. In the areas that were mostly in sugar maple, beech, and yellow birch, some of the virgin species have reproduced and there is also aspen and red maple. In the southern part of the county where the forest was oak and hickory, the stands are now oak and aspen with some hickory. The areas that originally were in jack pine and oak are still in these trees. The areas that had mixed stands of white pine, hemlock, yellow birch, and elm have been burned and logged, and now the trees are largely aspen.

The native vegetation varied according to the soils. On the poorly drained mineral soils, the trees were elm, black ash, red maple, and a variable number of swamp conifers. Conifers were more numerous on the coarser textured soils than on the medium-textured ones. Swamp conifers and red maple originally covered the woody peat soils, and wiregrass, bluejoint, sedges, cattails, and rushes grew on the marshes. In the areas of raw, fibrous peat, the typical cover was leatherleaf, sphagnum moss, blueberries, and a scattering of stunted black spruce or tamarack. Grass and some herbs covered the northwestern part of the county.

Settlement and Population

The first permanent settlements in Montcalm County were made between 1840 and 1850. During this period, and later, people came from the New England States, and from New York, Pennsylvania, Ohio, and southern

Michigan. These pioneers made a living by farming small clearings and by working in the woods. In 1840 Montcalm County was attached to Ionia County, but 10 years later, when the population was 891, it became a separate county.

The population increased rapidly after 1850, and in 1860 it was 3,984. The greatest increase was from 13,629 in 1850 to 33,140 in 1880. Between 1850 and 1880 lumbering was at its height. The population gradually decreased from 1880 until 1930, but since 1930 it has increased slightly. The 1950 census reported a population of 31,013 for the county, and of this number more than 78 percent was rural.

Greenville, which had a population of 6,668 in 1950, is the largest town. In that year, 1,168 people lived in Carson City, the second largest town, and 1,123 people lived in Stanton, the county seat. Smaller communities are Howard City, Edmore, Vestaburg, Lakeview, Sheridan, and McBride.

Railroads and Roads

All towns and many villages are served by one or more of the three railroads that run through the county—the Chesapeake and Ohio, the Grand Trunk Western, and the Pennsylvania.

Two main hard-surfaced roads, United States Highway 131 and State Highway 66, pass through the county from south to north. State Highway 91 runs northward and connects Greenville and Lakeview. Crossing the county from east to west, State Highway 46 serves the northern part of the county, and State Highway 57 serves the southern part. In addition to the Federal and State highways, nearly all rural residents have outlets over the gravel and hard-surface roads that can be used in all kinds of weather.

Use of the Land and Types of Farms

In 1954, 331,655 acres, or 72.8 percent of the county, was in farms. The rest of the county consisted mostly of forest and urban and industrial areas. A total of 221,489 acres, or 66.8 percent of the land in farms, was cropland; 30,531 acres, or 9.2 percent, was pastured woodland; and 29,419 acres, or 8.9 percent, was woodland that was not pastured. Pasture that was not cropland and not woodland covered 14,706 acres, or 4.4 percent of the land in farms. A total of 35,510 acres, or 10.7 percent, was classified as other land in farms.

In 1954 the farms of Montcalm County were grouped by type as follows:

Type of farm:	*Number*
Dairy	695
Livestock other than dairy and poultry	145
General	415
Primarily crop	40
Primarily livestock	65
Crops and livestock	310
Field-crops other than vegetables and fruit-and-nut	655
Cash grain	505
Other field crops	150
Vegetable	41
Fruit-and-nut	15
Poultry	55
Miscellaneous and unclassified	660

Agriculture

The early agriculture of the county had to be on a subsistence basis. Corn, potatoes, oats, wheat, and hay were grown mostly for home use.

The dry plain in the northwestern corner of Reynolds Township was the first area in the county to be farmed. Grass covered the coarse-textured sandy soils of this area, and trees did not have to be cleared. This area was considered healthier than most of the county because it was drier.

Because the soils have been severely eroded by wind and water, many farms have been abandoned. Some of the land is still farmed too intensively, but an increasing number of farmers are using methods of farming that maintain and increase productivity.

Agriculture is now the principal enterprise in Montcalm County. According to the United States census, the acreage of land used for farming increased slightly between 1900 and 1920 and then decreased slightly from 1920 to the present. The number of farms has decreased steadily from 4,700 farms in 1900 to 2,682 farms in 1954, but during the same time the average-sized farm has increased from 78 acres to 123.7 acres.

Crops

The principal crops grown in Montcalm County, in order of decreasing acreage, are corn, oats, alfalfa, wheat, field beans, timothy-and-clover hay, red clover, and potatoes (table 11). Since 1939 a large acreage of red clover has been grown for seed.

