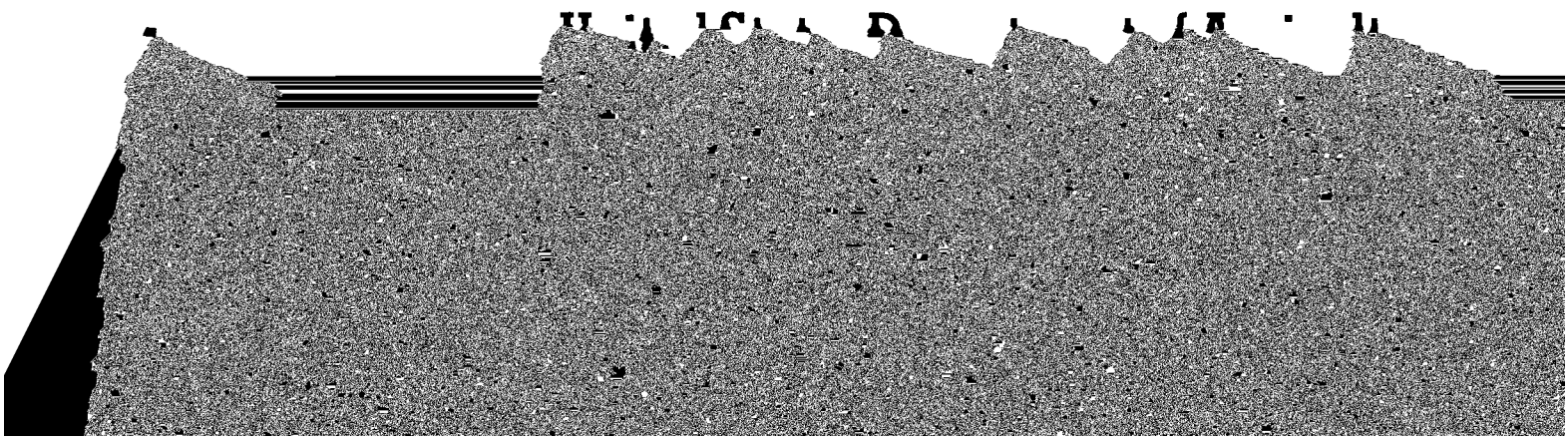
SOIL SURVEY OF

Clare County, Michigan



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

Major fieldwork for this soil survey was completed in the period 1967 to 1976. Soil names and descriptions were approved in July 1976. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1976. This survey was made cooperatively by the Soil Conservation Service and the Michigan Agricultural Experiment Station. It is part of the technical assistance furnished to the Clare County Soil Conservation District. Preparation of this soil survey was partly financed by the Clare County Board of Commissioners under provisions of an agreement with the Soil Conservation Service.

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

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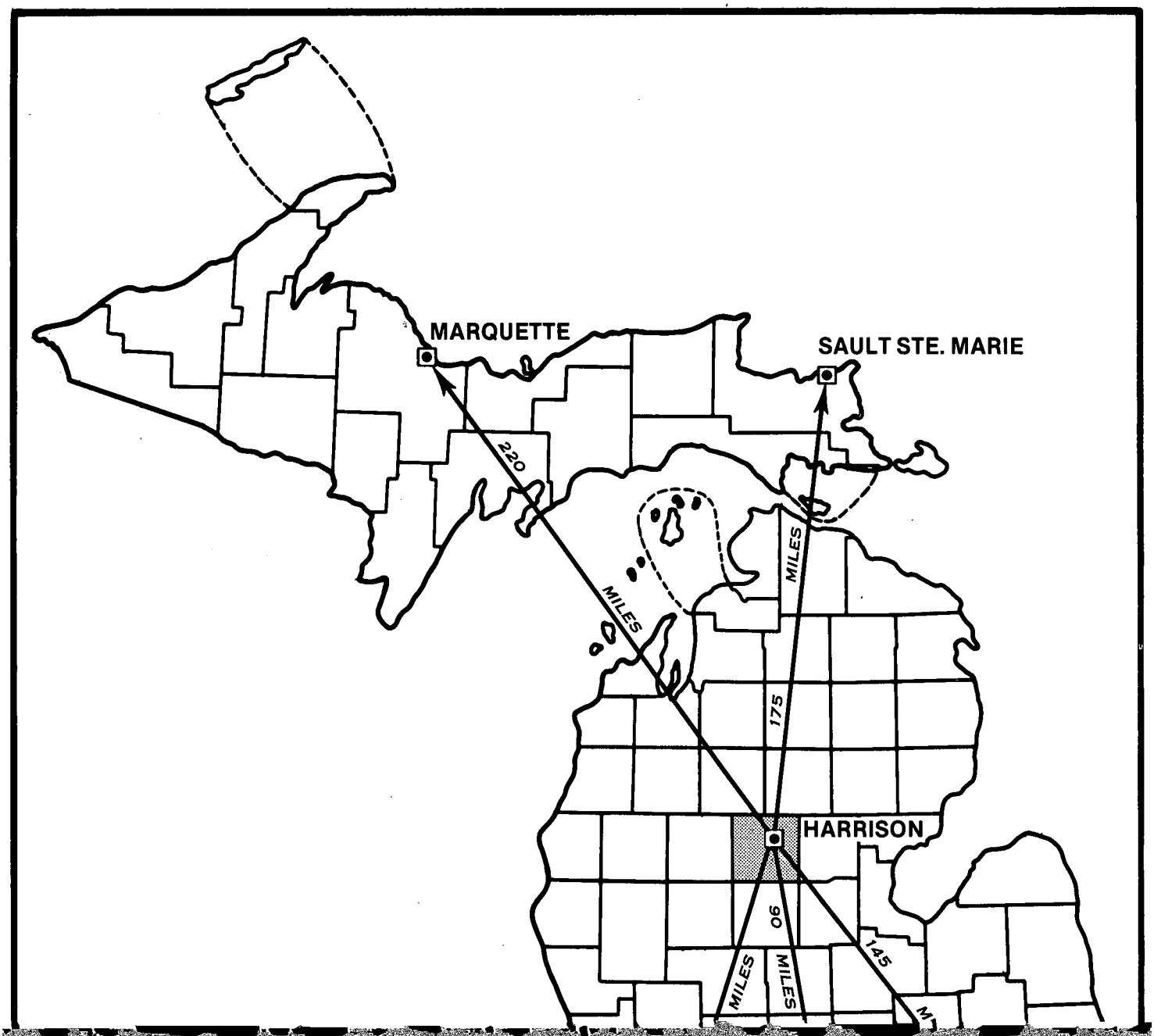
Foreword

The Soil Survey of Clare County, Michigan, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be too unstable


MARQUETTE
SAULT STE. MARIE
HARRISON
220
MILES
175
MILES
90
MILES
145

SOIL SURVEY OF CLARE COUNTY, MICHIGAN

By Paul G. Corder, Soil Conservation Service

Fieldwork by Paul G. Corder, Adam Hyde, William L. Bowman,
Neil W. Stroesenreuther, Sheldon G. Holcomb, and Joseph R. Dumont,
Soil Conservation Service, and Tom Nalepa, Johnnie Collins, Chwan Co Wang,
James P. Manor, and Phillip D. Manor, Michigan Agricultural Experiment Station

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

CLARE COUNTY is situated near the center of Michigan (see facing page). The county is bordered on the north by Missaukee and Roscommon Counties, on the

at Houghton Lake on February 1, 1918, is minus 48 degrees. In summer the average temperature is 67.0 degrees, and the average daily maximum temperature is

Farwell, Harrison, and Clare were among the earliest towns. Harrison was the site of a productive sawmill with a capacity of 45,000 feet per day in 1881. Today, it is a recreational center as well as the headquarters for county government. Farwell was the first county seat.

Natural resources

Probably the most important natural resource in Clare County is the soil. Almost a quarter of the county, mostly the southeastern part, is farmed. About 65 percent of the county is forested with hardwoods and softwoods.

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

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad

planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Map unit descriptions

1. Mancelona-Gladwin-Wheatley

Nearly level to gently rolling, somewhat excessively drained and somewhat poorly drained to very poorly drained soils that have a sandy and loamy subsoil or a sandy and gravelly substratum

These nearly level to gently rolling soils are mostly on outwash plains and old glacial lakebeds, generally close to streams, rivers, and lakes. Most areas are nearly flat, but some have slight rises or low knolls.

This map unit occupies about 5 percent of the county. It is about 50 percent Mancelona soils, 15 percent Gladwin soils, 10 percent Wheatley soils, and 25 percent soils of minor extent (fig. 1).

Mancelona soils generally are slightly higher on the landscape than Gladwin and Wheatley soils. They are in flat areas and on some slight rises and low knolls. Gladwin and Wheatley soils are in flat areas and drainageways. Mancelona soils are somewhat excessively drained, Gladwin soils somewhat poorly drained, and Wheatley soils poorly drained and very poorly drained. Gladwin and Wheatley soils have a seasonal high water table. Available water capacity is low in all three soils, and permeability is moderately rapid or rapid.

Mancelona soils are nearly level to gently rolling. Typically, the surface layer is black loamy sand about 3 inches thick. The subsurface layer is grayish brown gravelly

The minor soils in this map unit include the excessively drained Grayling soils, the somewhat excessively drained Graycalm soils, the somewhat poorly drained Colonville soils, and the very poorly drained Markey soils. Grayling and Graycalm soils are in the same landscape position as Mancelona soils. Colonville soils are on flood plains next to streams. Markey soils are in wet mucky areas.

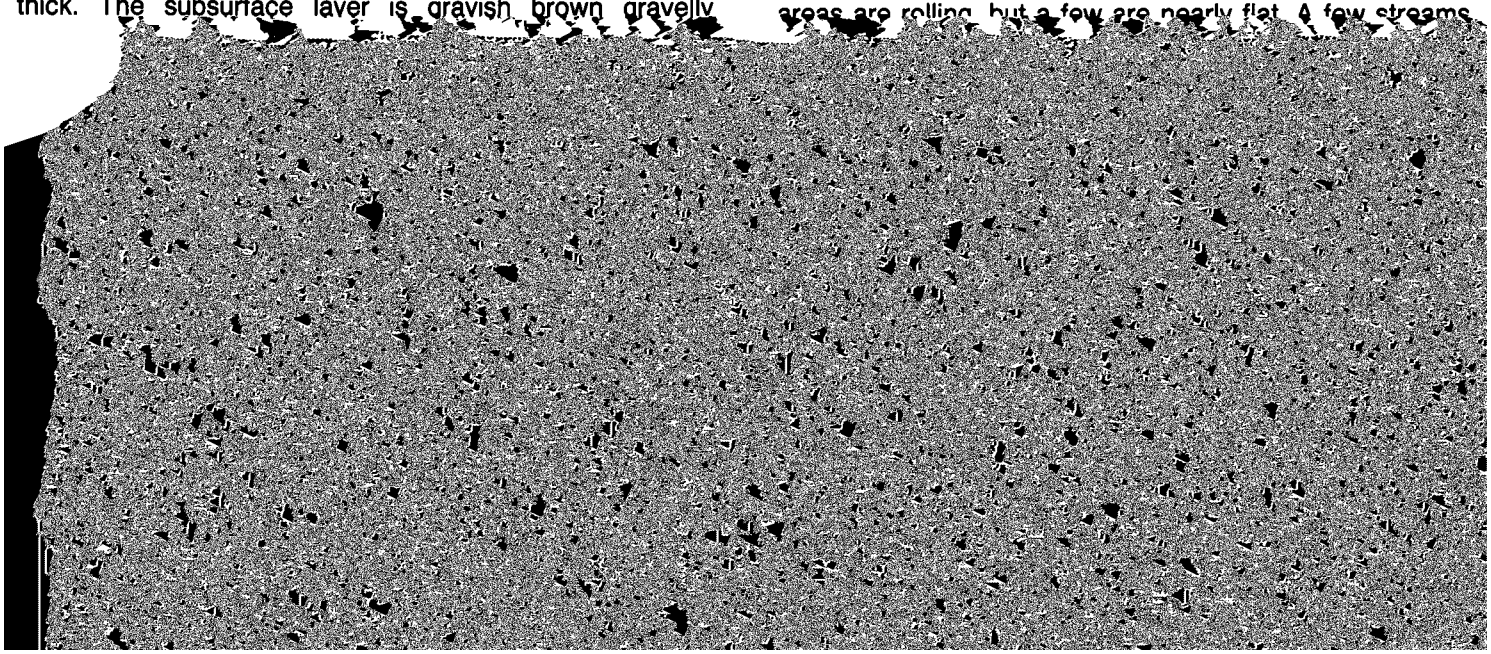
Most areas are used for woodland or pasture, but some are cropped. Susceptibility to soil blowing and droughtiness are the major problems for most uses. Drainage generally is needed before cultivated crops can be grown on the Gladwin and Wheatley soils. Most areas are undrained, however, because drainage outlets are difficult to locate. If drained, the soils become more droughty during the summer. The Mancelona soils are subject to erosion if cleared. As a result of the moderately rapid permeability, the effluent from septic tank absorption fields can pollute ground water. Cutbanks in excavations can cave in.

This map unit has good potential for pasture. It is a good to fair source of sand and gravel. It has fair potential for cultivated crops and upland wildlife habitat, good to fair potential for woodland, poor potential for most recreation uses, and a variable potential for engineering uses. The potential of Mancelona soils for building site development is good in the flatter areas and fair in the steeper areas. The Gladwin and Wheatley soils have poor potential for building site development because they have a seasonal high water table.

2. Montcalm-Menominee-Nester

Nearly level to rolling, well drained and moderately well drained soils that have a sandy and loamy subsoil

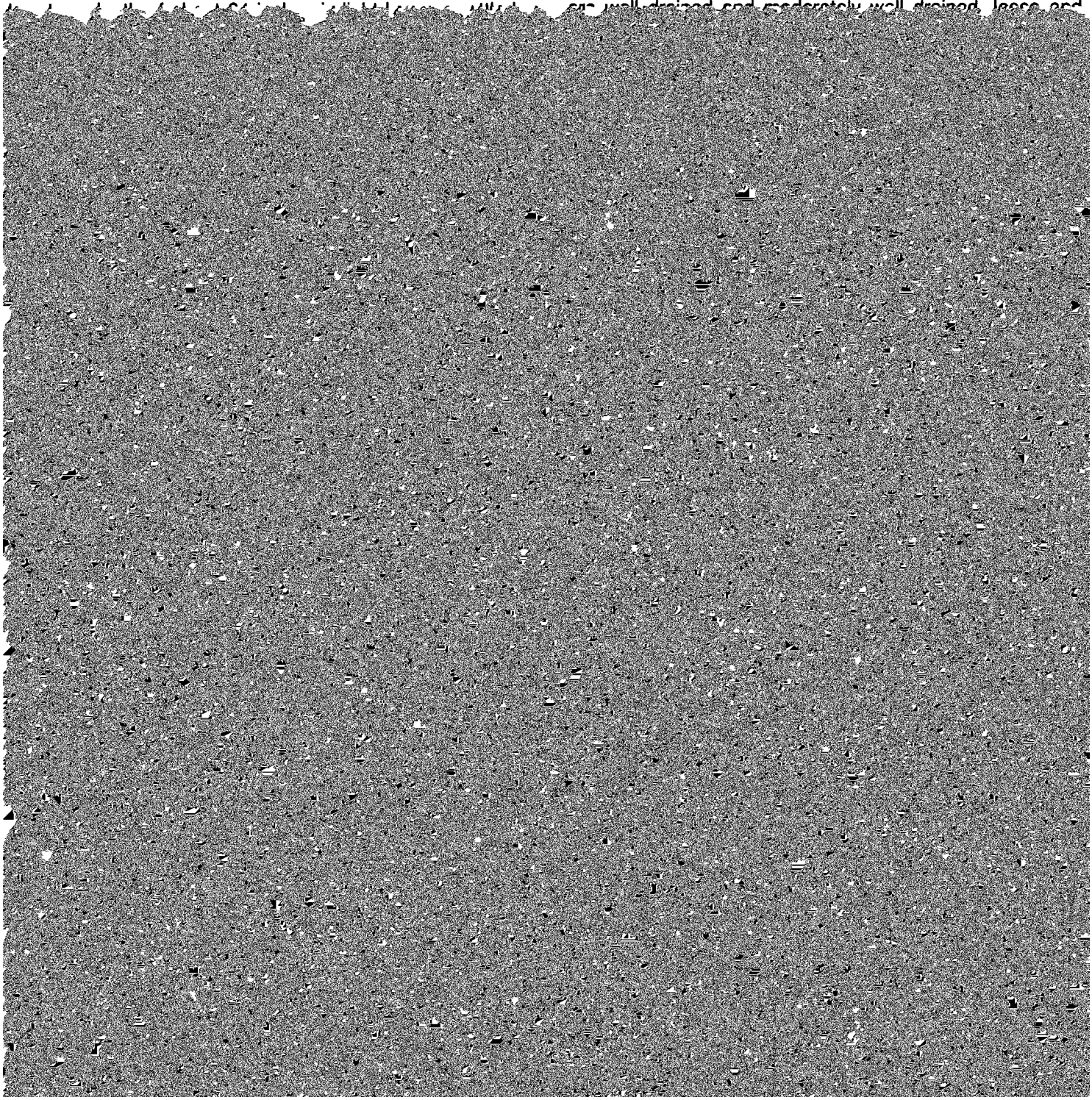
These nearly level to rolling soils are mostly on till plains and moraines but also are on outwash plains. Most areas are rolling, but a few are nearly flat. A few streams



sand about 7 inches thick. The subsoil is about 35 inches thick. The upper part is reddish brown and yellowish brown, friable loamy sand; the next part is a mixture of strong brown and pale brown, friable sandy loam and brown and reddish brown, firm clay loam; and the lower part is dark brown, mottled, firm clay loam. The substra-

and Kawkawlin soils, and 45 percent soils of minor extent (fig. 3).

Menominee soils generally are higher on the landscape than Iosco and Kawkawlin soils. They are on slight rises and knolls. Iosco soils are on very gentle knolls, and Kawkawlin soils are in nearly flat areas. Menominee soils are well drained and moderately well drained. Iosco and



Kawkawlin soils can be drained. The potential for recreation and engineering uses is fair to poor.

4. Nester-Kawkawlin-Sims

Nearly level to rolling, well drained to very poorly drained soils that have a loamy subsoil

These nearly level to rolling soils are mostly on till plains and moraines. Most areas are fairly flat, but some have slight rises and some have several hills.

This map unit occupies about 14 percent of the county. It is about 55 percent Nester soils, 20 percent Kawkawlin soils, 10 percent Sims soils, and 15 percent soils of minor extent (fig. 4).

Nester soils generally are higher on the landscape than

sion, and a high content of clay are the major problems for most uses. As a result of the high content of clay, the shrink-swell potential is moderate and the soils tend to warm up slowly in spring. All of the soils puddle and crust if plowed when too wet. Frost usually damages some crops every year. The Nester soils are the most susceptible to erosion. In the areas of Nester soils in scattered wet depressions, drainage is needed. It also is needed on the Kawkawlin and Sims soils, which are excessively wet. Sims soils are often flooded. Most areas of Sims soils are undrained because outlets are difficult to locate.

This map unit has good potential for woodland and certain types of wildlife habitat. It has fair to poor potential for most recreation uses and engineering uses because of excessive wetness, susceptibility to erosion, and the high

knolls, generally below Montcalm soils. Markey soils are in wet mucky areas.

This map unit is used mainly for woodland, but a few areas are cultivated or pastured. Susceptibility to soil blowing and erosion and droughtiness are the major problems for most uses. As a result of rapid permeability, the effluent from septic tank absorption fields can pollute ground water. Cutbanks in excavations can cave in.

7. Rubicon-Croswell-Au Gres

Nearly level to rolling, excessively drained, moderately well drained, and somewhat poorly drained soils that have a sandy subsoil

This nearly level to rolling map unit is mostly on outwash plains and till plains. It occupies about 9 percent of the county. It is about 30 percent Rubicon soils, 20

erosion on the Rubicon soils. Most areas are undrained because drainage outlets are difficult to locate. If drained,

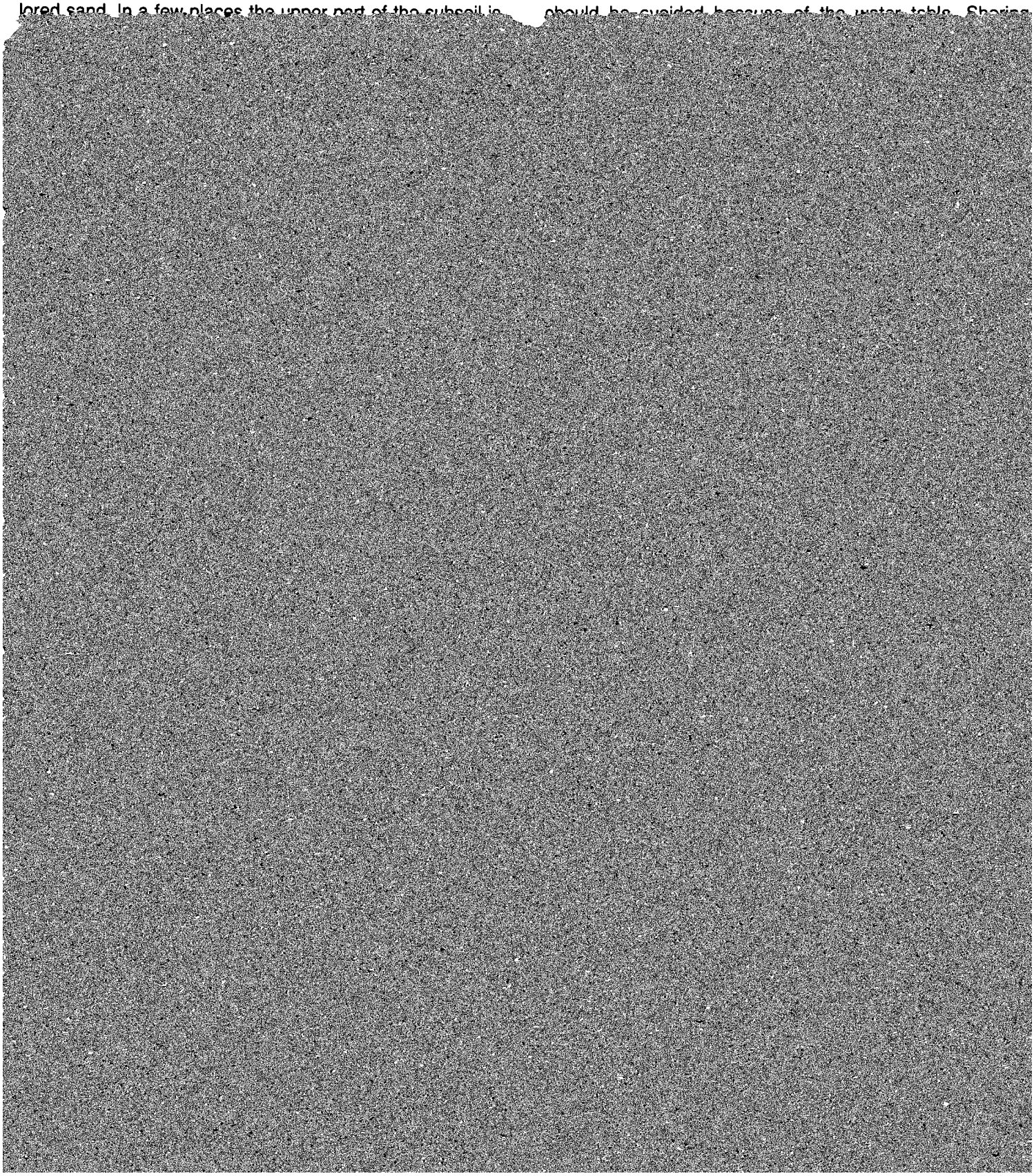
This map unit has good potential for wetland wildlife habitat. The excessive wetness and instability are such

poor potential for pasture because they are either too sandy or too wet for pasture grasses.

About three-fourths of the county has good to fair po-

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, wetness, or other characteristics that

lored sand. In a few places the upper part of the subsoil is



should be avoided because of the water table. Shoring

should be thinned and the most productive ones saved. They should be harvested during the winter. Equipment

This soil is used for woodland. The trees grow rapidly, but their growth is limited to some extent by the seasonal

keep the soil in production. Seedling mortality is severe in most years because of droughtiness and plant competition. Planting more trees than are necessary can compensate for seedling mortality, but thinning may be needed later. Planting trees in plow furrows reduces plant competition.

This soil is suitable for recreation uses, but the seasonal high water table is a limitation and the grass cover is usually not dense enough to withstand the heavy foot traffic. Wood chips can be added in areas where foot traffic is heavy, and topsoil can be added as a better medium for grasses grown as cover. Snowmobile trails are easily constructed and maintained. Wooded areas provide habitat and fair to poor potential for recreation uses and building site development.

Before cultivated crops can be grown, drainage is generally needed. In undrained areas, this soil remains wet late in spring and wet depressions hinder machinery and delay planting. Locating drainage outlets is difficult in most areas. The soil tends to be droughty, especially in drained areas in midsummer. Irrigation can improve productivity. Plowing under cover crops, green manure crops, crop residue, and manure conserves soil moisture. Soil blowing is a hazard if the soil is cultivated. Cover crops, stripcropping, and windbreaks are effective in controlling soil blowing. Blinding material is needed to prevent accumulation

has a few thin bands of loamy sand. In a few places the loamy sand bands in the lower part of the subsoil are not evident.

Included with this soil in mapping are small areas of the well drained Montcalm and somewhat excessively drained Mancelona and Melita soils, which are throughout the unit. These soils make up 10 to 15 percent of the unit. The Mancelona soil is underlain with sand and gravel. The Montcalm soil has sandy loam bands in the subsoil. The Melita soil has a clay loam subsoil 40 to 55 inches from the surface.

Permeability is rapid in the Graycalm soil, runoff is very slow, and available water capacity is low.

Most areas are wooded with an assortment of aspen, maple, and oak. This soil has good potential for pasture,

Capability subclass IVs; Michigan management group 5a.

GrC—Graycalm sand, 6 to 18 percent slopes. This somewhat excessively drained, gently rolling and rolling soil is on knolls. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is very dark grayish brown sand about 3 inches thick. The subsoil to a depth of about 60 inches is multicolored, very friable and loose sand that has a few thin bands of loamy sand. In a few places the loamy sand bands in the lower part of the subsoil are not evident.

Included with this soil in mapping are small areas of the well drained Montcalm, the somewhat excessively drained Mancelona, and the well drained and moderately well

of erosion can be reduced by land shaping and by constructing roads and streets on the contour. Shoring walls can keep cutbanks from caving.

If septic tank absorption fields are installed in this soil, the effluent can pollute ground water.

Capability subclass VIs; Michigan management group 5a.

GrD—Graycalm sand, 18 to 35 percent slopes. This somewhat excessively drained, hilly and steep soil is on uplands. Individual areas are irregular in shape and range from 10 to 160 acres in size.

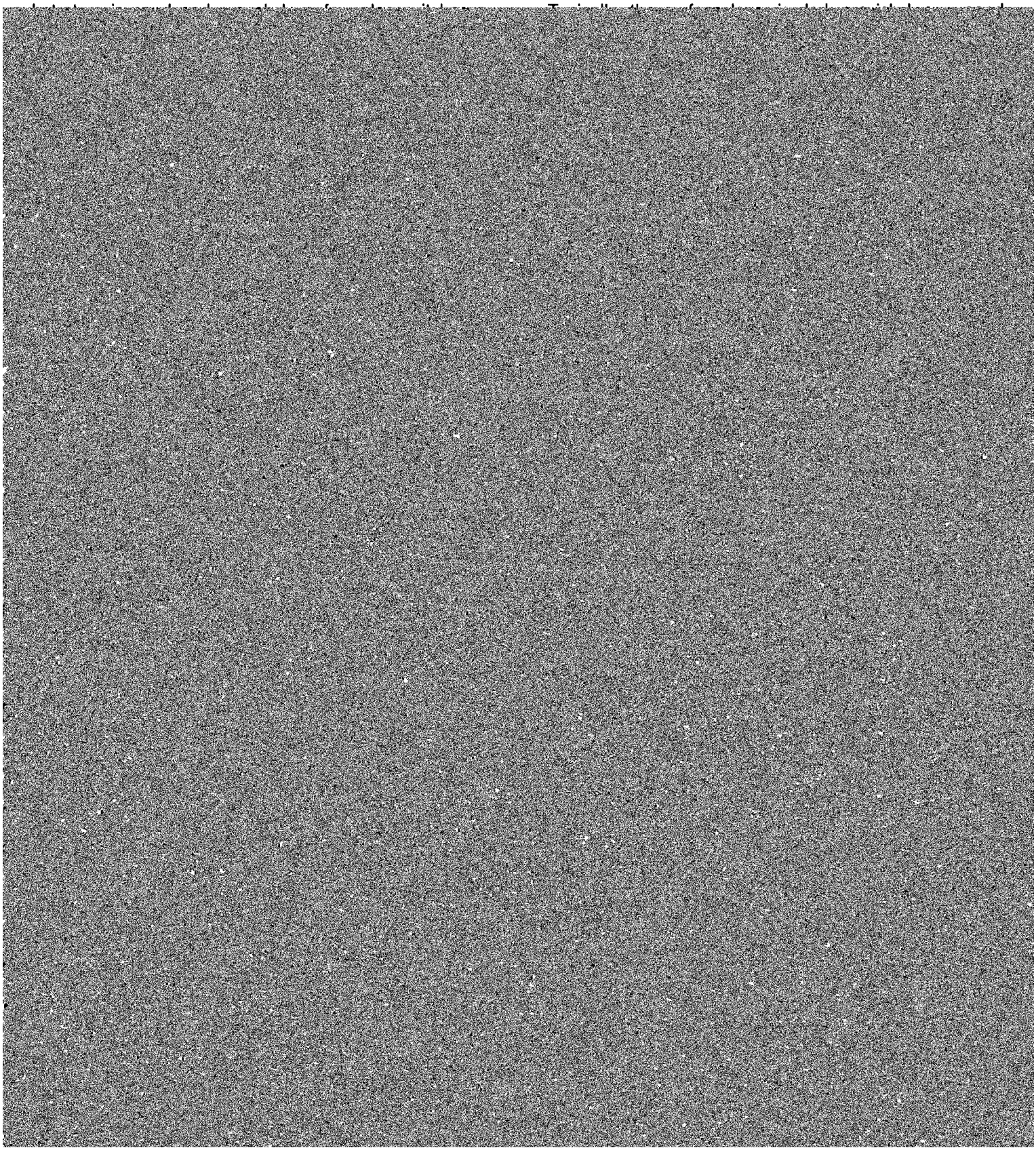
Typically, the surface layer is very dark grayish brown sand about 2 inches thick. The subsoil to a depth of about 60 inches is multicolored, very friable or loose sand that has a few thin bands of loamy sand. In a few places the loamy sand bands in the lower part of the subsoil are not evident.

brown, loose sand. The substratum to a depth of about 60 inches is light yellowish brown, loose sand. In places the substratum is sand and gravel. In a few places it has a few loamy sand bands.

Included with this soil in mapping are small areas of the excessively drained Rubicon soil throughout the unit and the somewhat poorly drained Au Gres soil in shallow depressions and drainageways. The Rubicon soil makes up about 10 percent of the unit and the Au Gres soil 5 percent. Available water capacity is higher in the Rubicon soil than in the Grayling soil.

Permeability is very rapid in the Grayling soil, runoff is very slow, and available water capacity is very low. The soil is extremely droughty.

Most areas are wooded with jack pine and assorted oaks. This soil has good potential for building site development and for recreation uses. It has poor potential for



These soils are usually covered with water the year round. The depth of the water ranges from a few inches to 2 or 3 feet.

In most areas these soils support cattails, reeds, and other water-tolerant grasses and shrubs. Dead trees are common in some areas. The potential for wetland wildlife habitat is good. The potential for cultivated crops, pasture, woodland, recreation uses, and engineering uses is poor.

Cultivated crops and pasture grasses cannot be grown because of the instability of the soils and the lack of drainage outlets. Most trees cannot grow on these soils because the water table is too high. Building site development and recreation uses are not feasible because the high water table is too high and the soils are unstable. The soils provide excellent habitat for wetland wildlife. Deep fish ponds can be dug, but gentle side slopes are needed to prevent caving and sloughing.

Capability subclass VIIIw; not assigned to a Michigan management group.

IkA—Iosco-Kawkawlin complex, 0 to 3 percent slopes. This map unit consists of somewhat poorly drained, nearly level and gently undulating soils in nearly flat areas and on very gentle knolls. Individual areas are irregular in shape and range from 10 to 80 acres in size. They are 50 to 60 percent Iosco soil and 30 to 40 percent Kawkawlin soil. The Iosco soil is on the very gentle knolls, and the Kawkawlin soil is in the nearly flat areas. The two soils are so intricately mixed or are in areas so small that mapping them separately is not practical.

Typically, the Iosco soil has a surface layer of very dark grayish brown loamy sand about 6 inches thick. The subsurface layer is grayish brown, mottled sand about 3 inches thick. Below this is a mottled subsoil about 51 inches thick. The upper part is dark brown, friable loamy sand; the next part is brown, loose sand; and the lower part to a depth of about 60 inches is brown, firm silty clay loam.

subsoil or in the substratum. In undrained areas of both soils, the seasonal high water table is within 1 foot to 2 feet of the surface during the period November through May.

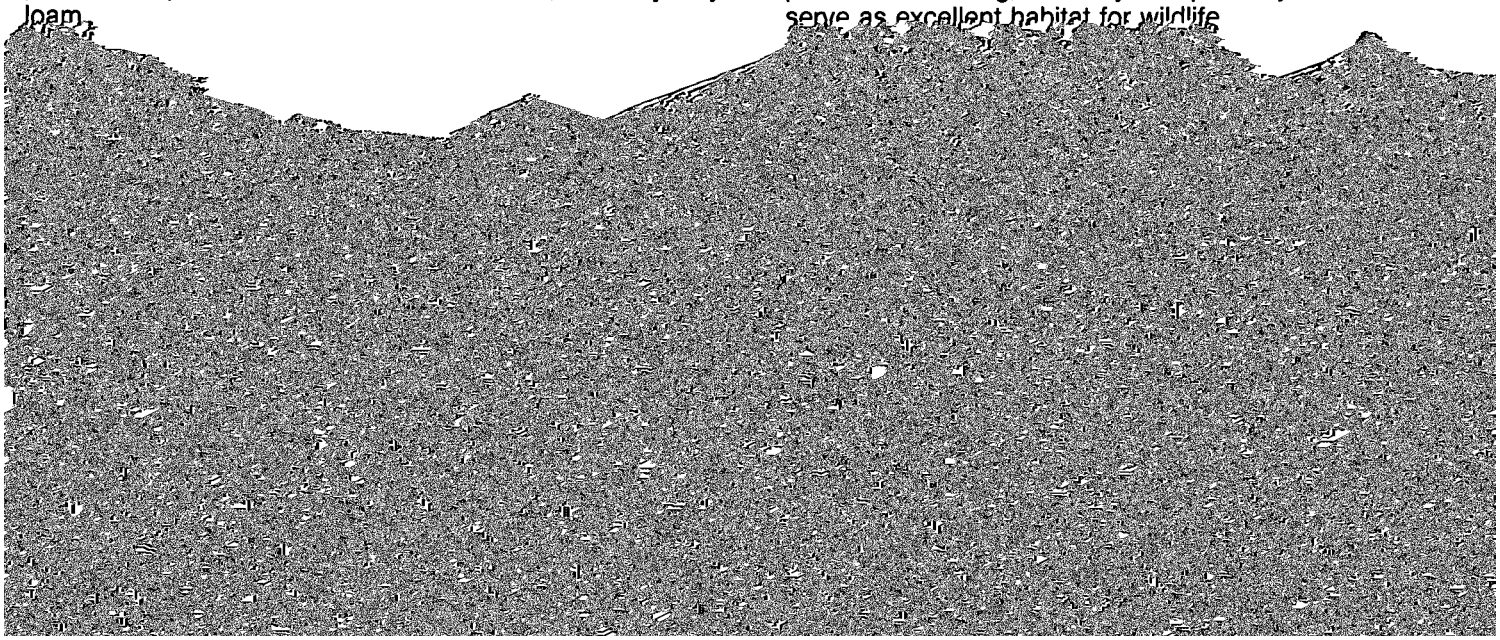
These soils are commonly used for pasture or woodland and in a few areas are cultivated. They have good potential for pasture and woodland wildlife habitat. They have fair potential for cultivated crops and woodland, fair to poor potential for recreation uses, and poor potential for most engineering uses.

Drained areas are suitable for cultivated crops. In many areas locating drainage outlets is difficult. Wet depressions hinder machinery and delay planting. In undrained areas the soils warm up more slowly in spring because of the seasonal high water table. Soil blowing is a hazard if the soils are drained. Windbreaks, cover crops, and strip-cropping help to reduce the risk of soil blowing.

These soils are suited to pasture. Many of the small depressed areas are ponded in the spring. Overgrazing or grazing when the soils are too wet results in surface compaction, puddling, and a susceptibility to soil blowing. Proper stocking rates, rotation grazing or strip grazing, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

These soils are suitable for woodland. After harvest, the trees usually regenerate without replanting. Regrowth is slow at first because of plant competition and seedling mortality. Spruce seedlings can be planted in the open areas if necessary.

The seasonal high water table in both soils and the sandy surface layer in the Iosco soil limit recreation uses. Locating drainage outlets is difficult. Frequent watering of grass helps to control droughtiness. Snowmobile trails are easily established and maintained. Deep and shallow ponds can be dug, but they fill up slowly. Wooded areas serve as excellent habitat for wildlife.



Typically, the surface layer is very dark gray loam about 6 inches thick. The subsoil is about 18 inches thick. The upper part is light brownish gray, friable loam and brown, firm silty clay loam, and the lower part is dark brown, mottled, firm silty clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam.

Included with this soil in mapping are small areas of the well drained and moderately well drained Nester soil on the higher knolls, the somewhat poorly drained sandy Iosco soil on slight rises, and the poorly drained and very poorly drained Sims soil in drainageways and shallow depressions. Each of these included soils makes up about 5 percent of the unit.

around foundations with suitable material, and by providing drainage around foundations.

The seasonal high water table and the moderately slow permeability limit this soil as a site for sanitary facilities. If possible, these facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIw; Michigan management group 1.5b.

Lg—Loxley and Greenwood mucky peats. This map unit consists of very poorly drained, nearly level soils in broad, flat or depressional areas. These soils are subject to frequent flooding for long periods. Individual areas are irregular in shape and range from 3 to 200 acres in size. They are 20 to 90 percent Loxley soil and 0 to 70 percent

flooding for long periods. Individual areas are irregular in shape and range from 4 to 640 acres in size.

Typically, the upper tiers of this soil are black, well decomposed muck about 50 inches thick. The bottom tier to a depth of about 60 inches is very dark brown, well decomposed muck.

Included with this soil in mapping are small areas of the somewhat poorly drained sandy Au Gres soil on slight rises and the very poorly drained Markey and Rondeau soils, generally on the edges of the unit. The Au Gres soil makes up about 5 percent of the unit and the Markey and Rondeau soils 10 percent. The Markey soil is a shallow muck that is underlain with sand and the Rondeau soil a shallow muck that is underlain with marl.

Permeability is moderately slow to moderately rapid in the Lupton soil, runoff is very slow, and available water capacity is high. The seasonal high water table is at the surface during the period September through May.

Most areas are wooded or covered with bushes. This soil has good potential for wetland wildlife habitat. It has poor potential for cultivated crops, pasture, woodland, and recreation and engineering uses.

Cultivated crops and pasture grasses are seldom grown because of the instability of the soil and the lack of drainage outlets. Most areas remain undrained. As a result, the soil is too unstable to support equipment and livestock.

Most areas are suitable as woodland. Northern white-cedar, black spruce, balsam fir, tamarack, and quaking aspen are the most common trees. The trees grow slowly because of the seasonal high water table. They are susceptible to windthrow because of the wetness and instability of the soil. They should be harvested during the

friable subsoil about 22 inches thick. The upper part is dark brown to brown gravelly loamy sand, the next part is dark brown gravelly sandy loam, and the lower part is dark yellowish brown gravelly loamy sand. The substratum to a depth of about 60 inches is light yellowish brown, calcareous sand and gravel.

Included with this soil in mapping are small areas of the somewhat poorly drained Au Gres and Gladwin soils in shallow depressions and drainageways. These soils make up about 5 to 10 percent of the unit.

Permeability is moderately rapid in the Mancelona soil, runoff is slow, and available water capacity is low.

This soil is used for pasture, woodland, and cropland. It has good potential for pasture, woodland, building site development, and recreation uses. It has fair potential for cultivated crops and upland wildlife habitat.

Cultivated crops are grown in many areas. This soil is droughty during the summer, and crops lack sufficient moisture unless rainfall is adequate. Irrigation can significantly improve productivity. Soil blowing and erosion are hazards, but they can be controlled by stripcropping, cover crops, and windbreaks.

This soil is suitable for pasture. Pasture grasses grow well early in spring, but the pasture tends to dry up during the summer. Overgrazing results in pasture depletion and susceptibility to soil blowing. Rotation grazing or strip grazing is needed.

This soil is suitable for woodland. Pine and hardwoods grow rapidly. The trees are usually cut for pulpwood. After harvest, aspen trees usually regenerate without replanting. Pine seedlings should be planted in the areas of other harvested trees. Seedling mortality is moderate in most

Capability subclass IIIs; Michigan management group 4a.

MaC—Mancelona loamy sand, 6 to 12 percent slopes. This somewhat excessively drained, gently rolling soil is on knolls. Individual areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 2 inches thick. The subsurface layer is grayish brown loamy sand about 2 inches thick. Below this is a dark yellowish brown, very friable subsoil about 26 inches thick. The upper part is loamy sand, and the lower part is gravelly sandy loam. The substratum to a depth of about 60 inches is light yellowish brown, calcareous sand and gravel.

Included with this soil in mapping are small areas of the somewhat poorly drained Gladwin soil in depressions and drainageways and the well drained Menominee soil throughout the unit. Each of these included soils makes up about 5 percent of the unit. The Menominee soil has a clay loam subsoil 20 to 38 inches from the surface.

Permeability is moderately rapid in the Mancelona soil, runoff is slow, and available water capacity is low.

This soil is used for woodland, pasture and cropland. It has good potential for pasture and woodland and fair are susceptible to erosion. The open and wooded areas provide fair habitat for wildlife.

This soil is suitable for building site development, but the slope, the droughtiness, and the caving of cutbanks are limitations. Shaping the land and building roads and streets on the contour help to overcome the limitation imposed by slope. Frequent watering of lawns is needed unless loamy topsoil is added. Shoring walls can keep cutbanks from caving.

If septic tank absorption fields are installed in this soil, the effluent can pollute ground water.

Capability subclass IIIe; Michigan management group 4a.

Mb—Markey muck. This very poorly drained, nearly level soil is in depressional areas. It is subject to frequent flooding for long periods. Individual areas are irregular in shape and range from 3 to 400 acres in size.

Typically, the organic tiers of this soil are very dark brown and very dark grayish brown, well decomposed muck about 32 inches thick. The substratum to a depth of about 60 inches is gray sand.

Included with this soil in mapping are small areas of the very poorly drained Lupton and poorly drained and very

digging shallow ponds. If deep fish ponds are dug, gentle side slopes are needed to prevent caving and sloughing.

Building site development is not practical. Overcoming the seasonal high water table and the instability of the soil is too difficult. Special assistance from engineers is needed before roads are built.

Most areas are used for woodland. The trees are subject to windthrow because of the shallow root zone. They can be harvested at any time of the year. After harvest, they regenerate without replanting. Regrowth is slow at first because of plant competition and seedling mortality. Spruce seedlings can be planted in the open areas if

Cultivated crops are suited to this soil, but they are seldom grown. Planting is delayed because of seasonally wet depressions that usually are dry by the summer. The shallow root zone can significantly reduce productivity in

Included with this soil in mapping are small areas of the somewhat excessively drained Graycalm and well drained Montcalm soils, which are throughout the unit. These soils make up 10 to 15 percent of the unit. They are deep

gently undulating soil is in flat areas and on slight rises. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark brown loamy sand about 4 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is about 25

This soil is suitable for woodland. The trees can be harvested at any time of the year. After harvest, they usually regenerate without replanting. The regrowth is slow at first because plant competition and seedling mortality are moderate. Pine seedlings can be planted if they are needed in the open areas.

substratum. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are pastured or wooded. A few are cultivated. This soil has good potential for pasture and woodland. It has fair potential for cultivated crops, building site development, and most recreation uses and as habitat for woodland and openland wildlife.

This soil is suitable for cultivated crops. It lacks available water during the dry summer months. It is easy to work. Excessive tillage increases the hazards of soil blowing and erosion. Drainage is needed in some of the scattered wet depressions and drainageways. Plowing under cover crops, green manure crops, crop residue, and manure conserves available water. Stripcropping, cover crops, grassed waterways, and minimum tillage help to reduce the risks of soil blowing and erosion. Windbreaks also reduce the risk of soil blowing. Contour strips in

Capability subclass IIIe; Michigan management group 4/2a.

MoC—Menominee-Montcalm loamy sands, 6 to 18 percent slopes. This map unit consists of well drained, gently rolling and rolling soils on knolls. It is about 55 percent Menominee soil and 30 percent Montcalm soil. The Menominee soil is on the tops and upper sides of the knolls, and the Montcalm soil is on the sides of the knolls. These two soils are so intricately mixed or are in areas so small that mapping them separately is not practical. Individual areas are irregular in shape and range from 15 to 60 acres in size.

Typically, the Menominee soil has a surface layer of black loamy sand about 3 inches thick. The subsurface layer is brown sand about 3 inches thick. The subsoil is about 38 inches thick. The upper part is dark brown, very friable sand; the next part is yellowish brown, friable loamy

Pasture grasses are grown in a few areas. They grow well early in the season, but the lack of soil moisture in the dry summer months retards growth. Overgrazing results in pasture depletion and susceptibility to soil blowing and erosion. Rotation grazing or strip grazing are effective in reducing the risks of erosion and soil blowing.

These soils are suitable as woodland. Care should be taken to control erosion. The trees can be harvested at any time of the year. After harvest, they usually regener-

40 to 55 inches below the surface and the Menominee soil a clay loam subsoil 20 to 38 inches below the surface.

Permeability is rapid in the Montcalm soil, runoff is slow, and available water capacity is low.

Most areas are wooded. Some are cultivated or pastured. This soil has good potential for pasture, woodland, building site development and recreation uses. It has fair potential for cultivated crops and upland wildlife habitat.

areas are irregular in shape and range from 5 to 80 acres in size.

Typically, the surface layer is dark grayish brown loamy sand about 7 inches thick. The subsoil is very friable loamy sand about 53 inches thick. The upper 25 inches is dark yellowish brown and yellowish brown, and the lower 28 inches is light yellowish brown and has bands of dark brown sandy loam. In places the lower part of the subsoil

The slope, the droughtiness, and the caving of cutbanks limit building site development. Shaping the land and building roads and streets on the contour help to overcome the limitation imposed by slope and reduce the risk of erosion. Frequent watering of lawns is needed unless loam topsoil is added. Shoring walls can keep cutbanks from caving.

The effluent from septic tank absorption fields in this

of other harvested trees. Seedling mortality and plant competition are moderate. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later. Plow planting seedlings in furrows reduces plant competition.

Paths and trails are suitable on this soil, but careful management is needed to control droughtiness and erosion. The grass cover is usually too sparse to withstand the heavy traffic in most recreation areas. Exposed areas should be kept to a minimum. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Snowmobile trails are easily established, but they are subject to erosion because of the lack of enough plant cover. The open and wooded areas serve as fair habitat for wildlife.

The slope, the droughtiness, and the caving of cutbanks limit building site development. Shaping the land and

lack of soil moisture in the dry summer months would retard growth. Overgrazing results in susceptibility to erosion and soil blowing. Rotation grazing and strip grazing can help in controlling erosion and soil blowing.

This soil is suitable as woodland. As a result of the slope, the use of equipment is limited and erosion is a hazard during harvest. Planting trees on the contour and building logging and skid trails on the contour help to reduce the risk of erosion and overcome the equipment limitation. Pine seedlings can be planted after the harvest. Plant competition and seedling mortality are moderate. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later. Plow planting seedlings in furrows reduces plant competition.

This soil is suitable for paths and trails, but careful management is needed to control the erosion that results from the heavy traffic in most recreation areas. Exposed areas should be kept to a minimum. Wood chips can be

Menominee soil is sandy in the upper part of the subsoil and has clay loam in the lower part and in the substratum.

Permeability is moderately slow in the Nester soil, runoff is slow, and available water capacity is high. The shrink-swell potential is moderate in the subsoil and substratum. The surface layer is friable and can be easily tilled

lagoons, but some land shaping may be needed. The included well drained Montcalm soil is suitable as a septic tank absorption field.

Capability subclass IIe; Michigan management group 1.5a.

NeC—Nester loam, 6 to 12 percent slopes. This well

be controlled and equipment more safely used if plowing and planting follow the contour of the land.

This soil is suitable as pastureland. Using the soil as pastureland or hayland is very effective in controlling erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotation grazing or strip grazing, deferment of grazing, and restricted use during wet periods keep the pasture and the soil in good condition.

This soil is suitable as woodland. Trees can be harvested at any time of the year. After harvest, they usually regenerate without replanting. Plant competition is moderate, and the stand can be thinned if necessary.

This soil is suitable for paths and trails, but other recreation uses are limited by the slope and the moderately slow permeability. Some land shaping can be done to lessen the slope. Wetness is a limitation after heavy rains. Keeping exposed areas to a minimum helps to control erosion. Wood chips help to control erosion in the areas where traffic is heavy. The wooded and open areas provide excellent habitat for wildlife.

Building site development is limited by the moderate shrink-swell potential, the low strength, and the slope. The shrinking and swelling can be controlled by constructing dwellings and small buildings without basements, by backfilling around foundations with suitable material, and by providing drainage around foundations. Replacing or covering the upper layer of the soil with suitable base material helps to ensure that local roads or streets function properly. Roads and streets should be built on the contour. Land shaping can lessen the slope.

The moderately slow permeability is a limitation if septic tank absorption fields are installed in this soil. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIIe; Michigan management group 1.5a.

NeD—Nester loam, 12 to 18 percent slopes. This well drained, rolling soil is on hills. Individual areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsurface layer is pale brown loam about 2 inches thick. The subsoil is dominantly dark brown, firm clay loam about 18 inches thick. The substratum to a depth of about 60 inches is dark brown, calcareous clay loam. In places the subsoil is less than 20 inches thick. In some areas the surface layer is clay loam.

Included with this soil in mapping are small areas of the well drained sandy Montcalm and Menominee soils on hillsides. These soils make up about 15 percent of the unit. The Montcalm soil has sandy loam bands in the subsoil. The Menominee soil is sandy in the upper part of the subsoil and has clay loam in the lower part of the subsoil and in the substratum.

Permeability is moderately slow in the Nester soil, runoff is rapid, and available water capacity is high. The shrink-swell potential is moderate in the subsoil and substratum. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It is easily eroded, however, and tends to crust or puddle after hard rains, especially in areas where the plow layer contains subsoil material.

Most areas are pastured or wooded. This soil has good potential for pasture and woodland and as habitat for woodland wildlife. It has fair potential for cultivated crops and poor potential for most recreation uses and for building site development.

This soil is suitable for cultivated crops, but the hazard of erosion is severe if row crops are grown (fig. 13). Stripcropping, cover crops, grassed waterways, minimum tillage or no-till planting, and close-growing crops help to control erosion. A cropping system that includes close-growing crops for a long period reduces the hazard. Droughtiness is a hazard to crops because much of the rainfall runs off.