The chief cash crop is potatoes, and in 1954 about 1,467,000 bushels were harvested. For many years Montcalm County has led the other counties in Michigan in the production of potatoes, but the acreage of potatoes in the county has decreased greatly since 1929. The acreage of rye, an important grain, has also decreased since 1929. Green beans, carrots, sweet corn, cucumbers, and onions are the main truck crops. In 1954, 3,267 acres of vegetables were harvested for sale.

From 1929 to 1954, about 30 percent of the acreage in crops was in hay and forage. Between 1929 and 1939, the area in alfalfa increased from 6,045 acres to 29,212 acres. From 1939 to the present, alfalfa has remained the leading hay crop in the county.

The principal fruit crop is apples (table II). Peaches, pears, plums, cherries, and grapes are also grown.

Livestock

Dairying is the most important livestock enterprise in Montcalm County. In 1954, there were about 18,000 dairy cows in the county and about 96,082,000 pounds of whole milk were sold. Large amounts of butter were made for home use and for sale.

Table 12 gives the number of livestock on farms in Montcalm County at stated intervals since 1930. The number of cattle has increased consistently since 1930, but the number of horses and mules has decreased. This decrease in horses and mules is a result of farm mechanization and more efficient farming. Sheep raising was once an important enterprise, but the number of sheep raised decreased from 10,248 in 1929 to 3,685 in 1954.

TABLE 11.—*Acreage of the principal crops and number of fruit trees and grapevines of bearing age, in stated years*

Crop	1929	1939	1949	1954
	Acres	*Acres*	*Acres*	*Acres*
Corn harvested for grain	11, 867	24, 198	22, 747	26, 451
Corn cut for silage	5, 768	4, 231	5, 118	5, 876
Small grains threshed or combined:				
Wheat	11, 281	10, 032	18, 257	18, 025
Oats	29, 969	24, 694	29, 810	26, 242
Barley	1, 587	723	384	270
Rye	8, 391	5, 161	2, 414	2, 225
Buckwheat	346	539	360	424
Other grains	(1)	573	42	29
Soybeans for all purposes	51	404	111	155
Other dry field and seed beans harvested for beans	20, 988	17, 330	16, 486	17, 038
All hay	49, 011	51, 297	45, 336	46, 291
Alfalfa cut for hay	6, 045	29, 212	23, 813	31, 172
Timothy, clover, and mixtures of grasses cut for hay	42, 470	20, 471	18, 646	13, 405
Small grains cut for hay	79	624	221	148
Other hay cut	388	830	2, 332	1, 362
Alfalfa seed harvested	53	2, 170	451	134
Red clover seed harvested	(2)	(2)	5, 635	5, 472
Other field seed crops harvested	10, 804	4, 573	142	338
Potatoes for home use or for sale	18, 541	14, 358	[3] 7, 075	[4] 5, 226
Vegetables harvested for sale	739	322	2, 347	3, 267
	Number [5]	*Number* [5]	*Number* [5]	*Number*
Apple trees	64, 502	34, 078	23, 093	20, 085
Peach trees	1, 877	3, 828	6, 799	5, 074
Pear trees	1, 575	1, 080	1, 092	216
Plum trees	2, 174	823	634	851
Cherry trees	1, 324	1, 312	195	2, 358
Grapevines	3, 878	2, 603	1, 383	533

[1] Not reported.
[2] Not reported separately this year.
[3] Does not include acres for farms with less than 15 bushels harvested.
[4] Does not include acres for farms with less than 20 bushels harvested.
[5] One year later than year at head of column.

TABLE 12.—*Number of livestock on farms in stated years*

Livestock	1930	1940	1950	1954
Cattle and calves	28, 077	[1] 29, 658	36, 775	37, 897
Milk cows	14, 304	18, 920	18, 129	18, 047
Horses and mules	8, 887	[1] 7, 404	2, 181	727
Sheep and lambs	10, 248	[2] 6, 625	3, 110	3, 685
Hogs and pigs	6, 071	[3] 7, 539	8, 392	11, 135
Chickens	[1] 207, 525	[3] 187, 147	[3] 128, 924	[3] 145, 489

[1] Over 3 months old.
[2] Over 6 months old.
[3] Over 4 months old.

Glossary

Acidity. The degree of acidity of the soil expressed in words and pH values as follows:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6. 6–7. 3
Very strongly acid	4. 5–5. 0	Mildly alkaline	7. 4–7. 8
Strongly acid	5. 1–5. 5	Moderately alkaline	7. 9–8. 4
Medium acid	5. 6–6. 0	Strongly alkaline	8. 5–9. 0
Slightly acid	6. 1–6. 5		

Aggregate (of soil). Many fine soil particles held in a single mass or cluster, such as a clod, crumb, block, or prism. Many properties of the aggregate differ from those of an equal mass of unaggregated soil.