This soil warms up more slowly in spring than more sandy soils. Drainage is needed in a few scattered wet depressions and drainageways. If the soil is worked when too wet, machinery bogs down and puddling and crusting occur. Plowing the soil at the right moisture content keeps puddling and crusting to a minimum and maintains good tilth. Plowing under green manure crops, crop residue, and manure also maintains tilth. Erosion can be controlled and equipment more safely used if plowing and planting follow the contour of the land.

This soil is suitable as pastureland. Using the soil as pastureland or hayland is very effective in controlling erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotation grazing or strip grazing, deferment of grazing, and restricted use during wet periods keep the pasture and the soil in good condition.

This soil is suitable as woodland. Trees can be harvested at any time of the year. After harvest, they usually regenerate without replanting. Plant competition is moderate, and the stand can be thinned if necessary.

Most recreation uses are limited by the slope and the moderately slow permeability. Paths and trails can be developed if care is taken to control erosion. Camp and picnic areas generally are difficult to establish because of the complex slopes. Keeping exposed areas to a minimum helps to control erosion. Wood chips on the paths and trails also help to control erosion. Wooded areas provide excellent habitat for wildlife.

Building site development is limited by the moderate shrink-swell potential and low strength. The shrinking and swelling can be controlled by constructing dwellings and small buildings without basements, by backfilling around foundations with suitable material, and by providing drainage around foundations. Replacing or covering the upper layer of the soil with suitable base material helps to ensure that roads and streets function properly. Roads and streets should be built on the contour. Land shaping can lessen the slope.

The moderately slow permeability is a limitation if septic tank absorption fields are installed in this soil. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IVe; Michigan management group 1.5a.

OtA—Otisco loamy sand, 0 to 2 percent slopes. This somewhat poorly drained, nearly level soil is in flat areas and depressions. Individual areas are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is dominantly very dark brown loamy sand about 4 inches thick. The subsurface layer is light brownish gray, mottled sand about 7 inches thick. The subsoil is about 39 inches of multicolored, very friable or loose sand that has sandy loam bands. The substratum to a depth of about 60 inches is brown, mottled sand. In places no sandy loam bands are in the lower part of the subsoil.

Included with this soil in mapping are small areas of the somewhat poorly drained Iosco soil throughout the unit and the poorly drained and very poorly drained Roscommon soil in wet depressions. The Iosco soil makes up about 10 percent of the unit and the Roscommon soil 5 percent. The Iosco soil is sandy in the upper part of the subsoil and has clay loam in the lower part of the subsoil and in the substratum.

Permeability is moderately rapid or rapid in the Otisco soil, runoff is slow, and available water capacity is low. In undrained areas the seasonal high water table is within 1/2 foot to 1 1/2 feet of the surface during the period November through May.

thinned and the most productive ones saved. They are usually cut for pulpwood. After harvest, they usually regenerate without replanting. Regrowth is slow at first because seedling mortality is severe. Spruce seedlings should be planted in the open areas as needed.

Recreational uses generally are not practical because of the seasonal high water table and the sandy surface layer. Locating drainage outlets is difficult. Frequent watering of grass helps to overcome the droughtiness of this sandy soil. Snowmobile trails are easily established and maintained. Deep and shallow ponds can be dug, but they fill up slowly. The wooded areas provide excellent habitat for wildlife.

Building site development is severely limited by the seasonal high water table, the caving of cutbanks, and the droughtiness. Construction of dwellings with basements should be avoided because of the seasonal high water table. Shoring walls and pumping excess water help to keep cutbanks from caving. Frequent watering of lawns is needed in midsummer.

The seasonal high water table limits this soil as a site for sewage disposal systems. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIIw; Michigan management group 4b.

Pt—Pits. This map unit consists of areas that have been excavated for sand or gravel (fig. 14). The excavations range from 4 or 5 to more than 40 feet in depth. Some excavations are below the water table. Drainage varies. Individual areas are irregular in shape and range

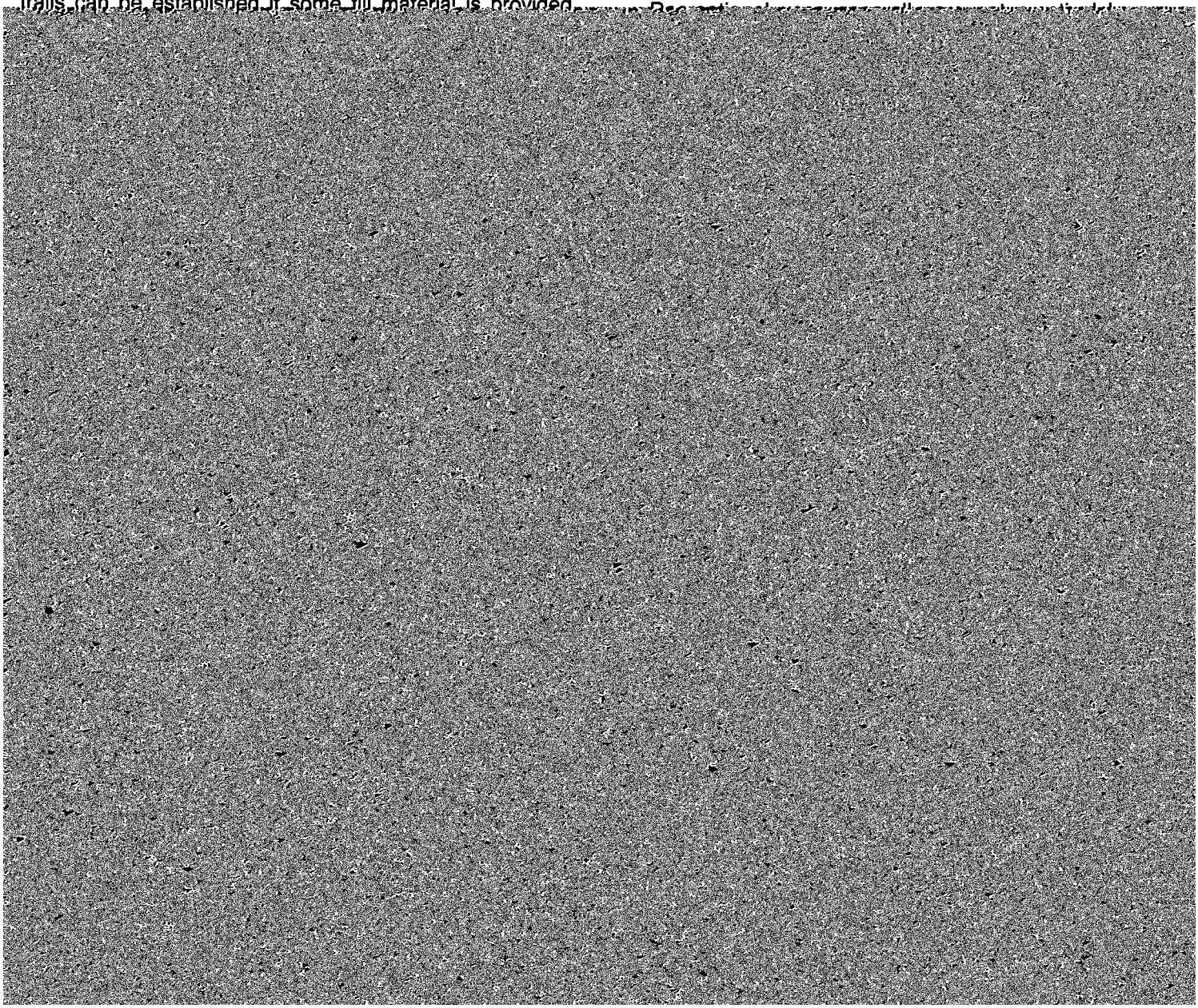
water table is usually very close to the surface throughout the year.

Most areas are covered with marsh grass or are wooded. This soil has good potential for wetland wildlife habitat. It has poor potential for cultivated crops, pasture, woodland, and recreation and engineering uses.

Cultivated crops and pasture grasses are seldom grown because of the instability of the soil and the lack of drainage outlets. The soil has a shallow root zone because of the limited depth to underlying marl. Most areas remain undrained. As a result, the soil is too unstable to support equipment and livestock.

Recreation uses generally are not practical because of the high water table and instability of the soil. Snowmobile trails can be established if some fill material is provided [illegible] up when soil moisture is depleted during July and August. Pasture can be grazed between periods of flooding. The soil is frequently flooded, but the duration is usually brief.

This soil is suitable as woodland. The trees grow slowly because of the seasonal high water table. They should be thinned and the most productive trees saved. The trees are subject to windthrow because of the wetness. They should be harvested during the winter. Equipment tends to bog down in this wet soil during the rest of the year. The trees are usually cut for pulpwood. After harvest, they usually regenerate without replanting. Regrowth is slow at first because of plant competition and seedling mortality. Planting seedlings is usually difficult because the soil is too wet.



uses. It has poor potential for cultivated crops, pasture, and wildlife habitat.

Cultivated crops and pasture grasses are not generally grown because the soil is droughty. Pastures furnish very little forage for livestock.

This soil is suitable as woodland. The trees can be harvested at any time of the year. After harvest, pine seedlings should be planted. Plant competition is moderate. Plow planting seedlings in furrows reduces plant competition. Planting more trees than are needed can com-

This soil is suitable as woodland. As a result of the slope, however, the soil is subject to erosion and the use of equipment is limited during harvest. Designing roads on the contour and properly managing the woodland during cutting can help to control erosion and overcome the equipment limitation. The trees can be harvested at any time of the year. After harvest, pine seedlings should be planted. Plant competition is moderate. It can be reduced by plow planting seedlings in furrows. Planting more trees than are needed can compensate for seedling mortality,

Most areas are pastured or wooded. The wooded areas commonly support red maple, sugar maple, white ash, quaking aspen, and American basswood. This soil has good potential for woodland and as habitat for wetland wildlife. It has fair potential for pasture and poor potential for cultivated crops and for recreation and engineering uses.

Cultivated crops are seldom grown because of the seasonal high water table, the crop damage caused by frost, and the flood hazard. Most areas remain undrained because locating drainage outlets is difficult.

Many areas are pastured. The soil is frequently flooded for brief periods in April and May. Grazing when the soil is too wet causes surface compaction and poor tilth. Deferment of grazing and restricted use during periods of flooding and during other wet periods keep the pasture and the soil in good condition.

This soil is suitable as woodland, but tree growth is restricted by the seasonal high water table. The trees should be harvested during the winter. Equipment tends to bog down in this wet soil during the rest of the year. The trees are subject to windthrow because the soil is wet. They are usually cut for pulpwood. After harvest, they regenerate without replanting. Regrowth is slow at first because of plant competition and seedling mortality. Planting seedlings is usually difficult because the soil is too wet.

Recreation uses generally are not practical because of the seasonal high water table. Locating drainage outlets is difficult. Snowmobile trails can be built if some fill material is provided. Wetland wildlife habitat can be improved by digging shallow ponds. Deep fish ponds can be dug. Wooded areas provide cover for wildlife.

Waste disposal and building site development are severely limited by the seasonal high water table, the flood hazard, the slow permeability, the shrink-swell potential, and the low strength. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities. Construction of buildings with basements should be avoided because of the water table. Frost action on sites for local roads and streets can be reduced by replacing or covering the upper layer of the soil with suitable base material. The shrinking and swelling can be controlled on building sites by constructing dwellings and small buildings without basements, by designing foundations and footings to prevent structural damage, by backfilling around foundations with suitable material, and by providing drainage around foundations.

Capability subclass Vw; Michigan management group 1.5c.

UbB—Ubly sandy loam, 2 to 6 percent slopes. This well drained and moderately well drained, gently undulating soil is on slight rises. Individual areas are irregular in shape and range from 4 to 80 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 4 inches thick. The subsurface layer is [illegible] subsoil is about 24 inches thick. The upper part is dominantly dark brown, friable sandy loam; the next part is strong brown, friable loam; and the lower part is brown, firm loam. The substratum to a depth of about 60 inches is brown, calcareous loam. In a few places the soil is gently rolling.

Included with this soil in mapping are small areas of the somewhat poorly drained Kawkawlin soil in depressions and drainageways and the well drained and moderately well drained sandy Menominee soil on rises. The Kawkawlin soil makes up about 5 to 10 percent of the unit and the Menominee soil 5 percent.

Permeability is moderately rapid in the upper part of the Ubly soil and moderately slow in the lower part. Runoff is slow, and available water capacity is high. The shrink-swell potential is moderate in the lower part of the subsoil and in the substratum. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

This soil is used for cultivated crops, pasture, and woodland. It has good potential for cultivated crops, pasture, and woodland and as habitat for upland wildlife; good to fair potential for recreation uses; and fair to poor potential for building site development.

Cultivated crops are grown on this soil. The soil can be tilled very easily, but careful management is needed to control erosion. Drainage is needed in some of the scattered wet depressions and drainageways. Stripcropping, cover crops, grassed waterways, and minimum tillage help to control erosion.

Use of this soil as pastureland or hayland is effective in controlling erosion. Overgrazing the pasture causes surface compaction and excessive runoff. Rotation grazing or strip grazing keeps the pasture and the soil in good condition.

This soil is suitable as woodland. The trees can be cut for pulpwood or logs at any time of the year. After harvest, they usually regenerate without replanting. Plant competition is moderate, and the stand can be thinned if necessary.

Most recreation uses are suitable on this soil. Playgrounds generally can be established in the less sloping areas. Some land shaping is needed. Wooded and open areas provide excellent habitat for wildlife.

Building site development is limited by the shrinking and swelling of the soil. The shrink-swell potential can be reduced by constructing dwellings and small buildings without basements, by designing foundations and footings to prevent structural damage, by backfilling around foundations with suitable material, and by providing drainage around foundations. On local roads and streets suitable base material is needed to replace or cover the upper part of the soil.

The moderately slow permeability and the high content of clay limit this soil as a site for waste disposal systems. If possible, sanitary facilities should be connected to com-

is suitable as a site for sewage lagoons. Some land shaping is needed.

Capability subclass IIe; Michigan management group 3/2a.

Wh—Wheatley loamy sand. This poorly drained and very poorly drained, nearly level soil is in broad, flat areas and in drainageways. It is subject to frequent flooding for long periods. Individual areas are irregular in shape and range from 3 to 640 acres in size.

Typically, the surface layer is very dark brown loamy sand about 8 inches thick. The upper part of the substratum is grayish brown, mottled sand and gravelly sand, and the lower part to a depth of about 60 inches is grayish brown, calcareous sand and gravel.

Included with this soil in mapping are small areas of the somewhat poorly drained Gladwin soil on slight rises, the

ging shallow ponds. If deep fish ponds are dug, gentle side slopes are needed to prevent caving and sloughing.

This soil is severely limited as a site for buildings or waste disposal systems by the seasonal high water table, the caving of cutbanks, droughtiness, and the flood hazard. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities. Construction of buildings with basements should be avoided because of the water table. Shoring walls and pumping excess water help to keep cutbanks from caving. Frequent watering of lawns is needed in midsummer. Frost action on sites for local roads and streets can be reduced by replacing or covering the upper layer of the soil with suitable base material.

Capability subclass Vw; Michigan management group 5c.

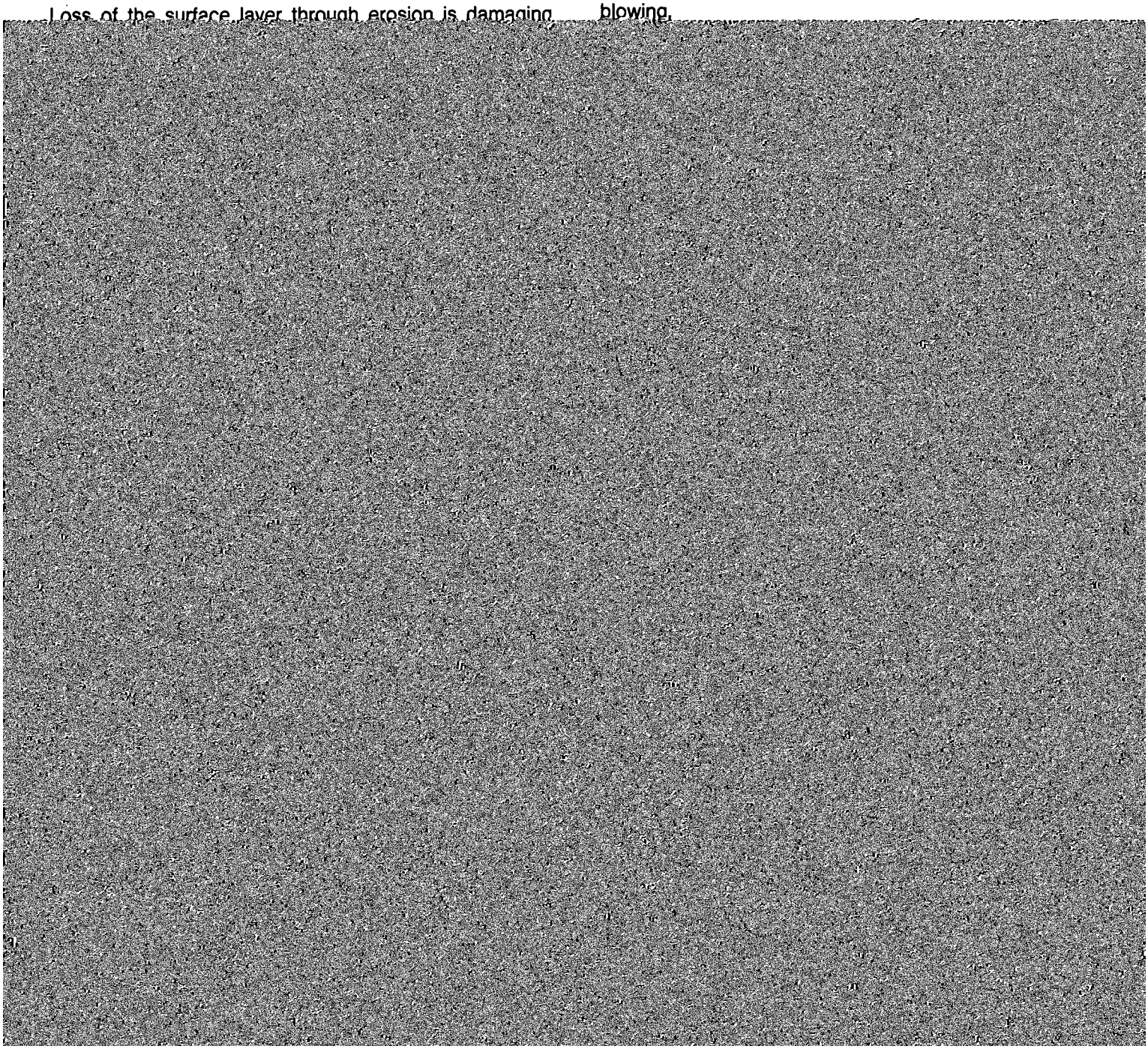
Wn—Winterfield-Eyart complex. This map unit con-

The acreage in crops and pasture has slowly been decreasing as the marginal cropland has been taken out of production. The use of this soil survey to help make land-use decisions that will influence the future role of farming in the county is described under the heading "General soil map for broad land-use planning."

Soil erosion is a major hazard on about two-thirds of the cropland in Clare County. It is a hazard on soils with slopes of more than 2 percent, for example, on McBride and Nester soils.

Loss of the surface layer through erosion is damaging

Soil blowing is a hazard on about half of the cropland in Clare County. It is a hazard on Au Gres, Brevort, Croswell, Gladwin, Graycalm, Mancelona, McBride, Melita, Menominee, Montcalm, Otisco, Roscommon, Rubicon, and Wheatley soils. Soil blowing can damage these soils in a few hours if strong winds prevail and the soils are dry and bare of plant cover or surface mulch. Overgrazing on these soils can result in blowouts and severe erosion. No-tillage, surface mulch, cover crops, stripcropping, windbreaks, and a permanent plant cover help to control soil blowing.



Soil fertility is naturally medium to high in the loamy Kawkawlin, McBride, Nester, and Sims soils. It is low in most sandy soils, such as Au Gres, Graycalm, and Montcalm soils.

Many sandy soils are naturally strongly acid to slightly acid. Unless these soils have been limed, applications of ground limestone are needed to raise the pH level sufficiently for good growth of alfalfa and other crops that grow best on nearly neutral soils. Available phosphorus and potash levels are naturally low to medium in most of these soils.

Lime and fertilizer should be applied according to soil tests (*3*), the need of the crop, and the expected crop yield. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply (*4*).

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils

Applications of lime are needed for all of these crops but blueberries, which are suited to an acid soil.

Most of the well drained soils in the survey area are suited to orchards and nursery plants. Those on south facing slopes generally are better suited. Soils in low positions where frost is frequent and air drainage is poor generally are poorly suited to early vegetables and orchards.

The latest information about growing special crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of

Capability classes and subclasses

class IV are subject to little or no erosion, though they

roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate*, that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior

predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 9 shows, for each kind of soil, the degree and kind of limitations for building site development; table 10, for sanitary facilities. Table 12 shows the kind of limitations for water management. Table 11 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 9. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 9 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Slope and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

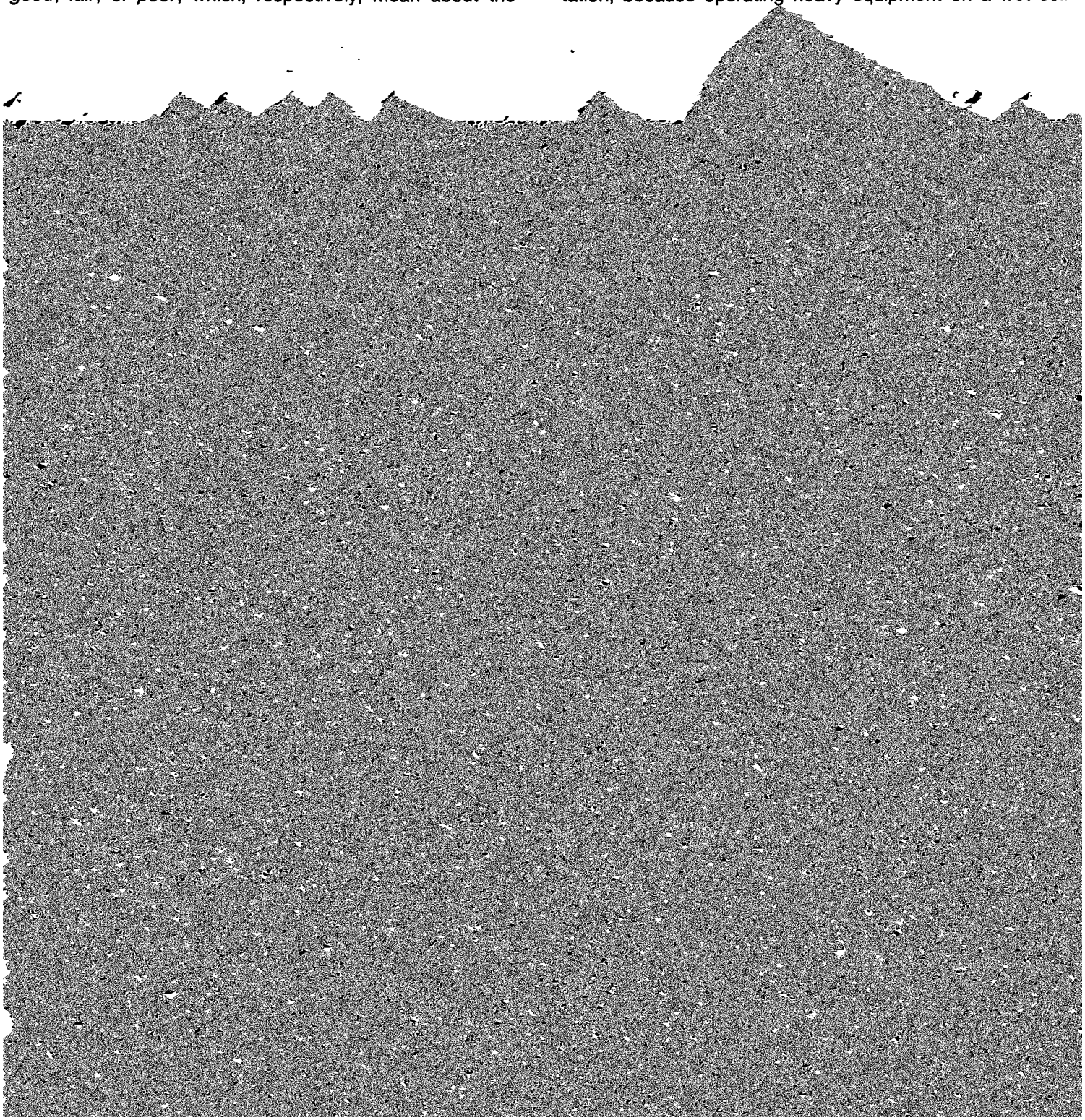
Local roads and streets referred to in table 9 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 10 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local

planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil

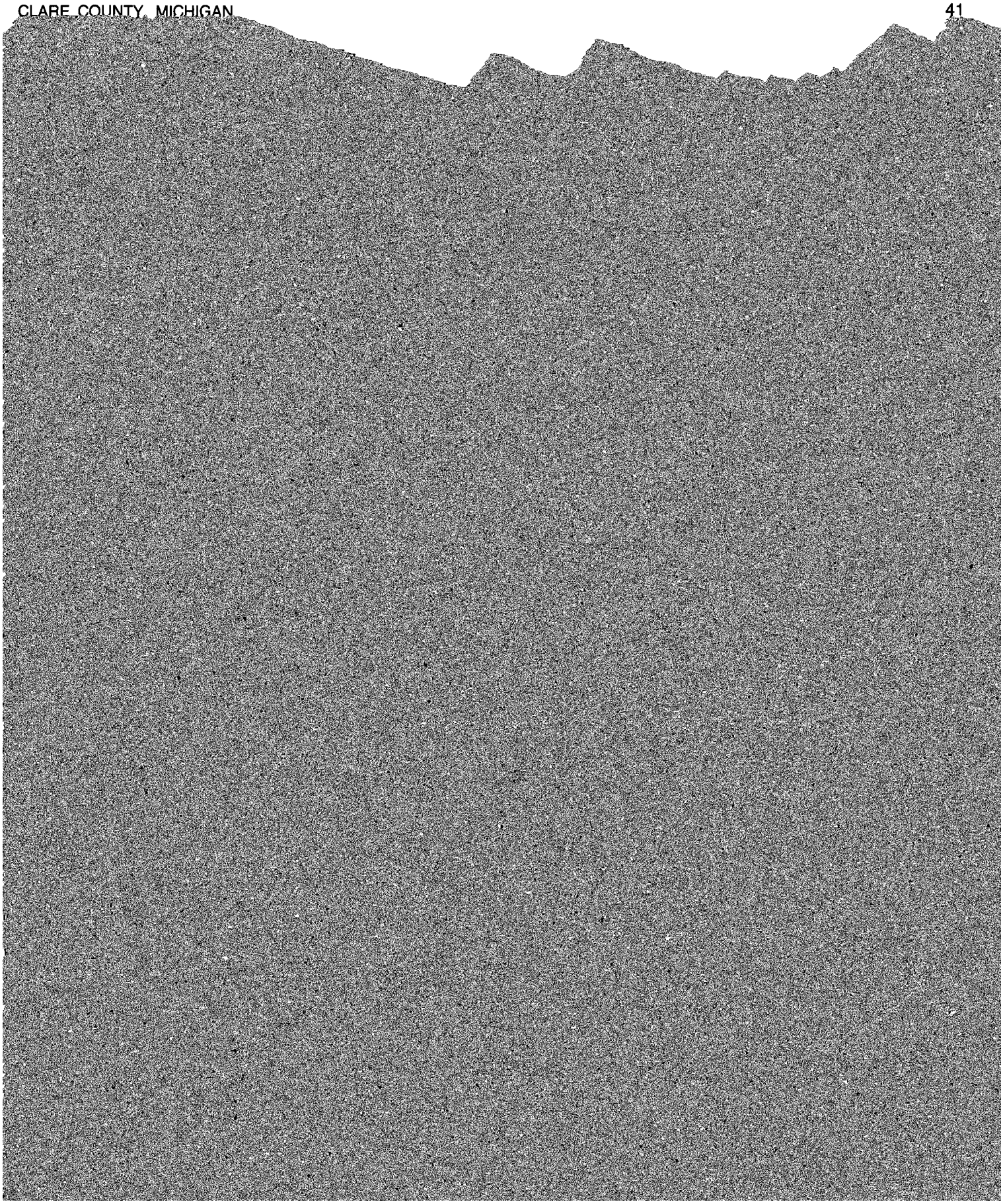


horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 15 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential and few cobbles and stones. They

preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management



Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bluegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are dandelions, goldenrod, ragweed, lambsquarters, and quackgrass.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are oak,

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, killdeer, field sparrow, cottontail rabbit, and red fox.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, owls, raccoon, deer, and bear.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, loons, blackbirds, muskrat, mink, and beaver.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of so

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 15 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 15 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation [illegible] percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 17 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thor-

tinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table, that is, perched or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*8*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Au Gres series

The Au Gres series consists of somewhat poorly drained, rapidly permeable soils. These soils formed in sandy deposits on outwash plains, lake plains, and till plains. Slopes range from 0 to 2 percent.

Au Gres soils are similar to Otisco soils and are commonly adjacent to Croswell, Grayling, Roscommon, and Rubicon soils on the landscape. Croswell soils have mottles between depths of 20 and 40 inches. They are on the slightly higher rises. Grayling and Rubicon soils are on the higher rises. They have no mottles. Also, Grayling soils lack albic and spodic horizons. Roscommon soils are grayer directly below the surface layer than Au Gres soils and lack an albic horizon. They are in wet depressions. Otisco soils have sandy loam bands in the lower part of the subsoil.

Typical pedon of Au Gres loamy sand, 0 to 2 percent slopes, 2,442 feet west and 429 feet south of the northeast corner of sec. 15, T. 18 N., R. 6 W.

A1—0 to 4 inches; black (10YR 2/1) loamy sand; weak medium granular structure; very friable; many fine roots; 1 percent pebbles; medium acid; abrupt wavy boundary.

A2—4 to 13 inches; light brownish gray (10YR 6/2) sand; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium granular structure; very friable; few fine roots; 1 percent pebbles; slightly acid; abrupt wavy boundary.

Bir—13 to 21 inches; dark brown (7.5YR 4/4) sand; few medium distinct dark reddish brown (5YR 3/4) mottles; weak medium subangular blocky structure; very friable and about 20 percent firmly cemented ortstein chunks; very few very fine roots; 1 percent pebbles; slightly acid; abrupt wavy boundary.

C1—21 to 33 inches; yellowish brown (10YR 5/4) sand; few fine distinct dark brown (7.5YR 4/4) mottles; single grained; loose; 1 percent pebbles; slightly acid; clear wavy boundary.

C2—33 to 48 inches; dark yellowish brown (10YR 4/4) sand; single grained; loose; 1 percent pebbles; neu-

C2g—19 to 31 inches; grayish brown (10YR 5/2) sand that has globular masses of loamy sand 1 inch to 3 inches in diameter; common fine distinct yellowish brown (10YR 5/6) and many medium distinct yellowish brown (10YR 5/4) mottles; single grained; loose; few fine roots; 5 percent pebbles; mildly alkaline;

ture; friable; few fine roots; strong effervescence;

B21ir—7 to 12 inches; dark brown (7.5YR 4/4) sand;

A1—0 to 8 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; friable; common fine roots; neutral; abrupt smooth boundary.

C1—8 to 20 inches; grayish brown (10YR 5/2) sand; single grained; loose; few fine roots; neutral; abrupt smooth boundary.

C2—20 to 35 inches; grayish brown (10YR 5/2) sand; many medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; very few very fine roots; neutral; abrupt wavy boundary.

A1b—35 to 37 inches; very dark grayish brown (10YR 3/2) sand; common fine distinct grayish brown (10YR 5/2) mottles; single grained; loose; neutral; abrupt wavy boundary.

C3—37 to 60 inches; grayish brown (10YR 5/2) sand; common fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; neutral.

The A1 horizon has hue of 10YR, value of 2, and chroma of 1 or 2. It is dominantly loam but in some pedons is sand, loamy sand, or sandy loam. It ranges from slightly acid to mildly alkaline and is 7 to 10 inches thick.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is sand, gravelly sand, or sand and gravel. It is slightly acid to moderately alkaline; the pH increases with increasing depth. The content of pebbles ranges, by volume, from 0 to 50 percent.

Gladwin series

The Gladwin series consists of somewhat poorly drained, moderately rapidly permeable soils. These soils formed in calcareous sand and gravel deposits on outwash plains and lake plains. Slopes range from 0 to 2 percent.

Gladwin soils are commonly adjacent to Mancelona and Wheatley soils on the landscape. Mancelona soils lack mottles in the upper part of the subsoil. They are above Gladwin soils on the landscape. Wheatley soils have a grayer subsoil than Gladwin soils. They are in the wetter depressions and drainageways.

Typical pedon of Gladwin loamy sand, 0 to 2 percent slopes, 2,540 feet east and 285 feet north of the southwest corner of sec. 25, T. 17 N., R. 3 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loamy sand; weak fine granular structure; very friable; many fine roots; 3 percent pebbles; slightly acid; abrupt smooth boundary.

A2—8 to 11 inches; grayish brown (10YR 5/2) sand; single grained; loose; common fine roots; 2 percent pebbles; neutral; clear wavy boundary.

B21ir—11 to 22 inches; dark brown (7.5YR 4/4) sand; few fine distinct yellowish brown (10YR 5/6) and light yellowish brown (10YR 6/4) mottles; weak coarse subangular blocky structure; very friable; many fine roots; 2 percent pebbles; slightly acid; abrupt wavy boundary.

B22t—22 to 29 inches; dark brown (7.5YR 4/4) gravelly sandy loam; common coarse distinct light yellowish brown (10YR 6/4) and light gray (10YR 7/2) mottles; weak medium subangular blocky structure; friable, slightly sticky; few fine roots; few thin clay films on faces of peds and in pores; 20 percent pebbles; mildly alkaline; abrupt wavy boundary.

IIC—29 to 60 inches; very pale brown (10YR 7/4) stratified gravel and coarse sand; single grained; loose; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to carbonates range from 24 to 40 inches. Pebbles make up 2 to 20 percent of the volume. The solum ranges from slightly acid to mildly alkaline.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is 2 to 4 inches thick. In cultivated areas an Ap horizon is evident. It ranges from 6 to 10 inches in thickness. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2 or 3. It is sand or loamy sand.

The Bir horizon has hue of 10YR, 7.5YR, or 5YR; value of 3 to 5; and chroma of 3 or 4. It is sand or loamy sand. Some pedons have an A'2 horizon. The Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. It is gravelly sandy loam, sandy loam, or gravelly loamy sand.

The IIC horizon has hue of 10YR, value of 5 to 7, and chroma of 3 or 4. It is gravel and coarse sand or sand and gravel.

Graycalm series

The Graycalm series consists of somewhat excessively drained, rapidly permeable soils. These soils formed in sandy deposits on outwash plains, till plains, and moraines. Slopes range from 0 to 35 percent.

Graycalm soils are commonly adjacent to the Grayling and Montcalm soils on the landscape. Grayling soils lack a spodic horizon and have no bands of loamy sand. Montcalm soils have bands of sandy loam. Grayling soils and both of the adjacent soils are in similar positions on the landscape.

Typical pedon of Graycalm sand, 0 to 6 percent slopes, 2,310 feet west and 700 feet north of the southeast corner of sec. 6, T. 20 N., R. 4 W.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) sand; moderate medium granular structure; very friable; many fine roots; very strongly acid; clear wavy boundary.

B21—3 to 6 inches; dark brown (7.5YR 4/4) sand; weak fine granular structure; very friable; common fine roots; strongly acid; clear irregular boundary.

B22—6 to 13 inches; strong brown (7.5YR 5/6) sand; weak fine granular structure; very friable; few fine roots; medium acid; gradual wavy boundary.

B3—13 to 22 inches; yellowish brown (10YR 5/6) sand; single grained; loose; few fine roots; slightly acid; gradual wavy boundary.

A2—22 to 35 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; very few fine roots; slightly acid; abrupt broken boundary.

A&B—35 to 60 inches; light yellowish brown (10YR 6/4) sand (A'2); single grained; loose; lamellae and bands of brown (7.5YR 5/4) and reddish brown (5YR 5/4) loamy sand (B't); weak medium subangular blocky structure; friable; individual bands are 1/4 inch to 2 inches thick and combined are 5 inches thick; 5 percent pebbles; slightly acid.

The thickness of the solum ranges from 40 to more than 60 inches. Depth to the Bt horizon ranges from 35 to 48 inches. Pebbles make up 0 to 5 percent of the volume. The solum ranges from very strongly acid to slightly acid.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly sand but in some pedons is loamy sand. It is 2 to 5 inches thick. In cultivated areas an Ap horizon is evident. It has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It is 7 to 10 inches thick. Some pedons have an A'2 horizon.

The B2 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. The B3 horizon has hue of 10YR, value of 5 to 7, and chroma of 4 to 6. The A2 horizon has hue of 10YR, value of 5 to 7, and chroma of 3 to 6. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It occurs as bands 1/16 inch to 2 inches thick. The total thickness of the bands within a depth of 60 inches is less than 6 inches.

Some pedons have a C horizon.

Grayling series

The Grayling series consists of excessively drained, very rapidly permeable soils. These soils formed in sandy deposits on outwash plains. Slopes range from 0 to 35 percent.

Grayling soils are commonly adjacent to the Au Gres, Croswell, Graycalm, and Rubicon soils on the landscape. All of these adjacent soils but Graycalm soils have albic and spodic horizons. Au Gres soils have mottles in the upper part of the subsoil. They are in wet depressions and drainageways. Croswell soils have mottles between depths of 20 and 40 inches. They are in slight depressions. Graycalm soils have loamy sand bands, generally below a depth of 40 inches. Grayling, Graycalm, and Rubicon soils are in similar positions on the landscape.

Typical pedon of Grayling sand, 6 to 18 percent slopes, 1,650 feet north and 264 feet east of the southwest corner of sec. 5, T. 20 N., R. 3 W.

A1—0 to 3 inches; black (10YR 2/1) sand; weak medium granular structure; very friable; 50 percent grayish brown (10YR 5/2) uncoated sand grains; common very fine roots; very strongly acid; abrupt smooth boundary.

B21ir—3 to 9 inches; yellowish brown (10YR 5/4) sand; weak fine subangular blocky structure; very friable; few very fine roots; strongly acid; clear smooth boundary.

B22ir—9 to 19 inches; yellowish brown (10YR 5/6) sand; weak fine subangular blocky structure; very friable; few very fine roots; slightly acid; clear wavy boundary.

C—19 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; slightly acid.

The thickness of the solum ranges from 15 to 30 inches. Pebbles make up 0 to 5 percent of the volume.

The A1 horizon has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. It is 2 to 3 inches thick. Some pedons have an A2 horizon.

The Bir horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 4 to 8. Some pedons have a B3 horizon.

The C horizon has hue of 10YR, value of 6 or 7, and chroma of 2 to 4. In some pedons it contains coarse sand.

Greenwood series

The Greenwood series consists of very poorly drained, moderately permeable or moderately rapidly permeable, acid peat soils on moraines and outwash plains. These soils formed in old lakes that were engulfed with herbaceous plants and are now leatherleaf bogs. Slopes range from 0 to 2 percent.

Greenwood soils are commonly adjacent to Loxley and Lupton soils on the landscape. Loxley soils have organic sapric tiers. In this survey area they are mapped with Greenwood soils. Lupton soils are not so acid as Greenwood soils and have organic sapric tiers. Greenwood and Lupton soils are in similar positions on the landscape.

Typical pedon of Greenwood mucky peat, in an area of Loxley and Greenwood mucky peats, 300 feet east and 825 feet south of the northwest corner of sec. 16, T. 18 N., R. 6 W.

Oi1—0 to 6 inches; dark brown (7.5YR 4/4) broken face and rubbed fibric material; about 95 percent fiber, 90 percent rubbed; massive; friable; herbaceous fibers; primarily live roots and sphagnum moss; extremely acid; clear smooth boundary.

Oe1—6 to 10 inches; very dark brown (10YR 2/2) broken face and rubbed hemic material; about 80 percent fiber, 20 percent rubbed; massive; friable; herbaceous fibers; many fine roots; extremely acid; gradual smooth boundary.

Oe2—10 to 35 inches; dark brown (7.5YR 3/2) broken face and rubbed hemic material; about 80 percent

fiber, 20 percent rubbed; massive; friable; herbaceous fibers; common fine roots; extremely acid; gradual smooth boundary.

Oe3—35 to 60 inches; dark brown (7.5YR 3/2) broken face and rubbed hemic material; about 90 percent fiber, 35 percent rubbed; massive; friable; herbaceous fibers; few very fine roots; very strongly acid.

The thickness of the organic tiers ranges from 51 to more than 60 inches. The tiers consist of primarily herbaceous fibers. They have hue of 5YR, 7.5YR, or 10YR; value of 2 to 5; and chroma of 2 to 4. Some pedons have a surface tier of hemic or sapric material. In some pedons the lower two tiers have layers of fibric or sapric material that combined, are less than 10 inches thick.

Iosco series

The Iosco series consists of somewhat poorly drained soils that are rapidly permeable in the upper part and moderately slowly permeable in the lower part. These soils formed in sandy deposits over loamy deposits on till plains, outwash plains, and lake plains. Slopes range from 0 to 3 percent.

Iosco soils are commonly adjacent to the Brevort, Kawkawlin, McBride, Melita, and Menominee soils on the landscape. Brevort soils typically have a grayish brown substratum. They are in wet depressions. Kawkawlin soils are finer textured in the upper part of the subsoil than Iosco soils. In this survey area they are mapped with Iosco soils. McBride soils have a fragipan. Melita soils are sandy in the upper 40 to 60 inches of the solum. McBride, Melita, and Menominee soils have no mottles in the upper part of the subsoil. They are on the higher knolls and hills.

Typical pedon of Iosco loamy sand, in an area of Iosco-Kawkawlin complex, 0 to 3 percent slopes, 120 feet east and 1,090 feet south of the northwest corner of sec. 8, T. 20 N., R. 4 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) loamy sand; weak medium granular structure; very friable; many fine roots; 1 percent cobbles; slightly acid; abrupt smooth boundary.

A2—6 to 9 inches; grayish brown (10YR 5/2) sand; common fine distinct dark brown (7.5YR 4/4) mottles; weak fine granular structure; very friable; few very fine roots; 1 percent cobbles; slightly acid; abrupt broken boundary.

B21ir—9 to 14 inches; dark brown (7.5YR 4/4) loamy sand; common fine distinct yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; dominantly friable but 20 to 30 percent firmly cemented ortstein; few very fine roots; 1 percent cobbles; slightly acid; abrupt wavy boundary.

B22ir—14 to 22 inches; dark brown (10YR 4/3) loamy sand; many medium faint brown (10YR 5/3) and many medium distinct dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; few very fine roots; 3 percent pebbles and cobbles; slightly acid; abrupt wavy boundary.

A'2—22 to 30 inches; brown (10YR 5/3) sand; common medium prominent dark brown (7.5YR 4/4) mottles; single grained; loose; 1 percent cobbles; slightly acid; abrupt smooth boundary.

IIB'21t—30 to 40 inches; brown (7.5YR 5/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; firm; few thin brown (7.5YR 5/4) clay films on faces of peds; 1 percent cobbles; neutral; gradual wavy boundary.

IIB'22t—40 to 60 inches; brown (7.5YR 5/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) and light olive brown (2.5Y 5/4) mottles; weak coarse subangular blocky structure; firm; few thin strong brown (7.5YR 5/6) clay films on faces of peds; 1 percent cobbles; mildly alkaline.

The thickness of the solum and the depth to carbonates range from 30 to more than 60 inches. The depth to the IIB't horizon ranges from 24 to 36 inches. Pebbles and cobbles make up 1 to 5 percent of the volume. The sandy part of the solum ranges from strongly acid to slightly acid.

The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. It ranges from 6 to 10 inches in thickness. In uncultivated areas a 1- to 6-inch A1 horizon is evident. The A2 horizon has hue of 10YR, value of 5 to 7, and chroma of 2 or 3. It is dominantly loamy sand, but the range includes sand.

The Bir horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 to 5; and chroma of 3 to 6. It is sand or loamy sand. The A'2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. The IIB't horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam, sandy clay loam, or silty clay loam. It ranges from slightly acid to mildly alkaline.

Some pedons have a IIC horizon. This horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 1 to 4. It is clay loam or silty clay loam.

Kawkawlin series

The Kawkawlin series consists of somewhat poorly drained, moderately slowly permeable soils. These soils formed in calcareous loamy till on low moraines and till plains. Slopes range from 0 to 4 percent.

Kawkawlin soils are commonly adjacent to the Iosco, Nester, Sims, and Ubly soils on the landscape. Iosco soils are sandy in the upper part of the solum. In this survey area they are mapped with Kawkawlin soils. Nester and Ubly soils do not have grayish mottles in the upper part of the subsoil. They are on the higher rises and hills. Also, Ubly soils are coarser textured in the upper part of the solum than Kawkawlin soils. Sims soils have a grayer subsoil than Kawkawlin soils. They are in wet depressions and drainageways.

Typical pedon of Kawkawlin loam, 0 to 4 percent slopes, 165 feet south and 36 feet west of the northeast corner of sec. 33, T. 18 N., R. 3 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam; moderate medium granular structure; friable; many fine roots; 2 percent cobbles; slightly acid; gradual wavy boundary.

B&A—6 to 11 inches; brown (7.5YR 5/4) silty clay loam (B) and light brownish gray (10YR 6/2) loam (A);

formed in old lakes that were engulfed with herbaceous plants and are now leatherleaf bogs. Slopes range from 0 to 2 percent.

Loxley soils are commonly adjacent to Greenwood and Lupton soils on the landscape. Greenwood soils have organic hemic tiers. In this survey area they are mapped with Loxley soils. Lupton soils are not so acid as Loxley soils and are in about the same position on the landscape as those soils.

Typical pedon of Loxley mucky peat, in an area of

herbaceous plants, then gradually were wooded in many areas, and are now wooded or marshy bogs. Slopes range from 0 to 2 percent.

Lupton soils are commonly adjacent to Greenwood, Markey, and Loxley soils on the landscape. Greenwood and Loxley soils are more acid than Lupton soils. In this survey area they are mapped together. Greenwood soils consist of organic horizons. Markey soils are underlain

Mancelona series

The Mancelona series consists of somewhat excessively drained, moderately rapidly permeable soils. These soils formed in calcareous sandy and gravelly deposits on outwash plains and lake plains. Slopes range from 0 to 12 percent.

Mancelona soils are commonly adjacent to the Gladwin,

ness. In cultivated areas an Ap horizon is evident. It has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It ranges from 6 to 9 inches in thickness. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2 or 3. It is loamy sand or gravelly loamy sand.

The Bir horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is sand, loamy sand, or gravelly loamy sand. Some pedons have an A'2 horizon. The Bt horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5; and chroma of 4 or 6. It is heavy loamy sand, sandy loam, gravelly sandy loam, or sandy clay loam. Some pedons have a B3 horizon.

The IIC horizon has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. It is sand and gravel, coarse sand, or gravelly sand.

Markey series

The Markey series consists of very poorly drained, moderately slowly to moderately rapidly permeable muck soils underlain with sand. These soils are on outwash plains, lake plains, till plains, and moraines. They formed in old shallow lakes that were engulfed with herbaceous plants, then gradually were wooded in many areas, and are now wooded or grassy bogs. Slopes range from 0 to 2 percent.

Markey soils are commonly adjacent to Lupton soils on the landscape. Lupton soils are deep organic soils. They are in about the same position on the landscape as Markey soils.

Typical pedon of Markey muck, 660 feet east and 891 feet north of the southwest corner of sec. 13, T. 17 N., R. 4 W.

Oa1—0 to 9 inches; very dark brown (10YR 2/2) sapric material, black (10YR 2/1) rubbed; about 10 percent fiber, 5 percent rubbed; weak thin platy structure; very friable; herbaceous fibers; many fine roots; mildly alkaline; clear smooth boundary.

Oa2—9 to 12 inches; very dark grayish brown (10YR 3/2) sapric material, very dark brown (10YR 2/2) rubbed; about 20 percent fiber, 5 percent rubbed; weak thin platy structure; very friable; herbaceous fibers; common fine roots; mildly alkaline; clear smooth boundary.

Oa3—12 to 24 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; about 10 percent fiber, 5 percent rubbed; moderate thick platy structure; very friable; herbaceous fibers; few fine roots; about 20 percent mineral soil material; mildly alkaline; gradual wavy boundary.

Oa4—24 to 32 inches; very dark brown (10YR 2/2) sapric material, black (10YR 2/1) rubbed; about 5 percent fiber, less than 5 percent rubbed; weak coarse subangular blocky structure; very friable; herbaceous fibers; less than 10 percent mineral soil material; mildly alkaline; abrupt smooth boundary.

IICg—32 to 60 inches; gray (N 5/0) sand; single grained; loose; mildly alkaline.

The thickness of the sapric material, or the depth to the sandy IIC horizon, ranges from 16 to 50 inches. The sapric material consists of dominantly herbaceous fibers, but woody fibers and fragments can make up as much as 15 percent of the volume. The sapric material ranges from medium acid to mildly alkaline.

The surface tier has hue of 10YR, value of 2, and chroma of 1 or 2. The subsurface and bottom tiers have hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 0 to 2.

The IIC horizon has hue of 2.5Y, 5Y, or 10YR; value of 5 or 6; and chroma of 0 to 2. It ranges from slightly acid to moderately alkaline. In some pedons it is calcareous.

McBride series

The McBride series consists of moderately well drained soils that are moderately rapidly permeable in the upper part and slowly permeable in a brittle layer in the subsoil. These soils formed in loamy till on moraines and till plains. Slopes range from 2 to 12 percent.

McBride soils are commonly adjacent to the Iosco, Kawkawlin, and Montcalm soils on the landscape. None of these adjacent soils have a fragipan. Iosco and Kawkawlin soils have bright mottles in the upper part of the subsoil. They are in slight depressions and drainageways. Also, Iosco soils are coarser textured in the upper part of the solum than McBride soils. Montcalm soils are coarser textured than McBride soils and have sandy loam bands in the solum. They are in about the same position on the landscape as McBride soils.

Typical pedon of McBride sandy loam, 2 to 6 percent slopes, 330 feet north and 2,500 feet east of the southwest corner of sec. 6, T. 20 N., R. 3 W.

A1—0 to 3 inches; black (10YR 2/1) sandy loam; weak medium granular structure; very friable; many very fine roots; 1 percent cobbles; strongly acid; abrupt smooth boundary.

A2—3 to 6 inches; grayish brown (10YR 5/2) sandy loam; weak fine subangular blocky structure; very friable; common very fine roots; 5 percent cobbles; medium acid; abrupt wavy boundary.

Bir—6 to 15 inches; dark brown (7.5YR 4/4) sandy loam; weak fine subangular blocky structure; dominantly very friable, but about 5 percent firmly cemented ortstein chunks; few very fine roots; 5 percent cobbles; medium acid; abrupt wavy boundary.

A'2x—15 to 30 inches; brown (10YR 5/3) and dark yellowish brown (10YR 4/4) loamy sand; massive; brittle and hard when dry; 70 percent of matrix is brittle; 1 percent cobbles; medium acid; clear wavy boundary.

A'&B'x—30 to 38 inches; brown (10YR 5/3) loamy sand (A'2) and dark yellowish brown (10YR 4/4) sandy clay loam (B); weak medium subangular blocky structure; firm (B), brittle when dry (A'2); A'2 surrounds peds of B; 5 percent cobbles; slightly acid; clear wavy boundary.