Alkalinity. (See Acidity).

Alluvial soils. Soils developing from transported and relatively recently deposited material (alluvium), with little or no modification of the original deposited materials by soil-forming processes.

Alluvium. Mineral and organic sediments of different sizes deposited on flood plains by streams.

Available water in soils. The part of the water in the soil that can be taken up by plants at rates significant to their growth; usable; obtainable.

Calcareous. A soil horizon containing enough calcium carbonate to effervesce (fizz) when treated with dilute hydrochloric acid.

Catena. A group of soils, within a specific soil zone, formed from similar parent materials but with unlike characteristics associated with differences in relief or drainage. Sometimes called a toposequence.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that contains 40 percent or more of clay, less than 45 percent of sand, and less than 40 percent of silt.

Coarse-textured soils. (See Sandy soils).

Consistence. The combination of properties of soil material that determines its resistance to crushing and its ability to be molded or changed in shape. Consistence depends mainly on the forces of attraction between soil particles. Terms used in this report to describe consistence are *compact, firm, friable, hard, loose, plastic, slightly plastic,* and *very friable.*

Compact. Dense and firm but without any cementation. The term denotes a combination of firm consistence and close packing or arrangement of soil particles.

Firm. Soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Friable. Soil material crushes easily under gentle to moderate pressure between thumb and forefinger and coheres when pressed together.

Hard. Moderately resistant to pressure; soil material can be broken in the hands without difficulty, but it is barely breakable between thumb and forefinger.

Loose. Noncoherent.

Plastic. Forms wirelike shape when rolled between hands; moderate pressure required for deformation of soil mass.

Slightly plastic. Forms wirelike shape when rolled between hands; soil mass easily deformable.

Very friable. Soil material crushes under very gentle pressure but coheres when pressed together.

Depressional area. A low-lying area that has either no surface outlets for the water that accumulates or has only poorly developed outlets.

Drainage (a practice). The removal of excess surface water or excess water from within the soil by means of surface or subsurface drains.

Drainage, soil. (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground space. (2) As a condition of the soil, soil drainage refers to the frequency and duration of periods when the soil is free of saturation. For example, in well-drained soils, the water is removed readily but not rapidly; in poorly drained soils, the root zone is waterlogged for long periods and the roots of ordinary crop plants cannot obtain enough oxygen.

First bottom. The normal flood plain of a stream, susceptible to frequent or occasional flooding.

Fragipan. A compact soil horizon that contains little clay. When dry, fragipans are very hard and brittle.

Genesis, soil (See also Horizon). The mode of origin of the soil, with special reference to the processes that form the solum, or true soil, from the unconsolidated parent material.

Granular (See also Structure). A kind of soil structure in which the individual grains are grouped into spherical aggregates with indistinct sides. Highly porous granules are commonly called crumbs. A well-granulated soil has the best structure for most ordinary crop plants.

Great soil group. Any one of several broad groups of soils that have the same kind and sequence of horizons in the profile. Examples are Gray-Brown Podzolic, Podzol, Gray Wooded, and Humic Gley.

Green-manure crop. Any crop grown and plowed under for the purpose of improving the surface layers of the soil profile, especially by the addition of organic matter.

Horizon, soil. Layer or part of the soil profile, approximately parallel to the land surface, that has more or less well-defined characteristics.

Horizon A. The upper horizon of the soil profile from which material has been removed by percolating waters; includes the cultivated part of the solum or plow layer; the surface and subsurface layers. It is generally subdivided in two or more subhorizons of which A_o is not a part of the mineral soil but is the accumulation of organic debris on the surface. Other subhorizons are designated as A_1, A_2, and A_3, depending on their properties.

Horizon B. The horizon of deposition, to which materials have been added by percolating waters; the illuviated part of the solum; the subsoil. This horizon may also be divided into several subdivisions, depending on the color, structure, consistence, or character of the material deposited. These layers are designated as B_1, B_2, and B_3, depending on their properties.

Horizon C. The horizon of partly weathered material, C_1, or material unweathered in place, C_2. This material is similar to that from which one or more of the overlying soil layers have been formed.

Horizon D. Any stratum, such as hard rock or layers of clay or sand, that are not similar to those from which the overlying soil was formed but which may have significance to the overlying soil.

Humus. The dark-colored, finely divided, well-decomposed, more or less stable part of the organic matter in mineral soils.

Leaching. Removal of materials in solution or suspension by the percolating soil water.

Micro-organisms. Forms of life too small to be seen with the unaided eye, or barely discernible.

Mineral soil. A general term for a soil composed chiefly of mineral matter, in contrast to organic soil, a large part of which is organic matter.