B'22t—38 to 55 inches; dark brown (7.5YR 4/4) sandy clay loam; weak coarse subangular blocky structure; firm; few thin brown (7.5YR 5/4) clay films on faces of peds; 5 percent cobbles; slightly acid; gradual wavy boundary.

C—55 to 60 inches; dark brown (7.5YR 4/4) sandy loam; massive; friable; 5 percent cobbles; mildly alkaline.

The thickness of the solum, which corresponds to the depth to carbonates, ranges from 40 to more than 60 inches. Pebbles and cobbles make up 1 to 15 percent of the volume. The upper part of the solum ranges from strongly acid to slightly acid, and the lower part ranges from strongly acid to neutral.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly sandy loam but in some pedons is loamy sand. It is 2 to 4 inches thick. In cultivated areas an Ap horizon is evident. It is 6 to 8 inches thick. It has hue of 10YR, value of 3 or 4, and chroma of 2. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2 or 3. It is loamy sand or sandy loam.

The Bir horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4 to 6. The A'2x horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 2 or 3. It is loamy sand or sandy loam. In some pedons it occurs only as part of the A'&B'x horizon. The A'2 part of the A'&B'x horizon has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. The B'2 part has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. The A'2 part is sand or loamy sand, and the B'2 part is sandy loam or sandy clay loam. The B't horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or sandy clay loam.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. It is mildly alkaline or moderately alkaline.

Melita series

The Melita series consists of somewhat excessively drained soils that are rapidly permeable in the upper part and moderately slowly permeable in the lower part. These soils formed in sandy deposits overlying calcareous loamy deposits on till plains, outwash plains, moraines, and lake plains. Slopes range from 0 to 6 percent.

Melita soils are similar to the Menominee soils and are commonly adjacent to Iosco and Montcalm soils on the landscape. Menominee soils are sandy in the upper 20 to 38 inches of the solum. Iosco soils have bright mottles in the upper part of the solum and have a loamy IIB horizon within 40 inches of the surface. They are below Melita soils on the landscape. Montcalm soils lack the loamy IIB and IIC horizons characteristic of Melita soils and have sandy loam bands in the lower part of the solum. They generally are in about the same position on the landscape as Melita soils.

Typical pedon of Melita sand, 0 to 6 percent slopes, 2,376 feet east and 50 feet south of the northwest corner of sec. 32, T. 18 N., R. 5 W.

A1—0 to 2 inches; very dark brown (10YR 2/2) sand; weak fine granular structure; very friable; dark grayish brown (10YR 4/2) uncoated sand grains; many fine roots; 1 percent pebbles; medium acid; abrupt smooth boundary.

A2—2 to 5 inches; grayish brown (10YR 5/2) sand; weak fine granular structure; very friable; many fine roots; 1 percent pebbles; medium acid; abrupt wavy boundary.

B21ir—5 to 12 inches; dark brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; common fine roots; 1 percent pebbles; medium acid; clear wavy boundary.

B22ir—12 to 20 inches; brown (7.5YR 5/4) sand; weak fine subangular blocky structure; very friable; common fine roots; 1 percent pebbles; medium acid; clear wavy boundary.

B23ir—20 to 29 inches; strong brown (7.5YR 5/6) sand; weak fine subangular blocky structure; very friable; few fine roots; 1 percent pebbles; neutral; abrupt wavy boundary.

B3—29 to 53 inches; yellowish brown (10YR 5/4) sand; few fine faint yellowish brown (10YR 5/6) mottles at 40 inches; single grained; loose; very few very fine roots; 1 percent pebbles; neutral; abrupt wavy boundary.

IIB2t—53 to 57 inches; brown (10YR 5/3) clay loam; moderate coarse subangular blocky structure; firm; common thin brown (7.5YR 5/2) clay films on faces of peds; 1 percent pebbles; mildly alkaline; clear wavy boundary.

IIC—57 to 60 inches; brown (10YR 5/3) clay loam; few fine distinct grayish brown (2.5Y 5/2) mottles; massive; firm; 1 percent pebbles; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 40 to more than 60 inches. Depth to the IIB2t horizon ranges from 40 to 55 inches. Pebbles make up 0 to 5 percent of the volume. The sandy part of the solum ranges from strongly acid to neutral. The depth to free carbonates ranges from 50 to more than 60 inches.

The A1 or Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A1 horizon is 1 inch to 3 inches thick. The Ap horizon ranges from 6 to 10 inches in thickness. The A2 horizon has hue of 10YR, value of 5 to 7, and chroma of 2.

The Bir horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 8. It is sand or loamy sand. Some pedons do not have a B3 horizon. Some have an A'2 horizon, which has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. The IIB2t horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam or silty clay loam. It is neutral or mildly alkaline.

The IIC horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam or silty clay

mottles; weak coarse subangular blocky structure; firm; few fine roots; 5 percent pebbles; neutral; clear

are underlain by finer textured material at a depth of 20 to 40 inches. Also, McBride soils have a fragipan. Melita soils are underlain by finer textured material at a depth of 40 to 60 inches. All of the adjacent soils are in about the same position on the landscape as Montcalm soils.

Typical pedon of Montcalm loamy sand, 0 to 6 percent

Nester soils are commonly adjacent to Kawkawlin, Menominee, Sims, and Ubly soils on the landscape. Kawkawlin soils have grayish mottles in the upper part of the subsoil. They are in shallow depressions and drainageways. Menominee soils have 20 to 40 inches of sand or loamy sand over a clay loam substratum. They are on

C2—44 to 60 inches; brown (7.5YR 5/4) clay loam; moderate coarse angular blocky structure; very firm; white (10YR 8/1) lime accumulation covering 65 percent of

B21ir—11 to 17 inches; dark brown (7.5YR 4/4) sand; few fine faint strong brown (7.5YR 5/6) and few medium distinct yellowish red (5YR 4/6) mottles; weak

Rondeau series

The Rondeau series consists of very poorly drained, slowly permeable or very slowly permeable muck soils underlain with marl. These soils formed in old lakes that filled with snail shells and decaying herbaceous plants. These old lakes are now bogs on outwash plains and moraines. Slopes range from 0 to 2 percent.

Typical pedon of Rondeau muck, 500 feet west and 2,475 feet south of the northeast corner of sec. 7, T. 18 N., R. 3 W.

Oa1—0 to 9 inches; black (10YR 2/1) broken face and rubbed sapric material; about 10 percent fiber, essentially none after rubbing; weak medium granular struc-

brighter than that of Roscommon soils. That of Au Gres and Croswell soils is mottled. Au Gres and Croswell soils are higher on the landscape than Roscommon soils, and Rubicon soils are on the highest plains and rises.

Typical pedon of Roscommon mucky loamy sand, 231 feet east and 561 feet south of the northwest corner of sec. 4, T. 19 N., R. 6 W.

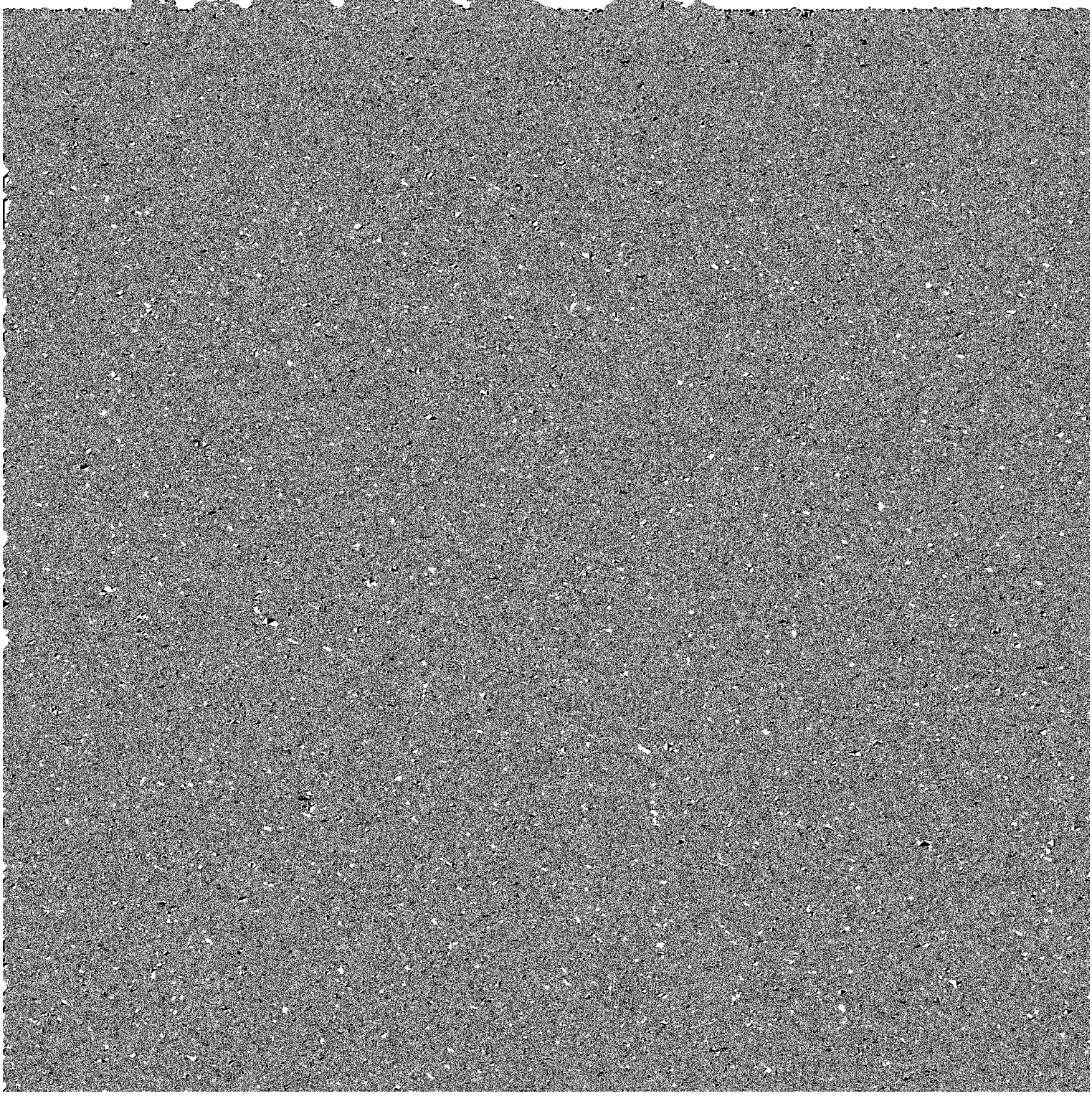
A1—0 to 7 inches; black (10YR 2/1) mucky loamy sand, very dark gray (10YR 3/1) dry; moderate medium granular structure; very friable; many fine roots; 2 percent pebbles; slightly acid; abrupt smooth boundary.

A3—7 to 10 inches; dark grayish brown (10YR 4/2) loamy sand; many medium distinct grayish brown (10YR 5/

A1—0 to 3 inches; black (10YR 2/1) sand; weak fine granular structure; very friable; many fine roots; 1 percent pebbles; very strongly acid; abrupt smooth boundary.

A2—3 to 8 inches; light brownish gray (10YR 6/2) sand; weak fine granular structure; very friable; common

B21g—9 to 21 inches; gray (10YR 5/1) silty clay loam; common fine faint gray (5Y 5/1) and common medium distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; firm; few fine roots; 1 percent pebbles; neutral; clear wavy boundary.



friable; common fine roots; medium acid; abrupt irregular boundary.

Bir—7 to 17 inches; dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; common fine roots; medium acid; clear wavy boundary.

A'2—17 to 18 inches; pale brown (10YR 6/3) sandy loam; weak medium subangular blocky structure; friable; few fine roots; slightly acid; abrupt irregular boundary.

B'21t—18 to 24 inches; strong brown (7.5YR 5/6) loam; moderate coarse subangular blocky structure; friable; pale brown (10YR 6/3) sandy loam coatings on faces of some peds; few fine roots; slightly acid; clear wavy boundary.

IIB'22t—24 to 31 inches; brown (7.5YR 5/4) loam; moderate coarse angular blocky structure; firm; common thin dark brown (7.5YR 4/2) clay films on faces of peds; mildly alkaline; abrupt wavy boundary.

IIC—31 to 60 inches; brown (10YR 5/3) loam; weak medium subangular blocky structure; firm; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 50 inches. Depth to the IIBt horizon ranges from 20 to 40 inches. Pebbles and cobbles make up 0 to 3 percent of the volume. The sandy loam in the upper part of the solum is medium acid or slightly acid, and the IIB'2 horizon ranges from slightly acid to mildly alkaline.

The A1 horizon has hue of 10YR, value of 3, and chroma of 1 or 2. It is 2 to 4 inches thick. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2. In cultivated areas an Ap horizon is evident. It is about 6 to 10 inches thick. It has hue of 10YR, value of 3 or 4, and chroma of 2 or 3.

The Bir horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. The A'2 horizon has hue of 10YR, value of 6, and chroma of 2 or 3. It is loamy sand or sandy loam. Some pedons have a B't horizon or an A'2&IIB't horizon, which grades to the IIB't horizon. The IIB't horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. It is loam, sandy clay loam, or clay loam.

The IIC horizon has hue of 10YR or 7.5YR, value of 5, and chroma of 3 or 4. It is loam or clay loam.

Wheatley series

The Wheatley series consists of poorly drained and very poorly drained, rapidly permeable soils. These soils formed in calcareous sandy and gravelly deposits on outwash plains and lake plains. Slopes range from 0 to 2 percent. The Wheatley soils in this survey area contain less gravel than is defined as the range for the series, but this difference does not alter the use or behavior of the soils.

Wheatley soils are similar to Roscommon soils and are commonly adjacent to Brevort, Gladwin, and Mancelona soils on the landscape. Roscommon and Brevort soils do not contain calcareous sand and gravel in the C horizon. Also, Brevort soils have a silt loam IIC horizon and are in about the same position on the landscape as Wheatley soils. Gladwin soils are brighter colored in the mottled upper part of the control section than Wheatley soils. They are slightly above those soils on the landscape. Mancelona soils have no bright or gray mottles in the upper part of the solum. They are on the highest parts of the landscape. Gladwin and Mancelona soils have an argillic horizon.

Typical pedon of Wheatley loamy sand, 125 feet south and 1,150 feet west of the northeast corner of sec. 24, T. 17 N., R. 3 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loamy sand; moderate medium granular structure; very friable; many fine roots; 5 percent pebbles; neutral; abrupt smooth boundary.

C1g—8 to 29 inches; grayish brown (10YR 5/2) sand; many medium distinct yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; very friable; few fine roots; 10 percent pebbles; neutral; abrupt wavy boundary.

C2g—29 to 40 inches; grayish brown (2.5Y 5/2) gravelly sand; single grained; loose; 25 percent pebbles; slight effervescence; mildly alkaline; gradual wavy boundary.

C3g—40 to 60 inches; grayish brown (2.5Y 5/2) sand and gravel; single grained; loose; 35 percent pebbles; strong effervescence; mildly alkaline.

The depth to free carbonates ranges from 15 to 30 inches.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is 7 to 9 inches thick. In uncultivated areas an A1 horizon is evident. It is 5 to 8 inches thick. It has hue of 10YR, value of 2, and chroma of 1 or 2. The A horizon is, by volume, 1 to 10 percent pebbles. It is neutral or mildly alkaline.

The Cg horizon has hue of 10YR, 5Y, or 2.5Y; value of 5 to 7; and chroma of 1 or 2. The upper part is sand or loamy sand and is 10 to 15 percent pebbles. It is neutral or mildly alkaline. The lower part is sand and gravel, gravelly sand, or coarse sand and gravel and is 25 to 40 percent pebbles.

Winterfield series

The Winterfield series consists of somewhat poorly drained, rapidly permeable soils. These soils formed in sandy deposits on flood plains. Slopes range from 0 to 2 percent.

Winterfield soils are commonly adjacent to the Evart soils on the landscape. Evart soils are grayer in the upper part of the substratum than Winterfield soils. In this survey area they are mapped with those soils.

Typical pedon of Winterfield loamy sand, in an area of Winterfield-Evart complex, 2,409 feet west and 1,320 feet south of the northeast corner of sec. 16, T. 19 N., R. 6 W.

A1—0 to 7 inches; very dark brown (10YR 2/2) loamy sand; moderate medium granular structure; very friable; many fine roots; slightly acid; abrupt smooth boundary.

C1—7 to 19 inches; brown (10YR 5/3) sand; many medium distinct yellowish brown (10YR 5/6) mottles; weak medium granular structure; very friable; few fine roots; neutral; clear wavy boundary.

C2—19 to 31 inches; yellowish brown (10YR 5/4) sand; common fine faint yellowish brown (10YR 5/6) and common medium distinct grayish brown (10YR 5/2) mottles; single grained; loose; few very fine roots; neutral; clear wavy boundary.

C3—31 to 60 inches; pale brown (10YR 6/3) sand; single grained; loose; 3 percent pebbles; neutral.

The A1 horizon has hue of 10YR, value of 2 to 4, and chroma of 2 or 3. It is dominantly loamy sand but in some pedons is sand. It is medium acid or slightly acid and is 6 to 9 inches thick.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. It is dominantly sand but in some pedons is gravelly sand. It is neutral or mildly alkaline. Distinct mottles that have chroma of 2 are within a depth of 40 inches.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Psamment (*Psamm*, meaning a sand texture, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Udipsamments (*Ud*, meaning udic moisture regime, plus *Psamment*, the suborder of Entisols that have a sand texture).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Udipsamments.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae.

plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the processes of soil formation have acted on the parent material (*2*).

Climate and plant and animal life are the active forces in soil formation. They slowly change the parent material into a natural body of soil that has genetically related layers, called horizons. The effects of climate and plant and animal life are conditioned by relief. The nature of the parent material also affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. It may be a long or short time, but some time is required for differentiation of soil horizons. Generally, a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on soils that few generalizations can be

vium deposited along a swift stream, such as the Muskegon River, is coarser textured than that deposited along a slow, sluggish stream, such as the Tobacco River. Colonville, Winterfield, and Evart soils are examples of alluvial soils.

Organic material is a deposit of plant remains. After the glaciers withdrew from the area, water was left standing in depressions in outwash plains, flood plains, moraines, and till plains. As the grasses and sedges growing around the edges of these lakes died, the plant remains did not decompose but remained around the edge of the lakes. Later, water-tolerant trees grew in the areas. As these trees died, their residue became part of the organic accumulation. In this way, the lakes were eventually filled with organic material and developed into areas of muck. Lupton soils formed in organic material.

county, but its effect is modified locally by the proximity to large lakes. Only minor differences in the soils of Clare County are the results of differences in climate.

Relief

Relief, or topography, has affected the soils of Clare County through its influence on natural drainage, erosion, plant cover, and soil temperature. Slopes range from 0 to 35 percent. Natural soil drainage ranges from excessively drained on the hilltops to very poorly drained in the depressions.

Relief influences the formation of soils by affecting runoff and drainage. Drainage in turn, through its effect on aeration, determines the color of the soil. Runoff is most rapid on the steeper slopes. In low areas water is temporarily ponded. Water and air move freely through well drained soils but slowly through very poorly drained soils. Well aerated soils are brightly colored because the iron and aluminium compounds that give most soils their color are oxidized. Poorly aerated soils are dull gray and mottled. Nester soils are examples of well drained, well aerated soils, and Sims soils are examples of poorly drained, poorly aerated soils. These two formed in similar parent material.

Time

Time, usually a long time, is needed for the development of distinct horizons from parent material. Differences in length of time that the parent material has been in place are commonly reflected in the degree of development of the soil profile. Some soils form rapidly; others slowly.

The soils in Clare County range from young to mature. The glacial deposits in which many of the soils formed have been exposed to soil-forming factors for a long enough time that distinct horizons have developed. Some soils forming in recent alluvial sediments have not been in place long enough for the development of distinct horizons.

Evart soils are examples of young soils formed in alluvial material. Sims soils are more mature. Horizons are more clearly expressed because much of the lime has been leached out.

Processes of soil formation

Several processes were involved in the development of soil horizons in the soils of Clare County: (1) accumulation of organic matter, (2) leaching of lime (calcium carbonates) and other bases, (3) reduction and transfer of iron, and (4) formation and translocation of silicate clay minerals. In most soils more than one of these processes has been active in the development of horizons.

Organic matter accumulates at the surface to form an [illegible] ganic-matter content. Roscommon soils, for example, have a high organic-matter content in the surface layer and Grayling soils a low organic-matter content (*5*).

Leaching of carbonates and other bases has occurred in most of the soils. Soil scientists generally agree that leaching of bases in soils usually precedes the translocation of silicate clay minerals. Many of the soils are moderately to strongly leached. For example, Melita soils are leached of carbonates to a depth of 57 inches, whereas Kawkawlin soils are leached to a depth of only 24 inches. Other factors being equal, differences in the depth of leaching are a result of time as a soil-forming factor.

The reduction and transfer of iron, a process called gleying, is evident in the somewhat poorly drained, poorly drained, and very poorly drained soils. The gray color in the subsoil indicates the reduction and loss of iron. Gleying and the reduction processes are evident, for example, in Sims soils.

Leaching of bases and translocation of silicate clays are among the more important processes in horizon differentiation in soils. In some soils translocation of clay minerals has contributed to horizon development. The eluviated, or leached, A2 horizon above an illuviated B horizon commonly has a platy structure, is lower in content of clay, and typically is lighter in color. The B horizon typically has an accumulation of clay and clay films in pores and on ped surfaces. The soils were probably leached of carbonates and soluble salts to a considerable extent before the translocation of silicate clay. Nester soils are examples of soils having translocated clay accumulated in the B horizon.

In some soils iron, aluminum, and humus have moved from the A horizon to the B horizon. The color of the B horizon in such soils is dark brown. Au Gres, Croswell, and Gladwin soils are examples of soils in which translocated iron, aluminum, and humus have affected the B horizon.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

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

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex soil. A map unit of two or more kinds of soil

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Delta. An alluvial deposit, commonly triangular in shape, formed largely beneath water and deposited at the mouth of a river or stream.

Diversion (or diversion terrace). A ridge of earth, gener-

water they receive is lost as runoff. All are free of the mottling related to wetness.

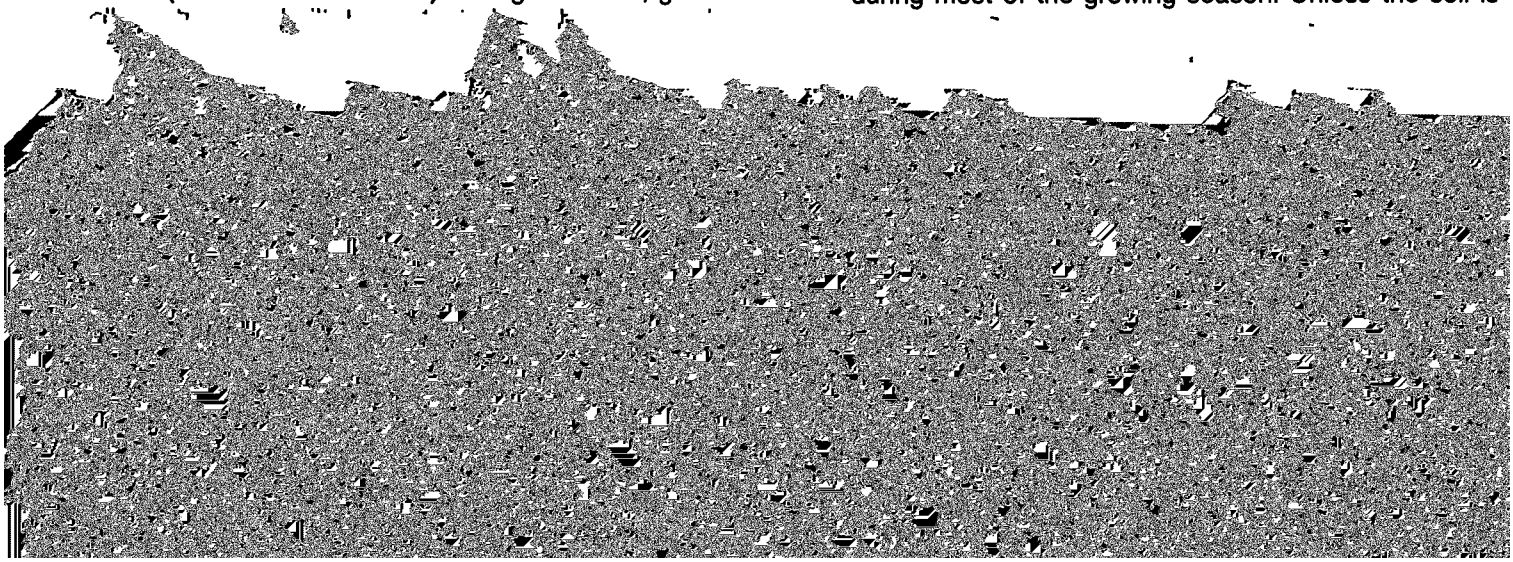
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is



Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper

fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

normally lives, as opposed to the range or geographical distribution.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse* more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Outwash, glacial. Stratified sand and gravel produced by

word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the basis of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Polypedon. A volume of soil having properties within the limits of a soil series, the lowest and most homogene-

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying

processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

sandy clay, silty clay, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tile drain. Concrete, plastic, or ceramic pipe installed at suitable depths and intervals in the soil to provide water outlets from the soil.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil (engineering). A presumably fertile soil or soil

ILLUSTRATIONS

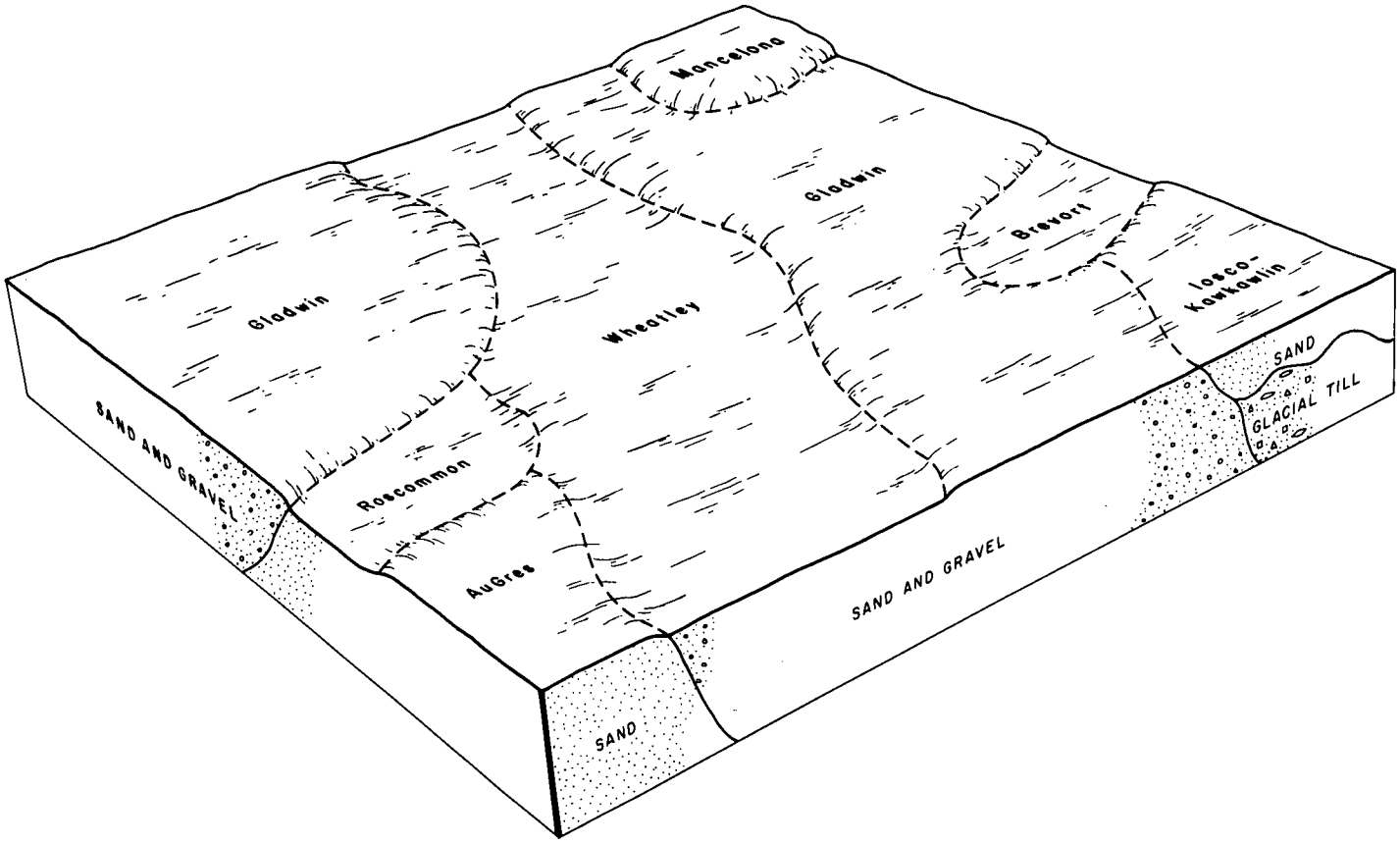
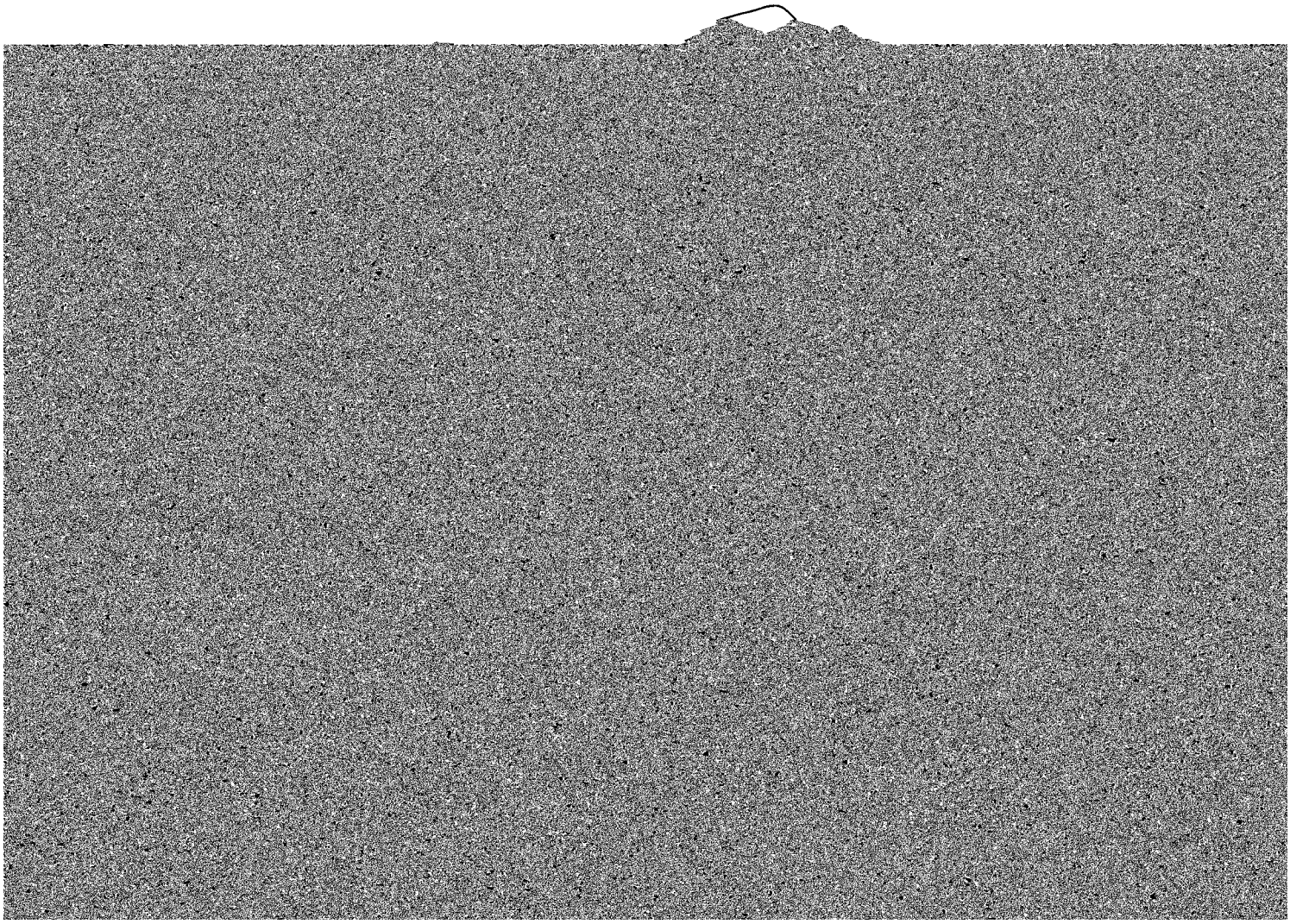
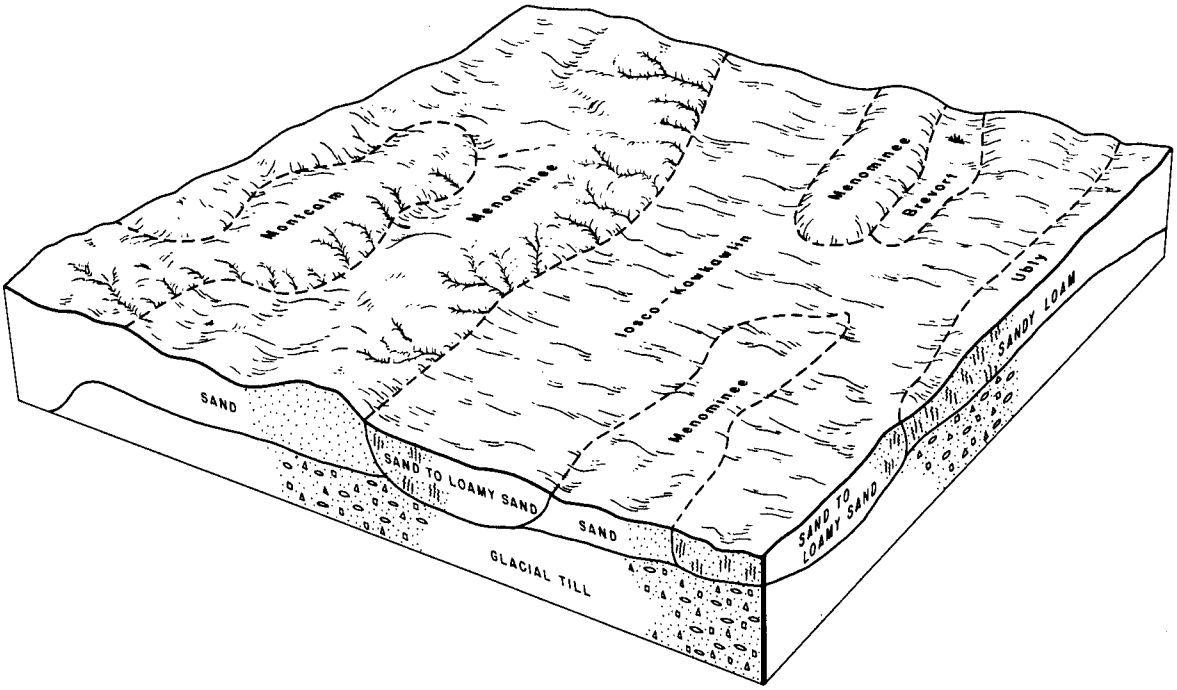


Figure 1..—Typical pattern of soils and underlying material in the Mancelona-Gladwin-Wheatley map unit.

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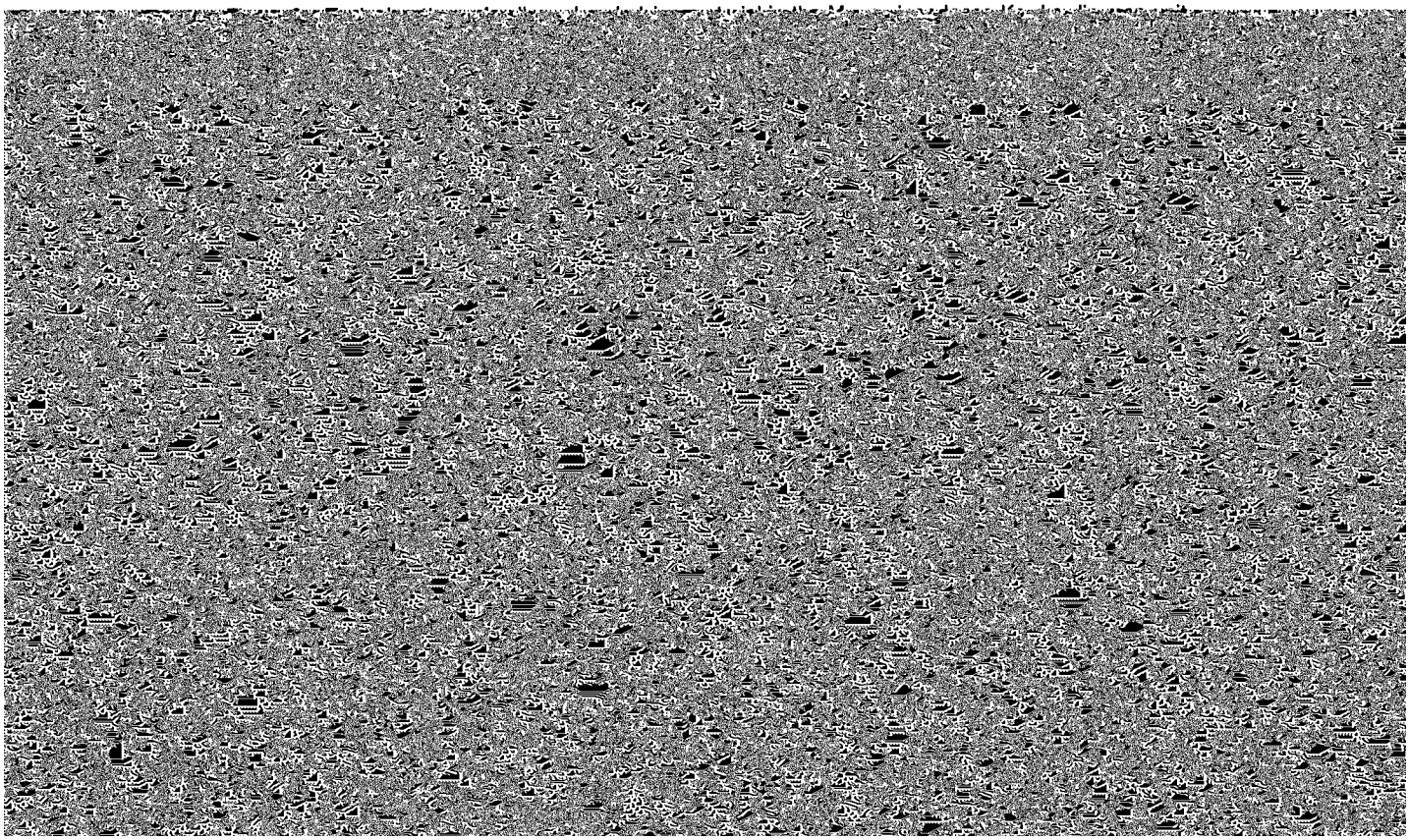

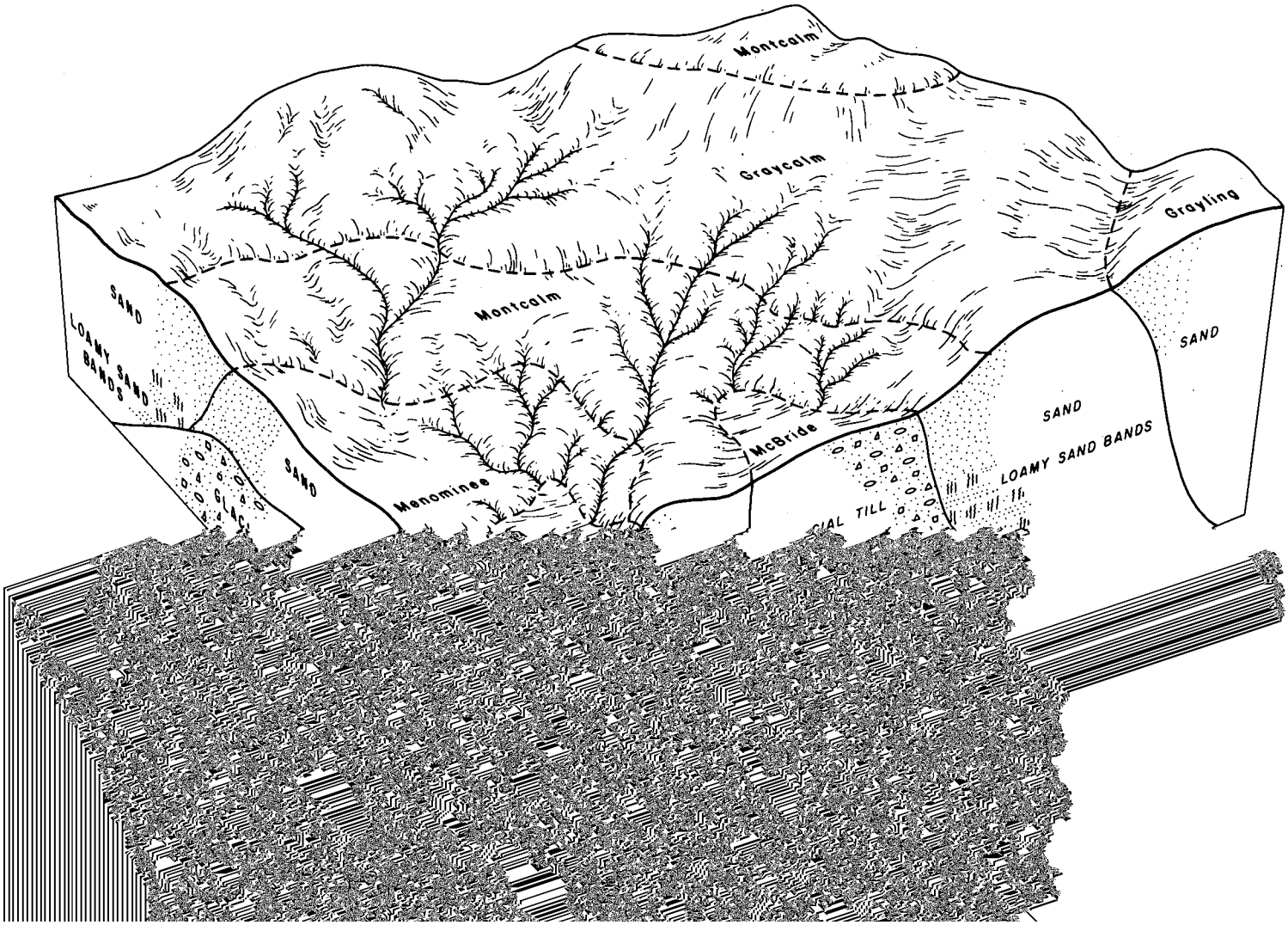
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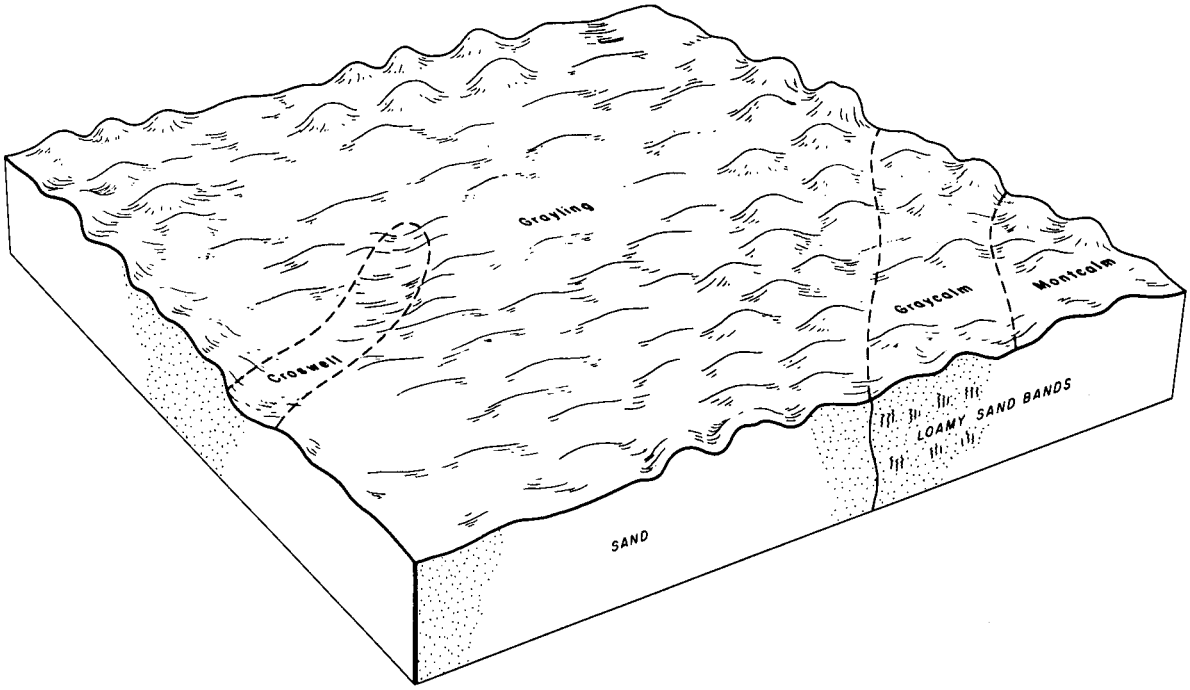


Figure 6.—Typical pattern of soils and underlying material in the Grayling map unit.

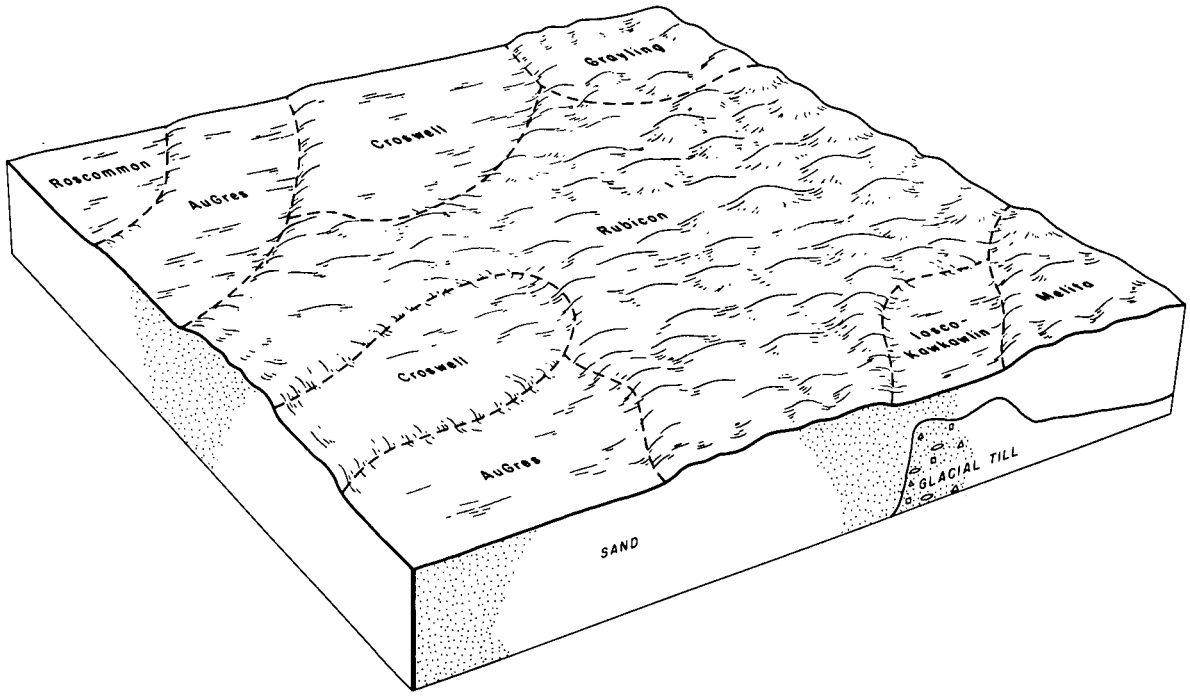


Figure 7.—Typical pattern of soils and underlying material in the Rubicon-Croswell-Au Gres map unit.

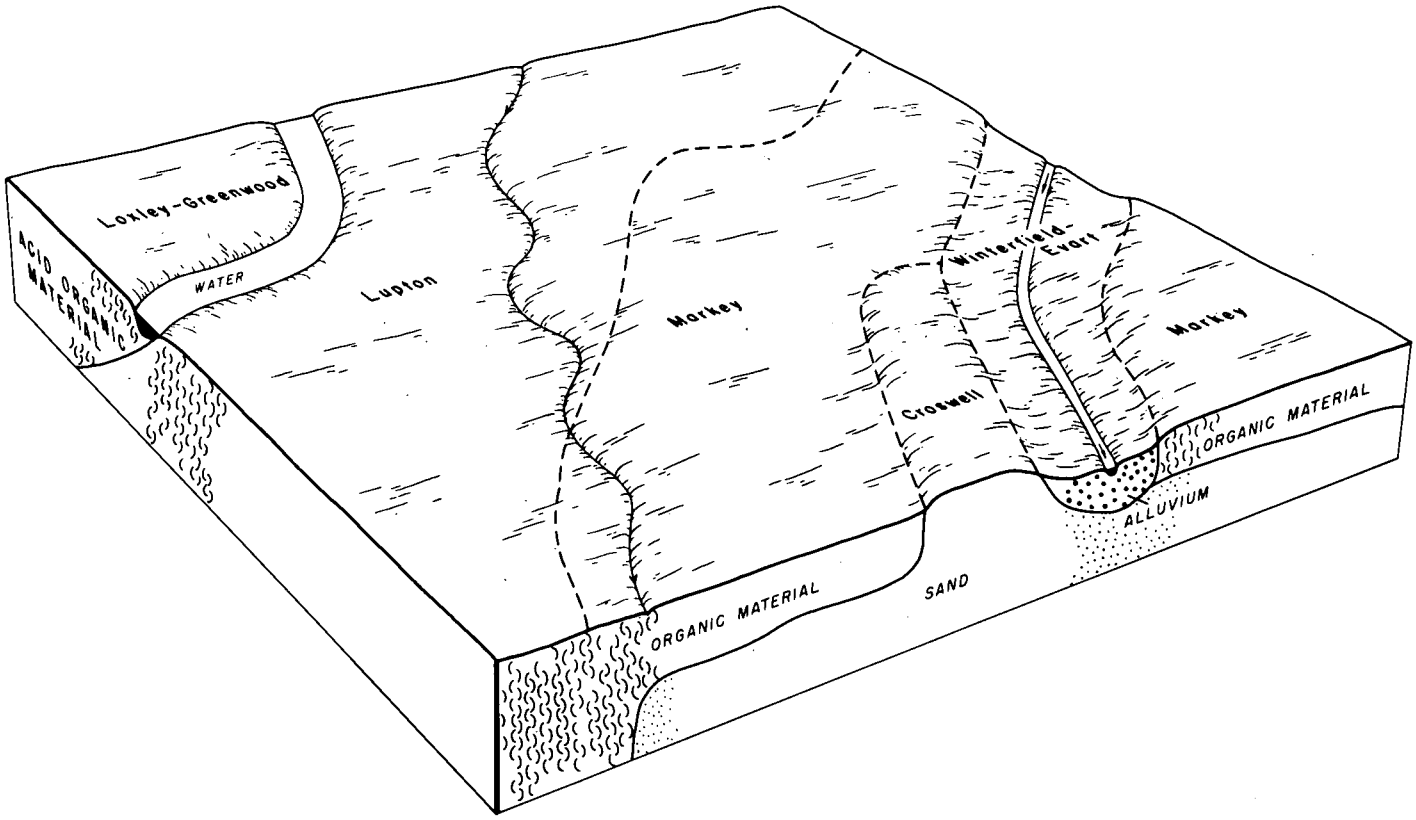


Figure 8.—Typical pattern of soils and underlying material in the Lupton-Markey map unit.