Morphology. The constitution of the soil, including the texture, structure, consistence, color, and other physical, chemical, and biological properties of the various horizons that make up the soil profile.

Mottles. Spots, streaks, or blotches of different colors.

Muck (See also Peat). Well-decomposed dark organic matter occurring in naturally poorly drained places. If the plant material in a layer, or horizon, of an organic soil is so completely decomposed that the plant structure can no longer be identified, the material is called muck. If the plant structures can still be identified, the material is called peat.

Ortstein. A hard cemented horizon that has an accumulation of iron oxides and organic matter.

Parent material (See also, Horizon C, Profile, and Substratum). The relatively unaltered geological deposits similar to those from which at least part of the soil has developed.

Peat (See also Muck). Raw relatively undecayed or slightly decomposed organic material accumulated under very poorly drained conditions.

Percolation. The downward movement of water through soil.

Permeable. Easily penetrated, as by water, roots, and air.

pH (See also Acidity). Term used to express the intensity of soil acidity or alkalinity.

Phase, soil. A subclass or category under the soil type that is usually based upon characteristics observable at the land surface, such as slope, degree of erosion, and stoniness.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. See Acidity.

Root zone. The part of the soil that is invaded by plant roots.

Runoff. The surface flow of water from an area; or the total volume of surface flow during a specified time.

Sand. Individual mineral fragments in soils having diameters ranging from 0.5 millimeter to 2.0 millimeters. The textural class name of any soil that contains 85 percent or more of sand and not more than 10 percent of clay.

Sandy clay. Soil of this textural class contains 35 percent or more of clay and 45 percent or more of sand.

Sandy clay loam. Generally, this soil textural class contains 20 to 35 percent clay, less than 28 percent silt, and more than 45 percent of sand.

Sandy loam. Generally, the sandy loam textural class has more than 50 percent sand and less than 20 percent clay.

Sandy soils. A broad term for the sand and loamy sand textural classes; soil with more than 70 percent sand and less than 15 percent clay.

Series, soil. A group of soils, usually formed from the same kind of parent material, that have soil horizons similar in their differentiating characteristics and arrangement in the soil profile, except for the texture of the surface soil. The soil series is an important category in detailed soil classification. Individual series are named for places near which they were first mapped. Thus names like Au Gres, Brevort, Carlisle, McBride, and Sims are names of soil series that appear on the Montcalm County soil map, and each connotes a unique combination of many soil characteristics.

Silt. Small mineral grains ranging from 0.05 millimeter (0.002 inch) to 0.002 millimeter (0.000079 inch) in diameter.

Silt loam. Soil material having (1) 50 percent or more of silt and 12 to 27 percent of clay or (2) 50 to 80 percent of silt and less than 12 percent of clay.

Silty clay loam. This soil textural class has 27 to 40 percent of clay and less than 20 percent of sand.

Slope. The incline of the surface of a soil. It is usually expressed in percentage of slope, which equals the number of feet of fall per 100 feet of horizontal distance.

Soil. The natural medium for the growth of land plants. The soil has layers, or horizons, that are the result of the integrated effect of climate and living matter acting upon geological deposits, as conditioned by relief, over periods of time.

Soil association. A group of soils that occur together in a characteristic pattern; a general soil area.

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 soils includes the A and B horizons. Usually the characteristics of the material in these horizons are quite unlike those of the underlying parent material. Roots and animal life 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. Soil structure is classified according to grade, class, and type.

Grade. Degree of distinctness of aggregation; expresses the differential between cohesion within aggregates and adhesion between aggregates. Terms: *Weak, moderate, strong, massive.*

Class. Size of soil aggregates. Terms: *Very fine* or *very thin, fine* or *thin, medium, coarse* or *thick,* and *very coarse* or *very thick.*

Type. Shape of soil aggregates. Terms: *Platy, prismatic, columnar, blocky* or *angular blocky, subangular blocky, granular* (nonporous), and *crumb* (very porous). (Example of soil-structure grade, class, and type: moderate coarse blocky).

Subsoil. Technically, the B, G, O_2, O_3, and O_4 horizons.

Substratum. (See also Horizon C and Horizon D). Material underlying the solum.

Surface soil. Technically, the A and O_1 horizons; commonly, the plow layer.

Texture. The relative proportions of sand, silt, and clay in a mass of soil. A coarse-textured soil is one high in sand; a fine-textured soil has a large proportion of clay.

Type, soil. A subclass or category under the soil series based on the texture of the surface soil. Except for texture of the surface soil, soils of the same type have horizons that are similar in differentiating characteristics and arrangement in the soil profile.

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, processes, or changes that have changed the upper part of the earth's crust through various periods of time.

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Areas surveyed in Michigan shown by shading.

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