Figure 9.—Flooding in an area of Colonville fine sandy loam. The Tobacco River commonly floods this area. The house is on the boundary of the flood plain.

Figure 10.—A formerly cultivated area of Graycalm sand, 0 to 6 percent slopes, now used for timber production.

Figure 11.—A hilly area of Grayling sand, 18 to 35 percent slopes. Because the plant cover is sparse, snowmobile trails are easily established.

Figure 12.—A typical area of Markey muck, which is covered mostly with cattails and cedar. This soil is too unstable for foot traffic during most of the year.

Figure 13.—Erosion on Nester loam, 12 to 18 percent slopes. The plant cover helps to control erosion.

Figure 14.—A typical area of Pits. Most of these areas are rough and have sparse plant cover.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

[Recorded in the period 1946-75 at Gladwin]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	28.8	11.2	20.0	50	-16	0	1.79	.9	2.5	5	13.1
February---	30.9	11.5	21.2	49	-15	0	1.48	.7	2.2	5	11.5
March------	39.9	20.3	30.1	68	-6	2	2.10	1.3	2.8	6	8.4
April------	55.7	32.0	43.9	82	14	47	2.93	1.8	3.9	6	2.3
May--------	67.9	41.6	54.7	89	25	199	3.04	1.8	4.2	7	T[2]
June-------	78.2	51.6	64.9	95	34	456	3.55	1.9	5.0	6	0
July-------	81.8	55.8	68.8	94	41	591	3.39	1.6	4.9	6	0
August-----	80.1	54.3	67.2	95	39	540	3.30	1.6	4.8	6	0
September--	71.4	46.1	58.8	91	27	285	3.14	1.8	4.3	7	T[2]
October----	61.6	37.5	49.5	84	18	107	2.61	1.1	3.9	6	.2
November---	44.8	27.7	36.2	69	5	8	2.56	1.7	3.3	6	4.1
December---	32.9	17.5	25.2	58	-10	0	2.41	1.2	3.5	6	11.6
Year------	56.2	33.9	45.0	98	-18	2,235	32.30	28.5	36.0	72	51.3

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

[2]Trace.

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1946-75 at Gladwin]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 5	May 19	June 3
2 years in 10 later than--	April 30	May 14	May 29
5 years in 10 later than--	April 21	May 5	May 20
First freezing			

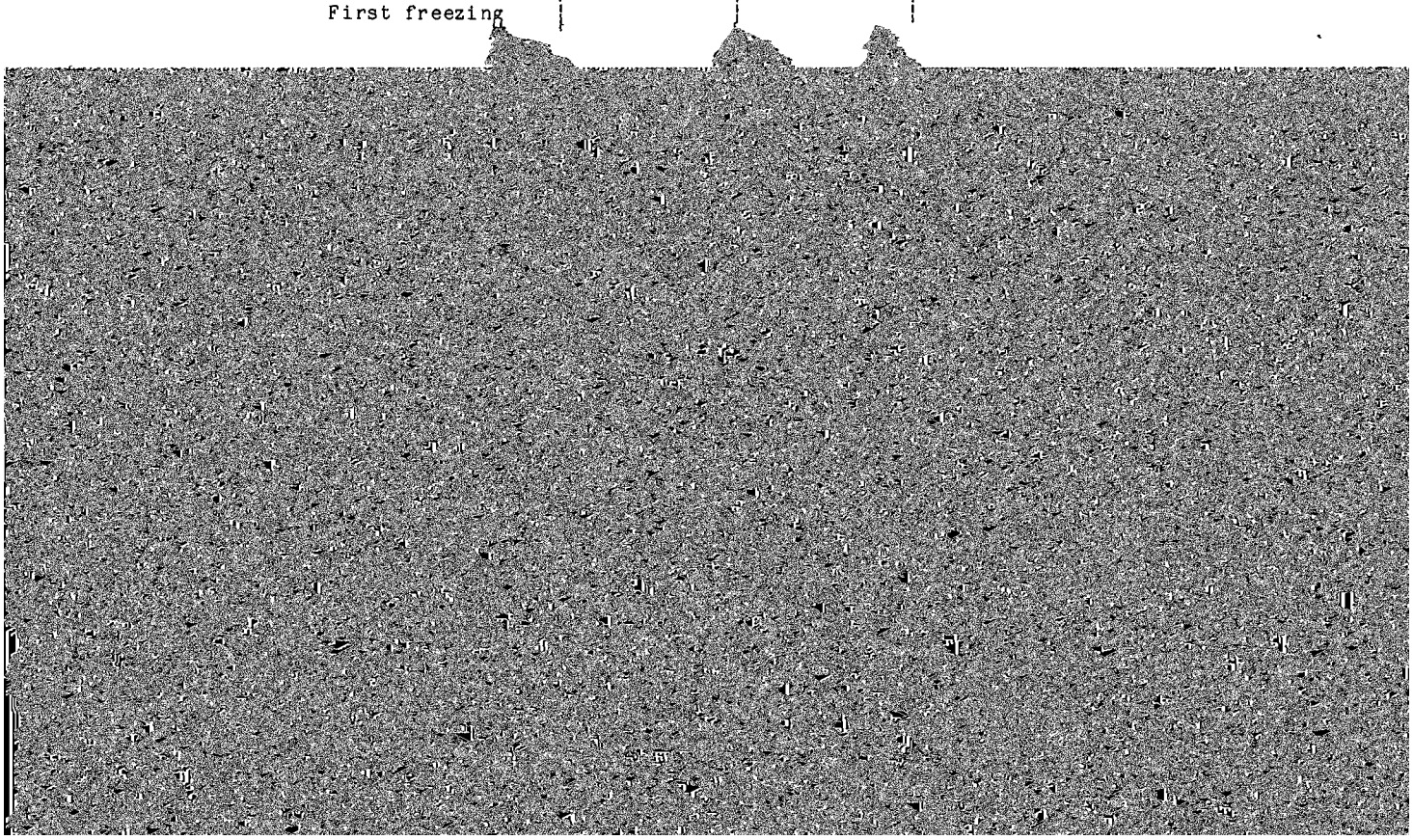


TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
AuA	Au Gres loamy sand, 0 to 2 percent slopes	6,730	1.8
Br	Brevort loamy sand	3,460	1.0
Co	Colonville fine sandy loam	2,110	0.6
CrB	Croswell sand, 0 to 4 percent slopes	12,380	3.4
GaA	Gladwin loamy sand, 0 to 2 percent slopes	3,940	1.1
GrB	Graycalm sand, 0 to 6 percent slopes	40,160	11.0
GrC	Graycalm sand, 6 to 18 percent slopes	24,175	6.6
GrD	Graycalm sand, 18 to 35 percent slopes	4,190	1.1
GyB	Grayling sand, 0 to 6 percent slopes	29,465	8.1
GyC	Grayling sand, 6 to 18 percent slopes	3,125	0.9
GyD	Grayling sand, 18 to 35 percent slopes	515	0.1
Hs	Histosols, ponded	2,030	0.6
IkA	Iosco-Kawkawlin complex, 0 to 3 percent slopes	10,695	2.9
KwB	Kawkawlin loam, 0 to 4 percent slopes	10,725	2.9
Lg	Loxley and Greenwood mucky peats	3,100	0.9
Lu	Lupton muck	21,330	5.8
MaB	Mancelona loamy sand, 0 to 6 percent slopes	8,180	2.2
MaC	Mancelona loamy sand, 6 to 12 percent slopes	775	0.2
Mb	Markey muck	18,040	4.9
McB	McBride sandy loam, 2 to 6 percent slopes	8,735	2.4
McC	McBride sandy loam, 6 to 12 percent slopes	2,465	0.7
MeB	Melita sand, 0 to 6 percent slopes	2,590	0.7
MnB	Menominee loamy sand, 0 to 6 percent slopes	14,760	4.0
MnC	Menominee loamy sand, 6 to 12 percent slopes	3,250	0.9
MoC	Menominee-Montcalm loamy sands, 6 to 18 percent slopes	510	0.1
MtB	Montcalm loamy sand, 0 to 6 percent slopes	27,060	7.4
MtC	Montcalm loamy sand, 6 to 12 percent slopes	15,675	4.3
MtD	Montcalm loamy sand, 12 to 18 percent slopes	4,385	1.2
MtE	Montcalm loamy sand, 18 to 35 percent slopes	3,175	0.9
NeB	Nester loam, 2 to 6 percent slopes	20,000	5.5
NeC	Nester loam, 6 to 12 percent slopes	10,645	2.9
NeD	Nester loam, 12 to 18 percent slopes	3,270	0.9
OtA	Otisco loamy sand, 0 to 2 percent slopes	1,515	0.4
Pt	Pits	1,080	0.3
Rn	Rondeau muck	375	0.1
Ro	Roscommon mucky loamy sand	7,035	1.9
RuB	Rubicon sand, 0 to 6 percent slopes	9,170	2.5
RuC	Rubicon sand, 6 to 18 percent slopes	3,040	0.8
Sm	Sims clay loam	5,100	1.4
UbB	Ubly sandy loam, 2 to 6 percent slopes	2,315	0.6
Wh	Wheatley loamy sand	3,935	1.1
Wn	Winterfield-Evart complex	5,290	1.4
	Water	5,580	1.5
	Total	366,080	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[All yields were estimated for a high level of management. Only arable soils are listed. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Grass hay	Pasture
	Bu	Ton	Bu	Bu	Ton	Ton	AUM*
AuA---------- Au Gres	50	10	45	25	2.2	1.7	3.4
CrB---------- Croswell	50	10	45	30	2.5	1.8	3.6
GaA---------- Gladwin	65	12	60	33	2.8	2.1	4.2
GrB---------- Graycalm	50	10	40	25	2.5	1.6	3.2
GrC---------- Graycalm	---	---	---	---	2.3	1.5	3.0
GyB, GyC---------- Grayling	---	---	---	---	---	1.6	3.2
IkA---------- Iosco-Kawkawlin	87	16	80	41	3.8	3.0	6.0
KwB---------- Kawkawlin	95	16	85	45	4.0	3.2	6.4
MaB---------- Mancelona	70	13	60	40	3.0	2.4	4.8
MaC---------- Mancelona	65	12	55	35	2.6	2.2	4.8
McB---------- McBride	75	14	75	35	3.5	2.5	5.4
McC---------- McBride	70	13	70	30	3.3	2.3	5.0
MeB---------- Melita	45	8	35	25	2.2	1.8	3.0
MnB---------- Menominee	70	13	70	35	3.5	2.5	5.0
MnC---------- Menominee	65	12	65	30	3.3	2.3	4.6
MoC---------- Menominee-Montcalm	65	12	60	35	3.1	2.3	4.6
MtB---------- Montcalm	70	12	60	38	3.0	2.4	4.8
MtC---------- Montcalm	65	11	55	35	2.8	2.3	4.6
MtD---------- Montcalm	---	---	50	24	2.8	2.0	4.0
MtE---------- Montcalm	---	---	---	---	2.5	2.0	4.0
NeB---------- Nester	80	14	75	40	4.0	2.7	5.4

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Grass hay	Pasture
	Bu	Ton	Bu	Bu	Ton	Ton	AUM*
NeC---------- Nester	70	13	70	36	4.0	2.7	5.4
NeD---------- Nester	60	11	65	32	3.8	2.7	5.4
OtA---------- Otisco	70	13	65	30	3.0	2.5	5.0
RuB, RuC---------- Rubicon	---	---	---	---	---	1.6	3.2

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
AuA---------- Au Gres	Slight	Slight	Severe	Slight	Slight	Quaking aspen--------	60	White spruce, black spruce, eastern white pine, northern white-cedar, Norway spruce, Austrian pine, white ash.
						Bigtooth aspen-------	60	
						Balsam fir----------	53	
						Paper birch---------	55	
						Sugar maple---------	53	
						Red maple----------	56	
						Eastern hemlock-----	---	
						Eastern white pine--	53	
Br---------- Brevort	Slight	Severe	Severe	Severe	Severe	Quaking aspen--------	40	
						Sugar maple---------	40	
						Balsam fir----------	40	
						Northern white-cedar	15	
						American basswood---	40	
						Red maple----------	40	
						Silver maple--------	65	
						Black spruce--------	15	
Co---------- Colonville	Slight	Slight	Slight	Slight	Moderate	Red maple----------	61	White spruce, eastern cottonwood, eastern white pine, northern white-cedar, Norway spruce, red maple, northern red oak.
						Sugar maple---------	61	
						Swamp white oak-----	66	
						American basswood---	65	
						Northern white-cedar	45	
						White ash----------	65	
						Balsam fir----------	61	
CrB----------	Slight	Slight	Severe	Slight	Severe	Red pine----------	61	Red pine,

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
GyB, GyC---------- Grayling	Slight	Slight	Severe	Slight	Slight	Jack pine----------	45	Jack pine, red pine.
						Northern pin oak----	45	
						White oak----------	45	
						Red pine----------	45	
						Quaking aspen-------	50	
GyD---------- Grayling	Moderate	Moderate	Severe	Slight	Slight	Jack pine----------	45	Jack pine, red pine.
						Northern pin oak----	45	
						White oak----------	45	
						Red pine----------	45	
						Quaking aspen-------	50	
IkA*:								
Iosco----------	Slight	Slight	Severe	Slight	Slight	Quaking aspen-------	60	White spruce, black spruce, eastern white pine, northern white-cedar, Norway spruce, Austrian pine.
						White ash----------	55	
						Sugar maple---------	53	
						Red maple----------	56	
						Yellow birch--------	53	
						Northern pin oak----	56	
						Eastern white pine--	53	
Kawkawlin---------	Slight	Moderate	Slight	Slight	Moderate	Sugar maple---------	61	White spruce, red pine, Norway spruce, Austrian pine.
						Northern red oak----	66	
						Swamp white oak-----	66	
						Red maple----------	66	
						White ash----------	65	
						Shagbark hickory----	---	
						American basswood---	65	
						Quaking aspen-------	70	
						Bigtooth aspen------	70	
KwB---------- Kawkawlin	Slight	Slight	Slight	Slight	Moderate	Sugar maple---------	61	White spruce, red pine, Norway spruce, Austrian pine.
						Northern red oak----	66	
						Swamp white oak-----	66	
						Red maple----------	66	
						White ash----------	65	
						Shagbark hickory----	---	
						American basswood---	65	
						Quaking aspen-------	70	
						Bigtooth aspen------	70	
Lg*:								
Loxley----------	Slight	Severe	Severe	Severe	Severe	Balsam fir----------	39	
						Black spruce--------	15	
						European larch------	---	
						Tamarack----------	35	
						Jack pine----------	39	
						Northern white-cedar	15	
						White spruce--------	40	
Greenwood---------	Slight	Severe	Severe	Severe	Severe	Balsam fir----------	39	
						Black spruce--------	15	
						Tamarack----------	35	
						Red maple----------	40	
						Silver maple--------	65	
						Black cherry--------	---	
Lu---------- Lupton	Slight	Severe	Severe	Severe	Severe	Balsam fir----------	42	
						Black ash----------	11	
						Northern white-cedar	26	
						Paper birch---------	45	
						Silver maple--------	66	
						Quaking aspen-------	46	
						Black ash----------	41	

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
MaB, MaC---------- Mancelona	Slight	Slight	Moderate	Slight	Moderate	Sugar maple---------	61	Red pine, eastern white pine, Austrian pine, jack pine, white spruce.
						Northern red oak----	66	
						Red pine----------	61	
						Jack pine----------	65	
						Eastern white pine--	61	
						Quaking aspen-------	70	
Mb---------- Markey	Slight	Severe	Severe	Severe	Severe	Balsam fir----------	40	
						Black spruce--------	15	
						Tamarack----------	35	
						Black ash----------	37	
						Quaking aspen-------	45	
						Northern white-cedar	15	
						Paper birch---------	40	
McB, McC---------- McBride	Slight	Slight	Moderate	Moderate	Moderate	Sugar maple---------	61	White spruce, eastern white pine, Norway spruce.
						Yellow birch--------	61	
						American basswood---	65	
						Eastern hemlock-----	---	
						Balsam fir----------	61	
						Northern red oak----	66	
						Red pine----------	61	
						Quaking aspen-------	70	
						Eastern white pine--	61	
MeB---------- Melita	Slight	Slight	Severe	Slight	Moderate	Sugar maple---------	61	Red pine, eastern white pine.
						Quaking aspen-------	70	
						Red pine----------	61	
						Red maple----------	66	
						Eastern white pine--	61	
						Yellow birch--------	61	
						American basswood---	65	
						Black cherry--------	---	
						American beech------	---	
MnB, MnC---------- Menominee	Slight	Slight	Moderate	Slight	Moderate	Sugar maple---------	61	Red pine, black walnut.
						Quaking aspen-------	---	
						Red pine----------	---	
						Silver maple--------	---	
						Paper birch---------	---	
						Yellow birch--------	---	
						American basswood---	---	
						Black cherry--------	---	
MoC*:								

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
MtE---------- Montcalm	Moderate	Moderate	Moderate	Slight	Moderate	Sugar maple--------- Quaking aspen------- Northern red oak---- Eastern white pine-- Red pine----------	61 --- 66 61 61	Red pine, eastern white pine, Austrian pine, jack pine, white spruce.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
Wn*:								
Winterfield	Slight	Slight	Moderate	Slight	Slight	Quaking aspen	60	White spruce, eastern white pine, black spruce, northern white-cedar.
						Yellow birch	53	
						White spruce	53	
						White ash	55	
						Balsam fir	53	
						Black spruce	32	
						Eastern white pine	53	
Evart	Slight	Severe	Severe	Severe	Severe	Quaking aspen	45	Northern white-cedar, black spruce, eastern white pine.
						American basswood	---	
						Northern white-cedar	---	
						Black spruce	---	
						Swamp white oak	---	

* See map unit description for the composition and behavior of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; the symbol > means greater than. Absence of an entry means that trees of the height class do not normally grow on this soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
AuA---------- Au Gres	---	White spruce, silky dogwood, American cranberrybush, blue spruce, Amur privet.	Black spruce, northern white-cedar, eastern white pine, Austrian pine.	---	Green ash, Carolina poplar, white ash.
Br. Brevort					
Co---------- Colonville	---	White spruce, silky dogwood, Amur honeysuckle, whitebelle honeysuckle, Amur privet, blue spruce.	Eastern white pine, tall purple willow, northern white-cedar, black spruce.	---	Green ash, Carolina poplar.
CrB---------- Croswell	Vanhoutte spirea	Lilac, arrowwood, white spruce, Amur privet, blue spruce, autumn-olive.	American mountainash, eastern white pine.	Red pine, jack pine, Scotch pine.	---
GaA---------- Gladwin	---	White spruce, black spruce, American cranberrybush, Amur honeysuckle, blue spruce, Amur privet, silky dogwood.	Northern white-cedar, Siberian crabapple, tall purple willow.	Eastern white pine	Green ash.
GrB, GrC, GrD----- Graycalm	Vanhoutte spirea	White spruce, lilac, arrowwood, blue spruce, Amur privet.	Red pine, jack pine, eastern white pine, northern pin oak, Norway spruce.	---	Carolina poplar.
GyB, GyC, GyD----- Grayling	Vanhoutte spirea	Lilac, autumn-olive, Amur privet, white spruce.	Jack pine, eastern white pine, red pine.	---	---
Hs*. Histosols					
IkA*:					
Iosco----------	---	White spruce, Amur honeysuckle, Amur privet, blue spruce, silky dogwood.	Black spruce, northern white-cedar.	Eastern white pine	White ash, green ash.
Kawkawlin---------	Vanhoutte spirea	White spruce, blue spruce, arrowwood, lilac, Tatarian honeysuckle.	Red pine, Scotch pine, jack pine.	Eastern white pine	Red maple, Carolina poplar.
KwB---------- Kawkawlin	Vanhoutte spirea	White spruce, blue spruce, arrowwood, lilac, Tatarian honeysuckle.	Red pine, Scotch pine, jack pine.	Eastern white pine	Red maple, Carolina poplar.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Lg*:					
Loxley	---	Black spruce, silky dogwood, arrowwood, Amur privet, white spruce.	Eastern white pine	Northern white-cedar.	Carolina poplar.
Greenwood	---	Black spruce, silky dogwood, arrowwood, Amur privet, white spruce.	Eastern white pine, Norway spruce.	Northern white-cedar.	Carolina poplar.
Lu Lupton	---	Black spruce, silky dogwood, Amur privet, white spruce.	Austrian pine, nannyberry viburnum.	Scotch pine, eastern white pine, northern white-cedar.	Green ash, Carolina poplar.
MaB, MaC Mancelona	Vanhoutte spirea	White spruce, lilac, Amur honeysuckle, blue spruce, Amur privet.	Red pine, jack pine, Scotch pine, eastern white pine, Norway spruce.	---	Carolina poplar.
Mb Markey	---	Silky dogwood, white spruce, Amur privet.	Austrian pine, eastern white pine.	Scotch pine, northern white-cedar.	Carolina poplar, green ash.
McB, McC McBride	Vanhoutte spirea	White spruce, Amur privet, lilac, silky dogwood.	Hawthorn, jack pine, red pine, black spruce, northern white-cedar.	Eastern white pine	Green ash.
MeB Melita	---	Autumn-olive, Amur honeysuckle, white spruce, blue spruce, lilac, Amur privet.	Red pine, jack pine, Scotch pine, eastern white pine, black spruce.	---	Carolina poplar.
MnB, MnC Menominee	---	Amur honeysuckle, white spruce, blue spruce.	Red pine, jack pine.	---	Red maple.
MoC*:					
Menominee	---	Amur honeysuckle, white spruce, blue spruce.	Red pine, jack pine.	---	Red maple.
Montcalm	Vanhoutte spirea	White spruce, Siberian crabapple, nannyberry viburnum, blue spruce, lilac, Amur honeysuckle, autumn-olive, Amur privet.	Red pine, Scotch pine.	---	Carolina poplar.
MtB, MtC, MtD, MtE Montcalm	Vanhoutte spirea	White spruce, Siberian crabapple, nannyberry viburnum, blue spruce, lilac, Amur honeysuckle, autumn-olive, Amur privet.	Red pine, Scotch pine.	---	Carolina poplar.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
NeB, NeC, NeD: Nester	Vanhoutte spirea	Arrowwood, lilac, blue spruce, white spruce, Amur privet.	Red pine, Scotch pine, northern pin oak, jack pine.	Eastern white pine	Carolina poplar.
OtA: Otisco	---	Silky dogwood	Black spruce, northern white-cedar, tall purple willow.	Red maple	Carolina poplar, white ash.
Pt*. Pits					
Rn. Rondeau					
Ro: Roscommon	---	Arrowwood, hawthorn, Amur privet, nannyberry viburnum, silky dogwood, tamarack, whitebelle honeysuckle.	Eastern white pine, black spruce, northern white-cedar.	---	Carolina poplar.
RuB, RuC: Rubicon	Vanhoutte spirea	Autumn-olive, Amur privet, lilac, white spruce.	Hawthorn	Red pine, eastern white pine, jack pine.	---
Sm: Sims	---	Austrian pine, hawthorn, silky dogwood, white spruce.	Black spruce, northern white-cedar, eastern white pine, green ash.	---	---
UbB: Ubly	---	White spruce, arrowwood, lilac, silky dogwood, blue spruce, autumn-olive, Amur privet.	Red pine, Norway spruce, Scotch pine.	---	Red maple, Carolina poplar.
Wh: Wheatley	---	Silky dogwood, white spruce, Tatarian honeysuckle, arrowwood, Amur honeysuckle.	Northern white-cedar, tall purple willow, eastern white pine, black spruce, Norway spruce.	---	Green ash, Carolina poplar.
Wn*:					
Winterfield	---	White spruce, Amur privet, silky dogwood, Amur honeysuckle, blue spruce.	Black spruce, northern white-cedar.	Eastern white pine	Red maple, Carolina poplar, green ash.
Evart	---	Tatarian honeysuckle	Eastern white pine, northern	---	---

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
AuA---------- Au Gres	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Br---------- Brevort	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, floods.
Co---------- Colonville	Severe: floods, wetness, cutbanks cave.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, frost action, wetness.
CrB---------- Croswell	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
GaA---------- Gladwin	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
GrB---------- Graycalm	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight.
GrC---------- Graycalm	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
GrD---------- Graycalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
GyB---------- Grayling	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight.
GyC---------- Grayling	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
GyD---------- Grayling	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hs*. Histosols					
IkA*:					
Iosco----------	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
Kawkawlin---------	Severe: wetness.	Severe: wetness, low strength.	Severe: wetness.	Severe: wetness, low strength.	Severe: frost action, low strength, wetness.
KwB---------- Kawkawlin	Severe: wetness.	Severe: wetness, low strength.	Severe: wetness.	Severe: wetness, low strength.	Severe: frost action, low strength, wetness.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without	Dwellings with	Small commercial	Local roads and streets

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
NeB---------- Nester	Moderate: too clayey.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength, slope.	Severe: low strength.
NeC---------- Nester	Moderate: too clayey, slope.	Moderate: low strength, shrink-swell, slope.	Moderate: shrink-swell, slope, low strength.	Severe: slope.	Severe: low strength.
NeD---------- Nester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
OtA---------- Otisco	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Pt*. Pits					
Rn---------- Rondeau	Severe: wetness, excess humus, floods.	Severe: floods, wetness, low strength.	Severe: floods, low strength, wetness.	Severe: floods, low strength, wetness.	Severe: floods, low strength, wetness.
Ro---------- Roscommon	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
RuB---------- Rubicon	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight.
PuC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 10.--SANITARY FACILITIES

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils. Absence of an entry means soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
AuA---------- Au Gres	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: too sandy, wetness, seepage.
Br---------- Brevort	Severe: wetness, percs slowly, floods.	Severe: wetness, seepage, floods.	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Poor: wetness.
Co---------- Colonville	Severe: floods, wetness.	Severe: seepage, floods, wetness.	Severe: seepage, floods, wetness.	Severe: seepage, floods, wetness.	Poor: too sandy, wetness, seepage.
CrB---------- Croswell	Severe: wetness.	Severe: seepage,	Severe: seepage,	Severe: seepage,	Poor: too sandy,

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
MtD, MtE---------- Montcalm	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage, slope.	Poor: slope, too sandy, seepage.
NeB---------- Nester	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
NeC---------- Nester	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
NeD---------- Nester	Severe: percs slowly, slope.	Severe: slope.	Moderate: too clayey, slope.	Severe: slope.	Poor: slope.
OtA---------- Otisco	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Fair: too sandy, seepage, wetness.
Pt*. Pits					
Rn---------- Rondeau	Severe: wetness, floods, percs slowly.	Severe: floods, seepage, wetness.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness, excess humus.
Ro---------- Roscommon	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy, seepage.
RuB---------- Rubicon	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
RuC---------- Rubicon	Moderate: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
Sm---------- Sims	Severe: wetness, percs slowly, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
UbB---------- Ubly	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
Wh---------- Wheatley	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy, small stones.
Wn*:					
Winterfield---------	Severe: wetness, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: too sandy, wetness, seepage.
Evart----------	Severe: wetness, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: too sandy, wetness, seepage.

* See map unit description for the composition and behavior of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
MaC: Mancelona	Good	Good	Good	Fair: too sandy, slope.
Mb: Markey	Poor: low strength, wetness.	Fair: excess fines.	Unsuited: excess fines, excess humus.	Poor: excess humus, wetness.
McB: McBride	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer.
McC: McBride	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
MeB: Melita	Fair: thin layer.	Fair: thin layer.	Unsuited: excess fines.	Poor: too sandy.
MnB: Menominee	Poor: thin layer.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy.
MnC: Menominee	Poor: thin layer.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy, slope.
MoC*:				
Menominee	Poor: thin layer.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy, slope.
Montcalm	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer, slope.
MtB: Montcalm	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer.
MtC: Montcalm	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer, slope.
MtD, MtE: Montcalm	Fair: slope.	Fair: excess fines.	Unsuited: excess fines.	Poor: slope.
NeB: Nester	Poor: low strength.	Poor: thin layer.	Unsuited: excess fines.	Fair: thin layer.
NeC: Nester	Poor: low strength.	Poor: thin layer.	Unsuited: excess fines.	Fair: slope, thin layer.
NoD	Poor:	Poor:	Unsuited:	Poor:

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ro---------- Roscommon	Poor: wetness.	Good----------	Unsuited: excess fines.	Poor: wetness, too sandy.
RuB, RuC---------- Rubicon	Good----------	Good----------	Unsuited: excess fines.	Poor: too sandy.
Sm---------- Sims	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
UbB---------- Ubly	Poor: low strength.	Poor: thin layer.	Unsuited: excess fines.	Good.
Wh---------- Wheatley	Poor: wetness.	Good----------	Good----------	Poor: wetness.
Wn*:				
Winterfield----------	Poor: wetness.	Good----------	Unsuited: excess fines.	Fair: too sandy.
Evart----------	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: wetness.

* See map unit description for the composition and behavior of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Soil name and map symbol	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Terraces and diversions	Grassed waterways
AuA---------- Au Gres	Seepage, wetness.	Favorable------	Favorable------	Fast intake, droughty, wetness.	Not needed-----	Droughty, wetness.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Lg*:						
Greenwood	Excess humus, wetness.	Favorable	Floods, frost action.	Wetness, floods, soil blowing.	Not needed	Wetness.
Lu Lupton	Excess humus, wetness.	Favorable	Floods, frost action.	Wetness, soil blowing, floods.	Not needed	Wetness.
MaB Mancelona	Seepage, piping.	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
MaC Mancelona	Seepage, piping.	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Slope, droughty.
Mb Markey	Seepage, wetness, excess humus.	Slow refill	Floods, excess humus, frost action.	Wetness, soil blowing, floods.	Not needed	Wetness.
McB McBride	Wetness	Deep to water, slow refill.	Percs slowly	Droughty, wetness, soil blowing.	Wetness, rooting depth.	Wetness, droughty.
McC McBride	Wetness	Deep to water, slow refill.	Percs slowly, slope.	Droughty, wetness, soil blowing.	Wetness, rooting depth.	Wetness, slope, droughty.
MeB Melita	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
MnB Menominee	Wetness, seepage.	Deep to water, slow refill.	Favorable	Droughty, fast intake, wetness.	Wetness, too sandy, soil blowing.	Droughty.
MnC Menominee	Seepage	No water	Not needed	Droughty, soil blowing, fast intake.	Soil blowing, too sandy.	Slope, droughty.
MoC*:						
Menominee	Seepage	No water	Not needed	Droughty, soil blowing, fast intake.	Soil blowing, too sandy.	Slope, droughty.
Montcalm	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Droughty, slope.
MtB Montcalm	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
MtC Montcalm	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty, slope.
MtD, MtE Montcalm	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Droughty, slope.
NeB Nester	Favorable	No water	Not needed	Favorable	Favorable	Favorable.
NeC Nester	Favorable	No water	Not needed	Slope, erodes easily, percs slowly.	Favorable	Slope.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Terraces and diversions	Grassed waterways
NeD---------- Nester	Favorable------	No water-------	Not needed-----	Slope, erodes easily, percs slowly.	Slope----------	Slope.
OtA---------- Otisco	Seepage, wetness.	Favorable------	Favorable------	Fast intake, wetness, droughty.	Not needed-----	Wetness, droughty.
Pt*. Pits						
Rn---------- Rondeau	Excess humus, wetness.	Slow refill----	Floods, frost action.	Wetness, percs slowly, floods.	Not needed-----	Wetness, percs slowly.
Ro---------- Roscommon	Seepage, wetness.	Favorable------	Floods---------	Wetness, droughty, fast intake.	Not needed-----	Wetness, droughty.
RuB---------- Rubicon	Seepage--------	No water-------	Not needed-----	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
RuC---------- Rubicon	Seepage--------	No water-------	Not needed-----	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty, slope.
Sm---------- Sims	Wetness--------	Slow refill----	Percs slowly, floods, frost action.	Wetness, percs slowly, floods.	Not needed-----	Wetness, percs slowly.
UbB---------- Ubly	Favorable------	No water-------	Not needed-----	Soil blowing---	Soil blowing, too sandy.	Favorable.
Wh	Seepage	Favorable	Floods	Wetness	Not needed	Wetness

TABLE 13.--RECREATIONAL DEVELOPMENT

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
AuA---------- Au Gres	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, too sandy.
Br---------- Brevort	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
Co---------- Colonville	Severe: wetness, floods.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness, floods.
CrB---------- Croswell	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
GaA---------- Gladwin	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.
GrB---------- Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
GrC---------- Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
GrD---------- Graycalm	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.
GyB---------- Grayling	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
GyC---------- Grayling	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
GyD---------- Grayling	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.
Hs*. Histosols				
IkA*:				
Iosco----------	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.
Kawkawlin----------	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
KwB---------- Kawkawlin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Lg*:				
Loxley----------	Severe: floods, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.	Severe: wetness, excess humus.

See footnote at end of table.

TABLE 13.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails

TABLE 13.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
NeC: Nester	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
NeD: Nester	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
OtA: Otisco	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, too sandy.
Pt*. Pits				
Rn: Rondeau	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
Ro: Roscommon	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
RuB: Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
RuC: Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
Sm: Sims	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
UbB: Ubly	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.
Wh: Wheatley	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
Wn*:				
Winterfield	Severe: floods, wetness.	Moderate: floods, wetness, too sandy.	Severe: wetness, floods.	Moderate: wetness, too sandy, floods.
Evart	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.

* See map unit description for the composition and behavior of the map unit.

TABLE 14.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
AuA---------- Au Gres	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Fair	Poor	Very poor.
Br---------- Brevort	Very poor.	Poor	Poor	Poor	Poor	Fair	Good	Poor	Poor	Fair.
Co---------- Colonville	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
CrB---------- Croswell	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
GaA---------- Gladwin	Poor	Fair	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor.
GrB, GrC---------- Graycalm	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
GrD---------- Graycalm	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
GyB---------- Grayling	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
GyC---------- Grayling	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
GyD---------- Grayling	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Hs*. Histosols										
IkA*:										
Iosco----------	Poor	Fair	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
Kawkawlin----------	Fair	Good	Good	Good	Good	Good	Fair	Good	Good	Fair.
KwB---------- Kawkawlin	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Lg*:										
Loxley----------	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Greenwood----------	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Lu---------- Lupton	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
MaB, MaC---------- Mancelona	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Mb---------- Markey	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
McB---------- McBride	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Fair	Poor	Very poor.
McC---------- McBride	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.

See footnote at end of table.

TABLE 14.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain	Grasses	Wild herbs	Hardwood	Conif	Wetland	Shallow	Openland	Woodland	Wetland

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
AuA---------- Au Gres	0-13	Loamy sand------	SM, SP-SM	A-2-4	0	95-100	90-100	50-75	10-25	---	NP
	13-21	Sand, loamy sand	SP-SM, SP, SM	A-2-4, A-3	0	95-100	90-100	60-80	0-15	---	NP
	21-60	Sand----------	SP, SP-SM	A-3, A-2-4	0	95-100	90-100	50-80	0-10	---	NP
Br---------- Brevort	0-8	Loamy sand------	SP, SM, SP-SM	A-2-4, A-3	0-5	95-100	95-100	50-75	0-30	---	NP
	8-31	Sand, loamy sand, loamy fine sand.	SP, SM, SP-SM	A-2-4, A-3	0-5	95-100	95-100	50-75	0-30	<20	NP-4
	31-60	Silt loam, clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	55-95	17-45	4-22
Co---------- Colonville	0-17	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	100	60-85	30-55	10-20	NP-6
	17-60	Fine sandy loam, gravelly sand, sand.	SM, ML, CL, SC, SP, SP-SM	A-2, A-4, A-1, A-3	0-2	90-100	80-100	45-90	0-65	<30	NP-10
CrB---------- Croswell	0-7	Sand----------	SP-SM, SM	A-3, A-2-4	0	100	95-100	50-70	5-25	---	NP
	7-29	Sand----------	SP-SM, SM	A-3, A-2-4	0	100	95-100	50-70	5-25	---	NP
	29-60	Sand----------	SP-SM, SM	A-3, A-2-4	0	100	95-100	50-70	5-25	---	NP
GaA---------- Gladwin	0-11	Loamy sand------	SM, SP-SM	A-1, A-2, A-3	0-5	90-100	65-95	45-70	5-30	<20	NP-4
	11-22	Sand, loamy sand	SM, SP-SM	A-1, A-2, A-3	0-5	90-100	65-95	45-70	5-30	<20	NP-4

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
IkA*:											
Iosco	0-6	Loamy sand	SM	A-2-4	0	95-100	95-100	50-70	15-30	---	NP
	6-30	Loamy sand, sand	SM, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	5-30	<20	NP-4
	30-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-4, A-6	0	95-100	95-100	90-100	65-95	20-40	5-25
Kawkawlin	0-21	Sandy loam	SM, SC, SM-SC	A-2	0-3	95-100	90-100	55-70	20-35	<30	NP-9
	21-31	Clay loam, silty clay loam	CL, CH	A-6, A-7	0-3	95-100	90-100	85-100	60-90	25-55	11-30

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
MnB, MnC---------- Menominee	0-11	Loamy sand------	SM, SP-SM	A-2-4	0	95-100	95-100	50-75	10-30	---	NP
	11-23	Sand, loamy sand, sandy loam.	SP, SM, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	0-15	---	NP
	23-60	Clay loam, loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-10	85-95	85-95	80-95	60-90	25-40	5-20
MoC*:											
Menominee----------	0-11	Loamy sand------	SM, SP-SM	A-2-4	0	95-100	95-100	50-75	10-30	---	NP
	11-23	Sand, loamy sand, sandy loam.	SP, SM, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	0-15	---	NP
	23-60	Clay loam, loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-10	85-95	85-95	80-95	60-90	25-40	5-20
Montcalm----------	0-7	Loamy sand------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	7-21	Loamy sand, sand	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	21-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	90-100	50-80	10-35	---	NP
MtB, MtC, MtD, MtE- Montcalm	0-7	Loamy sand------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	7-21	Loamy sand, sand	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	21-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	90-100	50-80	10-35	---	NP
NeB, NeC, NeD------ Nester	0-10	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	80-100	55-80	25-40	2-15
	10-38	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-100	65-90	35-60	15-30
	38-60	Clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	95-100	90-100	65-90	30-45	10-20
OtA---------- Otisco	0-11	Loamy sand------	SM, SP-SM, SC, SM-SC	A-2, A-3	0	95-100	95-100	50-75	5-30	<20	NP-10
	11-28	Loamy sand, sand	SM, SP-SM, SC, SM-SC	A-2, A-3	0	95-100	95-100	50-75	5-30	<20	NP-10

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Sm---------- Sims	0-9	Clay loam--------	CL	A-6	0-5	95-100	90-100	85-90	65-85	26-40	12-20
	9-28	Clay loam, silty clay loam.	CL, CH	A-6, A-7	0-5	95-100	90-100	90-95	65-85	36-55	15-28
	28-60	Clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	90-95	70-85	32-45	14-24
UbB---------- Ubly	0-7	Sandy loam-------	SM, SM-SC	A-2, A-4	0-3	95-100	90-95	55-70	25-40	<28	2-7
	7-24	Sandy loam, loamy sand, loam.	SP-SM, SM, SM-SC, SC	A-1, A-2, A-4	0-3	90-100	85-95	40-75	10-40	<30	NP-8
	24-31	Sandy clay loam, clay loam, loam.	SC, CL	A-6	1-5	95-100	90-100	75-100	35-90	20-40	10-25
	31-60	Loam, clay loam, silty clay loam.	CL	A-6	1-5	95-100	90-100	80-100	55-90	20-40	10-25
Wh---------- Wheatley	0-8	Loamy sand-------	SM, SP-SM	A-2-4, A-1-b	0-5	85-95	80-95	45-75	10-30	---	NP
	8-40	Gravelly sand, gravelly loamy sand, sand.	SM, SP-SM	A-2-4, A-1-b	0-5	85-95	80-90	40-60	10-20	---	NP
	40-60	Stratified gravel to sand.	GW, SW, GP, SP	A-1	5-10	20-80	20-80	20-40	0-5	---	NP
Wn*:											
Winterfield--------	0-7	Loamy sand-------	SM	A-2-4, A-4	0	100	95-100	50-90	15-45	---	NP
	7-31	Sand, loamy sand, loamy	SM, SP-SM	A-2-4, A-3,	0	100	95-100	50-90	5-45	---	NP

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means greater than. The erosion tolerance factor (T) is for the entire profile. Wind erodibility group is for the surface layer. Absence of an entry means data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
AuA---------- Au Gres	0-13	6.0-20	0.07-0.09	4.5-7.3	Low----------	0.15	5	2
	13-21	6.0-20	0.06-0.09	4.5-7.3	Low----------	0.15		
	21-60	>20	0.05-0.07	5.1-6.0	Low----------	0.15		
Br---------- Brevort	0-8	6.0-20	0.07-0.12	5.6-7.8	Low----------	0.17	5	2
	8-31	6.0-20	0.06-0.11	6.1-7.8	Low----------	0.17		
	31-60	0.2-0.6	0.14-0.22	7.4-8.4	Moderate------	0.43		
Co---------- Colonville	0-17	2.0-6.0	0.13-0.18	6.6-8.4	Low----------	0.20	5	3
	17-60	2.0-20	0.02-0.12	7.9-8.4	Low----------	0.15		
CrB---------- Croswell	0-7	6.0-20	0.07-0.09	4.5-6.0	Low----------	0.15	5	1
	7-29	6.0-20	0.06-0.08	5.1-6.5	Low----------	0.15		
	29-60	>20	0.05-0.07	5.6-7.3	Low----------	0.15		
GaA---------- Gladwin	0-11	6.0-20	0.06-0.12	6.1-7.8	Low----------	0.17	4	1
	11-22	6.0-20	0.05-0.11	6.1-7.8	Low----------	0.17		
	22-29	2.0-6.0	0.05-0.13	6.1-7.8	Low----------	0.17		
	29-60	>20	0.02-0.04	7.9-8.4	Low----------	0.10		
GrB, GrC, GrD---- Graycalm	0-3	6.0-20	0.04-0.10	4.5-6.5	Low----------	0.15	5	1
	3-22	6.0-20	0.05-0.10	4.5-6.5	Low----------	0.15		
	22-60	6.0-20	0.04-0.09	4.5-6.5	Low----------	0.15		
GyB, GyC, GyD---- Grayling	0-19	>20	0.05-0.09	4.5-5.0	Low----------	0.15	5	1
	19-60	>20	0.04-0.06	5.1-6.5	Low----------	0.15		
Hs*. Histosols								
IkA*:								
Iosco----------	0-6	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2
	6-30	6.0-20	0.06-0.11	5.1-6.5	Low----------	0.17		
	30-60	0.2-0.6	0.14-0.20	6.1-7.8	Moderate------	0.37		
Kawkawlin--------	0-21	2.0-6.0	0.12-0.15	5.1-7.3	Low----------	0.24	5	3
	21-31	0.2-0.6	0.10-0.20	5.1-7.8	Moderate------	0.32		
	31-60	0.2-0.6	0.13-0.20	7.9-8.4	Moderate------	0.32		
KwB---------- Kawkawlin	0-6	0.6-2.0	0.20-0.24	5.1-7.3	Low----------	0.32	5	6
	6-24	0.2-0.6	0.10-0.20	5.1-7.8	Moderate------	0.32		
	24-60	0.2-0.6	0.13-0.20	7.9-8.4	Moderate------	0.32		
Lg*:								
Loxley----------	0-13	0.6-6.0	0.45-0.55	<5.5	----------	---	---	3
	13-60	0.2-6.0	0.35-0.45	<5.5	----------	---		
Greenwood--------	0-6	>6.0	0.55-0.65	3.6-4.4	High----------	---	---	3
	6-60	0.6-6.0	0.45-0.55	3.6-4.4	High----------	---		
Lu---------- Lupton	0-60	0.2-6.0	0.35-0.45	6.6-7.8	----------	---	---	3
MaB, MaC---------- Mancelona	0-5	2.0-6.0	0.10-0.12	5.6-6.5	Low----------	0.17	4	2
	5-18	6.0-20	0.06-0.12	5.6-7.8	Low----------	0.17		
	18-27	2.0-6.0	0.06-0.16	6.1-7.8	Low----------	0.17		
	27-60	>20	0.02-0.04	7.4-8.4	Low----------	0.10		
Mb---------- Markey	0-32	0.2-6.0	0.35-0.45	5.6-7.8	----------	---	---	3
	32-60	6.0-20	0.03-0.08	6.1-8.4	Low----------	---		

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
McB, McC---------- McBride	0-15	2.0-6.0	0.10-0.15	4.5-7.3	Low----------	0.24	3	3
	15-30	0.06-0.2	0.02-0.04	5.1-6.5	Low----------	0.24		
	30-38	0.06-0.2	0.02-0.04	5.1-6.5	Low----------	0.24		
	38-60	0.2-0.6	0.03-0.05	5.1-7.3	Low----------	0.24		
MeB---------- Melita	0-53	>20	0.04-0.08	5.1-7.3	Low----------	0.15	5	1
	53-57	0.2-2.0	0.14-0.19	6.1-7.3	Low----------	0.32		
	57-60	0.2-0.6	0.13-0.18	7.4-8.4	Low----------	0.32		
MnB, MnC---------- Menominee	0-11	6.0-20	0.08-0.12	5.1-6.5	Low----------	0.17	5	2
	11-23	6.0-20	0.04-0.10	5.1-6.5	Low----------	0.17		
	23-60	0.2-0.6	0.14-0.18	5.6-7.8	Moderate------	0.32		
MoC*:								
Menominee--------	0-11	6.0-20	0.08-0.12	5.1-6.5	Low----------	0.17	5	2
	11-23	6.0-20	0.04-0.10	5.1-6.5	Low----------	0.17		
	23-60	0.2-0.6	0.14-0.18	5.6-7.8	Moderate------	0.32		
Montcalm---------	0-7	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2
	7-21	6.0-20	0.06-0.10	5.1-6.5	Low----------	0.17		
	21-60	6.0-20	0.04-0.13	5.1-6.5	Low----------	0.17		
MtB, MtC, MtD, MtE----------	0-7	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2

TABLE 17.--SOIL AND WATER FEATURES

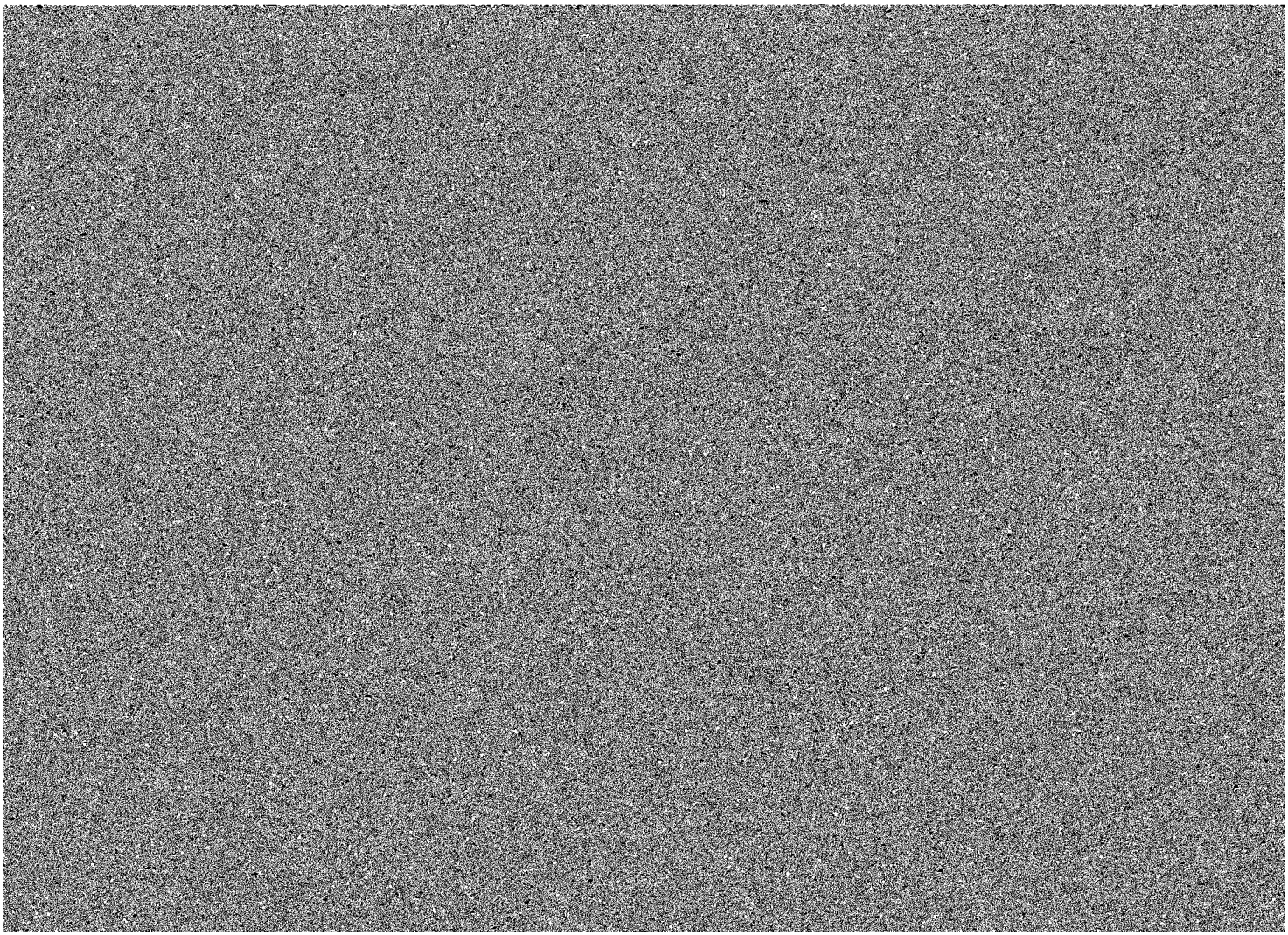
[Absence of an entry indicates the feature is not a concern. See text for descriptions of symbols and such terms as "rare," "brief," and "perched." The symbol > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
MtB, MtC, MtD, MtE---------- Montcalm	A	None--------	---	---	>6.0	---	---	Low------	Low------	Moderate.
NeB, NeC, NeD----- Nester	C	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
OtA---------- Otisco	A	None--------	---	---	0.5-1.5	Apparent	Nov-May	Moderate	Low------	Moderate.
Pt*. Pits										
Rn---------- Rondeau	D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Jan-Dec	High-----	High-----	Low.
Ro---------- Roscommon	A/D	Frequent----	Brief-----	Sep-May	0-1.0	Apparent	Sep-Jun	Moderate	High-----	Low.
RuB, RuC---------- Rubicon	A	None--------	---	---	>6.0	---	---	Low------	Low------	High.
Sm---------- Sims	D	Frequent----	Brief-----	Mar-May	0-1.0	Apparent	Nov-May	High-----	High-----	Low.
UbB---------- Ubly	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Wh---------- Wheatley	A/D	Frequent----	Long------	Nov-Apr	0-1.0	Apparent	Oct-May	Moderate	High-----	Low.
Wn*:										
Winterfield------	A/D	Frequent----	Brief-----	Nov-May	1.0-2.0	Apparent	Nov-May	Moderate	Low------	Low.
Evart----------	D	Frequent----	Long------	Nov-Jun	0-1.0	Apparent	Nov-Jun	Moderate	High-----	Low.

* See map unit description for the composition and behavior of the map unit.



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